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# Proceedings of the 2018 Connected Learning Summit

August 1-3, 2018, MIT Media Lab, Cambridge, MA

Edited by Jeremiah H. Kalir

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# Contents

## Part Two: Abstracts

## From the Editor

Welcome to the *Proceedings of the 2018 Connected Learning Summit*. We hope that while reading these proceedings, you come to regard this significant document as more than the careful curation of 217 conference presentations. Rather, we expect that many who read this will appreciate how these proceedings represent a groundswell of innovation among leading researchers, educators, and technology developers—all of whom were associated with the inaugural Connected Learning Summit.

As an exciting and much-anticipated synthesis among the Digital Media and Learning Conference, the Games+Learning+Society Conference, and the Sandbox Summit, the Connected Learning Summit emerged in 2018 to fuel a growing movement of innovators who are harnessing emerging technology and expanding access to participatory, playful, and creative learning. The first Connected Learning Summit—attended by more than 700 people at the Massachusetts Institute of Technology in August 2018—was an inspired gathering that fostered cross-sector connections and catalytic innovation among interdisciplinary leaders working across diverse learning environments. Amid many highlights of the summit, we share a special shout-out to keynote speakers Michelle King and Baratunde Thurston; your wit and insight galvanized our community, and we are sincerely grateful for your passion and presence.

Similar to the summit, this *Proceedings of the 2018 Connected Learning Summit* is the result of collaboration among many dedicated people. First and foremost, our thanks to all the participants who attended the summit, presented their research and technologies, shared their stories, and helped ensure a successful start to a new chapter in the storied history of these scholarly communities. The Connected Learning Summit Conference Committee has been most gracious and instructive in helping to guide this first-ever proceedings forward to publication. Furthermore, this proceedings would not have come together without dedicated assistance from Claudia Caro Sullivan, Jamieson Pond, and Karen Bleske. And, of course, we thank the team at Carnegie Mellon University's ETC Press, and in particular Drew Davidson and Brad King, for producing our proceedings as an attractive and open-access publication.

As you enjoy the *Proceedings of the 2018 Connected Learning Summit*, remember to mark your calendars as the 2019 Connected Learning Summit will be held October 2–5 at the University of California Irvine. Visit http://connectedlearningsummit.org/ for more information and to stay updated with all Connected Learning Summit announcements. We hope you join us at the second Connected Learning Summit, and that your leadership and innovation continue to advance equitable, creative, and connected learning.

On behalf of the proceedings team,
Jeremiah (Remi) Kalir, Editor

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# Part One: Research Papers

# Game-Based Learning With Direct Representation of Mathematics

**Sara Atienza (WestEd), Bryan Matlen (WestEd), Keith Devlin (BrainQuake), and Randy Weiner (BrainQuake)**

**Abstract:** Symbolic representations in mathematics (e.g., equations) are powerful and essential for more advanced mathematical thinking, but they cause major problems for K–8 learners. To engage mathematical reasoning without symbolic representations, BrainQuake has created diagrammatic mathematics puzzle games that provide an alternative, more learner-friendly interface to mathematical thinking and multistep problem solving. In this working paper, we first outline the design underlying BrainQuake's puzzle games, and we provide preliminary evidence that they can be used effectively in classroom settings. The latter part of this paper outlines a randomized control study—currently in progress—examining how BrainQuake's suite of puzzle games impacts students' mathematics achievement and attitudes. The results of the randomized trial will be presented at the conference. This work on the whole provides a concrete illustration of how understanding of deeper cognitive processing can be leveraged to design learning games that effectively support students in reasoning in mathematics.

## Introduction

Many K–12 students fail to realize their true mathematics potential, cutting them off from a wide variety of college majors and rewarding careers. This occurs at such a scale that it leads to a national skill shortage as well as limiting the individual student. BrainQuake designs and builds web and mobile learning puzzle games (for both classroom and home use) that solve three widespread and pervasive obstacles to the good mathematics learning that can improve students' mathematical proficiency.

Students face many obstacles when learning mathematics in formal educational settings. The first is the *symbol barrier* (Devlin, 2011): namely, that mathematical symbols inherit a grammatical structure that supports mathematical thinking, but that learning to use these symbols has been known to cause major problems for K–8 learners (Devlin, 2011; Nunes, Carraher, & Schliemann, 1993). They also create a barrier that prevents individuals (particularly from more impoverished backgrounds) who lack the appropriate literacies from recognizing that they have the capacity for mathematical thinking, with the result that they do not make the effort that would lead to success. Keith Devlin has called this problem—which is one of language, not mathematics—the symbol barrier (Devlin, 2011).

The second obstacle is that there are no deep assessments that scale. Existing, scalable assessments mostly measure only what students have done, not how they did it. As a result, besides encouraging test prep (which unfairly favors students from more privileged backgrounds [College Board, 2013]), they miss the most valuable information: How did the student approach and think about the problem—even if they did not solve it?

Finally, the third obstacle is that students often carry a negative attitude toward mathematics. In some cases a definite math phobia (Tobias, 1995)—or a "fixed mindset" (Dweck, 2007) exists. Like the symbol barrier, negative attitudes and fixed mindsets are obstacles to good learning.

BrainQuake's solution to these obstacles is to design products to provide an alternative, more learner-friendly interface to mathematical thinking and (multistep) problem solving, providing a means to break the symbol barrier. This provides a direct solution to Obstacle 1, and solutions to Obstacles 2 and 3 follow automatically from the way we solve Problem 1 (Matlen, Atienza, & Cully, 2015). Because the game objects in BrainQuake's products provide direct representations of mathematical concepts, players solve problems within the game itself. (They manipulate game objects instead of symbols on a page.) This enables the game to track solutions in detail and provide dashboard feedback to students, teachers, and parents, not just on performance but on possibly unrecognized mathematical proficiency, providing opportunities for targeted interventions. Being provided with information that they can do math (when suitably presented), people may start to develop a more positive attitude toward the subject (Dweck, 2007). Shute and Ventura (2013) call this kind of tracking *stealth assessment,* and they make powerful use of it in their science-learning game *Newton's Playground.* The *Wuzzit Trouble (WT)* application (http://wuzzittrouble.com), available on iOS and Android platforms and in a browser version, is a puzzle game built on similar principles.

*WT*'s user interface (UI) is a representation of certain kinds of integer-arithmetic problems (integer partitions—the expression of a whole number as a sum of other whole numbers—and Diophantine equations) equivalent, but alternative, to the familiar symbolic algebra representation (trading in a static, spatial configuration of symbols for a dynamic interaction with a digital gears mechanism). The game was designed to develop number sense and general analytic problem-solving and optimization skills, while at the same time providing mathematically less-well-prepared players with practice of basic whole number skills.

Figure 1 shows just how big a difference a well-designed representation can make. In both cases, the "player" has to solve the problem, indeed by essentially the same sequence of steps. It is only the representations that are different. In addition to intimidating many students, the symbolic representation of the problem creates significant cognitive load, in large part because it is a static representation of an intrinsically dynamic process of solving a system of equations. In contrast, the representation on the left is dynamic. The player rotates either of the two small drive cogs (having four and six teeth, respectively) to rotate the large gearwheel. The object is to bring the keys (located at teeth 8 and 22) in line with the triangular marker at the top. (Simple puzzles have just one drive cog; more complicated puzzles have two, three, or four cogs.) Collecting all the keys in this manner releases the Wuzzit from the trap. A small cog may be wound up to rotate up to a set limit of times with a single player action. Maximum stars are obtained by releasing the Wuzzit with the fewest number of rotation actions, making optimization a key objective. What makes *WT* a powerful mathematics learning tool (i.e., not just arithmetic) is the complexity of the harder puzzles, for which optimizing the score requires sophisticated algorithmic reasoning. The fact that children as young as third grade can perform well on the easier puzzles, including children regarded as at remedial level (Pope & Mangram, 2015), confirms results from other research (e.g., Nunes et al., 1993) that when presented using a representation more efficient for learning, such reasoning is within the capacity of the average child.

Same Math, Different Representation

Collect the keys to free the Wuzzit

For maximum stars, use the least number of moves. For maximal points, collect the bonus items before you pick up the last key.

Solve the system of equations

$$
\begin{array}{ll}
4x_1 + 6y_1 = z_1 & \pmod{65} \\
4x_2 + 6y_2 = z_2 - z_1 & \pmod{65} \\
4x_3 + 6y_3 = z_3 - z_2 & \pmod{65} \\
\ldots \quad \ldots \quad \ldots & \\
4x_n + 6y_n = z_n - z_{n-1} & \pmod{65}
\end{array}
$$

subject to the constraints

$$0 \le x_i, y_i \le 5, \ \ x_i y_i = 0, \ \ 1 \le i \le n$$

so that 8, 22, 32, 46 are members of the trace set

$$
\begin{array}{l}
\{4i \mid 1 \le i \le x_1\} \cup \{6i \mid 1 \le i \le y_1\} \cup \\
\{z_1 + 4i \mid 1 \le i \le x_2\} \cup \{z_1 + 6i \mid 1 \le i \le y_2\} \cup \\
\{z_2 + 4i \mid 1 \le i \le x_3\} \cup \{z_2 + 6i \mid 1 \le i \le y_3\} \cup \\
\ldots \quad \ldots \quad \ldots \\
\{z_{n-1} + 4i \mid 1 \le i \le x_n\} \cup \{z_{n-1} + 6i \mid 1 \le i \le y_n\}
\end{array}
$$

For maximum stars, solve with $n$ minimal.

For maximal points, ensure that one of 8, 22 occurs in the final component of the trace set.

*Figure 1. Wuzzit Trouble (left) and underlying mathematics (right).*

## Theoretical Framework

Though mathematics is often thought of as a collection of techniques for manipulating abstract symbols, it is in fact a powerful way of thinking about problems and issues in the world. Recognizing this fact, BrainQuake, unlike the vast majority of math-game developers in the market, places the emphasis of math education, particularly in middle and high schools, on developing mathematical thinking. Once students are able to think conceptually about mathematics, basic math skills are more easily acquired and far better retained (Kilpatrick, Swafford, & Findell, 2001).

According to this approach, in order to build truly successful mathematics learning games, developers must separate the activity of doing mathematics—a form of thinking—from its familiar representation in terms of symbolic expressions. To do so, educators and educational game developers must go beyond thinking of video games as a medium that delivers traditional pedagogy—a canvas on which to pour symbols—and instead see them as an entirely new medium to represent mathematical concepts. Concrete representations (such as representations used in some learning games, including *WT*) and the abstract symbolic representations in mathematics present a tradeoff in learning (Goldstone & Son, 2005; Koedinger, Alibali, & Nathan, 2008). Though students learn more efficiently when initially using concrete representations (Resnick & Omanson, 1987), that knowledge is often less robust relative to when students learn from abstract representations (Kaminsky, Sloutsky, & Heckler, 2006).

BrainQuake's approach to mathematics education is based upon the five-interwoven-strands model recommended by the National Research Council's (NRC's) Year 2000 report *Adding It Up* (Kilpatrick et al., 2001). The five strands are: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. Devlin (2011) provides a lengthy, in-depth analysis of how good game design embodies all five strands. For successful education in this environment, the teacher has to understand both what is being taught (the math) and what is involved in learning math. Further, the student has to interact with both the math and the teacher. Most current pedagogic theory and practice is based on this model.

For classroom and class-related uses of BrainQuake products, BrainQuake completely reimagines this classroom learning framework by introducing the game as an element in pedagogic practice. The approach draws on two decades of thinking about how best to use digital games in formal education settings (e.g., Bransford & Schwartz, 1999). Specifically:

- Engage student preconceptions by drawing on the knowledge and experience that students bring to the classroom, but that are rarely activated in formal teaching and learning;
- Provide opportunities for students to experience discrepant events that allow them to build new knowledge and understanding on top of their existing models.

To make use of video games to provide experiential learning that meets the educational goals promoted by the NRC, BrainQuake relies on educational principles presented by Gee (2003). In Devlin (2011), BrainQuake's cofounder and chief scientist refined and extended Gee's general education principles for mathematics education. The most relevant lessons taken from those principles include:

- Interaction/Feedback: Games provide immediate feedback to player behavior, allowing the player to adjust and pursue new information in order to accomplish the goal.
- Risk Taking: Games reduce the consequences of failure, encouraging players to take risks, try new techniques, and learn from their mistakes.
- "Just in Time" and "On Demand": While people rarely learn effectively from information presented out of context, information presented when relevant is very likely to be retained. Just-in-time in-game instructions and hints can be presented to the player just when she approaches a new challenge.
- Performance Before Competence: In games, players can explore new, well-scaffolded tasks before they are fully competent.
- Personalized Learning: A real-time adaptive engine can present the player with learning challenges tuned to his current performance level.

## Feasibility Study

The design of *WT* is based on well-grounded learning theory. However, its ultimate value for mathematics learning rests upon its ability to be used in context by practicing teachers and students. Toward this goal, a feasibility study of *Wuzzit Trouble* was conducted in 2015 with 205 students, six teachers, two public schools. In the feasibility study, teachers were asked to use *WT* in their classrooms at least three times a week for 10 minutes a day during a two-week period. The study consisted of a mixed-methods (both qualitative and quantitative) approach that aimed to assess the feasibility of using *WT* in classroom contexts. The study was designed to explore the following questions:

- Does playing *WT* increase student learning and attitudes toward mathematics?
- What are teachers' impressions of *WT* and how do they implement *WT* in their classroom?

Teachers used *WT* double the minimum requirement for the study, averaging four days each week for 20 minutes each use. Teachers used a variety of implementation models for *WT*, including as a mathematical warm-up activity and as a translational activity integrated into the content of the mathematical lesson. Despite this variation, all participating teachers provided positive ratings toward questions of *WT*'s feasibility, for example, indicating that they found *WT* easy to use, helpful for supporting classroom lessons, and that they would use it again.

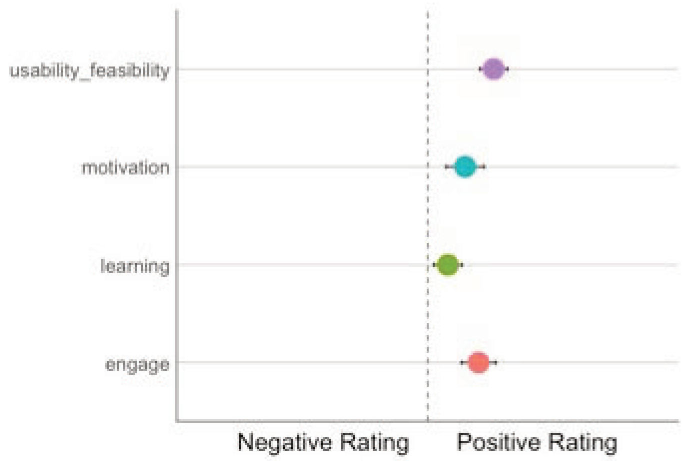


*Figure 2. Mean student response for each survey subscale. Dotted line indicates neutral response. Error bars represent 95% confidence intervals.*

Student ratings were assessed via a short Likert-response survey (see Figure 2). As can be seen in Figure 2, the students provided consistently positive findings across a range of subscales, including *WT*'s engagement (engage), usability/feasibility for classroom use (usability_feasibility), ability to improve motivation toward mathematics (motivation), and ability to support their mathematical learning (learning). All mean ratings were statistically different from a neutral rating in the positive direction ($p < .05$).

Overall, the 2015 feasibility study supports the conclusion that *WT* has strong potential for being an effective mathematics learning app that can be widely adopted for classroom use. Moreover, other independent studies of *WT* have shown similar findings, for instance, indicating that *WT* supports students' mathematical learning (Kiili, Devlin, Perttula, Tuomi, & Lindstedt, 2015; Pope & Mangram, 2015.)

## Pilot Study

Based on the positive findings of the feasibility study described above, BrainQuake has since developed two new games to assist students' mathematical reasoning. The new games are based in the same design theory as *WT*, but they target two additional areas of mathematics: algebraic and proportional reasoning. As with *WT*, the primary goal for the new puzzles is the development of (a) deep conceptual understanding (including number sense) and problem-solving capacity, (b) a positive disposition to mathematics, and (c) growth mindset.

Currently, we are conducting a randomized control study to explore the efficacy of the novel games. In the study, teachers are randomly assigned to either (a) use the games as a part of their mathematical lessons (treatment group), or (b) conduct mathematical lessons in the usual way, without the use of BrainQuake games (control group). This study is designed to address the following questions:

- Do BrainQuake products (henceforth referred to as the *BQ suite*) show promise for improving students' (a) mathematics achievement and (b) students' attitudes and beliefs toward mathematics, relative to a business-as usual-control group?
- Does the BQ suite show promise for supporting teachers' pedagogical content knowledge in mathematics?
- How feasible is the BQ suite for classroom implementation?

### Participants

Twenty-nine fifth- and sixth-grade teachers (15 control and 14 treatment) and approximately 812 students participated in the study. Participating schools came from rural, urban, and suburban school districts across California. Additional demographic information will be provided at the conference.

### Measures

Multiple measures of both students and teacher are collected, including demographic and baseline information about students' mathematical proficiency. The primary outcomes in the randomized study are students' performance on (a) a content knowledge assessment—which includes both multiple-choice and open-ended questions—and serves to assess students' mathematical understanding, and b) a survey of students' mathematical attitudes and dispositions. Moreover, teachers' pedagogical content knowledge (PCK) for mathematics will be assessed using the Learning Mathematics for Teaching (LMT) assessment, which has been shown to have a large and statistically significant effect on students' mathematics achievement (Ball, Hill, & Bass, 2005). Finally, classroom observations, teacher interviews, and student focus groups will allow us to determine the extent to which BrainQuake games were feasible for classroom use, and how they were implemented in the context of everyday classrooms.

## Data Analysis

Data collection will be completed by the end of January 2018. Analysis will be conducted and the findings will be presented at the 2018 CLS conference. Student and teacher surveys will be reverse coded and analyzed to determine whether usability, enjoyment, and feasibility questions differ from neutral responding—we will break down this analysis by socioeconomic status (SES) and gender. Usage data will help determine whether the adaptive engine delivers questions that are within students' ability and support student learning. For example, within a given difficulty level, we expect the number of moves until completion of puzzles to decrease across practice opportunities. Observational data will be triangulated with weekly teacher logs and surveys in order to develop a narrative of how teachers used the game during classroom instruction and how teachers interpret and use teacher dashboard information.

**Impact on student and teacher learning.** Student and teacher pre- and posttest data will be analyzed with ANCOVA models, using gender, pretest scores, and SES as covariates. The effect of the treatment on student outcomes will be analyzed using hierarchical linear models to account for the nested structure of the design (students within teachers). The model will include students' scores on the posttest as the outcome (as measured by the MDTP or Attitudes survey), corresponding pretest measures, and fixed effect covariates for school (e.g., SES), teacher (e.g., LMT), and student levels (e.g., SES, gender), respectively.

## Conclusion

The present work serves as a model example of how understanding of cognitive processes involved in learning mathematics can be leveraged to design learning games that effectively support students in mathematics. Preliminary findings thus far point to the conclusion that BrainQuake's games can serve as effective classroom learning tools that support mathematical reasoning, engagement, and competency. By the time of the conference, the findings from the pilot study will further inform the development of the BrainQuake games and how well-designed digital games can support student learning in schools.

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# Learning Despite Resistance

## Engaging Resistant Learners Through Creative Learning Activities

**Ulf Dalvad Berthelsen (Danish School of Education, Aarhus University)**

**Abstract**: Through a comparative analysis of two Scratch projects made by 2 different groups of 6th-grade students, this study shows how working with the visual programming language Scratch (www.scratch.mit-edu) provides resistant students with unexpected learning opportunities. The study compares the student projects with respect to level of code complexity, level of subject matter integration, and use of modalities and it is argued that the creative learning opportunities provided by the Scratch programming language encourage the resistant students to engage in meaningful learning activities despite their resistance.

### Introduction

Resistant students are stereotypically thought of as disruptive troublemakers with low academic achievements. Resistance can have many different causes and take many different forms, but resistant learners all have one thing in common: Their resistance is assumed to prevent them from reaching the intended learning outcome (Alpert, 1991; Hauschildt & McMahon, 1996; Johannessen, 2003; Kim, 2010; Martinez, 2001; Reda, 2007; Williams, 2006).

The aim of this paper is to show that creative learning activities provide an excellent starting point for overcoming student resistance. The paper presents a comparative analysis of two digital student products created in the visual programming language Scratch. The two projects are created by a group of nonresistant students and a group of resistant students respectively, and the analysis points out important similarities and differences between the two projects in order to show how and to what extent the group of resistant students engage in the task. The paper concludes by discussing creative learning activities as a means to overcoming student resistance.

### Background

The current study is part of a larger research project designed to explore how computer programming can be integrated across subjects in K–12 education. The two selected student projects result from a course in digital storytelling, in which 6th-grade students were asked to create digital stories in Scratch based on folktales such as *Snow White* and *Cinderella.* The course consisted of 10 weekly 90-minute sessions in which students worked in small groups collaborating on a digital story. For each session, the students first watched an instructional video explaining basic functionality in Scratch before moving on to develop characters, story line, and so forth in Scratch. Besides the instructional videos, the course material also included a booklet that helped the students organize the collaborative process and integrate subject matter into their Scratch projects.

The project resulted in several hundred Scratch projects varying from small test projects with only a few code blocks made by individual students to large projects with series of complex scripts made in collaboration between several students. Among these were many interesting and carefully worked out projects suggesting that the participants had put a lot of effort into their animated stories. However, a handful of projects stood out. Not because they did not represent an effort, but because the effort was put into—in a very explicit and provocative manner—not complying with the task of animating a fairy tale. The two projects analyzed in this paper represent each of these two types of projects. The first is an animation of *Cinderella*, and the second is a project that shows no relation at all to the assigned fairy tale. The two groups of students attended the same class, and, hence, received the same instruction.

## Methodology

From a user perspective, the visual programming language Scratch can be viewed as a multimodal typewriter. Instead of typing text, users drag and drop code blocks to create interactive animations, stories, and games by using a range of modalities such as text, color, sound, and two-dimensional motion. In order to capture this complexity, the two Scratch projects will be analyzed with respect to their formal structure in terms of code complexity and their content structure in terms of subject matter integration. Further, it will be discussed to what extent the learners use the modal affordances provided by the Scratch environment.

In order to compare the formal structure of the two projects, the analysis begins with a systematic review of the use of code blocks. There are six different block shapes (hat blocks, stack blocks, Boolean blocks, reporter blocks, wrap blocks, cap blocks) and 10 different categories (motion, looks, sound, pen, data, events, control, sensing, operators, more blocks), and each block, depending on its shape and category, represents a specific functionality in Scratch. A systematic overview of the use of code blocks, therefore, gives a good first estimation of the formal complexity of the projects.

The content of the two projects will be analyzed in terms of subject matter integration. The projects are the result of a creative collaborative process in which the students were asked to animate a fairy tale as part of a literature class. The course material supported the collaborative process by providing different kinds of scaffolds for developing characters, setting, and story line. Thus, an overview of how these elements were incorporated into the projects will give an estimate of the extent to which the students complied with the task.

Finally, the analysis focuses on the use of modalities. Cope and Kalantzis (2009) discuss a range of different modalities of which written language (on screen), oral language (recorded), visual representation (still or moving image), and audio representation (recorded music, ambient sounds, sound effects) are available in the Scratch environment. These modalities are fundamental features of contemporary communication, and an overview of how the students use these modalities will qualify the overall assessment of the student projects.

## Code Complexity

Tables 1 and 2 give an overview of the formal structure of the two Scratch projects. Table 1 represents the project (NL) made by the nonresistant learners, and Table 2 represents the project (RL) made by the resistant learners. NL comprises nine sprites, six backdrops, and 80 scripts, and RL comprises 15 sprites, eight backdrops, and 41 scripts.

| Sprites: 9<br>Backdrops: 6<br>Scripts: 80 | Motion | Looks | Sound | Pen | Data | Events | Control | Sensing | Opera-tors | More Blocks |
|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxx (76) | | | | |
|  | xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xx (32) | xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxx (56) | xxxxxxxxxx<br>xxxxx (15) | | | xxx (3) | xxxxxx (6) | | | |
|  | | | | | | | | xx (2) | | |
|  | | | | | | | | | | |
|  | | | | | | | xxxx (4) | | | |
|  | | | | | | | | | | |

*Table 1. Overview of project made by nonresistant learners.*

| Sprites: 15<br>Backdrops: 8<br>Scripts: 41 | Motion | Looks | Sound | Pen | Data | Events | Control | Sensing | Opera-tors | More Blocks |
|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xx (42) | | | | |
|  | xxxxxxxxxx<br>xx (12) | xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxxxxxxxxx<br>xxx (53) | | | | xxxxxx (6) | xxxxxxxxxx<br>xxxxxxx<br>(17) | | | |
|  | | | | | | | | xxx (3) | | |
|  | | | | | | | | | | |
|  | | | | | | | xxxxx (5) | | | |
|  | | | | | | | | | | |

*Table 2. Overview of project made by resistant learners.*

Despite the difference in number of scripts (80 vs. 41), the graphic representation in Tables 1 and 2 reveals that the overall structures of the two projects are very similar. Except for the lack of sound blocks in RL, the students have made use of blocks from the exact same categories. The most conspicuous difference, which also relates to the difference in number of scripts, is the difference in the use of the event/hat blocks. As can be seen in Figures 1 and 2, the students who made NL chose a performative approach to creating a digital story in the sense that one has to "enact" the story by pressing a rather long sequence of keys in the correct order, whereas the students who made RL chose a more gamelike approach, in which one moves the sprites around in order to drive the story forward. As a result, NL contains almost twice as many event/hat blocks, mainly of the type "When [key] is pressed." This difference also explains the difference in the use of motion/stack blocks, since NL, because of the performative approach, contains a large number of individual motion events.

Equally interesting, both groups of students made only very limited use of code blocks representing more complicated computational concepts. Except for event/hat blocks, which initiate events, the vast majority of code blocks in both projects consist of stack blocks representing simple events such as changing costume or moving the sprite around. In both projects, we find a few attempts to use control/ wrap blocks for creating loops and sensing/Boolean blocks for creating simple interactions, but none of the projects uses data blocks or operator blocks for constructing complex functionality, and none of the projects uses control/wrap blocks for creating complex embedded structures.

## Subject Matter Integration

Figures 1 and 2 show screen shots of the two projects. Figure 1 shows an inside view of NL, and Figure 2 shows an inside view of RL.

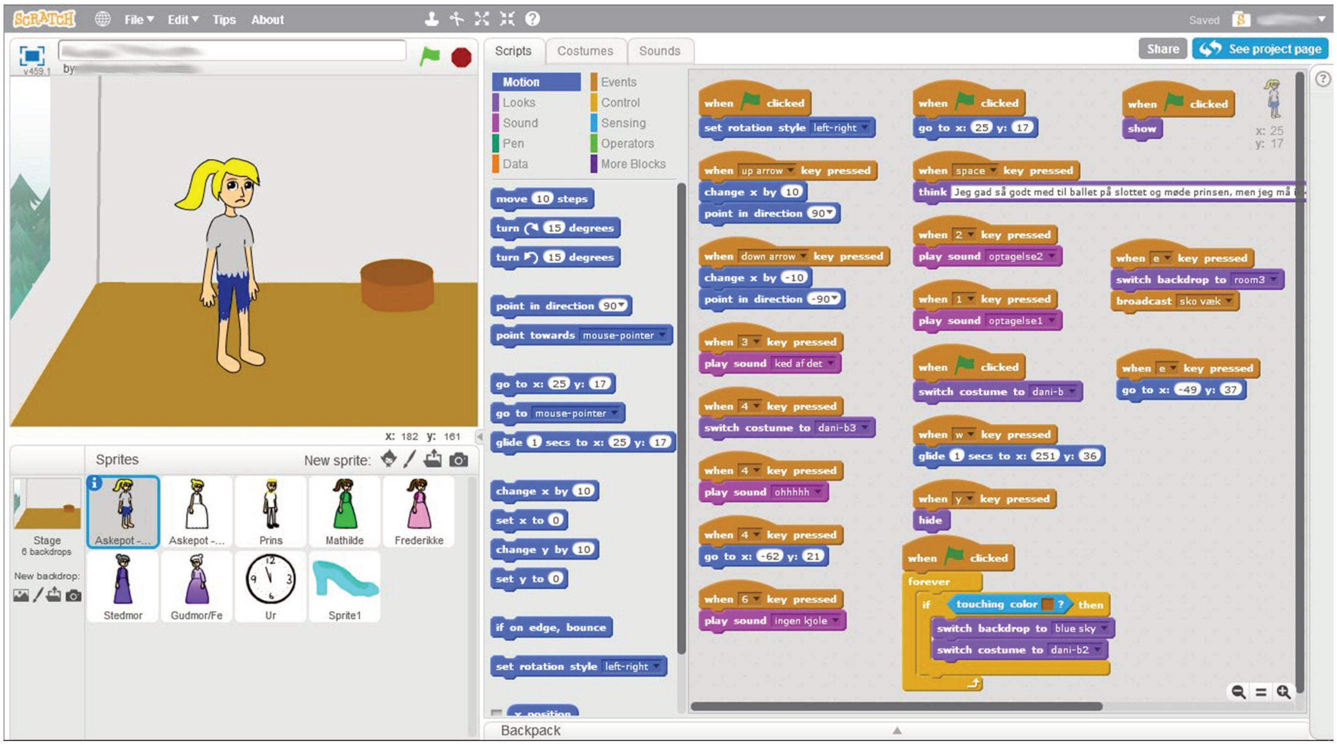


*Figure 1. Screen shot of project made by nonresistant learners.*

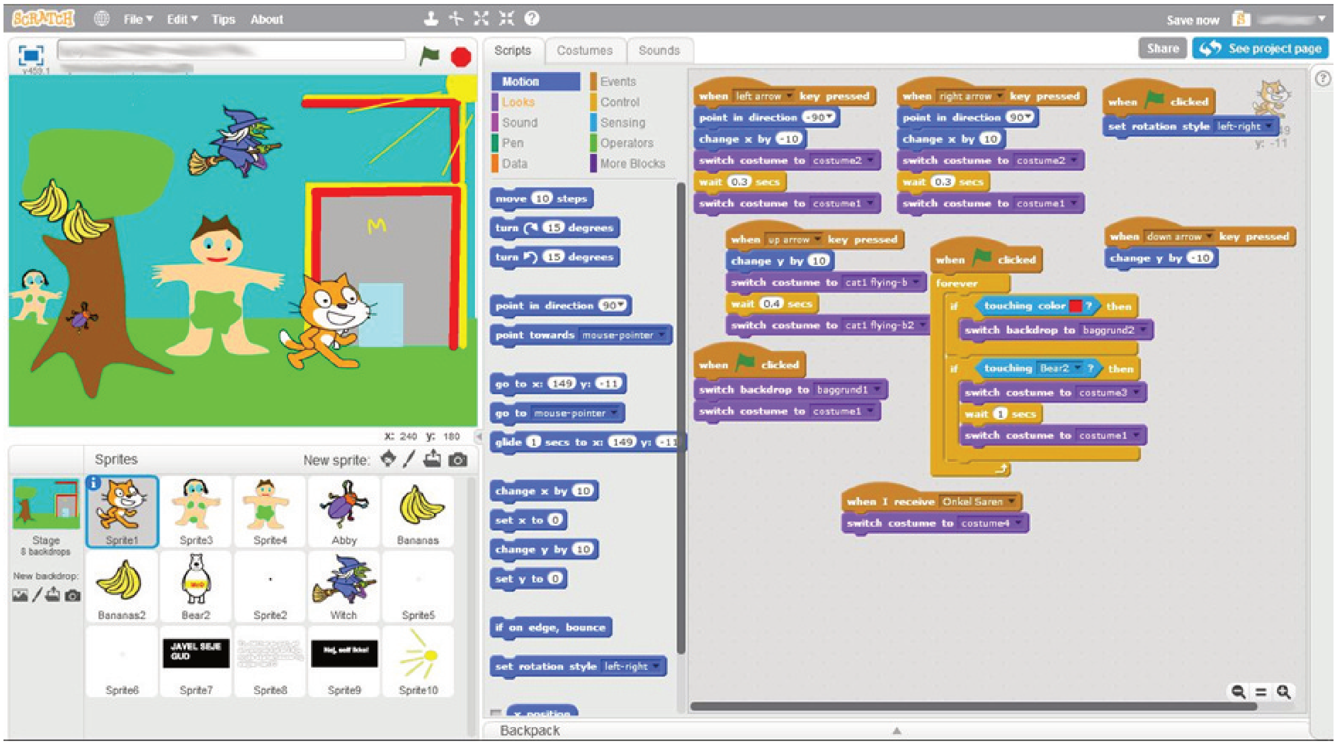

*Figure 2. Screen shot of project made by resistant learners.*

Despite their similar formal structure, the two projects differ significantly with respect to integration of subject matter. Most important, RL shows no relation at all to the assigned fairy tale. On the contrary, the project indicates that the students went to great lengths to create a project that demonstratively expresses their resistance toward the task. In contrast, the content and narrative structure of NL closely resembles that of the assigned fairy tale. The main differences with respect to subject matter integration, that is, setting, character development, and story line, are summed up in Table 3.

| | NL (Table 1/Figure 1) | RL (Table 2/Figure 2) |
|---|---|---|
| Backdrops and setting | - Close relation to assigned fairy tale (Cinderella)<br>- One backdrop per scene<br>- Linear sequence of backdrops<br>- Backdrops support storyline<br>- Backdrops depict scenes from the assigned fairy tale (home, garden, castle) | - No relation to assigned fairy tale (Snow White)<br>- Only one main backdrop<br>- Events occur on the same backdrop<br>- Unclear relation between backdrop and events<br>- Unclear relation between elements in the project (McDonald restaurant, tree, landscape) |
| Sprites and characters | - Sprites represent characters from the assigned fairy tale<br>- Clear internal relation between characters (Cinderella, the fairy, the step sisters, the prince)<br>- All nine sprites are created by the students<br>- Characters lines are taken from the assigned fairy tale<br>- Proper costumes and language | - No relation between sprites and assigned fairy tale<br>- Unclear internal relation between characters (a cat, a beetle, a witch, bananas, Adam and Eve)<br>- Ten sprites created by the students, five sprites chosen from the Scratch library<br>- No relation between characters lines and assigned fairy tale<br>- Obscene costumes and offensive language |
| Interaction and storyline | - Users interact with the project by pressing keys in a specific order<br>- Systematic relation between user interaction and story line<br>- Linear narrative structure<br>- Coherent story world<br>- Recreation of the story world from the assigned fairy tale<br>- Systematic relation between storyline and assigned fairy tale<br>- Proper storyline | - Users interact with the project by pressing keys or clicking sprites with the mouse<br>- No systematic relation between user interaction and storyline<br>- Non-linear narrative structure<br>- Non-coherent story world<br>- Creation of own (story) world<br>- Non-coherent story line<br>- No relation between assigned fairy tale and storyline<br>- Violent and provocative events |

*Table 3. Subject matter.*

From the comparison above, it is clear that the students behind RL acted disruptive on purpose and deliberately failed to comply with instructions. They created an alternative story world comprising violent events, obscene pictures, and offensive language. For instance, there is no real time line, but when the key “j” is pressed, a sprite displaying text appears with a message, apparently from a god, ordering the other characters to kill the cat. When the “space” key is pressed, the character “Adam” loses his fig leaf and displays his genitals. When the beetle is clicked with the mouse, it is crushed, and when the “u” key is pressed, the entire setting blows up.

Surprisingly, this does not mean that there is no indication of integration of subject matter in RL. Obviously, we find a high level of subject matter integration in NL. The students have re-created scenes and characters from the assigned fairy tale using the drawing tools available in Scratch, and they have used the functionality of the code blocks to re-create the story line. This is not the case in RL. However, if we disregard the provocative and offensive nature of the project as well as the fact that the students behind RL have deliberately tried to disrupt the course, it becomes clear that we, after all, can find examples of subject matter integration in the project. For instance, the students have engaged in developing an appalling setting, they have put effort into making up violent scenarios, and they have put effort, as well as a certain amount of humor, into developing the Adam costumes.

## Modality

As mentioned earlier, the Scratch environment can be seen as a multimodal typewriter providing a range of different expressive means, including written language, recorded oral language, visual representation, and sound. When the two projects are compared with respect to these modalities, there appear to be both similarities and differences (see Table 4).

| **Modality** | **NL (Table 1/Figure 1)** | **RL (Table 2/Figure 2)** |
|---|---|---|
| Text | - Looks/Stack block 'Think [`text`]'<br>- Sprite containing numbers on a watch<br>- Backdrop containing text 'The End' | - Several sprites containing text<br>- Backdrop containing larger amount of text |
| Oral language | - Sound/Stack block 'Play sound [`recorded speech`]' | |
| Visual representation | - Sprites created as bitmap and vector graphics<br>- Backdrops created as bitmap and vector graphics<br>- Motion/Stack Block 'Change x by [`value`]'<br>- Motion/Stack block 'Go to [`x,y coordinates`]' | - Sprites created as bitmap and vector graphics<br>- Backdrops created as bitmap and vector graphics<br>- Motion/Stack Block 'Change x by [value]'<br>- Motion/Stack Block 'Change y by [`value`]'<br>- Motion/Stack block 'Move [`value`] steps' |
| Sounds | - Sound/Stack block 'Play sound [`sound effect from library`]' | |

*Table 4. Modality.*

The most important difference between NL and RL is that RL is made entirely without using the sound modality, neither recorded speech nor sound effects from the Scratch library. Concerning the other modalities, both projects use them in a variety of ways. Both projects integrate written language to some extent, and both projects make extended use of visual representation.

## Disruptive but Creative

The comparison between NL and RL has shown that the two projects have a lot in common with regard to code complexity and also, to some extent, with regard to the use of modalities. However, there are also important differences, especially in relation to the content of the projects. The students behind NL complied with the task and followed instructions. The students behind RL, on the other hand, put a lot of effort into not complying with the assigned task and into creating a provocative project containing both obscene pictures and offensive language.

Thus, the analysis concluded, one important thing stands out. The resistant students showed both effort and engagement. Consequently, and despite their resistance to learning and learning activities, they were presented with a range of unexpected learning opportunities. Brennan and Resnick (2012) argue that the Scratch environment provides learners with the opportunity to engage with important computational concepts. As the analysis showed, the resistant students were also presented with the opportunity to engage with multimodal means of expressions and, to some extent, also with literary concepts.

One might think that the students' resistance and disruptive behavior prevented them from learning, but here it is important to notice that they actually engaged in creating a multimodal digital product when they could have chosen to do nothing at all. This suggests that creative learning activities, in this case working with Scratch, possess qualities that encourage resistant learners to engage in learning activities despite their resistance.

Of course, the project was also inacceptable in many respects. The obscenity and offensive language have already been mentioned, but the project is also disruptive in a way that disrespects both the teacher and the peer students in the class. Thus, the point to be taken is not that this behavior should be accepted, but rather that the engagement of the resistant students provides an excellent starting point for the process of overcoming resistance.

## Engaging Disruptive Learners Through Creative Learning Activities

It lies outside the scope of this paper to investigate what caused the unexpected engagement. However, following Papert (1980), it seems plausible to assume that the creative learning opportunities provided by the Scratch environment provide agency to the resistant students. Along these lines, Resnick (2017) suggest projects, passion, peers, and play as important features of creative learning activities. Features that, one hopes, will support resistant students on their path to becoming creative learners and provide teachers with means to scaffold the transformation.

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# Reproducing Digital Inequality

## Wealthy and Poor Parents' Approaches to Parenting in a Digital Age

**Alicia Blum-Ross (London School of Economics) and Sonia Livingstone (London School of Economics)**

**Abstract:** In this paper we examine how parents' access to resources—financial but also related resources, including cultural and social capital—influence how they approach digital media in their own and their children's lives. We detail 2 case study families, the Apaus (a low-income Ghanaian-British family) and the Thiebaults (a high-income French family living in London). Both families have sons who are learning to code, but how they pursue this interest and how they are supported by their parents illustrate how parental access to resources influences connected learning experiences. Contra the theories of Annette Lareau, we show how both families are actively turning to digital media to "cultivate" their sons' interests, at great costs relative to their very different resources, but that this cultivation may well be unequally converted into opportunities in the future**.**

### Digital Media in Diverse Homes

Throughout our interview with Cecilia Apau, the screen of a desktop computer in the corner of the room has been flashing. The black screen is alarmingly cut with bars of irregular pixelated bright colors—the telltale signs of a virus. Two of her children are playing on a supermarket-brand tablet and a smartphone, with another tablet lying broken in the corner. When we ask Cecilia, who works as a budget grocery store cashier, what happened to the computer, she shrugs, unsure of what is wrong or how to fix it. In contrast, Michel and Josephine Thiebault estimate that there are at least 15 top-of-the-line screen devices in the house, but to father Michel, a high-ranking corporate executive in a technology company, the cost was negligible.

These two families represent some of the extremes of family life in London, and yet there are some similarities. Both are migrant families, common in London. Cecilia Apau came to London from West Africa, Michel and Josephine Thiebault from Western Europe. Both homes are filled with technology, albeit of very different kinds—in the case of the Apaus the most affordable, and therefore with more restricted capacity, and adding up to a much more significant percentage of Cecilia's limited income. The Thiebaults, in contrast, think little of upgrading their devices to the latest models. Although their lives are different in many respects, both homes are nonetheless inhabited by digital-media enthusiast children, including sons (13-year-old Marc Thiebault and 8-year-old Eugene Apau) who are currently learning to code. Yet this interest, too, looks very different in its pursuit. Marc attends an expensive coding summer camp at a top London university to learn Python; Eugene attends a free weekly after-school program at his underresourced primary school to learn the more basic program Scratch.

In this paper we examine how parents' access to resources—financial but also related resources, including cultural and social capital (Bourdieu, 1986)—influence how they approach digital media in their own and their children's lives. We discuss the enduring importance of social class while also highlighting the ways in which economic resources do not necessarily determine how "media rich," or not, a family's home is (Livingstone, 2006). In narrating the experiences of parents well below the poverty line, those earning almost inconceivable salaries, and the majority in between, we show how class is powerful and yet not straightforward.

In her influential book, *Unequal Childhoods*, Annette Lareau (2011) differentiated the practices of "middle-class" and "working-class" parents in order to explain how the social reproduction of advantage and disadvantage occurs—inadvertently but systematically nonetheless—through the aggregate result of parents drawing on unequal resources when seeking individually to do their best for their child. Middle-class parents, especially, are often held to be so self-interestedly competitive that by pressuring themselves and their children to achieve ever more, they drive an ever-larger wedge between their families and those living in poorer circumstances. Broadly, we agree with this analysis, but we also question and complicate the account in several ways.

First, we show how "concerted cultivation" now occurs well beyond just middle-class families, both extending the reach of the concept but also, thereby, repudiating Lareau's contention that working-class families instead rely on an assumption of "natural growth." Thus, across society and certainly including many poor and marginalized families, we find parents making considerable efforts to "cultivate" (i.e., resource and support the individual achievements of) their children, albeit in diverse ways, and with diverse outcomes. Indeed, they are often aware that, as Lynn Schofield Clark argued, while middle-class children benefit from the social distinction that their parents' privileges confer, this is often at the cost of "the ethic of respectful connectedness" preferred by working-class families (Clark, 2013). Second, we pay particular attention to the ways in which digital media are deployed as agents of cultivation, with parents hopeful that through embracing digital devices, resources, and expertise, they can provide their children with a competitive advantage (or, more anxiously than ambitiously, prevent their falling "behind"). This is particularly evident in the current fashion for "coding" in which both Eugene Apau and Marc Thiebault are engaged. In this paper we detail the lives of these two boys in order to demonstrate how, while their parents share some level of investment in digital media as a tool for their child's advancement, the ways in which they invest in this belief financially and emotionally will come to yield very different results.

## Methods

This paper is based on a mixed-method study of U.K. parents conducted 2014–2018. We conducted qualitative semistructured interviews with 73 families in London in 2015 and 2016, followed by a quantitative survey of 2,032 parents across the United Kingdom in late 2017. For our qualitative research we specifically recruited families with dependent children (below the age of 18) who were highly diverse in socioeconomic status, family composition, ethnicity, and age of child(ren). We included parents from a wide variety of different ethnic and religious communities, living on annual incomes ranging from under £15,000 per year to well over £100,000. We met parents at school parents' evenings, at children's centers, through parenting organizations, and their children's after-school programs. Beyond our emphasis on recruiting a diverse range of families, we also proactively sought out families who, in one way or another, have confronted the idea of a "digital future" with distinct purposes or from a distinct perspective. This included families with children with disabilities—because they are so often excluded (Alper & Goggin, 2017) and because many expressed heightened hopes and concerns about what digital media might offer their children or see digital media as a much-needed workaround for social or economic inclusion in the future. It also included parents of children who had in some sense "voted with their feet" by attending a digital media and learning program—including code clubs and media arts and digital making programs.

The main grounding for our analysis comes from this qualitative fieldwork. Parents were interviewed face-to-face, generally at home although some we met for an interview in a public setting—usually while they were waiting for their child to come out of a class or in a café if they preferred. More than two thirds invited us to their homes, where we could see for ourselves the influx of digital devices in family life—sometimes neatly stacked away and awaiting permission to use, other times casually present underfoot or easily within reach, for use as desired. Some interviews were conducted with the whole family together. Sometimes we talked to parents both with and again without their children joining in; sometimes we talked to parent and child separately. Sometimes we observed the children in the coding or digital media class, sometimes also interviewing their teachers.

Taking an ethnographic approach (Coleman, 2010; Skinner, 2012) we complemented our semistructured interview protocol with a "media tour" around the home where permitted and including some creative participatory methods to elicit participation from very young children (A. Clark, 2010). Insights from the interviews and observations then informed the design of our national survey of U.K. parents. We surveyed 2,032 British parents of children aged zero to 17, of which 95% were recruited via an online panel, supplemented by 5% of specifically no- or low-Internet–using parents recruited face-to-face at home. Although this paper will primarily focus on the results from our qualitative data, we will also complement findings from our quantitative survey where appropriate.

## Theories of Families and Social Class

One of the most widely cited theories of families and social class was initially based on intensive qualitative fieldwork with the families of 9- and 10-year old children. After spending many hours with families of very different economic means, Lareau (2011) came to differentiate between "concerted cultivation," the practices of middle-class parents, and "natural growth" as the practices of working-class parents. According to Lareau, "concerted cultivation" describes how middle-class families consistently intervene in the educational experiences of their children. These parents (often, although not always, mothers) concertedly place their children in a series of environments in which they are exposed to new skills, connections, and ideas. Yet however pressurized such dedication to cultivating children might be, in Lareau's return to some of the families she initially interviewed 10 years later she showed how their strategies were, to an extent, successful (Lareau, Adia Evans, & Yee, 2016). Lareau found that middle-class parents were able to transmit to their children an understanding of the logics of institutions and how to question or even "game" these—for example, they were taught to navigate the structures and rules in their schools and later universities, and to negotiate new and advantageous paths in ways that working-class children were not. When she reinterviewed the students and their parents she found a number of ways in which the middle-class parents had "converted" their cultivation into academic and other successes (Lareau & Cox, 2011).

In contrast, Lareau characterized working-class parents as more concerned about children's place within the family, and that parents' attentions—amid pressures such as insecure jobs or housing or caring responsibilities for extended families—were instead focused on immediate needs and dilemmas. In Lareau's analysis, working-class parents were less likely than middle-class parents to believe that among their "crucial responsibilities" are the elicitation of "their children's feelings, opinions and thoughts" (Lareau, 2011, p. 3), were more likely to see strong boundaries between children and adults, and less likely to negotiate with children or spend time and resources establishing leisure-time pursuits for them. Calling this the philosophy of "natural growth," Lareau proposed that while this meant that working-class parents were no less loving, they were more at odds with the logics of the middle-class institutions the children might later navigate, such as school, university, health systems, or employment. These institutions operate according to what Lareau calls the "dominant set of cultural repertoires," meaning that families from nondominant communities are often perceived by middle-class professionals as "deficient" (Alper, Katz, & Clark, 2016) or indeed "troubling" (Ribbens McCarthy, Gillies, & Hooper, 2013). Although working-class parents have high hopes for their children, this mismatch of "cultural repertoires" means that middle-class families are more often able to transmit their "differential advantage" to their children (Lareau, 2011, p. 5).

In this paper we detail the experiences of two very different families. In so doing, we find evidence that both contests and supports some of this theorization of class. We found very few low-income families in our study engaging in what Lareau calls "natural growth"—all were working hard to support their children and provide them with a variety of opportunities even though they had very limited resources. This is in keeping with Dermott and Pomati's (2015) findings that many of the attributes of "good parenting" are practiced by parents regardless of social class, but that higher-income parents engage in these much more intensively, leaving lower-income parents left seeming derelict in their duties. At the same time we find evidence to support Lareau's theorization of "conversion," for even though all of the parents we will now detail were engaged in "cultivating" their children to the extent they were able, their drastically different circumstances will undoubtedly mean that their children are differentially able to capitalize on their parents' investments (Lareau et al., 2016).

## Below the Poverty Line

Single mother Cecilia Apau and her three children live in government-subsidized housing in South London. Cecilia migrated to the United Kingdom from West Africa 13 years ago; her three children were born in England. Despite living on a household income of less than £15,000 per year from her work as a cashier in a low-cost grocery store, in the past four years Cecilia has purchased a desktop computer, a laptop, two tablets, and two smartphones for her family's use, alongside a flat-screen TV with a cable box. When asked why she had originally decided to buy the now virus-ridden computer, she answered:

> Cecilia: Because my daughter [Esi, 12] needed to use the computer for homework and things like that.
>
> Author: So did she use it for her homework?
>
> Cecilia: Because it's not working, she doesn't usually. They use one of the Kindles, the tablets, to do it.
>
> Author: Okay, so how long has it been broken for?
>
> Cecilia: Almost a year now.

The tablets had been purchased so that her children could practice "maths, spelling, reading, anything. … I want them to learn every day, to improve their reading." She has downloaded around 20–30 apps that she deems "educational," but she could not say what she thought the children were learning from them. Most of the apps were free ones that she had found herself, but one was specifically designed to prep for the year-end standardized tests, as recommended by a teacher at Esi's former primary school.

Cecilia encourages her youngest son, Eric, 4, to "read books" on YouTube by typing in the name of a favorite book (e.g., *Jack and the Beanstalk*) and watching a video of the pages of an illustrated book being flipped while a voice-over reads the story. Cecilia reports, "It helps him, because I've got three [children] and I'm working as well, I don't have time to read. So … it's like I'm reading it to him." When we asked Cecilia if she told her children's teachers about what she was using at home, she said, "It hasn't occurred to me" and that she was too busy to linger at school, but neither do the teachers ask. Cecilia does not really worry about her children's safety online, even for Esi, who has her own smartphone, as she trusts her not to look at anything "inappropriate." Cecilia has a basic level of digital literacy: She can download apps and use WhatsApp and Facebook to keep in touch with friends and family, but the first email she ever sent was to us, responding to the request for an interview.

In contrast, Eugene, 8, is especially enthusiastic about digital media and signed up for his school's volunteer-run after-school coding club. At the club Eugene quietly got on with his coding using Scratch, although he was not the most advanced. Cecilia said she would like to see Eugene's creations but could not because

> this one [desktop] is not working. … I don't know what he is doing really. … He tries to explain to me but I don't really understand what he's trying to tell me. … He really wants to show me what he did. … He keeps pressing me to fix it but there's nothing I can do.

Ultimately Eugene left code club, describing it as "boring." His mum wondered if this was "because he can't practice it at home."

## Wealthy Elite

White French parents Michel and Josephine Thiebault had originally come to London for Michel's high-level corporate job. The Thiebault home is a drastic contrast to the Apaus'. They access their property through a private gate with its own doorman and security system, which has the effect of cutting them off from the more mixed nearby area. For Michel, teaching young people about technology is not just about "embrac[ing] the digital trend." Josephine shares Michel's enthusiasm, signing the boys up for technology camps and sitting on the board of DigiCamp—the expensive summer technology camp where we first met Marc, 13, in his Python II class. Neither Josephine nor Michel seem especially concerned about what their children will encounter online, trusting them for the most part. Michel and Josephine emphasize the importance of learning to create rather than passively consume technology, and they have educated themselves substantially to be able to support and encourage their sons' interests. Although she does not work in technology herself, Josephine differentiates between the affordances and possibilities of different coding languages such as Java versus Python, noting with pleasure when Pierre, 18, describes coding as "just like learning how to write."

From an early age Marc taught himself to use Java to create mods in *Minecraft* and is following along with Code Academy tutorials on YouTube to continue with his Python class and create his own "RPG" (role-playing game). His own digital skills are a proud point of differentiation when he compares himself to his peers, as he scoffs at friends at school who "just have an iPhone. … They just play on it, but they don't even know how it works." Both Marc and Pierre have spent several summers and school holidays attending intensive technology camps—Marc starting at age 7—including a camp at Stanford, where the family formerly lived, to learn "coding, robotics, engineering of solar car and engineering robotics, many things like that." All told the boys have attended about a dozen such camps each—which means the family has spent many thousands of pounds in enrollment fees and travel. Pierre is poised to go to university, hoping to study Computer Science and is awaiting the results of his applications. Marc dreams of returning to Stanford to study engineering. Looking into their son's futures, Michel and Josephine are both driven to support their sons in meeting challenges, but they are also subtly but decidedly assured about their abilities to do so.

When Michel describes the future he imagines a world of “sensors … artificial intelligence systems” and notes that “if you don’t understand a piece of that, you are going to be completely lost.” Unlike for “pathetic” others who “don’t have a clue about computing” and who use computers uncritically (he describes bank tellers evocatively as acting “like robots”), for whom this technology may come to look “magical,” Michel sees his sons as agents who will be better able to navigate the digital world as a “natural element of culture” using their superior knowledge. He goes so far as to describe their arguably superadvanced critical understanding of the digital world as skills that “any gentleman should have.” Josephine tempers this language somewhat, but she shares Michel’s vision of their sons as able to navigate the future and crucially retain the ability to choose their own pathways, in a way that other children may not. She says,

> I think if you understand the digital economy, everything around digital, you will be more independent, and you will have more choice and be able to choose. … [I want to] give them a chance for the digital life, because I don’t want them to be passive guys, so I would like [them] to be active guys … to be active in this future.

## Conclusions

Although the technology that the Apaus have is in many ways limited, and the activities the children engage in are fewer, proportionate to the time and resources she has available Cecilia Apau is investing, heavily, in her children’s future, and she is embracing technology to do so. In common with other poorer families, she has prioritized buying computers, even when this caused her financial hardship or when she could not guarantee consistent access, because she believed that this would help her children. This, she considers, is part of providing the “basic conditions” (Mayo & Siraj, 2015) for academic success at home, along with other activities such as sending her children for extra tuition, buying academic workbooks, and so forth that demonstrated her investment in her children (Dermott & Pomati, 2015). In writing about low-income families Lareau is also clear that these children are deeply loved, and that their parents “worried about them, and sought to help them” but that class made a “critical difference in the resources parents could bring to bear on their children’s behalf” (2011, p. 262). Cecilia’s desire to buy the computer, despite the hardship it brought her and her inability to help support its use, is consistent with the finding that poorer parents are equally, if not more, likely to identify educational benefits for computers (Wartella, Rideout, Lauricella, & Connell, 2013). However, Cecilia’s case also shows how beliefs and realities do not always match up. She had purchased the technology, but she could not support its use or troubleshoot when things went wrong. Although Cecilia had some enthusiasm for Eugene’s interests, or at least a wish to support it and therefore exhibited an “embedded theory of learning” (Sefton-Green, 2013) for why it would be helpful to him (and was to some extent “cultivating” this interest), ultimately it seemed unlikely that he would pursue this interest in the future. Cecilia has a sense that coding is a good thing but no tools to support it and no great sense of loss when Eugene disengages from it. Is anything really lost for him? The promise remains vague, as does the sense of missed opportunities—which are only vaguely articulated by the school (indeed the club is run by volunteers and not teachers) and any government rhetoric about coding is too far removed for her to access.

In contrast, Pierre and Marc Thiebault seemed poised to turn their experiences in connected learning settings into future academic achievement and success, with their parents’ help. In part, this was due to Michel and Josephine's intimate knowledge of the opportunities that they were well placed to "broker" (Barron, Martin, Takeuchi, & Fithian, 2009; Hamid et al., 2016) for their sons' opportunities, but although this was in some sense intensive—in terms of time and finances—on the other hand Michel and Josephine did not actually appear overly stressed about their son's futures, given their confidence in some kind of positive outcome. In contrast to Lareau's depiction of parents anxiously attempting to conserve their class position, there is considerable variation among parents of all levels of socioeconomic status (SES). So Michel and Josephine were confident that they could use their institutional knowledge to create interventions specific to the outcomes they and their sons desired (Lareau & Cox, 2011), as opposed to Cecilia's more generic belief that technology would help her kids learn. Michel and Josephine support Marc and Pierre's interests, and although "coding" is diverting in the present their ambitions are set higher. In a sense, they seem already assured of a successful pathway ahead. So, insofar as children are not equally able to "convert" their knowledge gained at home and in their community into value that is recognized and rewarded by schools, universities, or employers, we suggest that it is less a failing of parental philosophy, intent, or effort that accounts for inequality but, rather, a failing of society that unequally resources its children and, especially, is often deaf to the interests, knowledge, or achievements of its poorer and minority children.

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# Connected Learning

## Exploratory Programming in the Classroom

**Angela Chang (Emerson College, Massachusetts Institute of Technology)**

**Abstract:** Exploratory programming is an open-ended learning approach to teach coding in small groups using open-source tools. We describe how students used this hands-on approach to learn programming at a liberal arts college. In 1 semester, students progressed beyond basic programming concepts to independently extend their knowledge. Students used freely available, open-source tools, and online learning resources to create surprisingly complex and varied novel investigations of social, political, and cultural issues. They readily used their skills to appropriate different technological platforms or project outputs. Using creative coding, students learned to engage in programmatic thinking irrespective of specific technology implementations. They also participate in supportive programming communities. This approach costs little to implement, supports nontraditional programming students, and teaches real-world programming techniques.

### Introduction

Nontraditional (or casual) programmers are on the rise (Bau, Gray, Kelleher, Sheldon, & Turbak, 2017). Besides computer science classes, many resources (books, online courses, web tutorials, and support forums) are freely available (Shen, 2014). Despite these offerings, students might still have trouble learning to program (Wiedenbeck, 2005). We propose an exploratory programming approach toward coding literacy. Some might be merely curious about programming, not necessarily in becoming professional programmers.

### Background

Exploratory programming (Montfort, 2016) combines creative coding and humanistic inquiry. Like traditional STEM teachings, this approach uses hands-on activities and project-based outputs to guide progress. However, exploratory programming differs from existing pedagogies by emphasizing learning together in small groups, interacting with vibrant professional communities, and focusing on open-ended creative output. Students sample diverse technological experiences provided by programming and tinker to craft their own experiences.

#### Case Study: Code, Culture, and Practice Class at Emerson College

Emerson College is a communication and liberal arts institution situated in metropolitan Boston, Massachusetts. Although no computer science or engineering degrees are offered, three coding classes are available. Two of these classes covered technical platforms: Introduction to Interactive Media (HTML, CSS, JavaScript) and Introduction to Game Design (Unity). Like traditional computer science classes, these classes target a specific language or technology platform.

Code, Culture, and Practice teaches basic programming as a tool for humanistic thought. Although Python is used, students get experience using multiple programming languages and platforms. Offered by the Liberal Arts and Interdisciplinary Studies Department, the class caters to upperclassmen with little or no prior programming experience. We report observations from classes that occurred in Spring 2016, Fall 2017, and Spring 2017.

The class was oversubscribed for two out of three semesters. A total of 66 students enrolled. The average class size was 22 students, with roughly equal female and male attendees (although students at this college may prefer to use gender-neutral descriptions). Figure 1 describes the class in bullet points.

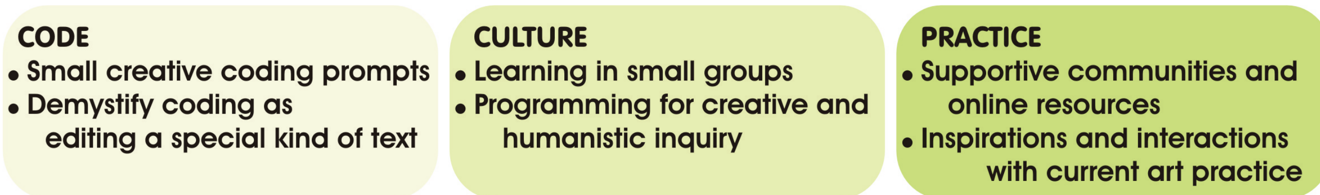


*Figure 1. A summary of Code, Culture, and Practice, an exploratory programming approach.*

## Exploratory Programming in Practice

The first class aimed to convince students that they possessed all the necessary tools to code on their own machines. Before the initial class, students were asked to download and try a coding-friendly text editor. Plain-text editors that display line numbers are not included in operating systems, but they are essential for basic coding. Once installed, they were ready to begin.

Poetry generators (Montfort, 2014) provide a fun way to reveal the inherent coding environment within their laptops. Students read about the historical roots of creative computing (Montfort, 2014). After experiencing these poetry generators, they were shown how to download the JavaScript source. Without any detailed coding instruction and merely by substituting certain words, the content of these computational poems was appropriated. They could open the file using their favorite browser to see the immediate effect of their edits.

Through tinkering, students soon learned what types of changes they could make without breaking the code. They began to recognize patterns in text and functionally distinguish data from code. Overcoming errors was part of the process, and they were shown how to undo their changes, start over, or navigate auto-highlighted text to find errors. There was safety knowing that nothing catastrophic could happen from this process. The satisfaction of being immediately able to test their changes locally within the first class showed them that programming was feasible. After customizing the content, they read the output aloud. Presentation was seen as a way to explore the potential design space together. The diversity of customized computerized poems was noted and appreciated.

This exercise initiated students to the process of iterative development (Figure 2) used by all developers. Students could observe parallels between the familiar process of editing text and modifying code. The class adjourned with a challenge to continue modifying their poems at home.

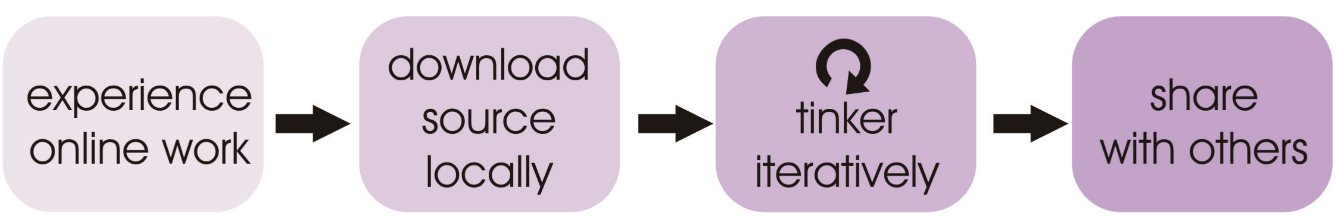


*Figure 2. Creative iterative development process.*

### Promoting a Supportive Environment With Small Groups

One of the instructor's main tasks was to foster a sense of community so students felt comfortable working closely. Short lectures took the form of live-coding (Rubin, 2013). Small code examples were used to demonstrate coding concepts. Then, students worked in groups (with a maximum of five people) to try the examples together. Each class period required a personal deliverable and group output. These frequent outputs helped to keep students focused on individual and shared productivity.

In small groups, students shared struggles or triumphs more willingly than out in the open. Meanwhile the instructor checked in with each group to suggest approaches or hints. Small groups allow each individual member to contribute more actively than in a larger group. Assisting each other became part of the lesson. Students continued their conversations outside of class (e.g., through messaging, phone, or meeting up in person). They often created shared documents and repositories (Ito, 2013).

### Learning to Code by Tinkering With Small Programs

Subsequent classes covered programming fundamentals by manipulating code directly. We purposefully examined different languages to show that programming logic is common across languages. Students compared similarities between JavaScript and Python poetry programs. Then, they explored calculations on data types to get a feel for each language's syntax and structure. Jupyter notebooks preserved the progression of steps toward developing functions and were annotated so students could proceed through each notebook at his or her own pace (Shen, 2014). These notebooks also enabled the instructor to identify individual student problems.

Specific, short code examples (no more than five lines usually) were carefully chosen to introduce basic programming concepts. These textual toys referenced the work of the Oulipo, an inventive group that pioneered many creative literary experiments (Motte, 1986). Short Python snippets were explained by reading the code verbally. Flow diagrams illustrated data calculations. These programs could also be reused on voluminous data sets. Students could revisit this code to analyze real-world data streams from social media, online news, and government websites for their final projects.

In the last third of the semester, the class covered visual display programming (with Processing IDE). Object-oriented code was covered, allowing multiple programmers to combine classes to create an experience together. Groups modified games, with each member customizing a part of the interface.

### Coding as a Tool for Creative Inquiry

Students were repeatedly shown the workings and intentions behind media works. Then, they were prompted to describe how they might modify the works to suit. For example, when learning string manipulation, students were asked to select two pieces out of 100 from *Exercises in Style* (Queneau, 1981). They examined the aesthetics linguistically and programmatically. For example, they might correlate exclamation marks with abruptness. These small challenges aimed to give students a curious context to think about (and experiment) with code outside class. They worked on iteratively creating, just like professional artists (Kleon, 2012).

### Creative Inspirations From External Resources

Using a flipped classroom, works by contemporary media artists were presented to initiate students to the active investigative dialogues taking place at the time. These artists would discuss their creative investigations online and perform readings of their computational works. Artists such as Allison Parrish, Ranjit Batnagar, and Leonard Richardson share their source on GitHub. Parrish's word-play tutorials explore bots as artificial intelligent collaborators. Richardson's *In-Dialogue* invites anyone to create custom mash-up novels from *Project Gutenberg*. Batnagar's *Pentametron* generates an endless sonnet from public tweets. Access to source code from these thoughtful artworks inspired students to learn by tinkering. Students adapted the examples and shared their results with the class. Some students even posted their mods for the open-source community or engaged the artists online.

### Toward Sustainable Self-Learning

After students mastered basic programming concepts, harder tasks were assigned to give practical applications of these principles. Students delighted in using nested loops to crack each other's ciphers or share custom image filters made using the Python Imaging Library (PIL). These advanced topics also gave them a reason to seek out online forums such as StackOverflow and Reddit. Myriad detailed explanations on how to tackle a particular problem could be found and students compared solutions. Forums addressed issues that were unique to student projects or machine configurations.

Students were motivated to scour online resources and even post questions on these forums. They were surprised to learn that professional programmers participated in these same knowledge-seeking endeavors. If their posts were answered, they relished being considered seriously by these well-respected technical communities. As the class became more challenging, students relied on these external forums even if they did not ask questions. They were now comfortable accessing external learning resources to learn new ideas. Figure 3 depicts a sampling of resources students used.

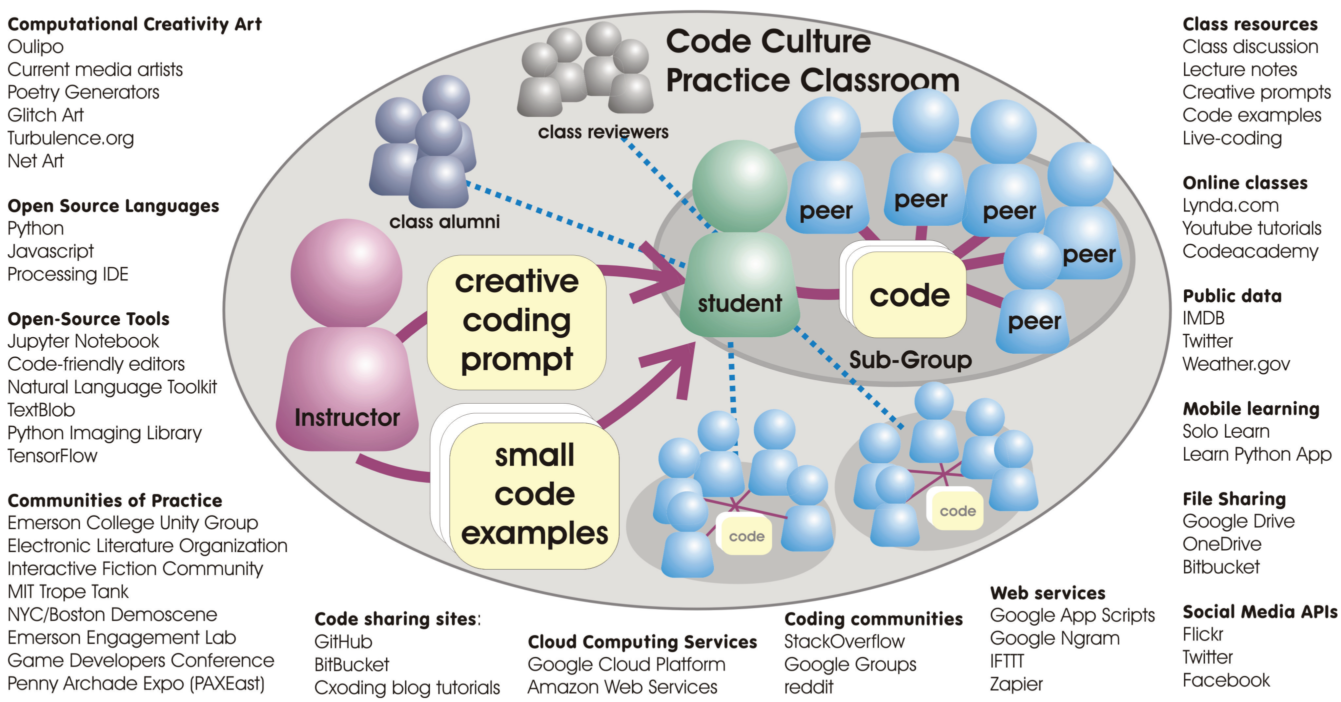


*Figure 3. Some connected learning resources explored by novice programming students.*

## Discussion: Supporting Diverse Learners on Their Coding Development

The majority of the students had never coded. Students were pursuing degrees in various disciplines, such as Journalism, Interactive/Visual Media and Arts, Media Production, Marketing Communications, and Writing, Literature, and Publishing (WLP). A few students reported that they had previously interacted with code, perhaps in a high school class, but were not regularly coding. Some students had unsuccessfully tried to take online coding courses (such as Code Academy) but did not feel confident about programming. A few reported that they had learned web design but were unable to extrapolate that knowledge to code their own designs. In each class, one or two students could be described as proficient coders in web technologies, but they were not familiar with Python. Unlike traditional computer science students, students were interested in coding but had no intention of becoming professional coders.

The first time the course was taught, we did not account for math anxiety. Students did well using Python for basic mathematics calculations. However, many struggled when using loops to process images or when following complex manipulations. In subsequent classes, more time was spent on visualizing information flow through a program (e.g., showing how pixels were addressed, or how each position of a string or list was manipulated).

From the onset, the class was designed to heighten students' awareness of current sociocultural, technology, and media arts themes. The instructor strove to connect with students' interests in the course. The instructor shared information about the local interactive fiction, game-development, and demoscene communities. Emerson College students talked about trips to Penny Arcade eXchange, Game Developers Conference, and political rallies. Students were asked to discuss personal projects (such as LGBT activism or applying for citizenship). The instructor used knowledge about student interests to facilitate connections between students and to select interesting data sets to study.

Appealing content motivated students to persist in tackling intricate challenges. Social media application-programming interfaces (APIs) were exciting, and students frequently turned to Flickr and Twitter APIs for their final projects. They readily looped through Twitter data to find nested details. One student used semantic analysis to collect a corpus of sexual harassment postings from the #MeToo movement. Another student documented the pervasiveness of racism online. One student commented,

> I'm a visual learner, so when we got to Processing, I saw how I could use it to create a prototype for my TalkHer App. It's a social network for women to connect with each other about politics, activism, and news. (Spring 2017)

That student used her prototype to pitch a socially motivated startup at MassChallenge, a statewide accelerator program

In every class, there were two to three students who were recovering from medical, emotional, or psychological issues. Students disclosed test anxiety, math phobia, adverse medication reactions, depression, and drug rehabilitation issues. Beyond ensuring that each student received professional support from the college support infrastructure, demystifying coding as "just editing a special kind of text" and focusing on the process of continuous creative output seemed to boost self-confidence. Giving them opportunities to express themselves through code helped them feel supported and valued. Personalized attention and immediate feedback from classmates who met regularly encouraged students to ask questions and sound out their developing ideas.

Recognizing students as individuals was essential to their success. Face-to-face interactions provided avenues for informal feedback to identify stumbling blocks. Smaller groups led students to recognize that their individual contributions were valuable and unique. Students were asked to switch partners each week so that they could interact deeply with many different people. For each assignment, students were encouraged to share their intent. These personal disclosures helped students form final-project groups. Students cared for each other's welfare. When students were absent, group members would reach out and keep each other informed. On return, students often shared with the class any insights while learning outside of class.

Many students remarked that they valued help from fellow students. Experienced students often completed the challenges early. These star students would then guide peers through coding and assisting the teacher. The class was also satisfying for advanced coders because they could share their works regularly with a live peer audience. These students enjoyed showing others how they could extend the basic lesson. This arrangement allowed the instructor to devote more attention to solving harder problems or addressing students who needed individual help beyond what a fellow student could explain.

**Appropriate, modify, reuse to iterate quickly.** Tinkering with code can yield satisfying results more quickly than building up from scratch. Once students developed an intention to explore, the class took off. Students figured out how to figure things out, and they could identify potential solutions and test them quickly. By experiencing, iterating, and combining resources, students settled on a desired result.

**Frequent individualized assessment of coding progress.** Each class provided ample opportunity to code together, like in a coding support group. The act of programming anything, even something small, was a good precursor to tackling larger pieces of code. Many assigned tasks required little effort but prepared students for thinking in code. Tangible outputs from lectures and homework provided another avenue for gauging progress. More numerous outputs, interactions, and peer reviews resulted in higher mastery and project quality.

**Encourage informal learning.** In later classes, the coding prompts were designed to help students break their final project into manageable pieces. The instructor encouraged students to try programming outside of class—for example, while sitting on the train or waiting for a meeting. The idea was to see coding as a casual activity that could happen outside class. The instructor also wanted them to experience coding as cultural currency—which students could do together socially. Students were shown interviews of programmers working together casually, talking about collaboration.

**Use final projects to connect students with professional tools and people.** In the last three weeks, a final project was proposed. Students had to craft an interesting experience using computation. Outside reviewers were invited to critique students' final presentations and demos. A mix of academics and professional programmers attended. Some visitors examined code and discussed implementation choices with students. Visitors asked questions about the cultural implications or reflected on artistic merits. Many students felt camaraderie with these visiting practitioners. It bolstered student self-assurance to be considered as colleagues.

### Considerations That Foster Collaborative Feedback and Sharing

Internet access and a projector were required for teaching the class. Students brought their own laptops. All the learning resources were freely available. However, the following considerations helped foster collaboration and learning:

**Furniture mobility had a large effect on group collaboration.** One semester used fixed seats. People were reluctant to change partners because it was inconvenient to hop over seats. Flexible-use classrooms allowed students to transition between working independently and together. Participants started off in a circle for face-to-face discussions, working separately on their laptops. Then, when one person wanted to share a solution or needed help, all would cluster behind one screen. Movable chairs and desks enabled students to quickly shift their shared visual reference. Physical proximity when working together heightened the level of intimacy and increased ease in informal discussions. Control over their space enabled others to retreat from the group when needed.

**Class size affected the feedback that people were able to give each other.** In small classes, people had the opportunity to work together multiple times. More frequent interactions were desirable, and students in small classes benefited from a frequent history of working together. It was easier to give students personal guidance when there were fewer students. Approximately 15 students per class was manageable and yet allowed for enough interesting variety in projects, programming abilities, and cognitive diversity. In peer reviews, students in larger classes reported more interpersonal conflicts and were more selective about working with others.

**Physical presence enabled immediate informal discussion and sharing.** By troubleshooting problems in situ, progress was efficient. Student examples often spurred people to riff off one another. When students faced an issue, they could share their findings without the need to properly compose a solution. Others working at different paces may have missed the sharing. To preserve these teachable moments, the instructor kept a “Hall of Fame” of solutions to share at the next class.

**Students were coached on how to work effectively in groups**. Students were assigned new partners every two classes so everyone could practice working with diverse working styles. At midsemester, confidential peer surveys were given to address expectations. Students were counseled on being responsive and communicating clearly. Because of attendance issues or large class sizes, some people may not have worked together. Peer reviews from people who had not worked together were not useful. However, multiple positive experiences working in groups helped struggling students improve.

### Sustainable Self-Learners

Many students went from never having seen code to being proficient using libraries and repurposing code. Students tackled APIs even the teacher had not used (such as TensorFlow or Unity’s Twitter API). Some used the Natural Language Toolkit sentiment analysis to visualize political tweets, sexual harassment, and mental health stigmas. Another group scraped news sites to identify partisan bias, scoured the Internet Movie Database to suggest movies, or searched GameSutra to create a visualization of game reviews. One student made MemeCaptionBot, a Twitterbot, to explore crowdsourced voting. They circulated a photo and calculated which captions received the most retweets. The bot superimposed the winning caption onto the photo and posted the meme. Another student wrote a motivation bot to retweet encouragements from Twitter. They learned to create a cron job to automate posts.

Yet another student proposed to redesign the Google Ngram visualizer using particle systems. They found a Python API to download the data. Then, they learned about particle systems by viewing Daniel Schiffman’s tutorials on YouTube. The student ported sample Java code into Python to prototype his design. “At first I thought I had to code it from scratch, but now I realize I can just combine things other people have done," said the student. At the final presentation, this student was thrilled to show his work to a programmer from Google.

This creative-inquiry process has many benefits. These search and appropriation skills are transferable outside of the class. Students of this method contributed to the greater knowledge available. Many uploaded their work to GitHub to be reused by others.

### An Explosion of Creativity Versus Chaos

The final projects varied widely in focus and aims. Students investigated cultural topics such as racism, gender rights, and politics. Other students pursued artistic explorations: for example, a dramatic play generator, a text-adventure based in their school locale, or a shared remote backup system for roommates. They explored relaxation, color identity, or more holistic topics. This explosion of ideas demonstrated that the exploratory programming model supported student interests and creativity. The final projects addressed so many different themes and employed such a wide assortment of technologies that reviewers commented, "Did they all take the same class?"

We were surprised with the breadth of student projects and yet pleased by variety. Even technically conservative students contributed interesting pieces worthy of discussion and peer interest. With only one instructor, it was challenging to give every student in-depth guidance. Additional technical support could provide more directed advice to scaffold each student's creative journey. One student posted his Unity questions online, with little success. He finally got help from a previous student who advised him on creating a virtual reality state machine in Unity. Such questions were beyond the instructor's firsthand knowledge and would have required much time to research. Creating academic partnerships with external programmers or institutions would accelerate students' learning potential. These partners could consult on specific student projects as needed and might not require much time from the experts.

## Conclusion

Although there are many approaches to learning programming, we believe the exploratory approach is ideal for helping casual programmers start their programming journey. Although this approach does not provide a thorough computer science education, it gives students programming knowledge that can lead to more serious study. Learners get hands-on experience with popular resources (languages, open-source repositories, and tools) used by many career programmers. They are taught a creative inquiry process that transcends any particular technological platform or predefined commercial output. Most important, developing these skills gives them the ability to connect with programming professionals via supportive online communities.

So, what does it mean to teach everyone to program? To suit a diverse population requires many different approaches. Exploratory programming emphasizes a technically and emotionally supportive local environment. The classroom helps students take fuller advantage of freely available learning resources and support from networked communities. We believe this approach promotes sustainable self-directed learning because it allows students investigative freedom to guide their work. This yields surprising and satisfying discoveries for the learner. In our study, students sought out challenging topics independently driven by their own curiosity.

We found that coding literacy is directly useful for nonprogramming majors. They use it to shine a unique lens on the world. Programming has cultural and ethical impact (Rushkoff, 2010). Exploratory programming can be useful for the general population, not just liberal arts students. Cognitively diverse programmers can make novel contributions to social, political, and cultural conversations.

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# Using Digital Badges to Promote Student Agency and Identity in Science Learning

**Katie Davis (University of Washington Seattle), Caroline Pitt (University of Washington Seattle), Adam Bell (University of Washington Seattle), and Ada Kim (University of Washington Seattle)**

**Abstract:** This paper investigates the potential for digital badges to support youth agency and identity in an after-school science program serving diverse high school students. We conducted contextual interviews with 36 students aged 14–19 participating in the program, inviting them to interact with a badge system prototype designed to help them track their progress through the program. Students were optimistic about the potential for badges to provide visible learning pathways, connect learning across contexts, and establish the credibility of the skills they acquired in the program. They also raised several challenges associated with sharing their badges with external audiences, such as the challenge of demonstrating the value of a badge and privacy concerns. This paper demonstrates how the design of a digital badge platform can successfully embody supports not only for student agency and identity in science learning, but also greater equity in and access to future learning and career opportunities.

## Introduction and Related Work

Agency—what learners can imagine themselves to be and to do (Barton & Tan, 2010; Holland, Lachicotte, Skinner, & Cain, 1998)—is key to achieving success in science learning. Agency is developed through everyday practices and active participation within a particular sociocultural context (Lave & Wenger, 1991; Nasir & Hand, 2008). The recognition that students receive from teachers, family members, and peers helps them to define their capabilities, which directly impacts their developing identities as learners (Barton & Tan, 2010; Nasir & Cooks, 2009). In this way, agency and identity are deeply intertwined and central to learning.

Existing research demonstrates how important it is to account for agency and identity in science learning, particularly with respect to reaching diverse learners, who are traditionally underrepresented in science-related fields (Barton & Tan, 2010; Bricker & Bell, 2014). Barton and Tan (2010) explored how youth represented themselves as community science experts in an after-school science program that took place in and centered on their neighborhood community. Students were able to study the scientific process of urban heat islands at their own level of interest. The learners were given the opportunity to take on the role of scientist by presenting their findings to the community, which supported their agency in developing science identities. Similarly, Nasir & Hand (2008) documented the development of agency and self-expression (identity) among a group of African American high school students as they participated in a mathematics class and on their school's basketball team. Students' practice-linked identities were supported by giving them the opportunity to compare themselves to experts in their fields of interest and by allowing them to see what learning pathways were available to them in the future.

In another example, Bricker and Bell (2014) articulated the importance of affirming a learner's agency and identity by documenting a young girl, adopted from Haiti, and her interest in science. During perfume-mixing sessions at home with her mother, the young learner participated in authentic science practices of measurement, tracking and labeling, systematic journaling, and apparatus use, all of which contributed to her feeling like a scientist. She gained affirmation from her mother, who viewed her as a person capable of doing science activities in everyday life. These jointly constructed science activities positioned the girl on a cultural learning pathway that was grounded in her personal interests and developing science identity (Bell, Bricker, Reeve, Zimmerman, & Tzou, 2012).

This research demonstrates that, for students to experience success in science, it helps if they see themselves as people who can do science and for whom science plays an important role in their lives. This work also shows that informal settings are typically more successful in this regard than formal educational settings, giving students greater control over their learning (Clegg, Gardner & Kolodner, 2010; Crowley, Barron, Knutson, & Martin, 2015). At the same time, informal settings present their own set of challenges with respect to supporting learners' developing sense of agency and identity. Students may receive little guidance in how to manage what they have learned and to plan what they are going to learn next. To make decisions about what kinds of science knowledge they want to learn, students need to see possible options in the learning pathways available to them. They also need channels to display their accomplishments in out-of-school settings in order to gain recognition for their developing science identities (Bell et al., 2012; Ito et al., 2013).

Prior work has explored ways to use sociotechnical systems to support students' science learning, such as Quest Atlantis, River City, EcoMuve, and Whyville (Bruckman, 1998; Kafai, 2010; Kafai & Dede, 2014; Scardamalia & Bereiter, 2014). Using the text-based virtual reality program MOOSE Crossing, for instance, Bruckman (1998) studied the formation of a science-based community of practice among 8- to 13-year-olds. In this online environment, students formed identities and developed agency by sharing skills and knowledge and receiving feedback from others. In another example, the virtual platform of Whyville engaged players from ages 8 to 16 in science activities, many in the form of games (Kafai, 2010). Whyvillians were able to create avatars of themselves that were seen by other players, participate in community message boards, and engage in collaborative science games (e.g., Whypox). Findings from studies of these activities identified how the online collaborative world facilitated a social learning context for constructing science identities through directed play (Kafai, 2010). Virtual environments such as MOOSE Crossing and Whyville enabled knowledge building and supported learners' sense of agency by giving them opportunities to shape objectives, acquire resources, implement strategies, and evaluate outcomes (Scardamalia & Bereiter, 2014).

Such efforts to support learning in virtual worlds empower students by creating spaces for them to practice being scientists separate from their real-world spaces (Kafai & Dede, 2014). Another approach to supporting agency and identity through sociotechnical systems is to use them to document and recognize science learning that takes place in real-world contexts. Digital badge platforms represent a specific type of sociotechnical system that aims to do just that. Digital badges are web-based digital icons that contain metadata associated with specific learning goals and outcomes (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013). As openly networked platforms, badge systems hold promise for promoting equity and access in learning by making it possible for all students to view their learning trajectories and share their skills and accomplishments across a variety of contexts (Davis & Singh, 2015; Riconscente, Kamarainen, & Honey, 2013). Currently, students who already have access to learning and career opportunities in science are the ones who receive the greatest support for showcasing their science achievements (Davis & Fullerton, 2016; Klein & Davis, 2016). Badges hold promise for disrupting the status quo by recognizing and validating science achievement across and within personally defined trajectories for learning, as opposed to a one-size-fits-all model of science achievement that excludes many learners (Cannady, Greenwald, & Harris, 2014). However, little empirical research exists that explores this promise of digital badges systematically.

We address this gap in research through contextual interviews with 36 high school students participating in an after-school science program. Through these interviews, we explored how students perceived a digital badge platform designed to embody supports for agency and identity in informal science-learning contexts. We discuss how insights from this study can be used to support efforts to promote equity and access in science learning.

## Method

The goal of the current study was to investigate how students perceived a digital badge platform designed to embody the conjecture (Sandoval, 2004) that students' developing science agency and identity are supported when their skills and achievements are visible to and valued by audiences of import, and when they are placed in control of their learning pathways. We were guided by the following research question: *What opportunities and challenges did students perceive in the design of the digital badge platform?*

### Badge Platform

The badge platform was designed with input from the program coordinators and students in the after-school science program (Davis & Singh, 2015; Klein & Davis, 2016). It comprises a front-facing website in which each student in the after-school program has a personal profile (see Figure 1). When students log into their profiles, they can see the badges they have earned and those not yet earned, keep track of their progress, view their friends' badges, and share their progress with people outside the program.

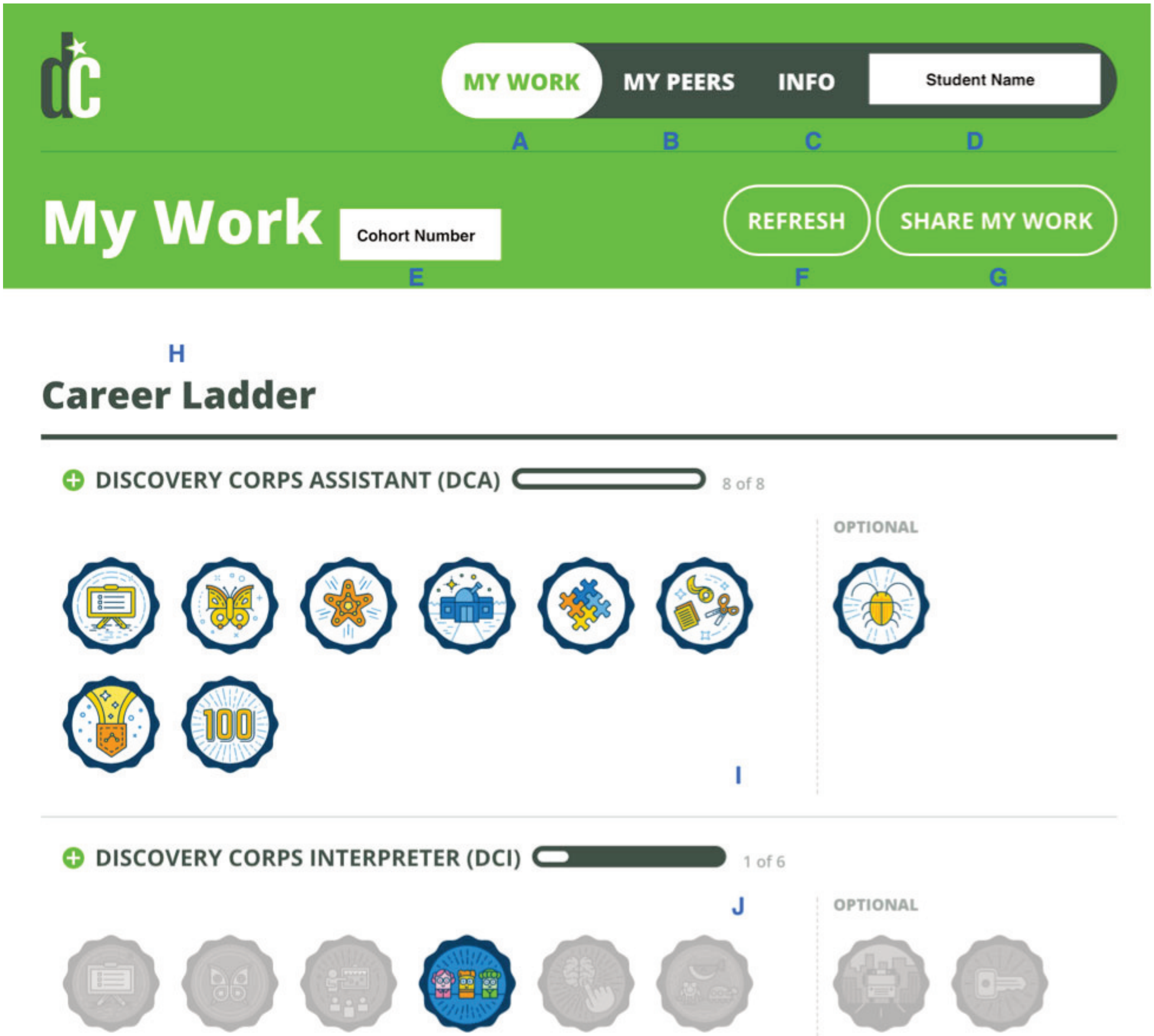


*Figure 1. Screen shot of a hypothetical student's badge profile page. A. "My Work" button; B. "My Peers" button; C. "Info" button; D. Student's name; E. Cohort number; F. "Refresh" button; G. "Share My Work" button; H. Career Ladder, showcasing badge pathways; I. DCA Badges: full-color badges represent those badges that a student has already earned; J. DCI Badges: grayscale badges represent unearned badges.*

## Research Site and Participants

The research site was the Science Center of a major city in the Northwest United States offering an after-school science program for high school students. The program is designed to support science learning and job-skill training among diverse high school students until they graduate from high school or an academically equivalent program. The program is organized around a hierarchical curricular structure called the "Career Ladder," which engages youth participants in increasingly advanced levels of science learning and training. When students have demonstrated their mastery of job positions at one level of the Career Ladder, program coordinators promote them to the next level.

With help from the program coordinators, we successfully recruited 36 of the 65 students enrolled in the program (55%) to participate in a one-on-one, in-person interview. We worked with the program coordinators to select a mix of students who were representative of the larger student body. Of those interviewed, 53% (19) were girls and 47% (17) were boys, and the age range was 14–19 ($M$ = 16.4 years). The sample was 31% (11) Asian, 22% (8) White, 22% (8) African American, 6% (2) Latino, and 19% (7) identified as other ethnicities. This racial/ethnic breakdown is considerably more diverse than the city's public school system, which was 47% White in 2016, the year we conducted the study. In terms of socioeconomic status, 47% (17) reported that their mother/female guardian had less than a four-year degree, 25% (9) had a four-year degree, and 22% (8) had a higher degree. The remaining 6% (2) responded "unknown."

### Data Collection

The research team conducted interviews lasting 30–40 minutes from late April 2016 to mid-May 2016. All interviews were recorded and transcribed verbatim. The interview protocol asked students a variety of questions about their school and after-school science-related activities, their feelings about science, and their plans for pursuing science in college and beyond. The last section of the interview—the focus of the current analysis—was a contextual interview (Beyer & Holtzblatt, 1995) inviting participants to assess the digital badge platform prototype developed during the course of the project. Interviewers displayed the prototype on a laptop screen and asked participants to comment on it. The interview was piloted in December 2015 with three program students and revised according to feedback provided by the students and the project evaluator.

### Data Analysis

Using thematic analysis (Boyatzis, 1998), two members of the research team developed a coding scheme based on themes identified in a prior study investigating stakeholders' views of digital badges (Davis & Klein, 2015), as well as themes that emerged inductively from an initial review of the interview transcripts. To ensure that codes were applied consistently and accurately, two coders each coded a set of three randomly chosen interviews and came to consensus (Smagorinsky, 2008). In this first round of reliability coding, the Cohen's Kappa values for the badge-related codes ranged from 0 to 1, with an average Kappa value of 0.71. The second round of reliability coding consisted of another set of three interviews, focusing on the code groups that had Kappa values less than 0.6. The average reliability for this round was 0.96, ranging from 0 to 1. The only code below 0.70 was one of the badge opportunity codes: provides a permanent record of learning, accomplishments, which occurred only once. Because of its low occurrence, researchers decided to discuss and come to consensus for this code each time it arose during the coding process. Having reached acceptable levels of reliability (Landis & Koch, 1977), the coders divided the remaining interviews and completed coding.

## Results

### Students' Perceptions of Digital Badges

After being shown the digital badge prototype, 75% (27) of the interview participants reported having an overall positive opinion of using digital badges at the Science Center. Maya (all names are pseudonyms), age 16, stated:

> I think it's a good idea because it would be really hard to explain everything I did in the program on my

> [college] application and just a link would direct college admissions [officers] to my achievements and what I did.

Another 22% (8) of the interviewees were ambivalent about the prototype. Larry, age 17, said: “I’d say I feel personally, pretty neutrally about them. They don’t really do a whole lot for me, but I see their potential to be helpful.” Colin, age 16, was the only one to express outright dislike for the idea, stating: “I think I’m gonna say that I don’t like them very much at all. I feel like they might just create too much competition between members of [program] and that the badges feel very unprofessional.”

### Opportunities

Consistent with their generally positive attitude toward the badge prototype, students discussed specific opportunities associated with badges more frequently than challenges. Across the 36 interview participants, opportunities were mentioned a total of 195 times, whereas challenges were mentioned just 69 times. The three types of opportunities mentioned most frequently were that digital badges could: (a) provide visible learning pathways (discussed by 83% of students), (b) connect learning across different contexts (78% of students), and (c) establish the credibility of a learner’s skills and accomplishments (78% of students).

In terms of *navigating learning pathways*, many students stated that the badge platform would help them to understand their current position in the program and empower them to visualize their future learning goals. Max, age 17, observed: “This [badge platform] would be really helpful to know what next steps do you wanna take or … [w]hat skills do I wanna emphasize first.” Students also thought that using digital badges would motivate their learning, as Olivia, age 18, said: “[By knowing] what you need to do to get to the next thing, it might motivate you to work quickly to get more badges.” Sarah, age 15, described how using digital badges could give students agency in documenting their own learning pathways: “It’s pretty interesting and it’s an easy way to keep track of your accomplishments. … Going through your achievements, feeling proud of yourself … and possibly a way to keep up with what you’ve done.”

With respect to *connecting their learning across different contexts*, students saw clear benefits to the digital badge platform. Ross, age 17, said: “I think they’d definitely be more useful than just like a poster in like a room [physical poster in program office]. … Outside of the Science Center, you can have access to that information and to share with others.” Students explicitly indicated that using digital badges would help them demonstrate transferable skills in different settings. Yvonne, age 16, explained, “For employers, they are looking for people to hire that have a certain set of skills that they are looking for […] plus since it’s not you editing that, it’s other supervisors and other employers updating it, you can’t lie about it.”

Interviewees also highlighted the importance of being able to explain the after-school program in different contexts and how it helped develop their science skills and identity. Maya, age 16, stated: “Well, it would show that you developed all these skills, and that they [external audiences] can see how well you did in that program, and your interest in science a lot.” Victor, age 16, particularly focused on the explanatory nature of the badges: “Especially since you guys have descriptions of what each badge meant. … Obviously you would just show them [external audiences], ‘Oh, I got this badge,’ they wouldn’t know what it means, but with the description that would help.”

Students expressed that digital badges would *increase the credibility of their learning and achievements* in and out of the Science Center. Ross, age 17, observed: “Especially with the soft skills like teamwork and leadership, that's something that's really important and there are a lot of core values for a lot of colleges … it's good to have proof of it." Adele, age 17, believed the platform would give her both credibility and more agency:

> This would be really, really useful for college applications because I'm pretty sure if we just went up to them now and said, 'I worked at [program]' … I don't have any proof of anything. … If they wanted anything, I have to go through a really long process of 'Hey, [supervisor]' or something**.**

### Challenges

The most commonly mentioned challenges that students mentioned were that digital badges might (a) be no more valuable than a résumé line/add no value (discussed by 42% of students), (b) place undue emphasis on extrinsic rewards (31% of students), and (c) introduce privacy concerns (31% of students).

Larry, age 17, pointed out that *badges might not add discernable value to a résumé or application* and might even add unnecessary work for college admissions officers, "And that [the system] might be a big positive for some, but for others I feel like it would just be, 'I have to learn this system now; I don't want it. What is this, just tell me.'" Similarly, Colin, age 16, expressed concern about whether external audiences would understand the value of badges: "It feels very … a lot like showing off your video game achievements. I feel like people might see them and say, 'Oh, that's interesting,' and then not take your job as seriously as you want it to be."

Although many interview participants described how digital badges could motivate them to move forward in their learning pathways, several students thought that badges might *promote competitiveness* in a negative manner or make the process of advancing in the program seem daunting. Alex, age 18, explained: "Yeah. [I think there might be] a little bit of extrinsic motivation … with being able to see everyone else's [badges]. I think that there might be a little bit of … jealousy and stuff." Colin, age 16, also expressed mixed feelings about the extrinsic nature of badges:

> It's just like a wall of like empty badges that you need to fill. It does feel a little intimidating. It's kind of like when you enter a new video game and you haven't completed all of the levels and you complete them and then you look back, and you're like, "Whoa, that's a lot." I feel like it can seem a bit intimidating as well.

Colin was concerned that the badge system would place undue focus on completing achievements rather than documenting learning.

Some students raised *privacy concerns* linked to displaying their achievements through the badge platform, as Lily, age 15, said: "I think it depends on whether they [students] feel comfortable in sharing that information. And it also depends [on] what kind of information [is shared]." Nathan, age 15, explained:

> [An admissions officer said] "Anything that you put on social media, and these websites, they look you up, and they find all of it. There's nothing to hide on the Internet." And, again, if someone didn't get that many badges, and everyone else's profiles are on there, I'm afraid that it would make me or some of [the] other members look bad.

While students such as Nathan felt comfortable having the badge platform as a personal and program resource, they were more cautious about sharing their achievements with broader audiences, citing privacy concerns and trepidation about linking their work with their social media profiles.

## Discussion

The current investigation explored the potential for digital badges to support youth agency and identity in an after-school science program serving diverse high school students. This work is motivated by the recognition that agency and identity are important factors for engaging and supporting the success of students who are typically underrepresented in science-related subjects and careers (Barton & Tan, 2010; Bricker & Bell, 2014; Nasir & Hand, 2008).

The results demonstrate the potential for a sociotechnical system—in this case digital badges—to document and recognize science learning that takes place in real-world contexts, as opposed to systems designed to support learning in virtual worlds that are separate from students' real-world spaces (Kafai & Dede, 2014). Our contextual interviews showed that students were generally enthusiastic about digital badges, identifying considerably more opportunities than challenges. The top opportunities they identified suggest that students were able to recognize the potential for digital badges to help them gain recognition for their achievements and experience control over their learning pathways in the science program. Recognition of alternative forms of credentialing has the potential to increase equity in science-learning pathways by allowing students to use experiences from outside the classroom as evidence of their learning accomplishments (Tyson & Roksa, 2016). Increased awareness and use of these alternative credentials may allow more diverse students access to science-learning and career opportunities (Spaulding & Johnson, 2016; Wyn, Cuervo, Crofts, & Woodman, 2017).

At the same time, the students identified challenges associated with sharing one's badges to external audiences, which align with previous related research (Davis & Klein, 2015). Doubts about the external credibility of badges, as well as privacy concerns related to sharing badges publicly represent challenges that must be overcome if badges are going to succeed in realizing the potentials documented in this study.

### Limitations and Future Work

The diversity of our sample of high school students represents a strength of the current investigation, allowing us to capture the experiences and viewpoints of a wide range of learners. At the same time, we must acknowledge that this sample was drawn from one science program in one particular city in the United States. It would be worthwhile in future work to examine the experiences of students in different geographic regions across the country, particularly more rural areas, which are not represented in the current study.

The results point to the potential for digital badges to support learners' science agency and identity. In our future work, we will investigate the extent to which this potential is realized in the implementation of the badge platform in the after-school science program. Specifically, we will track students' use of the platform and how their opinions of it change over time, paying particular attention to whether and how badges help place students in control over their learning pathways and help them to display their accomplishments to audiences of import.

## Conclusion

Prior work has demonstrated the importance of agency and identity in science learning, particularly for students who have traditionally been underrepresented in science. The current investigation extends this work by demonstrating how supports for student agency and identity in science learning could be embodied successfully in the design of a digital badge platform intended to track and showcase their learning in an after-school science program. Students in the program were overwhelmingly enthusiastic about the badge platform and identified numerous opportunities associated with its incorporation into the program. The findings from this investigation point to the potential not only to support science agency and identity, but also to provide supports for increased equity in science-learning pathways.

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# Technology Use in Rural and Urban Public Libraries

## Implications for Connected Learning in Youth Programming

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**Abstract:** Public libraries represent fertile ground for promoting connected learning. However, there is great variation in public library systems across the United States, with important implications for the way connected learning is introduced and implemented in specific libraries. This paper examines variations in the way youth-serving library staff in rural and urban library systems employ technology and enact connected learning in their youth programming. We conducted interviews with 46 youth-serving library staff working in rural (22) and urban (24) public libraries across the United States. Our analysis revealed differences between rural and urban libraries in the range of their community partnerships; the roles that their librarians and youth assume in designing, leading, and evaluating youth programs; and their sources of external support. We discuss the implications of these findings for designing professional-development initiatives that are tailored to the distinct contexts in which public youth librarians work

### Introduction

Public libraries are increasingly recognized as promising spaces to promote connected learning—learning that is interest-driven, peer-supported, and connects youth to academic and career opportunities (Hoffman, Subramaniam, Kawas, Scaff, & Davis, 2016). Libraries are well positioned to introduce their youth patrons to hands-on learning experiences that engage them with their peers and adult mentors around a shared purpose (Subramaniam, Scaff, Kawas, Hoffman, & Davis, 2018). Many libraries are discovering ways to incorporate digital technologies that enable youth to gain important skills while creating something of personal value, such as e-textiles or music recordings.

Not all libraries are the same, however. They vary in size, staffing structure, availability of resources, opportunities for professional development, and access to community partners, among other distinctions (IMLS, 2017; Real & Rose, 2017). Often, these differences are tied to geography. The set of resources and challenges experienced by librarians serving rural communities are bound to be distinct from those experienced by librarians serving suburban or urban communities. Differences in broadband access, physical space, and the sociodemographic characteristics of youth patrons will undoubtedly affect the types of youth programming that librarians choose to offer.

We extend prior work on connected learning in public libraries by investigating how youth-serving librarians and staff enact connected learning in rural and urban libraries. We interviewed 46 youth-serving librarians and staff working in rural (22) and urban (24) public libraries across the United States. We asked participants to describe their current youth programs, their use of digital and networked technologies, and the successes and challenges they have faced while creating and implementing youth programs. Our results contribute new insight into the distinct challenges associated with implementing connected learning in diverse library systems. We consider implications for tailoring professional-development initiatives to the particular contexts in which public youth librarians work.

## Related Work

### Connected Learning in Libraries

The connected learning framework centers on youth interests, opportunities, and relationships (Ito & Martin, 2013). Public libraries are spaces for informal, self-directed learning for youth from nondominant backgrounds, who have been traditionally excluded from institutionalized sources of privilege (Ito & Martin, 2013). Libraries are also social centers and technological hubs in their communities, making them natural environments for connected learning (Braun, Hartman, Hughes-Hassell, Kumasi, & Yoke, 2014; Hoffman et al., 2016). Many public libraries in the United States have embraced participatory learning, making connections across their communities, as evidenced by the proliferation of learning labs, makerspaces, teen hangout spaces, media production facilities, and community partnerships (Hill, Proffitt, & Streams, 2015; Hoffman et al., 2016). Youth-serving librarians are encouraged to move outside their comfort zones and learn new technologies alongside their young patrons, becoming colearners and collaborators instead of instructors (Braun & Visser, 2017; Martin, 2017).

### Rural and Urban Contexts for Connected Learning

In our review of existing academic and practitioner literature surrounding connected learning in libraries, we found that most attention focuses on urban libraries, leaving rural libraries with little representation (Hoffman et al., 2016). However, rural libraries represent 38% of all public libraries in the United States (Real & Rose, 2017). Additionally, rural libraries face unique challenges to implementing connected learning, including limited broadband access, funding sources, and available partnerships (Real & Rose, 2017). There is no single consensus on the definition of *rural* (Swan, Grimes, & Owens, 2013), although a 2007 ALA-APA survey demonstrates that most rural library staff describe “rural” in terms of population size, distance from a city, and/or being within an agricultural area (American Library Association [ALA], 2007). Regardless of the definition, there are clear differences between urban and rural library systems that have bearing on their ability to enact connected learning, as detailed below.

Examples of innovative connected learning initiatives tend to come from library systems based in heavily populated areas such as Chicago (Austin, Ehrlich, Puckett, & Singleton, 2014; Ito & Martin, 2013). For example, the YOUmedia program in Chicago Public Library provides a safe space for teens to explore their interests and develop relationships with peers and mentors (Austin et al., 2014). However, examples of connected learning environments in urban and well-resourced library systems are not the most fitting models for rural library staff to envision what connected learning could look like in their libraries.

Although both rural and urban libraries are important providers of Internet access for people who lack access at home, filling this need represents a greater challenge in rural areas, where fully 45% of adults are without Internet access (Horrigan & Duggan, 2015). Additionally, the infrastructure for broadband Internet in rural areas does not always exist; even when it does, it often costs more than in urban areas (American Library Association, 2016; Real & Rose, 2017).

Local governments largely fund library budgets. Since people in rural areas have lower incomes, on average, and are more likely to be retired, resulting in lower tax revenues, rural libraries tend to have smaller budgets (Real & Rose, 2017). Rural library systems also tend to be smaller than urban libraries—90% have a single location—making them less able to take advantage of "economies of scale" such as resource sharing, training, and bulk purchasing (Miller, 2017; Real & Rose, 2017). Libraries in urban areas receive more funding from nongovernment sources. Sin (2011) speculates that this may be because these libraries have more resources to dedicate to fund-raising or grant writing, or because their patrons are more able to support the library financially.

Youth programming differs between rural and urban contexts in the United States as well. Fewer rural libraries offer formal after-school programs (26.5% of rural libraries vs. 51.4% of urban libraries) and STEAM events (19.7% of rural libraries vs. 48.9% of urban libraries); fewer rural libraries (42.6%) offer social, peer-supported events for young adults than urban libraries (78.9%; Real & Rose, 2017). Rural areas also have fewer community organizations available to partner with or receive support from. A 2007 survey reports that only 43% of rural libraries had at least one community partnership, most commonly with schools, homeschoolers, and/or daycare centers (Flatley & Wyman, 2009). Urban libraries can partner more easily with local businesses and informal learning institutions.

In light of these differences between rural and urban library environments, in this paper we seek to understand what factors have an effect on how youth-serving librarians and staff enact connected learning in rural and urban library systems.

## Method

This paper draws on work completed in the first year of a three-year project, ConnectedLib, funded by the Institute of Museum and Library Services (IMLS). The project, a collaboration between researchers at the University of Washington and the University of Maryland, and library partners at Providence Public Library, Kitsap Regional Library, and Seattle Public Library, is creating a set of continuing education modules that will introduce connected learning principles to public youth services librarians.These methods have been previously discussed in detail in Subramaniam, Scaff, Kawas, Hoffman, & Davis, 2018.

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### Participants and Data Collection.

In 2015 and 2016, we conducted in-depth phone and in-person interviews with 46 youth-serving public library staff to discuss their use of technology in teen services. Our sample consists of 24 library staff who self-identified as working in rural libraries, and 22 library staff working in urban areas. Geographically, the participants came from 33 states and the District of Columbia. Our decision to include rural and urban libraries, and not suburban libraries, is deliberate. It is a recognized challenge to establish precise boundaries delineating suburban areas (Fahrenthold, 2013; Swan et al., 2013). Suburban environments can look more like urban or rural areas depending on how these boundaries are drawn. Thus, to maintain analytic clarity, we have opted to focus our analysis on comparing and contrasting rural and urban library contexts. This strategy also allows us to provide sufficient depth of analysis for each context within the publication format.

The protocol used in the interviews included many questions, including several that asked about library staff's youth populations, use of technology in youth programming, and partnerships, in addition to questions designed to gauge to what extent their programs integrated connected learning. We introduced connected learning only at the very end of the interview, to determine librarians' familiarity with the concept.

### Analysis

Our research team used a joint iterative process (Smagorinsky, 2008) to create a coding scheme using thematic analysis (Boyatzis, 1998). The codes were designed to align with the connected learning framework (Ito & Martin, 2013) and address our overall research goal, which is to understand those factors affecting youth-serving librarians' ability to enact connected learning in rural and urban library systems. The collaborative, iterative discussions that involved all researchers helped us ensure that the interpretation and use of codes was consistent among coders. We calculated Cohen's Kappa statistics for each code, eventually achieving an average Kappa statistic of 0.98, with an extremely satisfactory range of 0.76–1.00 (Landis & Koch, 1977). Coding was completed using Dedoose, a software platform designed for qualitative analysis.

## Findings

In our analysis, we used participants' descriptions of their youth programs and associated technology use to look for evidence that they were—or were not—enacting connected learning principles in their library settings. The following four themes emerged in our analysis as the most influential factors shaping the ability of rural and urban youth librarians to offer connected learning programs for youth: (a) community partnerships; (b) the roles that librarians tend to take (or think that they should take) in planning and implementing technology-based programming for youth; (c) youth involvement (or lack thereof) in program design and evaluation; and (d) existing external supports to offer technology-infused programs. These factors repeatedly emerged in our analysis (in 18 or more librarians interviewed per library type). However, we acknowledge that there were a very small number of librarians representing each library type for whom these factors were not central. The themes and quotes we present below are representative of the vast majority of rural and urban library participants.

### A Range of Community Partnerships

The urban librarians we interviewed described a diverse portfolio of partners that offer technology equipment, technology expertise, space, mentorship for youth programming, and also advocate for youth participation. Partners can vary from youth organizations, local industries, community colleges, higher educational institutions, technology companies, local foundations, public and private schools, museums, science centers, and law enforcement to local artists, tattoo artists, graffiti artists, and other individuals who have jobs where youth have expressed an interest.

Rural librarians, by contrast, tended to have a rather limited pool of partners in their community, with many being able to name only one partner that they have worked with. Most often, when discussing partnerships, rural youth-serving librarians referred to their local public school as their partner. Brian, a youth-services librarian at a Western library, explained the nature of his library's partnership with the local school:

> We really appreciate those partnerships, because it allows us to go into the schools, but it also allows us to reach those students that are underserved. Most likely, if they are at an after-school program, their parents might not have as much opportunity to get to the library. … So being able to take those technologies … and expose those kids to them …

The partnerships that rural librarians establish are focused on bolstering two purposes for their youth programming. First, they seek partners to supply the space and/or technology needed for a desired program. Second, rural library partners provide support in the form of troubleshooting and maintaining technological equipment in the library, as well as advice on what equipment to buy. Leilani, a children's librarian at a Western library, shared about "the guy" they have who is "a retired electrical engineer and … [has] been advising us on what to buy and whatnot."

Urban librarians are able to leverage partnerships that transform their youth-program offerings, in addition to providing technology support, equipment, and space, as described by the rural librarians. By offering programs in conjunction with community partners (e.g., a combined effort between the Boys and Girls Club and the library), urban libraries can have a greater impact on youth than if they offered a program by themselves. They can also tap community partners for their expertise in technology and associated literacies (e.g., digital photography, woodwork, music, wearable art) and for their ability to serve as mentors in technology projects (e.g., in workshops such as "How to Be a YouTube Star" and "Girls Who Code").

### Expert or Facilitator? Librarians' Shifting Roles

Almost universally across our sample, rural librarians positioned themselves as experts in the youth program they offered, or they said they feel as if they have to be experts of technology in order to be able to offer technology-based programs. The practice of librarians' being the expert and/or provider of information is a model that librarians have been accustomed to through the story-time programs that every library in the nation has been offering for decades. Brian described this longtime practice:

> You start with a story time, and it's a librarian doing a program for an audience. There's obviously that back and forth. …The kids are involved when they come, but it's still very much a presenter and audience. … It seems that many libraries still have kind of that take on programming.

As a result of this practice, rural librarians do one of the following: (a) They offer technology programs they believe that they (or another library staff) have expertise in and "teach" teens how to use that technology; or (b) they provide the technology without any knowledge of how to facilitate its use. This second point is illustrated by a description of the 3D printers that Tim, an assistant librarian in the West, brought into his library. "So I've been trying to bring technology in, but at this point, I haven't come up with a good plan on how to actually employ it with the kids." Only a few rural librarians said they offer technology programs that feature a community partner or youth taking the leadership role in facilitating the program.

We found evidence of urban librarians who are more open to inviting teens and community partners to facilitate technology-based programs, while they take on a more supporting role. The following example demonstrates how Holly, an urban librarian from a Western library, framed her role as an expert, learner, and facilitator in a STEM program that she offers at her library:

> I had a Science Explorers Club that met twice a month at one of my libraries. … I actually used my older teen

> volunteers as mentors, like peer mentors, to come and help out the tweens and the parents with any kinds of experimentation that we would do. … I always did a training session with them before each Science Explorers program. So they understood the concepts really well and knew what their jobs were, and then we created stations in which they were manning. And so they had some sort of mastery over this concept. And then I was there to sort of facilitate and answer the harder questions, and to make sure that everyone was included in doing something.

### The Nature of Youth Involvement

Very rarely, rural librarians described including youth voice in the design of their programs. More typically, they based their program design on the resources, access, and expertise available within their library. Carmen, a youth-services librarian at a Northeastern library, shared her thoughts on rural librarians' ability to design interest-driven programs:

> You always have to start with an idea. In a perfect world, you'd be able to follow exactly what the kids are interested in. It's not always possible, but I think the librarians do their best. They do what they can. It also depends on time, and the weather, and transportation is a big issue in…

In addition to transportation and proximity issues, many rural librarians struggle with getting youth to come to the library to participate in any program. Lily, a teen-services librarian at a Western library, observed:

> And then as soon as they get a little more autonomous, suddenly, [coming to the library is] not something they really wanna be doing. They're busy, they … It's just not the thing anymore, and if we can keep them interested, if we can keep them … If we can keep our activities up to what they need, and what they want to a point, then, hopefully they'll keep up the community involvement.

This quote suggests that part of the challenge rural librarians face in getting youth to come to the library involves the difficulty they have with gauging youth's interests.

Our urban librarian participants described a variety of ways they engage youth to share their interests. These strategies include inviting youth to serve on teen councils or advisory boards that brainstorm, plan, and sometimes even evaluate youth programs at the library; asking youth about the technologies they want to learn or experiment with; and allowing youth to work with community partners and conceptualize programs that will benefit the broader population of youth in their community. Diane, a librarian at a Southern library, reported:

> So the Teen Advisory Board … that's a huge way to find out what the teens want is to put open invitations out for the teens to come in, and come to these meetings and to communicate with me what their needs are. We've also done anonymous surveys with a teen idea box.

Despite these efforts to obtain youth input in urban libraries, we found little evidence of librarians' using more engaging techniques such as participatory design and design-thinking processes to capture youth voice and interests.

### Sources of External Support

External support (such as training, funds, and equipment) to offer technology-based programs in rural libraries comes almost exclusively from state library agencies. State library grants are awarded to libraries to purchase technology (such as Oculus Rift, iPads, and 3D printers); provide continuing education courses and workshops through state library conferences and webinars; start technology programs (such as robotics clubs and makerspaces); and provide technical support for technology equipment in the library. As discussed earlier, rural librarians occasionally mentioned receiving external support from community partners, such as providing space or technology expertise.

The urban librarians in our sample rarely mentioned state support. This trend does not mean that urban libraries do not receive support from their state library agency, just that other external supports are paramount in urban libraries. Some libraries, for instance, have development offices/fund-raisers within their library systems that they can leverage to seek funding sources on their behalf. As described earlier, community partners provide diverse forms of support. Local industries influence the type of technology programs that urban libraries can offer, as stated by Kayla, a youth-services librarian working in an urban library in the Midwest: “After Google Fiber announced that they would be here, Mozilla opened an office locally and we received funding from their gigabit fund, and that was an interesting project that we continue to develop.” Urban libraries also partner with and leverage the resources of those local nonprofits and higher education institutions that share similar community and learning goals.

Compared to rural librarians, the urban librarians we interviewed were more likely to describe tapping into various professional networks outside of their immediate community. For example, Hannah, a youth-services librarian at a Mideast library, referred to her connection to the YOUmedia community of practice, which she said is “… really, really, really helpful. … They keep finding little sources of funding, bringing us all together again, but even the sharing resources or people will call us.”

## Discussion and Practical Implications

The findings from the current study contribute new insight into the role that geographic context plays in the design and implementation of youth programs in public libraries. In so doing, they add complexity to the general consensus that public libraries are well positioned to support connected learning (Hoffman et al., 2016). In our review of connected learning literature, we have found that most attention has been given to urban libraries’ efforts and ability to support youth’s connected learning experiences (Hoffman et al., 2016). We do not dispute the need for this attention. Many urban libraries serve youth who otherwise lack access to rich, technology-enabled learning experiences (Reich & Ito, 2017). However, our analysis shows that rural libraries face distinct challenges of their own that must be addressed if they are to succeed at introducing connected learning into their environments.

Our analysis revealed four factors that both shape youth programming and distinguish rural and urban libraries from each other: (a) community partnerships; (b) librarians’ role as expert versus facilitator; (c) youth involvement in youth programming; and (d) sources of external support. The differences that emerged between rural and urban participants within each theme point to distinct challenges facing rural librarians’ ability to enact connected learning in their youth programs. For instance, the more restricted sources of community partners and external support in rural libraries, which aligns with previous research (e.g., Flatley & Wyman, 2009; Real & Rose, 2017), makes it challenging for these libraries to offer youth programs that align with youth’s diverse interests and academic/career goals. In addition, the more traditional roles that librarians (i.e., expert) and youth (i.e., learner) tend to assume in rural libraries further limit opportunities to implement programs that are interest-driven and peer-supported. Urban librarians were generally more comfortable placing youth and community partners at the helm of their programs and assuming a facilitator role, better positioning them to offer programs that are driven by youth's interests, engage youth in hands-on, production-centered activities, and in which youth and adults come together around a shared purpose.

We have used the insights from this research to inform the design of a professional-development "toolkit" to support public youth librarians in their efforts to infuse connected learning principles into their youth programming. Designed collaboratively with public library partners representing a range of library contexts, the toolkit can be tailored to librarians' unique contexts, providing them with strategies to enact connected learning with the resources at their disposal.

The toolkit contains nine modules, each addressing a key dimension of designing and implementing connected learning programs, such as Mentoring, Capacity Building, Community Partnerships, and Assessment and Outcomes. In addition to containing in-depth information about each topic, the modules include library-based case studies, illustrative videos, and hands-on exercises that help librarians to apply what they are learning to their specific contexts. For example, each module employs a K-W-L chart for librarians to record (a) what they already know about the connected learning topic (the *K* in K-W-L), (b) what they want *(W)* to learn, and (c) what they have learned *(L)* once they have completed the module. This activity encourages librarians to reflect on and articulate their specific goals, thereby helping them to tailor the modules to their distinct contexts.

We believe the toolkit can be used to address the specific challenges facing rural librarians identified in this study. For instance, the Community Partnerships module helps librarians to identify, develop, and maintain community partnerships by presenting best practices and case studies of successful library–community partnerships, as well as concrete strategies for establishing partnerships. The Capacity module supports librarians' efforts to build external support for youth programming by helping them to map out their existing capacity in various areas, such as space, staffing, technological infrastructure, and partnerships. It then helps librarians to develop a personalized road map that addresses the specific capacity challenges they face, including how to optimize services with their existing capacity. The Youth Development module and Design Thinking module will help rural librarians to expand their view of the librarians' role in youth programming and encourage them to place greater emphasis on youth voice. After working through the Youth Development module, librarians will have a better understanding of the major developmental milestones during adolescence, including the various ways that teens use digital media technologies. This understanding will position them to recognize and respond to youth's interests and motivations. The Design Thinking module introduces librarians to design-thinking methods and how to employ them to develop youth programming with and for youth.

## Limitations and Future Work

Although our sample represents a broad range of rural and urban libraries across the United States, we acknowledge that suburban libraries are absent from our analysis. We have justified this decision as an effort to maintain analytic clarity and the ability to provide sufficient depth of analysis within the constraints of the publication format (see Method section). However, we anticipate broadening our focus in future work to include librarians who describe their library contexts as suburban. Because of the variety of suburban neighborhoods, it would be informative to investigate under what circumstances their dynamics align with rural libraries, and when they are more similar to urban libraries. Such insight would provide a more complete picture of the conditions under which public youth librarians are best able to enact connected learning.

## Conclusion

This study investigated variations in youth programming and technology use among rural and urban youth librarians. We found variations in their range of community partnerships; the roles that librarians and youth assume in designing, leading, and evaluating youth programs; and sources of external support. We discussed how these differences pose challenges for rural librarians' ability to enact connected learning in their youth programming. We described how a professional-development toolkit could be used to address the challenges faced by public youth librarians working in rural areas.

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# Networked Inquiry and Performative Knowledge

## Approaching the Process of Finding Problems in Learning Networks

**Magdalena Day (National University of Cuyo)**

**Abstract:** The purpose of this paper is to offer a framework for the analysis of knowledge production in networks of students. The theoretical approach includes sociological developments related to networks (Castells, 2005) combined with the pedagogy of philosophy with children and young people (López, 2009), which we apply to educational research. To begin with, we consider inquiry as the starting point of the learning process. This process occurs in a context denominated the “community of inquiry” (Lipman, 2003), which includes technology-enabled interactions that go beyond classrooms. Because of this connectedness, this community is viewed as a network that constitutes itself around the practice of problematization. In this regard, the question is not how a certain device, platform, software, or app could change the interaction between students and already defined educational contents, but rather, how students can find problems to answer creating a different type of knowledge.

### Networks, Technology, and Education

The idea of networks is present in every activity of our contemporary life (Galloway & Thacker, 2007).[1] In education, it is common to talk about networks of knowledge, for instance, or networks of learning, to name a few. This is due to the permeability of new technologies, such as the Internet and social networks, in our societies (Castells, 2005). The interconnectivity provided by these technologies has led authors such as Manuel Castells to talk about networks as the “variable geometry” (Castells, 2000, p. 9) of social relations.

For Castells, “technology is embodied in technical relations, relations socially conditioned, for in itself is not an independent, nonhuman, dimension” (2004, p. 4). Therefore, technology is not viewed as an exogenous variable—what the category Information and Communication Technologies (ICTs) accounts for—but rather as a layer of social structure (Castells, 2000) that enables interconnection.

The networking logic, meaning multiple relations between a networks’ nodes, would be the features by default in our societies and of most relevant social practices, including education.

Nevertheless, we understand that what we are dealing with in terms of knowledge production and learning in networks is not just the flow of information,[2] but rather the connected practice of inquiry.

On the other hand, we take it that any device, platforms such as smartphones, virtual classrooms,[3] and even apps could be conceived of as part of the networks in which students participate. Consequently, the connection among students, technology enabled, would be part of any educational experience.

1. “Even beyond the fields of technology and philosophy, the concept of the network has infected broad swaths of contemporary life” (Galloway & Thacker, 2007, p. 25). We take Castells’s basic definition of network as a “set of interconnected nodes” (Castells, 2005, p. 550).
2. Information is one of the key elements for diverse network theorizations. We choose to work with Castells’s, in which subjectivity, socialization, and shared meaning are at stake. For some basic definitions in this matter see Barabási (2009) or Watts (2013).
3. In sessions with teachers the term *virtual classroom* came up as the equivalent of online platforms in which they shared materials for students, or discussion groups for certain subjects. They also called it *extended classroom*.

Furthermore, the examination of networks from a sociological perspective that we present here sets us free from the dichotomy between a *normal* educational experience, and one that involves, or *includes*, technology.

As a result, in terms of educational research, the question could be raised: "But how would we know when are we talking about technology in education if we do not use the term '*ICTs'*?" Our answer is: by using the concept of network.

If we take virtual-digital-technological developments of any kind as part of the networks of students,[4] there is no need whatsoever to use the ICTs category. The network concept involves all of the above (students, apps, platforms, social networks, etc.).

Moreover, the idea is not to assess what a particular technology introduced ex post to a classroom can do, but rather to understand to what extent the technologies and platforms that students and teachers already use (Latour, 2008) are part of a network's practice of inquiry.

Our selection of authors and theories looks for a way in which any technological experience can involve the production of knowledge, not only its diffusion. In this regard, we understand networks as the framework for most relevant social practices, such as education and as the way in which students relate to each other.

Hence, our conception of education is far from the one that equates it with the "acquisition of information" (Lipman, 2003, p. 3). Rather, this conception is closer to Matthew Lipman's model of critical thinking, for which the learning process is situated in a context or framework that this author called the "community of inquiry" (2003, p. 20).[5]

Therefore, it is key to comprehend the nature of this new community of inquiry, conceived as a network.[6]

## Networks as Communities of Inquiry

Our "blended approach" (Castells, 2010) includes sociological theory related to networks and a philosophical tradition regarding learning called *philosophy with children and young people* (PWC from now on). This tradition, mainly in its version from Argentina and Brazil, is an adaptation of Matthew Lipman's philosophy for children (also denominated as P4C) that originated in the United States.

Lipman's method was inspired by the thought of pragmatist philosophers such as John Dewey and C. S Peirce, who saw experience as a source of meaning and knowledge (López, 2009, p. 18).

The PWC philosophical tradition embraces Lipman's view, adding conceptualizations of Michel Foucault and Gilles Deleuze to rephrase this "art" (López, 2009), focusing on children's experiences not through pedagogical novels, but rather through problematization.

4. We will not differentiate among the three concepts as we think that each of them will be considered as a node or as part of the network.
5. "To use Professor Dewey's phrase, instruction should be an interchanged experience in which the child brings his experience to be interpreted by the parent or the teacher" (Lipman, 2003, p. 85).
6. Latour's (2011) actor-network theory (ANT) might be considered as a microsociological approach, while Castells's network society would be a macrosociological one. Castells considers networks as the "social morphology" that predominates over action (Castells, 2005), and he states that networks are the "variable geometry" (Castells, 2000) of social relations in the information age. According to Latour, there is no difference between the micro- and the macrosocial levels. It is by following the actors' (people, computers, microbes) association with others that a network is found. But they both share the perspective of taking technology into account of human networks (Latour, 2008).

Indeed, problematization is the key activity in the classroom, with the teacher as a coordinator rather than a storyteller. There is also a close relation between experience, meaning, and creating space for the unexpected (López, 2009) to come up in this philosophical practice.

After this theoretical confession has been made, we need to explore the nature of the community of inquiry, following Matthew Lipman's (2003) consideration of this key concept for our reasoning.[7] "Lipman wants to make little communities of inquiry out of classrooms to reproduce in them the form of deliberation typical of scientific community" (López, 2009, p. 21).

This deliberation is the one that Thomas Kuhn refers to when he says that "effective research scarcely begins before a scientific community thinks it has acquired firm answers to questions" (Kuhn, 2012, p. 5).

Although he makes reference to physicists and natural sciences practitioners, there is a social element, a consensual one in his argument, that could easily be replicated in any other discipline regarding the process of knowledge production that we see as transforming itself (Day, 2017).

And in the case of learning networks, we can translate Kuhn's thinking into the way in which a community decides in which problems to work, which would be the same as saying what kind of knowledge this networks aims to create. This is the type of deliberation involved in the community of inquiry and in its problematization process.

As Lipman (2003) examines:

> How is inquiry guided? … I find Dewey's answer a compelling one. Inquiry takes place in situations—in contextual wholes or fields. A situation is a whole by virtue of its "immediately pervasive quality." This quality is not only what binds all constituents in the situation into the whole but is also unique and indivisible. No two situations have the same permeating quality. (p. 85)

What occurs in networks is a collective interchange, a "communal dialogue" (Lipman, 2003, p. 139) that produces "the phenomenon of distributed thinking, in which each participant contributes to the single thinking process."

In this way, it is not fanciful to think of the network not only as a new dynamic for communities of inquiry, but of network as inquiry (Latour, 2011), meaning inquiry in association with others.

Hence, we can think of networks of inquiry, in which students learn to problematize together. Interconnection would be the nature of the process of asking questions, learning from each other's experience, and so forth.

In this way, both problematization and learning from other students (indirectly by distributed thinking as a form of "movement" of inquiry within the network) would be part of the process of knowledge production in the network.

Regarding this reflection on knowledge production in communities of inquiry, Lipman (2003) adds that

> the epistemology of that community will be that of the reflective equilibrium. This equilibrium should be

7. *From Philosophy With Children and Youth. The Community of Inquiry From the Concepts of Event and Tragic Experience*, by M. Lopez, 2009, Buenos Aires, Argentina: Noveduc.

> understood in the fallibilistic sense that, in the classroom of the community of inquiry, the aim is not to find an absolute foundation of knowledge, like a bedrock. Instead, there is a constant remaking, improving, revising of all its parts in order to maintain the equilibrium. (p. 197)

This author adds that "what the community of inquiry 'produces'" is "a process that aims at producing a product" (p. 83) and that this process "is not merely conversation or discussion; it is dialogical. This means it has a structure … its procedural rules, which are largely logical in nature" (Lipman, 2003, p. 83).

For the PWC tradition the community of inquiry is the deliberative space of the philosophical and dialogical practice, but the product of this practice is problematization (López, 2009).

We believe that today, networks are the new configuration of the community of inquiry. And it is in this deliberative space, which is both virtual and physical, that also "the possibility of asynchronous interaction in chosen time, at distance" (Castells, 2013, p. 34) is possible.

This new practice is not only "enabled" but entirely transformed by the communication and information exchanges that constitute the basis of social practice. Furthermore, there is no "ex post" interaction related to technology in the classroom (or in the community of inquiry), but a new and emergent space with a dual nature and a flexible consideration of the time needed for dialogue.

Ultimately, even when we consider networks as the structure and dynamic (Watts, 2013) of social interactions, we ought to develop a model that is closer to philosophy, or to social theory, than it is to network theories.[8]

8. Though there might be a network science (Watts, 2013), we argue that it would be hard to sustain that there is a network theory (or even a general one to use for education). What both Castells (2005) and Latour (2008) give us is the possibility to think of agency in networks even when their frameworks are different.

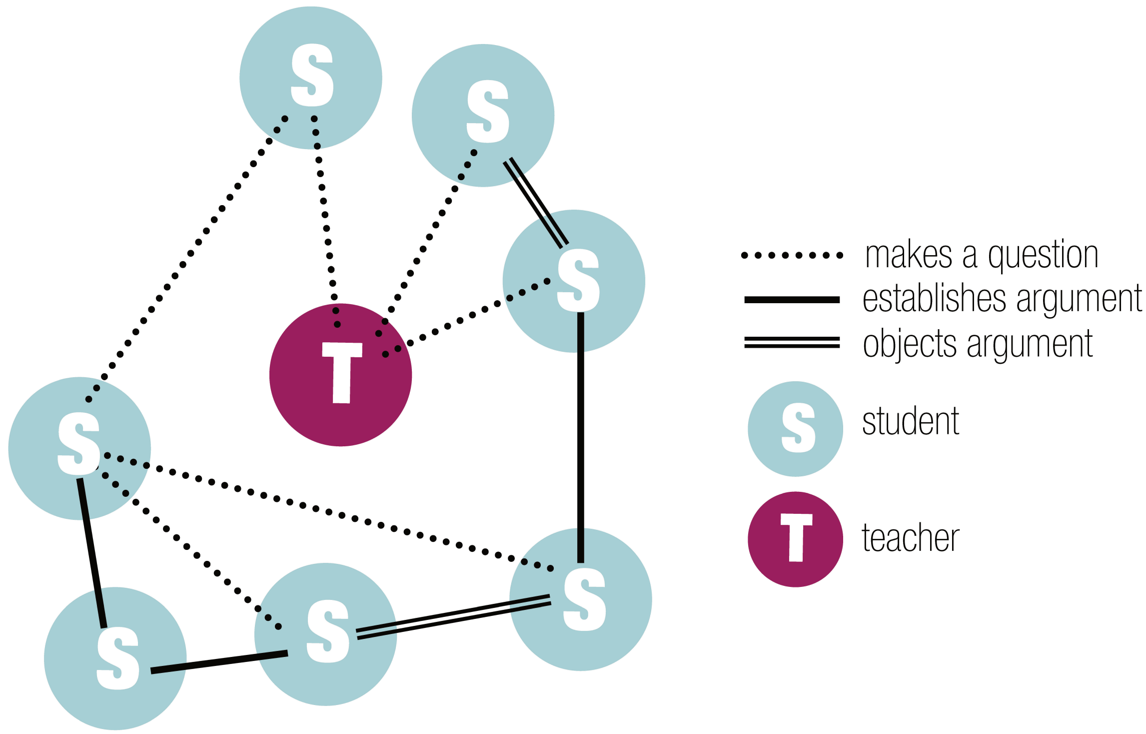


*Figure 1. Networked inquiry model.*

Following that question is that we have developed a first model for our purposes that includes students and teacher as part of the network, and for which technologies, virtual platforms, digital contents, and so forth are embodied in practices.

For practice we understand: inquiry as making questions, establishing an argument (an idea, hypothesis, etc.), objecting to that argument (as being opposed to and bringing up another one to which the networks' inquiry movement could change), searching for different words or ways to present it, and so on.

## Problematizing and Learning in Networks

As we stated earlier, the reason for the use of technology in the classroom could be thought of as being the facilitation of knowledge "absorption" by the students (e.g., student interacting with multimedia contents, searching for new information, etc.)

However, by applying the PWC pedagogy to an educational experience that considers its space of practice (the classroom, students) as a network, the process of learning changes, as learning goes beyond absorbing contents introduced by teachers, software, or an app, and becomes the process of problematizating about students' ideas and experiences on any subject.

As a result, students learn not by answering to situations already defined, but by being part of the problems that they help to define (López, 2009) in a network, with the tools and thought processes developed by themselves.

> Pedagogy has already discovered the importance of problems and tried to involve students in its constituency. However, it is important to perceive that problems are not provisory nor contingent, and that they are not condemned to disappear through the production of knowledge. The problem is not the opposite of knowledge, it is not its double neutralized. … Problems are not difficulties to be overcome but thinking in itself, the constituent act that establishes thought. (López, 2009, p. 73)

The challenge is to think which type of networks and which dynamics can lead students to the "problem finding" process as a first step for knowledge production, with a form of inquiry that emerges.

In this regard, Paul Rabinow argues that the key of problematization "is not to intervene**,** but to understand and to make a diagnoses … in order to see a situation not only as something given, but also as equally a question" (2003, p. 6).

A strong intervention of teachers (also called "coordinators") and guided inquiry are not compatible with PWC. Problematization is thought to be the practice of a whole group, or different *nodes*, in networks terminology. There is a minimum level of guidance in this pedagogy, but it mostly relies on students' interventions and leading roles while in the dialogue.

Making problems the center of an activity is also a common practice in disciplines such as mathematics. In this field, it is not so much the answer but the proof, the technique, and the validity of the developed answer (Ernst, Hodge, & Yoshinobu, 2017) that matter. Also, it implies collaboration in the development of the problems. For instance, the inquiry-based learning (IBL) method is "a form of active learning," with "two principles, the 'twin pillars' that education research has shown to be at the core of most implementations of IBL: 1. Deep engagement in rich mathematics. 2. Opportunities to collaborate (in some form)" (Ernst et al., 2017, p. 571).

In our view of learning, knowledge production is tied to a network problematization. Therefore, what is knowledge could be defined in relation to the product of a specific problematization, or outcome, that helps the network in its goal of getting its own answers.

To make this case stronger, we quote Richard Sennet (2008), a sociologist from the pragmatic tradition, who states that "there is in learning skills, the intimate, fluid join between problem solving and problem finding." Even though the author refers to skills useful to the labor market, we use it as an inspiration to affirm that today, learning starts with finding problems to solve.

And the process—or procedure—of problematization has different moments that we adapt to our consideration of the community of inquiry as a network:

- The constitution of the network of inquiry into what we denominate "one moment of thought": This would mean bringing together both virtual and physical stages. In the traditional PWC practice, it usually starts in a circle of chairs integrated by students and teachers, but in our proposal this would mean joining what happens in the classroom and what takes place in the flows of digital/virtual space.
- Presentation/"pretext" by teacher of the subject that will open the dialogue/deliberation: It can be a question, an idea, or material as a trigger.

- Open agenda of questions to problematize about.
- Statement of the problem.
- Reframing the problem and finalization of the experience.

As we stated in 1. there are two moments to consider, so this practice of problematization could be initiated virtually and continued in the classroom, or vice versa, it could start at school and have its development virtually.

Whatever the option chosen, the idea is not to think of one space as a complement of the other, but rather, as a single one, and to use this pedagogy to create new knowledge and redefine the many contents and programs that are being used by teachers or schools.

## Networked Performative Knowledge

The inherent epistemological assumption of these pages is that students are subjects of knowledge, and that they are at the center of the process of inquiry. Thus, they do not receive education, meaning only those contents given by teachers in a defined program, even when that could be critical or reflective. Rather, they create problems and take part in the development of the knowledge production involved in its solution.

In addition, this knowledge-production process is always situated in a context, the community of inquiry. As that community is understood as a network, the validation is given by the network.

We agree with the statement that "much of our collective knowledge is generated by groups" (Zollman, 2012, p. 2). However, if we pay attention only to the communication among the members of the network, those interactions might effectively be reduced to the analysis of information flows.

And we believe that neither is a behavioral perspective an adequate one for understanding how the process of thinking and learning in a network unfolds, nor is it sufficient with applying actor-network theory (ANT) to analyze each node's practice/association within the network.

This is why we think that the question is not how a certain technology helps in the diffusion of information, skills, or knowledge, but rather how the network functions when problem finding and solving are involved. For instance, massive open online courses (MOOCs), social networks, virtual classrooms, online mobile apps, or even blockchains as decentralized networks could always be thought of as the technologies behind networks. But new technologies might even appear to consider in the future.

Considering that meaning "can only be understood in the context of the social relationships in which information and communication are processed" (Castells, 2013, p. 54), we ought to understand the network of inquiry as such context. Even though, as Castells argues, "communication is the sharing of meaning through the exchange of information," (2013, p. 54) we differentiate between the flow of information and inquiry. "The child does not become social by learning. He must be social in order to learn"[9] (Lipman, 2003, p. 84).

In the network understood as a space for learning and for knowledge production, there would be a

9. Lipman is originally quoting G. H. Mead's "The Psychology of Social Consciousness Implied in Instruction."

"shared" (Castells, 2013, p. 137) "emergent meaning" (Wegerif, 2007, p. 160) to be interpreted by the teacher at the moment of applying the PWC pedagogy and for the research of such practices.

Therefore, both nodes' inquiry (student/teacher) as a practice and the network's inquiry practice as a whole are key to understanding that emergent meaning each time that a network problematization takes place.

For this theoretical approach to be useful for teachers, learners, and practitioners, we should ask which situations in the network we can include for the analysis. Also, how students engage in diverse networks' problematizations is key to the different knowledge-production processes in which they are participating.

Furthermore, we could rethink how schools and classrooms function in the networks of inquiry that they enable or are part of, with students simultaneously integrating different networks at the same time.

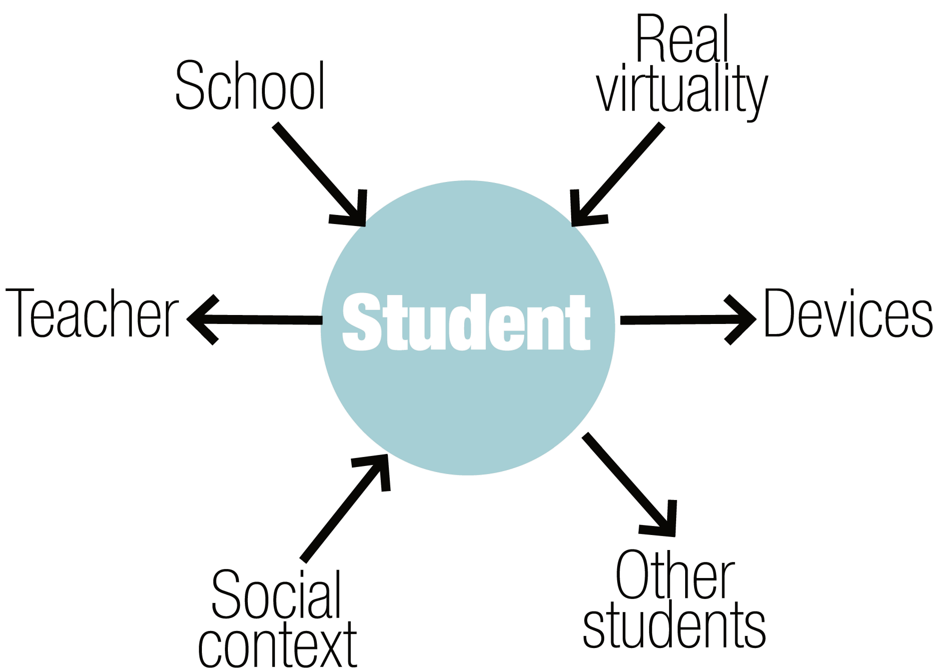


*Figure 2. This image aims at showing how students form and are part of several networks at the same time. "Real virtuality" is Manuel Castells's concept to describe the digital/virtual place in which socialization and subjectivity take place.*

In this regard, the idea of knowledge being "performed" (Terranova, 2006, p. 287) through networks also raises the question of whether those networks are the equivalent of classrooms, or even schools.[10]

10. "Lyotard identified information with a shift in the status of knowledge as such, where the latter is increasingly wrested away from its status of grand explanation or narrative and bent towards the technical requirements of performativity. For Lyotard, information refers to a mode of knowledge that is no longer reflective or contemplative but performative and pragmatic (Lyotard, 1989)." From "The Concept of Information," by T. Terranova, 2006, *Theory, Culture and Society, 23*, 286–288. We include this use

Furthermore, it turns networks as “contingent” (Rorty, 2009) frameworks, meaning performative communities of inquiry in which the nature of schooling could be redefined.

Finally, performativity in the network of inquiry could also have two lectures: one that has to do with knowledge, specifically the way in which a problem is found and its answers proposed, which is “to bring something new into the world” through words that enact it (Butler, 2015, p. 205).[11] On the other hand, it can be related with the two spaces or situations mentioned earlier: the virtual and the physical. Consequently, understanding this performative knowledge is not only about words or communicative action, but also about bodies and the “organic” (Butler) conditions of thought.

## Conclusions

Our aim is to rethink the community of inquiry as a pedagogy, and as a model for educational research, from the perspective of its sociomateriality and its specific nature.

Our purpose is to elucidate how knowledge production and validation occur in networks. The question that remains is how problem finding, and the knowledge required for problem solving, works out in the network, independently of the technology behind it.

We argue that this process of finding problems to solve as a way of learning collaboratively starts with inquiry in a specific network. We find that the network has an internal dynamic, which can be understood as “network as inquiry” (Latour, 2011, p. 5), in which each node constitutes a practice to be traced, but also, a dynamic of the network as a whole, with the network as a structure in which meaning making is emergent and complex as it merges from both micro- and macrolevels of inquiry.

Finally, we suggest to go from thinking in inquiry-based learning (Ernst et al., 2017) to networked inquiry learning.[12] Given that the main reason behind these pages is in which way networks may alter the answer to the question “How do we know?” a first hint would be: in a networked and performative manner.

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of *performative* as it involves information and knowledge and cybercultures. We acknowledge the existence of similar uses (Boll, 2017), but we do not consider them related to the virtuality in question.

11. Even though we acknowledge the use of performativity in learning by authors such as Butler-Kisber (2010) and Escudero Nahón (2018), we apply the term exclusively to the PWC pedagogy.
12. IBL is used in the world of mathematics, but we suggest that we take it into consideration for developing an educational model related to networks.

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This paper has only one author. It is written in the first person of the plural *(our, we)*, following the tradition of using a conversational tone with the reader. The author would like to thank reviewers and colleagues at the Connected Learning Summit 2018 for their feedback, suggestions, and comments that she hopes will be reflected in this final version of the paper.

# Identifying Shifting Roles, Expectations, and Practices in the Early Adoption of Challenge-Based Learning for Online Courses

**Catherine L. Dornfeld Tissenbaum (Northeastern University) and Kemi Jona (Northeastern University)**

**Abstract:** Challenge-based learning situates learning in authentic contexts, with opportunities to meaningfully apply new knowledge and skills. However, the shift from traditional modes of instruction to challenge-based learning (CBL) introduces new roles, expectations, and practices for both instructors and students. In this design-based research study, we use an ethnographic lens to investigate feedback from instructors and students about their first semester with CBL. We identified common difficulties, strategies, and suggestions to incorporate into future design iterations of CBL courses, along with opportunities for deeper investigation into students' learning processes and development of agency within CBL courses.

## Introduction

Challenge-based learning (CBL) is a form of inquiry learning that situates learning in authentic contexts where students are asked to engage in real-world tasks or challenges that result in work-relevant "deliverables." Our CBL approach is theoretically grounded in an understanding of learning and cognition that is deeply situated, "being in part a product of activity, context, and culture in which it is developed and used" (Brown, Collins, & Duguid, 1989), with the underlying goal of helping students to develop adaptive expertise that can readily transfer to real-world settings (Edelson, 2001; Martin, Rivale, & Diller, 2007). As an inquiry learning approach, CBL emphasizes students' agency within authentic contexts and assessments to provide a learning environment that motivates students to construct knowledge that can be meaningfully applied in the future (Barron et al., 1998; Blumenfeld et al., 1991; Edelson, 2001; Martin et al., 2007). For example, students learning to develop a website must also learn how to communicate with clients and manage time, which are necessary skills in the workplace. Positive outcomes associated with CBL include improvements in learning attitudes, conceptual outcomes, and knowledge sharing (Martin et al., 2007; O'Mahony et al., 2012).

While CBL helps students to learn and apply knowledge and skills in meaningful ways, transitioning from traditional instruction to CBL can be difficult. Instructors must develop challenges that highlight key disciplinary principles that transfer across contexts while balancing open-ended inquiry and specific learning objectives (Blumenfeld et al., 1991; Edelson, 2001; Martin et al., 2007). Instructors must also create and/or assemble supporting materials along with formative and summative assessments that reflect real-life tasks, so that students can seek content, construct knowledge, and manage their increased agency in learning (Barron et al., 1998; Edelson, 2001; Martin et al., 2007). However, determining an appropriate level of scaffolding may be difficult for instructors (Belland, Kim, & Hannafin, 2013; Hmelo-Silver, Duncan, & Chinn, 2007). Scaffolding is essential for inquiry learning, but understanding how and when to scaffold students is challenging, especially in light of communication differences across online and in-person courses (Hmelo-Silver et al., 2007; Ya Ni, 2013.). To help students manage their coupled responsibilities for inquiry and learning processes, instructors may highlight disciplinary thinking, embed guidance, and structure complex tasks within the course (Hmelo-Silver et al., 2007).

In addition, the transition to CBL for both students and instructors can be problematic for more practical reasons. In postsecondary settings, and particularly in online courses, the dominant instructional model of lectures, readings, problem sets, and multiple-choice assessments is deeply entrenched (Blumenfeld et al., 1991). This model defines well-understood roles, routines, and sets of expected transactions for both students and instructors. The impact of this instructional model on our focal population of adult learners who are returning to university studies for professional advancement has been well documented, with six-year graduation rates below 50% overall and less than 30% for part-time students (Miller, 2014). For this population, we hypothesize that the motivational and educational benefits of our CBL design approach may be particularly beneficial, yet we recognize that the shift to CBL requires significant shifts in expectations and practices (Belland et al., 2013; Blumenfeld et al., 1991). Taking a design-based research approach, this study focused on the first stage of transitioning to CBL for courses that support nontraditional students' professional studies. Our implementation plan included the integration of CBL into five online courses in the first semester, followed by 30 courses (online and in-person) in the second semester, with more courses planned. The plan involved major redesign of courses, including the development of challenges appropriate to course goals; the positioning of students in roles with greater agency, including control over project management; the creation of simulated email exchanges with clients, which gave students practice with real-life communication skills; the addition of formative feedback, which gave students opportunities to revise their projects; and incorporation of rubrics as summative assessments, which reflected course objectives and key content and skills for future contexts.

To systematically identify how to better support both students and instructors, as well as to improve the design of our CBL courses, this study sought to understand how instructors and students transitioned into CBL as a new instructional approach, especially in light of other demands on instructors' and students' lives, such as full-time jobs. As a first step toward understanding this transition, we conducted an ethnographic study of feedback from instructors and students, using a variety of data sources from the first semester of CBL implementation. Our research question was: What difficulties did instructors and students face in transitioning to CBL for online courses, and what insights can we gain to better support students and instructors? This question has theoretical implications for understanding how nontraditional adult students learn in online CBL environments, and practical implications for the design of courses that integrate CBL.

## Methods

### Participants and Context

Our participants included six instructors, an instructional designer, and nine working adult students involved in online bachelor's completion programs in information technology. The instructors taught sections of five online courses: Human Computer Interaction; Systems Analysis and Design; End-User Data Analysis Tools; Database Management Systems; and Web and Mobile Development. Five instructors were first-time CBL instructors, with three (Anna, Ryan, and Bill) also teaching a traditional section for comparison. Two instructors (Kyle and Tim) taught only CBL sections. Another instructor (LeAnn) taught a traditional section but was heavily involved in CBL planning. Section enrollment varied from seven to 21 students, with an average of 15 students per section. We obtained feedback from nine students about their first semester with CBL via interviews (three students) and surveys (six students). We interviewed only CBL students but distributed surveys to CBL and traditional students.

### Data Sources and Analysis

We collected four types of data about the first semester of CBL implementation, as shown in Table 1. These data included (a) informal monthly "fireside chats" with faculty; (b) three months of online chat communication with faculty via Slack; (c) three student interviews; and (d) six student survey responses. We used a holistic approach to qualitatively analyze the multiple data sources, as informed by grounded coding (Strauss & Corbin, 1998). For the fireside chats, we transcribed the instructors' feedback and annotated themes within and across the chats. We also annotated transcripts of Slack communication, students' interviews, and survey responses, using themes from the fireside chats. We also noted emergent themes. We conducted open coding of themes across data sources and then collapsed codes into categories that represented initial difficulties, strategies, and suggestions for CBL adoption. We discuss these findings below.

| Data Source | Participants |
|---|---|
| Monthly informal "fireside chats", via videoconferencing | Six instructors + research team |
| Slack communication | Six instructors + research team |
| Student interviews | Three students |
| Student surveys | Six students |

*Table 1. Data sources and participants for the first semester of CBL implementation.*

## Findings

We used an ethnographic lens to understand how instructors and students transitioned to CBL in online courses, with an explicit goal of identifying insights to better support and scaffold both learners and instructors adopting CBL. Our analysis identified five common difficulties involved in implementing CBL for the first time, which we discuss below. We also identified instructors' strategies for addressing these difficulties, along with suggestions for the future. Finally, we included student feedback separately to show how the instructors' transitions impact students' transitions. In discussing our findings, we have used pseudonyms to protect participants' identities.

### Difficulties

We found five common difficulties among courses implementing CBL for the first time: (a) setting expectations, (b) balancing guidance and independence, (c) scaffolding levels, (d) scheduling deadlines, and (e) providing formative feedback. We discuss these difficulties here.

**Setting expectations.** Instructors noted initial difficulties with setting expectations for students and exploring options that would "inform [students] of what is expected of them." With the redesign, CBL courses included new structures (e.g., challenges), modes of communication (e.g., simulated email exchanges), roles (e.g., students role-playing employees, working with simulated clients, and instructors acting as mentors), and demands (e.g., project management, communication), and thus necessitated adjustment. One instructor, Bill, indicated that setting expectations was important:

> Because it's nontraditional. So if I'm in this CBL course, what's expected of me? And let them know up front, it's more independent. You do a lot of the work up front. You communicate. Your instructor is your mentor. It's not the weekly, "Let's do Chapter 5. Let's do Chapter 6." That kind of teaching. (Bill, Sept. 25 fireside chat)

LeAnn, another instructor, noted that early communication was key in helping students adjust to CBL:

> You know, if we could get everybody like, day one, when they get to college, give them a different experience, then they wouldn't be as likely to do that. So, I think that's just a matter of—they gotta get used to it. (LeAnn, Sept. 25 fireside chat)

A major part of setting expectations was helping students to adjust to new roles. With CBL, instructors expected students to take on the role of an employee, while instructors played the role of a mentor and/or client within the authentic challenge scenarios. The purpose of shifting these roles was to foster student engagement and retention, help students build "soft skills," and develop discipline-specific knowledge and skills within authentic contexts. Instructors emphasized to students that success in the course would prepare them for success in their future careers and workplaces.

> All of this education that you're doing is not for me, it's for you, because you have to go out there. And out there is where it's going to matter. And if you're good at this, you'll be successful. And if you're not good at this, you'll be less than successful. (Bill, Sept. 25 fireside chat)

> For me, it's much more like doing on-the-job training than it is a lot of the traditional instruction. Because they're, you know, in many ways what you're doing is giving these guys projects, and you're saying, "Here's the project, here's what I expect to see for the project. Here's how I'm looking for the results to come back." And then trying to structure it sufficiently so they can succeed with as much of their own work as possible, and as little outside doing-of-the-work by you as possible, and really more guidance than actual doing. (Kyle, Oct. 25 fireside chat)

> Because I think what it does on them, is as we're teaching this, we're teaching them to do some research. We're teaching them to make decisions. We're teaching them to manage their time. And those are all necessary soft skills that they need in the workplace. (Bill, Nov. 25 fireside chat)

With shifts in roles, the instructors stressed that students would need to develop more independence, and thus agency, in their work. The instructors expected students to attempt to solve challenges on their own, then ask for help, rather than ask for point-by-point instructions. Bill described this as such: "Don't look for somebody to say, 'Look, here's the answer.' Go find the answer."

**Balancing guidance and independence.** While instructors increased students' agency in tackling challenges, they also expected to provide guidance. This is a common feature with other inquiry-learning approaches, in which scaffolding is key to students' success (Barron et al., 1998; Belland et al., 2013; Hmelo-Silver et al., 2007). However, in this first stage of CBL adoption, instructors struggled to determine appropriate levels of guidance in their courses. On Slack, Kyle expressed that students felt "thrown into [the] scenario without more guidance." LeAnn added that "figuring out what's the right balance between handing them enough or handing them too much or not enough—[it's] always gonna be a little trial-and-error." Bill also expressed the need to strike a balance between increasing students' agency and providing support:

> But I'm resisting doing the actual instruction for some of where they need to go. And that's me, that's because, that's traditionally what I do, is provide instruction. "Here's how you do it." And some of the stuff is complicated, and, you know, I let them struggle a little bit, but I'm not going to take the boat too far away from them. And eventually I'm going to throw a life preserver and [say], "Look at this and see if it will help you." (Bill, Oct. 25 fireside chat)

**Scaffolding levels.** One way that instructors embedded guidance was by scaffolding the structure of the course. Kyle described creating "bite-sized assignments" that broke down complex tasks into smaller subtasks. Ryan also noted how tasks were connected when situated within a challenge:

> If they've been at Northeastern up until the challenge based, our main focus has been quizzes, assignments, and not always connected from top to bottom. And when we went to challenge based, my whole attitude changed, because I was looking at every single task as a building block to the next task. (Ryan, Nov. 25 fireside chat)

Anna, another instructor, echoed this approach by intentionally scaffolding week-by-week tasks that built toward students' final projects. This approach was based on her own experiences in studying human-computer interaction.

> So I went about it a different way. I made it more structured. Even the challenge based, I put them on a strict timeline, because from my own experience, if you're a grad student, well if you're a student and you have other things going on in your life, it's just so hard to catch up if you don't do regular work. (Anna, Nov. 25 fireside chat)

**Scheduling deadlines.** When scaffolding tasks within challenges, instructors encountered issues with communicating and enforcing deadlines. As discussed on Slack and in the fireside chats, this was partly due to design tension between the instructional design team and the instructors. Removing deadlines facilitated the import/export of course materials from one semester to the next, but it also removed critical information for instructors and students. One instructor edited the course to include deadlines, but another instructor did not, citing his respect for the instructional design team's vision. We noted this as an instance of divergent attitudes about ownership of course design. However, all instructors noted that they posted deadlines in multiple places (e.g., syllabi, announcements) to communicate this information to students. They also noted that, in the real workplace, employees have multiple projects and more flexibility with deadlines, and that they might want to consider offering flexibility to students when students share about other demands on their time with their instructors.

> When you're in a job, you don't just have one project to work on. You have a bunch of them. So that's the same equivalent as taking two or three courses. "This week I work on Project A. I still know that my deadline, I know all my deadlines (I hope). And I don't do anything on Project B until the very end, maybe, the five weeks that we're working on." So what we've done is we've given them a more realistic, real-life situation, okay? (Ryan, Nov. 25 fireside chat)

> But [the student] was going through a million other things. It isn't the course that made him disappear, it was his life. (Bill, Nov. 25 fireside chat)

**Providing formative feedback.** Integrating smaller subtasks into courses allowed instructors to provide more formative feedback, especially for tasks that built on each other from week to week. The instructors also noted that asking for feedback is a critical workplace skill, and they actively encouraged students to send drafts of their work via email, discussion board posts, and web meetings. The instructors also connected the addition of formative feedback to the shift in roles:

> Because part of the premise is, you are not allowed to proceed with the code until you get approval from your client that they like your wireframe design. That's one of the caveats they have to deal with. If I don't approve your wireframe, you're gonna go back and do another wireframe. (Bill, Sept. 25 fireside chat)

> And a couple of them, I said, "This needs to be redone. You basically did a pencil sketch that showed me nothing. So, you need to clean that up, you need to make it more professional." So, I threw it back at them and

> say, “Look, I’m the client. I don’t understand what you’re showing me. You need to show me something that I can understand.” (Bill, Sept. 25 fireside chat)

In summary, students initially struggled with the expectations of CBL, including the shift toward increased student agency and open-ended inquiry. Congruently, instructors struggled with balancing the level of scaffolding in their courses. The instructors hoped to foster self-directed learning skills by asking students to engage in independent work before providing help. Instructors found ways to break down complex challenges into smaller assignments but had issues with scheduling and enforcing deadlines. This was echoed in students’ feedback, as students working full-time jobs needed flexibility in deadlines. In response, instructors encouraged students to (a) send drafts of their work for formative feedback, and (b) share when demands on students’ time increased, as the instructors identified iteration and communication as necessary workplace skills.

### Strategies and Suggestions

The instructors shared strategies they used to address initial difficulties in adopting CBL. First, the instructors set expectations through multiple modes of communication, including their syllabi, videos, weekly announcements, and emails. They also used these communication modes to keep students engaged. Anna and Ryan held virtual office hours each week so that students could ask questions. Anna also created a separate discussion board for students to communicate directly with each other. The instructors also supplemented their course materials by creating demonstrations and adding suggested websites (e.g., w3schools.com for web development).

As mentioned earlier, some instructors built in “bite-sized assignments each week or two, to make it easy to see/feel a regular rhythm in the course (and to make sure people aren’t letting a lot of learning wait until the last minute),” as mentioned by Kyle on Slack. This was echoed by Anna, who recommended building in interim tasks. Both Bill and Anna invited students to send drafts for feedback. Kyle also mentioned his plan to evaluate and revise assignments postsemester to determine when students might benefit from more guidance.

The instructors also shared suggestions for the future, such as setting explicit course goals and objectives to clearly identify course content and overlap between courses, especially prerequisites. The instructors agreed that a separate introductory module would be helpful in setting expectations for CBL courses. As part of setting expectations, Bill added:

> I would suggest that they make contact early with the students and make it clear what this course is about. Not necessarily the topic, they know that before they enroll. But what the course—the methodology of the course—and how different it will be, and how much they have to give, even more of themselves than they would in a traditional course. I think that communication has to be up front. (Bill, Oct. 25 fireside chat)

The instructors also recommended building in self-assessment and project-management components for additional guidance in understanding students’ progress toward course objectives, along with tracking students’ knowledge and skills.

### Student Feedback

Students’ feedback in interviews and surveys echoed the five common difficulties described above. In this section, we add students’ reflections to the instructors’ thoughts.

**Setting expectations and scheduling deadlines.** Students noted that the demands of CBL were high, especially the amount of time required to complete challenges. Students compared completing these real-world challenges to having an actual job in the area. One student with full-time employment stated that one CBL course was manageable for her, but two CBL courses put her at her limit. She recommended that instructors reevaluate the level of work and timelines involved in each challenge. Students also agreed that weekly tasks were difficult to complete, but biweekly tasks helped students to stay on track in a flexible way. In thinking about flexibility, we noted that the surveys indicated that most students took these courses to fulfill a degree requirement. Our takeaway here is to rethink the balance between situating students in authentic challenges and helping them to progress toward their degrees, with other real-life demands in mind, and to build in support for time management.

**Balancing guidance and independence, scaffolding levels, and providing formative feedback.** Based on survey responses, most students did not have extensive prior knowledge or experiences relevant to the course. However, students indicated in interviews and surveys that the instructors were responsive to their needs, and that this communication was helpful. One student, Raj, mentioned that he also benefited from collaborating with other students who were working in his field of interest. However, Anika had a different experience after her teammate withdrew from the course, and she suggested redistributing teams when appropriate. Overall, our instructors reliably provided as-needed guidance; however, we will reconsider the advantages and disadvantages of collaborative components in future curricula.

Students appreciated having challenges that were relevant to their fields of interest. However, one student, Vince, disliked that a “practice” challenge was not relevant to the final project but scaffolded subsequent challenges. Vince also mentioned that he liked the open-ended nature of the course, but that the initial lack of structure was difficult for him to manage. Another student, Jeff, sent a follow-up email that stated that he liked the overall course format and progression in the assignments, but that he would have preferred more scaffolding throughout the course, including more structure, additional materials, and sample solutions. These comments point to different student perceptions in how much tasks are scaffolded and sequenced. Further analysis into how to best balance open-endedness with scaffolding is needed as we move forward.

Students’ survey responses indicated that they used the textbooks, online searches, and instructor communication as primary resources for learning. Students disagreed on the usefulness of assignments, with several indicating that assignments were “busy work.” Several students felt motivated in their program and prepared for the future, while others were not comfortable using new skills. Greater understanding of students’ negative experiences will help guide us in addressing those issues more proactively, both in CBL course design and engagement with instructors.

## Discussion

Challenge-based learning helps students to use their agency to explore solutions to authentic challenges and meaningfully apply new knowledge and skills (Brown et al., 1989; Hmelo-Silver et al., 2007; Martin et al., 2007). However, transitioning from traditional instruction to CBL may be difficult for students and instructors (Barron et al., 1998; Blumenfeld et al., 1991). For our study, we sought to document the difficulties instructors and students faced in transitioning to CBL for online courses, along with the productive strategies used in addressing these difficulties. We planned to use these insights to guide design-based revisions and to support other instructors in CBL implementations.

We found that instructors and students struggled with the expectations of CBL in the early weeks of the semester, although instructors noted that most students adjusted. Instructors also struggled with balancing guidance and independence; creating scaffolded assignments; scheduling and enforcing deadlines; and providing formative feedback. Students struggled with CBL's open-ended structure; increased agency; time management; and formative feedback. Overall, finding an optimal level of scaffolding remains a challenge in CBL (Barron et al., 1998; Hmelo-Silver et al., 2007).

Following our design-based research paradigm, we are integrating these insights about difficulties, strategies, and suggestions into future design iterations of CBL courses and professional-development materials for faculty. We plan to include additional scaffolds in the design of CBL courses, such as introductory modules that set expectations; self-assessments of course progress; and project-management tools. We will also share our findings with our CBL instructors so that they may further reflect on helpful strategies for adjusting to CBL, which will be used in training workshops for past, present, and future CBL instructors.

An unexpected benefit of the introduction to CBL, in conjunction with the fireside chats and Slack discussions, was that we (the research team) gained a new venue for engaging with faculty and richer dialogue around teaching and learning than with our traditional courses. The shift to CBL problematized several learning issues for the instructors, especially contextualization of course content and connections between assignments, and generated a shared dialogue among instructors about how to best support students' learning. We also identified opportunities to explore students' learning processes in more depth, especially in how instructors communicate expectations to students; how students collaborate with each other for team projects; and how different students use different resources to support their learning. Given the small sample in this study, we see these fine-grained investigations as opportunities for exploring online learning in greater depth, and especially for maximizing the experiences of nontraditional adult learners in professional degree programs.

## Conclusion

Challenge-based learning may help nontraditional adult learners in online courses to reach their goals of developing applicable knowledge and skills for their field. However, the transition to CBL may be difficult for instructors and students. By examining instructors' and students' feedback, we identified key difficulties, strategies, and suggestions for the redesign of future CBL courses. We also found opportunities for deeper analysis of learning processes, especially regarding communication between instructors and students about course expectations, supportive materials, and collaboration.

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# Representation of Mental Illness in Video Games

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**Abstract**: Portrayals of mental illness appear frequently in video games and have the potential to shape cultural attitudes toward psychopathology for better or for worse. Yet research on such portrayals is practically nonexistent. The limited available research focuses almost exclusively on how specific characters fit into film and television mental illness tropes. Representations of mental illness in games are broader than this; for instance, they may include settings (e.g., insane asylums) and specific terminology (e.g., clinical diagnoses). Until now, there has been no framework to help identify and categorize the many game-based representations of psychopathology. This paper puts forth a new framework that does just that in an attempt to address the limitations of previous research and to offer guidance for future game researchers and developers on how to think critically about the representation of mental illness in games.

## Introduction

Since 2014, there has been a dramatic increase in games research and media coverage centered on the representation of diverse populations and experiences in digital games. These discussions have focused on the lack of non-White, non-male characters and on stereotyped portrayals of gender and race (Jenkins & Cassell, 2008; Salen & Zimmerman, 2003; Sarkeesian, 2013; Shaw, 2014; Williams, Martins, Consalvo, & Ivory, 2009). As this area of study continues to develop, it is important to expand research and analysis of representation to include less visible marginalized groups, such as persons with mental illnesses. Approximately 24% of video games portray mentally ill characters (Shapiro & Rotter, 2016) and the presence of mental illness–related content, such as insane asylums and straitjackets, or pejorative terms such as “crazy” and “psycho,” increases the frequency with which players come in contact with mental health representations. Compared to other marginalized groups, the portrayal of those with mental illness is common, yet research on the portrayal of mental illness in digital games is practically nonexistent (Ma, 2017).

How games portray persons with mental illnesses and psychopathological content conveys a sense of their cultural value (Klein & Shiffman, 2009) and, conversely, our cultural values take cues from the media we consume (Lule, 2016). Over 40 years of media research has consistently found that mass media are the most common public source of information about mental illness and that media portrayals of mental illness tend to be negative, exaggerated, and inaccurate (Ma, 2017; Singorielli, 1989; Stout, Villegas, & Jennings, 2004; Wahl, 1995). Exposure to negative media portrayals of mental illness have been linked to negative or stereotyped perceptions of the mentally ill among people without a mental illness (Ma, 2017; McGinty, Webster, & Barry, 2013; Stout et al., 2004) and impaired help-seeking behaviors and treatment adherence for persons coping with a mental illness (Maier, Gentile, Vogel, & Kaplan, 2014; Stuart, 2006).

Before we can systematically analyze how mental illness is portrayed in games, we first need to identify what constitutes mental illness in games. What does it mean for a game to portray mental illness? This paper will examine previous attempts to identify and analyze mental illness in video games, create an updated framework for categorizing mental illness portrayals, and provide examples of classic and contemporary games that fit those categories.

## Mental Illness and Games Studies

Previous research has attempted to map film and television tropes of mental illness to video games' portrayals of mental illness (Shapiro & Rotter, 2016). These tropes include: the homicidal maniac, the rebellious free spirit, the specially gifted or enlightened, the female patient-seductress, the narcissistic parasite, the zoo specimen (Hyler 2003), the simpleton, and the failure or victim (Pirkis, Blood, Francis, & McCallum, 2005). Shapiro and Rotter (2016) analyzed depictions of mental illness across the top 50 best-selling video games each year from 2011 to 2013. Of the 96 games they surveyed, 23 games (24%) depicted one or more mentally ill characters. Forty-two individual characters were identified as portraying mental illness, 29 of which (69%) acted violently and in line with the homicidal maniac trope. Of the remaining characters, one (2.4%) was categorized as a narcissistic parasite, two (4.7%) were categorized as zoo specimens, and 10 (23.8%) did not fit into an established category but displayed psychologically disturbed attributes such as cognitive or behavioral dysfunction or paranoia. The authors noted that their findings were consistent with the portrayal of mentally ill persons in other forms of media.

Morris and Forrest (2013) evaluated mental illness representation in a single video game, *Batman: Arkham Asylum* (Rocksteady Studios, 2009). In this action-adventure game, Batman battles his way out of an asylum for the criminally insane after being trapped inside. The authors summarized the portrayals of the mentally ill as featuring "stereotypical and discriminatory mental health representations commonly found in other video games" (pp. 757–758). Asylum inmates were depicted as "feral" and "animal-like" and were referred to by guards as "psychos," "insane," and "freaks." The Joker is even directly referred to in the game as a violent "schizophrenic," a clinical term for persons experiencing a constellation of symptoms such as hallucinations, delusions, lack of emotional expression, and disorganized speech or behavior (American Psychiatric Association, 2013). The stereotypes and discriminatory representation of mental illness in *Batman* is reflective of representations in other video games and across other forms of media. The authors expressed optimism about the potential of games to help destigmatize mental illness but also concern regarding the current state of mental illness representation. They urged game developers to think critically about the portrayals they create.

A well-played examination of *The Walking Dead: Season One* (Telltale Games, 2012) explored how psychological trauma was integrated as a core game mechanic (Smethurst & Craps, 2015). Combining work by game scholars and informed by psychological and sociological trauma studies, the authors suggested a "trauma-theoretical" approach. They suggested "inter-reactivity," empathy, and complicity to be unique affordances of games that effectively elicit compassion for traumatized characters and provoke a sense of responsibility for the occurrence of traumatic events. In a scene in which Lee, the player-character, is faced with cutting off another character's leg, the player is required to target and tap the screen to swing an ax. This is followed by a brief cutscene in which the camera shifts from first-person to a third-person perspective, allowing the player to view the player-character as well as all of the nonplayer characters. During this time, the player has no control—the player cannot move the camera, change his or her mind, or make any other decisions. Once the scene ends, the player must tap the screen to initiate the next swing. By alternating between first- and third-person perspectives, and between being an active agent and a passive observer, the game gives the player the space and the time to consider his or her choices and their visceral, gory, agonizing consequences. Although this research did not directly analyze *The Walking Dead* for portrayals of mental health, it did provide an additional way to conceptualize the representation of mental illness in games; specifically, that mental health issues can be embodied in game mechanics, not just characters.

Outside of academia, game critics also have weighed in on the representation of mental illness in games. In July 2014, Polygon posted an article by games critic Patrick Lindsey titled, “Gaming’s favorite villain is mental illness, and this needs to stop.” Lindsey, who worked on the interactive fiction game *Depression Quest* (Zoë Quin, 2013), discussed the tendency of games to depict mentally ill characters as broken, less than human, and completely foreign. According to Lindsey, “These characters are dehumanized, portrayed as mental disorders embodied and wrapped in ostensibly human packaging.” In instances when the mentally ill are more than subhuman entities, they tend to be murderous villains. Lindsey identified Vaas Montenegro from *Far Cry 3* (Ubisoft Montreal, 2012) and Makarov from *Call of Duty: Modern Warfare* (Infinity Ward, 2007) as examples of characters who appear to have no motivation for their murderous inclinations other than being criminally insane. Lindsey also called out the use of “sanity meters,” a graphical user interface that quantifies how “crazy” a character is, as an example of mental illness as a game mechanic.

A July 2013 article published on Kotaku similarly identified games as using insanity as a game mechanic and the raison d’être for an aggressive, violent villain. Written by neuroscientist Ian Mahr, “Nobody Wins When Horror Games Stigmatize Mental Illness” dove into the common tropes associated with mental illness in horror games. These tropes related to the “crazed killer” and “horrific insane asylum” were identified as common story devices used to tie up loose exposition or backstory or to provide justification for a character’s behavior. His analysis reflected established tropes in media around the mentally ill as dangerous and particularly violent and also emphasized the role psychiatric environments and artifacts (i.e., straitjackets, medication, etc.) play in portraying mental illness in games.

Additional critique in this area comes from the website Not Your Momma’s Gamer (NYMG). NYMG is a website founded by Samantha Blackmon, a professor of rhetoric and games studies, and Alex Layne, a professor of gender and gaming issues. Articles posted to NYMG include exploration of mental illness as the new “damsel in distress” trope (Barry, 2015), critique the horror genre’s frequent reliance on mental illness as a means to induce fear (Nixon, 2013), and parsing the difference between madness and mental illness in games and what those representations reflect about society (Layne, 2016). The feminist perspective taken by many of these articles provides a needed bridge of intersectionality for mental illness and other minority populations portrayed in the games space.

## Summary

The minimal literature available on mental illness in games has consistently found games to be populated with negative, stereotyped portrayals. Research has focused on mental illness as portrayed by game characters and has suggested that game mechanics, narrative, and settings might also convey representations of mental illness. The frames used to identify and analyze mental illness in games has drawn extensively from research in other media, such as television and film, as the starting point for analysis. Digital games are a unique medium with specific affordances that differentiate them from other forms of media (Madigan, 2015), so drawing on a framework established to serve a different form of media may not produce generalizable results. That said, because of the scarcity of available research on the portrayal of mental illness in games, frameworks from other media can serve as a solid place to start creating a parallel framework for games. Adopting defined mental illness tropes from television or film is a natural starting point for the first foray into representation in games. However, using this frame has resulted in a near-universal finding of negative and stereotyped portrayals, which is not particularly helpful in encouraging future research. It more or less conveys that video games are terrible at portraying mental illness—case closed. Similarly, this research does not provide game designers any helpful feedback or guidance on how to create portrayals of mental illness that are anything other than terrible.

What follows is a reframing of previous research into a framework that captures character portrayals of mental illness as well as game narratives, mechanics, and environments that allude to or directly reference psychopathology. In addition, this framework expands upon previous research approaches by including space for considering progressive portrayals of mental illness and creating a method for categorizing less obvious portrayals. The goal of this framework is to enable games researchers to consistently identify mental illness representations in games so that future research can spend more time focusing on analyzing portrayals and less time figuring out what category they may fit into. Additionally, this framework aims to raise awareness within the game-development community about the casualness with which mental illness is often portrayed in games and the potential impact of that casualness, and to support game developers in designing better portrayals of psychopathology.

## A Dimensional Approach to Categorizing Psychopathology in Games

Identifying and analyzing mental illness representations in games is uniquely challenging. Unlike with many portrayals of other marginalized groups, mental illness is often not outwardly visible. Even if it were, it is not enough to identify merely the presence or absence of a portrayal of mental illness in a game—researchers also must be able to analyze the depth and accuracy of that portrayal. For example, both *Final Fantasy VI* (Square, 1994) and *Depression Quest* (Zoë Quin, 2013) portray mental illness, but only one of them (*Depression Quest*) explores what it means to cope with a mental illness while the other uses mental illness as a convenient plot point. How do you compare Arkham Asylum from *Batman* (Rocksteady Studios, 2009) to the Ospedale Psichiatrico di Volterra from *Town of Light* (LKA, 2016), the psychiatric hospital modeled on a still-standing insane asylum from 19th-century Italy that is littered with historically accurate artifacts? These games have wildly different goals, but they all offer representations of psychopathology and are worthy of study.

One potential solution is to view representations not as merely present or absent but as points on a spectrum that tend to cluster into one of three groups: One-Dimensional, Two-Dimensional, and Three-Dimensional representations (see Figure 1). Portrayals that cluster around the One-Dimensional group are flat and lack defining characteristics that make them unique or interesting. Two-Dimensional portrayals have specific properties that are essential to making them what they are (e.g., a square must have four points and removing or adding a point means it is no longer a square), but there is no depth to the representation. Portrayals that cluster toward the Three-Dimensional group also have specific properties that make them what they are, but these properties extend beyond the surface and provide depth and alternative perspectives. Three-Dimensional representations are to Two-Dimensional Representations as a cube is to a square.

The idea of viewing mental illness portrayals as a spectrum was inspired by the diagnostic criteria for specific psychological disorders, which also use a spectrum rather than distinct categories (e.g., present vs. absent), such as autism spectrum disorder (American Psychiatric Association, 2013). One of the limitations from previous research is that it focused on trying to sort mental health representations into distinct categories: good or bad; present or not; homicidal maniac or zoo specimen. Using a spectrum allows for flexibility so that researchers do not find themselves attempting to fit fuzzy representations (e.g., does that character *really* meet all criteria for PTSD?) into distinct categories, as happened in the Shapiro and Rotter (2016) study when a quarter of all the characters they evaluated did not fit into any established category. You can land somewhere in between groups and still have a sense of where you are in terms of representation, as opposed to being tossed into an "other" category.

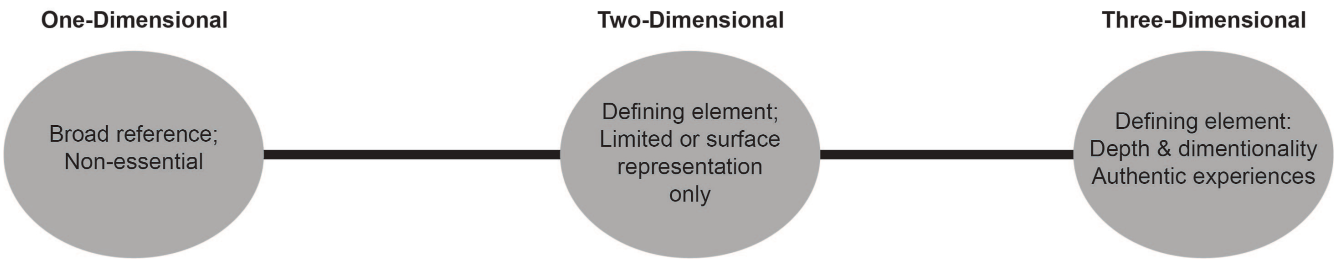


*Figure 1. Video game psychopathology spectrum.*

## One-Dimensional Representations

At the left end of the spectrum are One-Dimensional representations. These consist of broad references to mental illness wherein the representation is a nonessential element to a character, story, or environment. These references are background noise, something that is alluded to but not established and which carry minimal significance. One-Dimensional portrayals acknowledge that mental illness is something that exists in the world, but only through passing references. For example, Heimskr is a Nord priest in *The Elder Scrolls V: Skyrim* (Bethesda Game Studios, 2013) who preaches loudly outside the keep in Whiterun. His sermons predict the end-times for Skyrim and he is regarded by some of the nonplayer characters (NPCs) in Whiterun as mentally ill: "That Heimskr's crazy." There is no further attempt to understand his insanity. Labeling Heimskr as crazy is not essential to any aspect of the game. Removing the pejorative reference would not impact the game in any measurable way and it would also break from perpetuating stigmas and stereotypes around mental illness. One-Dimensional representations are not inherently problematic as they can also provide neutral or even positive representations. For example, an NPC could mention in passing that he went to therapy before or, when searching a house, a player could find a prescription for psychiatric medications or a psychiatrist's business card. These kinds of neutral, nonstigmatizing references may even be helpful as they may normalize the presence of mental illness and its ephemera in mundane daily life.

Another type of One-Dimensional representation are the "illness in name" characters whose names presuppose the presence of a mental illness (Shapiro & Rotter, 2016). This includes the Psychos from *Borderlands* (Gearbox Software, 2009), Crazy Red from *Animal Crossing: New Leaf* (Nintendo, 2012), and the descriptively named Disturbed Suspect from *L.A. Noire* (Team Bondi, 2011). Naming these characters does nothing in terms of story or character development—other than signal to the player that there is something odd about the character or situation—and could be removed without anything related to the character, narrative, or setting being lost.

## Two-Dimensional Representations

In the middle of the spectrum are Two-Dimensional representations wherein psychopathological features are essential to, or a defining element of, a character, story, or setting. A key element of these representations is that they lack depth; the game does not explore mental illness beyond the surface level. Two-Dimensional representations often provoke commonly held views or beliefs about what mental illness is, what it does, and what it looks like. These portrayals serve as a kind of shorthand between the game developer and the player, enabling the developer to convey a great deal of information with minimal effort. For example, have you ever played a game in which your character woke up in a psychiatric hospital and something *good* happened? Probably not. The stereotype of a psychiatric hospital as a terrifying place where terrible things happen is so pervasive that it serves as a convenient, easy way to tell players to be afraid and to expect trouble.

Two-Dimensional representations can also be used as a tool to explain a character's behavior or backstory. In *Final Fantasy VI* (Square, 1994), Kefka, the game's villain, is motivated to destroy the world solely because he is "insane." Vaas Montenegro from *Far Cry 3* and Makarov from *Call of Duty: Modern Warfare* also are inclined toward extreme violence because of insanity. Their psychopathology is core to who they are but any attempt to dig deeper reveals a hollow shell of a character.

Not all Two-Dimensional representations portray negative stereotypes. For example, Sandal from the role-playing game *Dragon Age: Origins* (Bioware, 2009) appears to have a cognitive impairment rendering him nearly mute, and it is strongly implied that Symmetra from the team-based shooter *Overwatch* (Blizzard Entertainment, 2016) is on the autism spectrum (Kriss, 2016). These characteristics are important to each character's identity (Sandal) or personality (Symmetra) but are not explored, questioned, or discussed. It is critical that these kinds of neutral representations be included in assessments of mental illness representation; otherwise, researchers may overestimate the percentage of portrayals that are over the top or that propagate negative stereotypes. These representations also serve as a model for game developers on creating characters with mental illness symptoms in a neutral or nonstigmatizing way.

### Three-Dimensional Representations

At the right end of the spectrum are Three-Dimensional representations of mental illness. These characters, narratives, and environments are more than just plot points or convenient backstory; they are essential and fully realized components. These representations have depth and dimensionality and examine the experience of mental illness from multiple perspectives. One prominent example of Three-Dimensional representations is *Hellblade: Senua's Sacrifice* (Ninja Theory, 2017). *Hellblade* features character, narrative, and environmental representations of mental illness and delivers a thoughtful and emotionally engaging story that explores the complexities of mental illness without stereotype or sugarcoating. *Hellblade* was developed in cooperation with mental health professionals as well as individuals who experienced voice-hearing or other psychosis-related symptoms.

Three-Dimensional representations do not need to be true to life in terms of narrative or design, but they do need to reflect authentic experiences. For example, *Neverending Nightmares* (Ifinitap Games, 2014) is a 2.5D psychological horror game with cartoon graphics with an almost entirely black-and-white color palette. Matt Gilgenbach, the game's creator, has been very open about his experience coping with major depressive disorder and obsessive-compulsive disorder and how he integrated those experiences into gameplay. *Neverending Nightmares* is not realistic in terms of graphic fidelity to the real world and the story is fictional, but the gameplay creates both cognitive and emotional experiences that are multidimensional, complex, and reflect the lived experience of the game's creator. *Night in the Woods* (Finji, 2017) is another example of how a game with a cartoon aesthetic can portray and convey the experience of mental illness in a way that respects the complexity of mental health and the everyday experiences of those who cope with mental illness, and it offers players an authentic experience while avoiding the flavor of mental health tourism.

## Conclusion

The lack of research around psychopathology in video games is somewhat shocking considering how common mental illness is worldwide and how frequently it appears in games. Mental illness affects one in every five Americans (Mental Health America, 2018) and stigma is a major factor that inhibits help-seeking behaviors (Maier et al., 2014). Media representations of mental illness have been found to influence perceptions of the mentally ill, mental health professionals, and those who seek therapy, and they accurately predict how likely persons with a mental illness are to see themselves as broken or unacceptable (self-stigma; Maier et al., 2014). How mental illness is portrayed in games reflects how we, as a society, perceive the mentally ill. But since culture also takes cues from media, it is possible for games to change how society thinks about persons with mental illness, seeking treatment, and mental health professionals.

The video game psychopathology spectrum presented in this paper can be useful for game developers as it provides a system to critically evaluate mental health portrayals and proactively protect against shortchanging those portrayals when they arise in games. Avoiding the perpetuation of harmful tropes and stereotypes is a crucial part of breaking down mental health stigma. For researchers, the spectrum provides a solid foundation for collecting, sorting, and analyzing portrayals of mental illness in games. Going forward, future research can more accurately document the prevalence of mental illness in games and begin to dig deeply into specific types of representations and how they may impact players' thoughts or beliefs about mental illness, seeking treatment, or mental health professionals. More research on how games can reduce stigma against mental illness is encouraged using both serious games (e.g., Cangas et al., 2017; Ferrari, Bush, Clark, & Archie et al., 2016) and commercial games.

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# Reviews Matter

## How Distributed Mentoring Predicts Lexical Diversity on Fanfiction.net

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**Abstract:** Fanfiction.net provides an informal learning space for young writers through *distributed mentoring:* the networked giving and receiving of feedback. In this paper, we quantify the cumulative effect of feedback on lexical diversity for 1.5 million authors.

### Introduction

Millions of young writers and readers connect and engage with each other through participation in online fanfiction communities. Fanfiction offers a space for writers to challenge mainstream narratives by including marginalized voices and alternative identities (Jamison, 2013). Low barriers to participation allow language and literacy learners to practice their skills and socialize with others (Black, 2008). Many fanfiction authors profess to have learned about writing and life from this activity (Campbell et al., 2016). Studies have shown how sophisticated informal learning takes place in these communities at the same time while young people give and receive feedback. This interwoven network of mentoring and learning, termed *distributed mentoring,* is characterized by its distribution over a diverse audience and its embeddedness in the affordances of the web (Campbell et al., 2016; Evans et al., 2017).

In this paper, we seek to overcome the challenge of quantitatively measuring distributed mentoring and its effect on fanfiction writing. *Abundance* is a single aspect of distributed mentoring that represents the sheer volume of feedback; overall, this provides direction to the writer even though the individual comments may be shallow (Evans et al., 2017). We measured abundance by counting the cumulative number of reviews an author has received when she or he posts a new fanfiction chapter. To study its effect, we made use of an automated textual measure on a vast corpus of fanfiction: 61.5 billion words comprising 28 million chapters, produced over 20 years by 1.5 million authors. The efficacy of automated measures for evaluating learning is somewhat limited. However, the Measure of Textual Lexical Diversity (MTLD; McCarthy & Jarvis, 2010) accurately measures a writer's breadth in terms of his or her distinct vocabulary. Previous work has modeled language learning as the growth in cumulative vocabulary (Durán, Malvern, Richards, & Chipere, 2004), and writing quality as measured by human raters has been found to be correlated with lexical diversity (Crossley, Salsbury, McNamara, & Jarvis, 2011; McNamara, Crossley, & McCarthy, 2010; Yu, 2010).

In our analysis, we correlate lexical diversity with the abundance of distributed mentoring for authors on Fanfiction.net. We further compare lexical diversity with self-reported age. Previous studies make predictions about the relationships between adolescence, distributed mentoring, and lexical diversity. Campbell et al. (2016) report participants' claims that they became better writers as they received feedback on Fanfiction.net. However, they also improve their writing through experiences gained outside of the fanfiction community and from the natural maturation that occurs specifically during late teenage years. White (2014) measured a pronounced growth in lexical diversity among a small group of high school students during the ages of 15 to 18 years old. Thus, we can expect to find changes in lexical diversity in correlation with measures of both distributed mentoring and maturation. This leads to our hypotheses:

H1: Lexical diversity will increase between subsequent chapters after increased reviews.

H2: Lexical diversity will increase during late adolescence.

H3: Lexical diversity will increase between chapters as an author matures.

H4: Lexical diversity will be greater as an author has cumulatively received more reviews.

This paper contributes new understanding about distributed mentoring in fanfiction. We find statistical evidence that there is a positive relationship between lexical diversity in fanfiction stories and the distributed mentoring that the authors receive. We replicate prior findings (White, 2014) that found that significant lexical development occurs during late adolescence with a large-scale longitudinal analysis, expanding the previously known scope to a large English-speaking population. Finally, we present a mixed linear model of lexical diversity with respect to reviews and maturation.

## Related Work

### Fanfiction

A fan community "transforms the experience of media consumption into the production of new texts" (Jenkins, 2006). To describe how fan communities attract and support fan authorship, Jenkins (2006) coined the term *participatory culture,* defined by the following characteristics: relatively low barriers to engagement, strong support for creation, and some type of informal mentorship to pass along knowledge. Kelly Chandler-Olcott and Donna Mahar (2002) described fanfiction as an undervalued medium through which one can examine students' writing development. They found that recognizing fanfiction in formal learning communities can improve literary engagement and achievements. Rebecca Black (2008) suggested that fanfiction communities build interactive language skills as language learners engage in discussions with other fans. Black noted how the community's emphasis on encouragement, constructive feedback, and collaboration provided focused and individualized grounds for improvement. This one-to-many environment affords writers the opportunity to ask specific questions of reviewers, receive grammar corrections, and to get feedback from native speakers.

Previous large-scale data collection and analysis has leveraged the digitization of fan communities to understand fandom. On Fanfiction.net alone (as of February 2017), there are approximately 61.5 billion words of fiction—enough for 615,000 novels of 100,000 words each. In 2016, Smitha Milli and David Bamman (2016) applied computational methods to fanfiction to study the nature of fanfiction communities as both mass-scale literary archives and social networking platforms. Furthermore, they proposed the use of fanfiction communities as a resource for the prediction of future reader responses in the literary market. In 2017, Yin, Aragon, Evans, and Davis (2017) collected and published a trove of metadata from Fanfiction.net, finding that community engagement and support varies between fandoms. The current study expands the scope of research into story content, and builds on previous work by examining the outcomes of author–reader relationships. Our research seeks to quantitatively explore the connection between community engagement and improved language skills.

### Distributed Mentoring

Distributed mentoring, proposed by Campbell et al. (2016) and Evans et al. (2017), is a collaborative mentoring process that takes place in networked spaces, enabled by computer-mediated interactions. The theory of distributed mentoring draws on Hutchins's (1995) framework of distributed cognition to describe knowledge as embedded in artifacts of interaction. Fanfiction participants may simultaneously be experts and novices in different aspects of the practice, such as canon knowledge or grammar. In addition, the role of each review varies. Evans et al. (2017) categorized 4,500 reviews into 13 overlapping categories. Specifically, they found that 35.1% of reviews were shallow and positive, 46.6% specifically targeted aspects of the text, and 27.6% encouraged updates. They additionally interviewed fanfiction authors, finding that authors develop strategies to pick the most helpful comments and incorporate them into their writing. This ethnographic investigation of Fanfiction.net revealed how its rich network contributes to authors' development through distributed mentoring. To empirically evaluate this theory, our work tackles the challenge of quantifying distributed mentoring on a large scale. The *abundance* aspect of distributed mentoring describes how a large volume of relatively shallow comments provides overall direction to authors (Evans et al., 2017). Additionally, the positivity of the feedback provides affective support. We represented the abundance of distributed mentoring in our analysis as a count of the number of reviews received by a user. To assess the outcome of distributed mentoring, we analyzed texts with an automated measure, described next.

### Lexical Diversity

Lexical diversity (LD) is a measure that describes the range of word usage in a text. The Measure of Textual Lexical Diversity (MTLD) provides a reliable reflection of LD well suited for narrative discourse (Fergadiotis, Wright, & Green, 2015). The properties of MTLD match our need for an efficient automated comparison between fanfiction texts of varied length, as based on numerous studies, MTLD is associated with narrative quality and language ability. McNamara et al. (2010) compared expert evaluations of 120 undergraduate student essays with MTLD, finding significant differences between low- and high-proficiency argumentative essays, with mean scores of 72.64 and 78.71, respectively. Treffers-Daller (2013) assessed narrative texts written in French by 64 students, finding that the MTLD of these texts correlated moderately with the students' scores on the C-Test, a general measure of French language ability. Olinghouse and Wilson (2013) assessed narrative, persuasive, and informative compositions by 105 fifth graders and found that MTLD accounted for 8.4% of the expert-judged quality variance among the narrative texts. Mazgutova and Kormos (2015) compared MTLD between argumentative essays written by students before and after an English for Academic Purposes class at a British university, finding a significant increase in MTLD. In a longitudinal study by White (2014), MTLD increased significantly from grade 11 to grade 13 among New Zealand students aged 15–18 years old, indicating that late adolescence constitutes a significant period of lexical development. Our analysis longitudinally measured MTLD changes over the course of Fanfiction.net users' authorship.

## Method

### Fanfiction Archive

Fanfiction.net contains nearly 7 million stories, posted in chapters, covering approximately 10,000 different fandoms (fandoms refer to the fictional universe or characters borrowed by a fanfiction author, e.g., *Harry Potter*). Each story contains an average of 4.17 chapters ($SD$ = 8.12). To gather these texts for analysis, we developed a scraping program based on the legacy of Yin et al. (2017). Using a combination of Apache HttpComponents and jsoup, we archived a snapshot of 16 years of fanfiction data during January to February 2017. The resulting data set included 672.8 GB of data, with 28,493,311 chapters from 6,828,943 stories, as well as 8,492,507 users and 176,715,206 reviews. In total, we retrieved about 61.5 billion words from story text alone (not including reviews).

### Ages and Profile Parsing

To examine the relationship between lexical diversity and age, we gathered the ages of Fanfiction.net users from their profiles. We parsed biography text from the entire set of 8,492,273 user profiles and extracted self-reported age information using regular expressions. We found 284,448 profiles containing self-reported ages ($M$ = 16.80, $SD$ = 8.32), of which 62.3% were from users aged 13 to 19 years old, indicating that a majority of Fanfiction.net users are adolescents. This is supported by data from previous work (Yin et al., 2017). We computed author age approximations for each fanfiction chapter by adding the self-reported age to the difference between the chapter publication and user profile update times. For instance, a user who updated her profile in January 2010 stating she was 21, and published a story in June 2011, would be estimated at 22.5 years old for that story. Self-reported ages have obvious limitations; for example, reported ages ranged from 0 to 99 years old. We excluded 105,184 users from the analysis because they did not author any English fanfiction, while we also excluded 24,792 authors who reported ages that placed their adjusted age below 10, and 21 were eliminated because their profile update time could not be found. The analysis included 154,451 authors and their ages and lexical diversity for 3,696,107 fanfiction chapters.

### Lexical Diversity Scoring

MTLD is defined as the average length of substrings within a text that maintain a given ratio of unique words to total words. The algorithm keeps track of a running type-token ratio (TTR) as each word is processed sequentially; the running TTR increases when new words are found and decreases when word repetitions occur. The algorithm maintains a count of *factors*, defined as a sequential group of words with a TTR of 0.72 or below (McCarthy & Jarvis, 2010). Each time a factor is found, the running TTR is reset and a count of factors is incremented by one. When the algorithm completes, any remaining words become a partial factor, which is 0 if the running TTR is 1.00 and approaches 1 as the running TTR approaches 0.72. The output unit of MTLD is the mean length in words of factors within the given text. We chose to use the 0.72 threshold provided by McCarthy and Jarvis (2010), which was calibrated using a corpus containing fiction and nonfiction texts. We implemented MTLD in Python (see www.github.com/jfrens/lexical_diversity) and processed 28,493,311 fanfiction chapters with a minimum length of 100 words. In total, 61,560,528,896 words were processed.

### Publication Time Estimation, Language, and MTLD Outliers

Chapter publication times are not directly accessible on the website, thus we made estimates using story and review metadata. We took the story publication time as the publication time of the first chapter. For subsequent chapters, we used the time of the first review as an estimate of its time of publication. To verify the accuracy of this estimate, we compared story publication time with first review time for the first chapters, and found that the median time to review a first chapter was three days, and 42% of first chapters received their first review within 24 hours. Chapters with zero reviews were assigned publication times equal to the nearest known chapter times. We obtained story languages from metadata available on Fanfiction.net. We verified the accuracy of this data using the Python library langdetect. Overall, the metadata matched with langdetect when finding English versus non-English for 99.5% of chapters. MTLD varies with language, and previous studies used lemmatization with MTLD while working with non-English languages (Treffers-Daller, 2013). Our study included English texts, representing 25,266,230 of 28,493,311 chapters, and did not use lemmatization.

While most fanfiction chapters had MTLD between 50 and 150, a few texts had extremely low or high scores. We reviewed a sample of texts with MTLD below 5 and found that almost all of these low-scoring texts were nonnarrative word repetitions. A sample of texts above MTLD 300 were mostly nonnarrative, including number sequences, lists of random words, tables of contents, glossaries, and random typing. We eliminated 2,678 outlier chapters with MTLD below 5 or above 300 from the analysis. We also eliminated 22 chapters with erroneous data and 427,662 chapters containing fewer than 100 words. The data set used for our analysis of lexical diversity included 53,185,524,320 words contained in 24,835,868 chapters of fanfiction from 5,906,217 stories. Chapter MTLD scores in this set were normally distributed around the mean of 97.35, with a standard deviation of 21.96.

### Mixed Linear Models

Mixed linear models are a class of regression model suited to testing longitudinal differences on a continuous dependent variable. In a mixed model, fixed effects represent independent variables of interest. Random effects typically account for individual differences, such as between students, and group differences, such as between classrooms. In our regression analyses, fixed effects were used to model our independent measures: cumulative reviews and time. Random effects were used to group data by user and by fandom. Fandom is an important confound to control, as Yin et al. (2017) found that the number of reviews exchanged varies by fandom, and we found that MTLD varies by fandom.

## Results

### Reviews and Incremental Change in Lexical Diversity

To test H1, we examined the MTLD change between subsequent chapters written within a one-month window with respect to their reviews. We calculated 19,709,160 MTLD differences for this analysis, with a mean increase of .019 ($SD$ = 20.69). We determined the number of reviews received by the author between chapter publications ($M$ = 4.51, $SD$ = 6.67). We used reviews and days as fixed effects and user as a random effect in our mixed linear model. The fixed effects were weakly correlated ($r$ = 0.30). The resulting coefficient for reviews (see Table 1) indicated that each additional review predicted a decrease in MTLD of 0.007, while the coefficient for days indicated that each day between chapters was associated with an increased MTLD of 0.024. Cohen's $F2$ for both variables was < 0.001, indicating the effect sizes were nominal. The results contradict H1, showing that increased numbers of reviews do not predict an immediate increase for the subsequently written chapter.

| Fixed Effect | β | SE | $F^2$ |
|---|---|---|---|
| Days Between | 0.024* | <0.001 | <0.001 |
| Reviews Between | -0.007* | <0.001 | <0.001 |

*Table 1. Fixed effect coefficients predicting MTLD differences between chapters. Columns included are coefficients (β), standard error (SE), and Cohen's F2 (F2). *p < 0.001.*

### Age and Lexical Diversity

We examined the relationship between age and MTLD for English-speaking Fanfiction.net authors who self-reported their ages (see Figure 1). The mean chapter MTLD increased from 93.6 at age 15 to 97.1 at age 19, and thereafter remained generally flat. To test H2 (that lexical diversity increases during late adolescence) we analyzed the 1,608,824 chapters by 71,983 authors with estimated ages from 15.0 to 20.0 years old with a mixed linear regression. Age was the only fixed effect, while user and fandom were modeled as random effects. The significant ($p < 0.001$) and positive coefficient of 1.66 indicated that MTLD substantially increased each year during late adolescence. Cohen's *F2* was 0.007, indicating the effect size was small relative to variance. This result supports H2, replicating previous findings that show adolescence to be a significant period of lexical development (White, 2014).

### Distributed Mentoring Abundance and Lexical Diversity

To operationalize the abundance of distributed mentoring, we counted, for each chapter in the English data set ($N$ = 24,835,868), the cumulative number of previously received reviews by the same author. The median number of reviews was 59, with a right skew ($M$ = 420.38, $SD$ = 1741.70), and a maximum of 128,870 reviews. To visually examine the relationship between cumulative reviews and lexical diversity, we created logarithmic groups of chapters by the number of previously received reviews and computed the mean MTLD score among chapters in each bucket. As shown in Figure 2, the mean lexical diversity (MTLD) increased with reviews, from 93.22 when reviews were absent to 102.33 when more than 10,000 reviews had been accumulated by the author (see Figure 2).

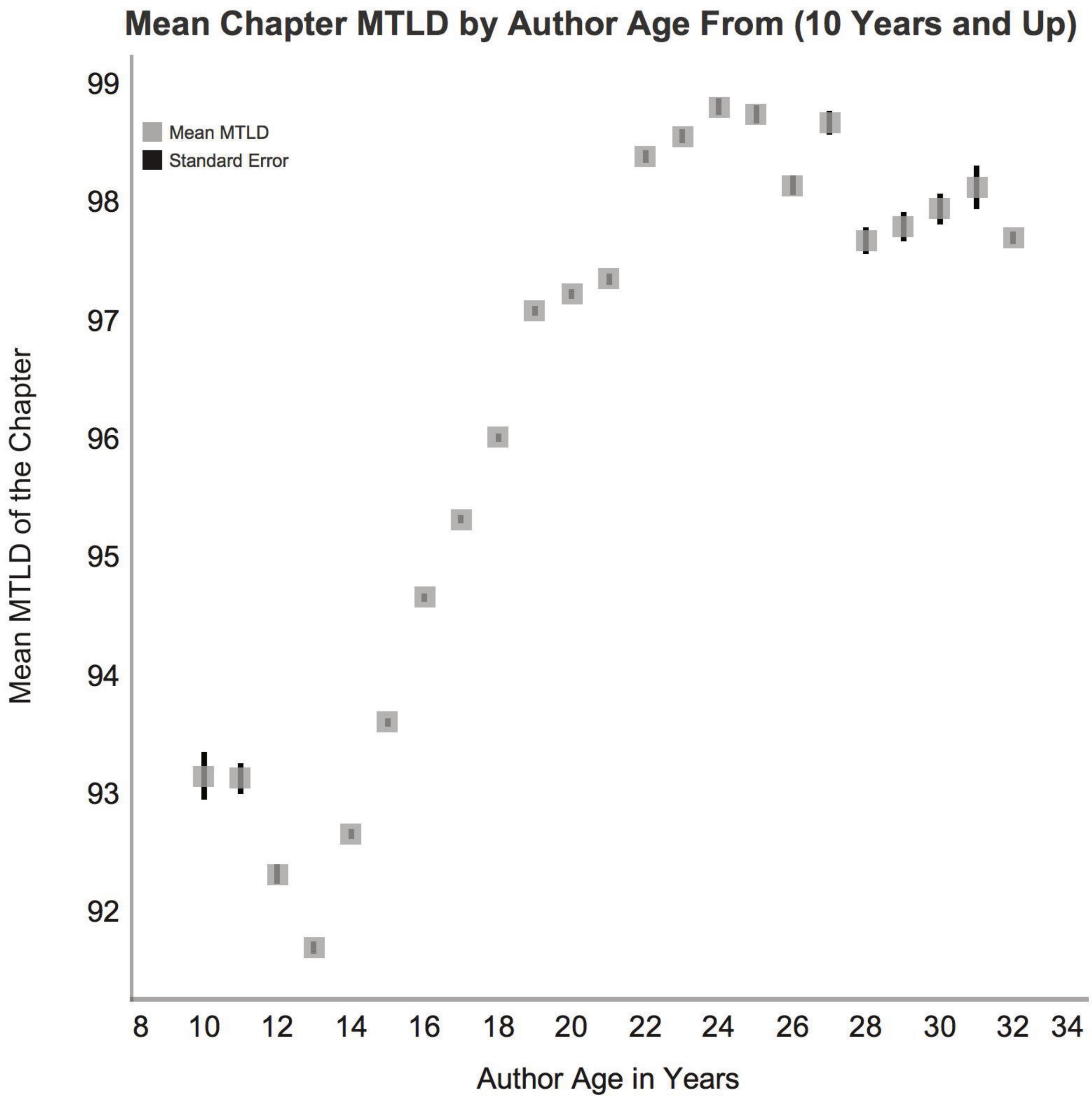


*Figure 1. Mean MTLD of chapters by author age (154,451 authors self-reported age in their profile).*

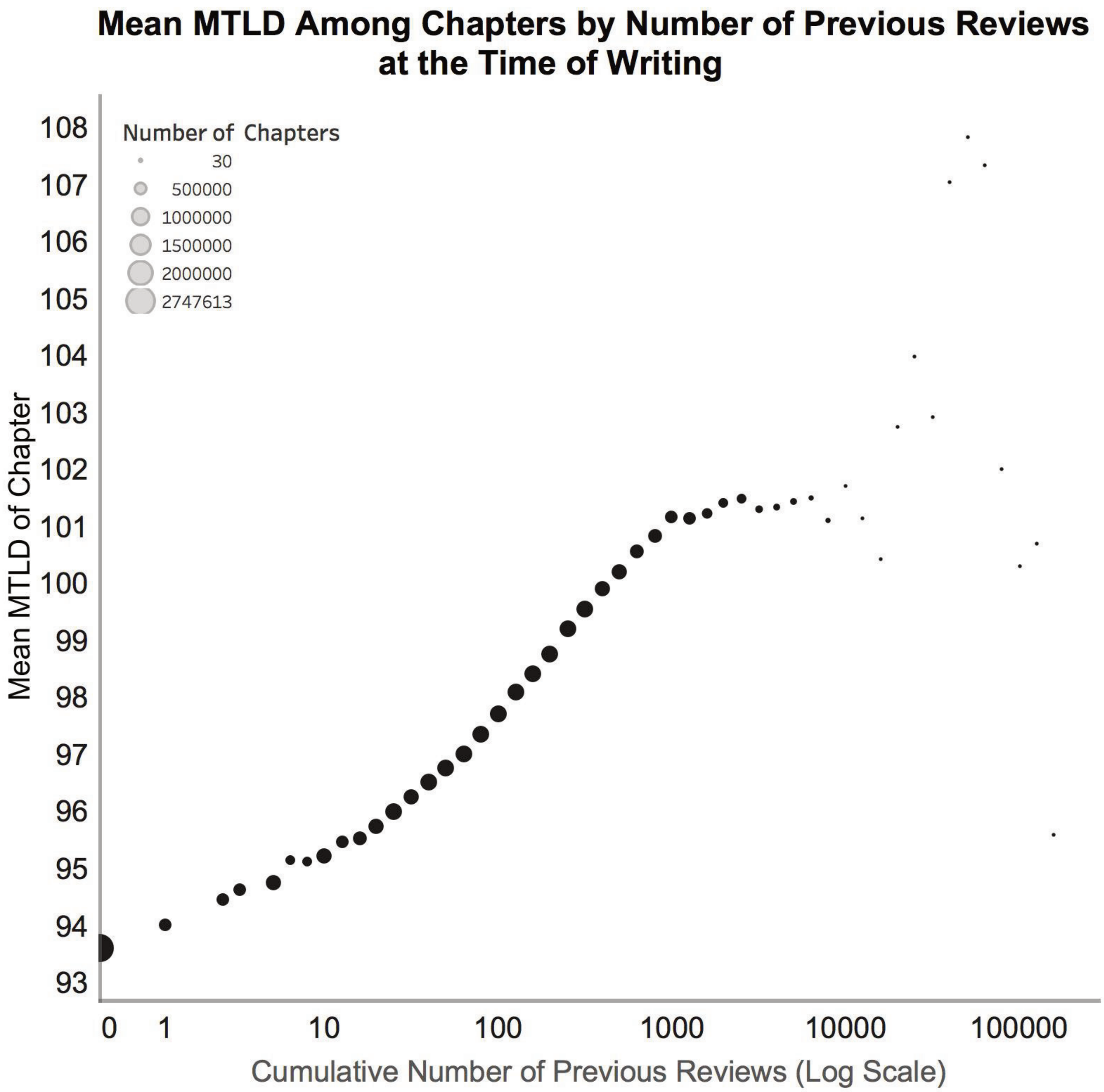


*Figure 2. Mean MTLD of chapters by authors' cumulative number of previous reviews.*

We performed a mixed linear regression to test H3 (maturation predicts increased lexical diversity) and H4 (accumulating reviews predicts increased lexical diversity). This analysis tracks MTLD changes during authors' first 50 chapters; 1,065,606 authors wrote at least two chapters, and 16,658,721 chapters were analyzed in total. The two fixed effects were weakly correlated ($r$ = 0.27). Cumulative reviews and days each significantly predicted chapter lexical diversity (see Table 2). For each day of maturation, MTLD increased by .0032. For each review received, MTLD increased by .0018. This supports H3 and H4 and indicates that distributed mentoring and maturation uniquely contribute to authors' development.

| Fixed Effect | β | SE | $F^2$ |
|---|---|---|---|
| Days | 0.0032* | <0.001 | 0.004 |
| Cumulative Reviews | -0.0018* | <0.001 | <0.001 |

*Table 2. Fixed effect coefficients predicting MTLD based on maturation (days) and distributed mentoring abundance (cumulative reviews). *p < 0.001.*

## Limitations

Limitations and validity threats should be considered. First, there could be other causes for an increase in lexical diversity correlated with distributed mentoring as operationalized by the reviews. Second, our finding does not imply any causal relationship. Third, we do not know the degree to which the stories were edited. Moreover, lexical diversity does not capture all aspects of narrative writing quality, nor does it represent all learning that occurs among fanfiction writers. More broadly, no algorithm assesses text like a human evaluator, and no behavioral measure can peek into minds to see what is learned.

## Discussion

We found that an abundance of distributed mentoring predicts increased lexical diversity among fanfiction chapters. This was robust when we accounted for maturation and fandom differences. Also, the effect sizes (Cohen's *F2*) were very small, indicating the variance in MTLD is mostly predicted by factors other than distributed mentoring or maturation. It is unsurprising to find this high degree of noise in an automated learning measure. The results imply that reviews exchanged on Fanfiction.net shape authors' writing. Lexical diversity trends with narrative quality (Fergadiotis et al., 2015; Olinghouse & Wilson, 2013) and language ability (Mazgutova & Kormos, 2015; Treffers-Daller, 2013; White, 2014). Our findings contribute behavioral evidence in support of claims by young authors interviewed by Evans et al. (2017) that the community contributed to their development as writers. While reviews did not immediately increase lexical diversity on authors' subsequent chapter, the effect occurred over time as reviews accumulated. Receiving roughly 650 reviews predicted the same increase in lexical diversity as one year of maturation. This underscores the significance of informal writing communities in the lives of young writers and the importance of affordances for distributed mentoring in such communities.

Several implications follow from our analysis of the abundance of distributed mentoring, particularly for members of learning communities such as Fanfiction.net. Participants in informal learning communities should be encouraged to embrace and interact with those who have not yet received feedback on their work. This type of community support can occur spontaneously, such as the "Review Revolution" on Fanfiction.net (Campbell et al., 2016), but the creation of affordances by community developers to facilitate review encouragement would likely yield a significant dividend for new writers. There are also fundamental implications for stakeholders, such as parents, teachers, designers, and researchers. We need to recognize the role of fanfiction in shaping the development of today's connected youth. The type of feedback given through distributed mentoring has been discounted by researchers as shallow and therefore not valuable (Magnifico, Curwood, & Lammers, 2015). Our results contribute behavioral evidence to the growing number of ethnographic and qualitative studies demonstrating the importance of fanfiction for shaping the identities (Black, 2008), expression (Jenkins, 2006), and literacy (Chandler-Olcott & Mahar, 2002; Jamison, 2013) of young people. We should honor what young people are doing. Our findings support calls to acknowledge this learning experience and to incorporate it into formal education (Alvermann, 2008). Involved adults should encourage adolescent participation in informal writing communities so that young writers can engage in and benefit from distributed mentoring.

This work opens areas for exploration in the study of connected learning in fanfiction communities. Evans et al.'s (2017) aspects of distributed mentoring provide a framework for the exploration of reviews. Future work can extend ours by quantitatively examining different kinds of mentoring in the more than 170 million reviews present on Fanfiction.net. We hypothesize that, given an equal abundance of reviews, a greater diversity of review perspective and content will be associated with improved outcomes. Another potential direction comes from identifying and understanding the roles that users take on within Fanfiction.net. As noted by Campbell et al. (2016), there is no overt distinction among users in their profile pages, especially age-based distinctions typical of offline settings, unless they elect to report this information. Thus, the context of Fanfiction.net provides teens and emerging adults with unique opportunities to assume mentorship roles. A network analysis is needed to review the roles that exist in the fanfiction community and how the roles of the author and reviewer interact in the network and help to uncover design principles for incorporating distributed mentoring into other learning settings.

## Conclusion

Young adults at an age critical to lexical development represent the majority of Fanfiction.net users. This co-occurrence of development with fanfiction authorship, along with our found association between reviews and lexical diversity, underscores the importance of distributed mentoring in online writing communities for the growth of young authors. This study is the largest application of MTLD to a public corpus, as well as the first longitudinal analysis of writing at such a massive scale. Our findings support calls to promote reviewing behavior and to incorporate fanfiction into formal learning. Work remains to further explore reader–reviewer relationships, to examine aspects of distributed mentoring beyond sheer abundance, and to assess how to support mentorship in informal online learning communities.

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# Writing Game Journalism in School

## Student Voices on Games and Game Culture

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**Abstract:** In this paper, we explore how students engage in journalistic writing activities relating to video games and game culture. The paper is based on a pilot study with student texts and interviews relating to the development of the online learning resource spiljournalist.dk, which allows Danish secondary students to publish journalistic articles in terms of game reviews, columns, and feature stories. The analytical findings indicate that students position themselves as writers through 3 different voices. The "gamer" students primarily based their articles on their own knowledge and experience as gamers. By contrast, the nongamer students tended to write more critically about games and game culture from an outsider's perspective. Finally, a third group of students primarily positioned themselves as journalists.

### Introduction

It is widely documented that children spend a considerable amount of time on playing games. As an example, Danish boys between 11 and 13 years play games for an average of more than two hours each day (World Health Organization, 2016). As a part of their game activities, many players spend time navigating, reading, and producing various types of game-related texts. In this way, gaming activities involve a broad variety of literacy practices, which are often related in quite complex ways and tend to serve many different purposes depending on what games are being played, how they are played, where they are played, and with whom they are played (Gee, 2003). Empirical studies have shown valuable findings when extending game-related literacy practices into formal school contexts—especially by letting students read or produce different types of paratexts such as game guides or wikis (Apperley & Beavis, 2011; Hanghøj, 2017; Steinkuehler, 2011). However, in spite of this promising learning potential, game-related literacy practices have not (yet) become a part of mainstream first-language (L1) education.

One of the major reasons for using game experiences to develop new literacies in formal education is that students are rarely given the opportunity to produce meaningful texts, which serve clear purposes and have readers in mind who go beyond the teacher and the school context (Purcell-Gates, Duke, & Martineau, 2007). The scope of these challenges has recently been documented in a Danish context through a large-scale mixed-methods study of student assignments and student texts (Slot, Hansen, & Bremholm, 2016). According to this study, students in Danish as L1 subject primarily spend their time on filling out skill-oriented assignments as well as analyzing literature through premade templates. The students' texts primarily address their teachers and follow predefined assessment criteria with little or no reference to out-of-school contexts. In this way, these writing assignments can be understood as "schoolish" as they primarily exist and are carried out within the norms and values of the school domain.

In this paper, we report early findings from a design-based research (Barab & Squire, 2004) project, which explores how secondary students in Danish as L1 subject engage in writing game journalism across different genres such as game reviews, columns, or feature stories. The Game Journalist project is based on the assumption that games may provide a meaningful context to students when writing journalism, regardless of their game preferences or level of game experience. Based on our pilot study, this paper addresses the following research question: How do students position themselves as writers through different voices across in- and out-of-school domains when writing game journalistic articles?

## Case: Game Journalism

The pilot study was conducted by using a WordPress blog prototype for the spiljournalist.dk (gamejournalist.dk) concept, which is currently under development. The aim of the spiljournalist.dk concept is twofold. First of all, the website will serve as a learning resource, where secondary teachers and students in Danish as L1 subject can find relevant inspiration and concepts, which can help them to write journalistic articles about games and game culture. The articles must be written in different journalistic genres such as game reviews, feature stories, or columns/commentaries. These genres reflect established modes of writing game journalism, which involve a wide body of different types of journalistic paratexts relating to games that are produced by both a broad mix of dedicated gamers and professional game journalists (Nieborg & Shivoren, 2009; Zagal, Ladd, & Johnson, 2009).

Second, teachers using the website are invited to submit student articles of broader journalistic interest and sufficient quality to the editorial team at spiljournalist.dk. Based on the teachers' recommendations, a selected number of student articles are then made publicly available on the spiljournalist.dk website to other potential readers of game journalism. In this way, the spiljournalist.dk concept both represents a formal learning resource and a potential gateway for students to reach a broader audience of children and young people interested in games and game culture.

As a part of the concept, students should be allowed to produce and publish journalistic videos or podcasts instead of writing traditional texts. This reflects the ways in which many gamers do not necessarily read traditional game journalistic texts but gather information about games and game culture through game videos, which are mediated through social media such as YouTube and game-streaming channels such as Twitch (Sjöblom & Hamari, 2016). However, the video journalism and podcast formats were not explored in the current pilot study.

## Theoretical Perspectives

We understand the process of writing journalism about games at school through the theory of scenario-based education (Hanghøj, Misfeldt, Bundsgaard, & Fougt, in press). The aim of the theory is to conceptualize educational activities and scenarios, which enable the interplay of knowledge practices across in-school and out-of-school domains. According to this theory, domains can be understood as clusters, or families, of different literacy practices, which involve different criteria for what counts and does not count as valid knowledge (Barton & Hamilton, 2000). More specifically, it may be argued that students writing about games involve interplay of knowledge practices across four different domains: the pedagogical domain of schooling, the domain of disciplinary knowledge (Danish as L1 subject), the domain of everyday life (e.g., game activities), and the scenario-based domain of game journalism, which primarily exist outside school contexts.

The dynamic relationship among the four domains and knowledge practices involved in students' game journalistic writing activities is illustrated in Figure 1.

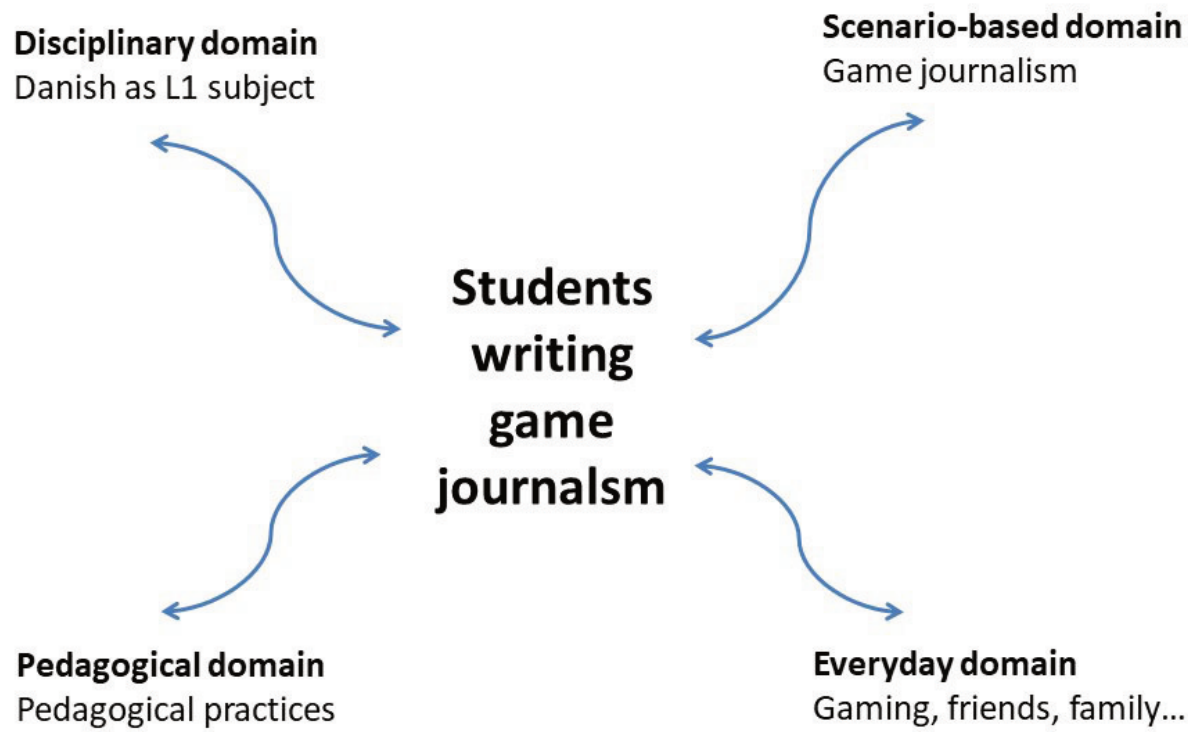


*Figure 1. The interplay of knowledge practices across domains.*

By using the framework of scenario-based education it becomes possible to understand how students' game journalistic writing activities involve knowledge practices from all the four domains. More specifically, the domain of schooling refers to the institutionalized pedagogical practices recognized as "school only," for example, practices deriving from the special asymmetric relationship between teacher and student. This involves the teachers' everyday practices for giving overt instruction or guiding students through writing processes and providing them with feedback. The disciplinary domain refers to the subject-specific discipline of Danish, which implies specific disciplinary topics and genre-specific concepts relevant to writing game journalistic texts. Third, the scenario-based domain refers to the professional practice of game journalism, which involves specific criteria for what counts and does not count as journalistic writing—for example, whether a feature story is recognizable as newsworthy or whether a game review provides correct information about the game being reviewed. Finally, the everyday domain refers to nonspecialized knowledge practices that mainly exist outside school contexts, such as the students' everyday knowledge and experience with digital games.

In order to understand how students experienced the interplay of knowledge practices across the four domains when writing game journalistic texts, we follow the perspective of New Literacy Studies (Barton & Hamilton, 2000). This means that we are interested in understanding the students' writing activities as *literacy practices*, which involve both the students' game journalistic articles as written texts as well as the students' reflections and social practices that relate to the students' texts.

We are particularly interested in how the students' *positioned* themselves and how their texts expressed different *voices*. According to dialogical self theory (Hermans, 2001; Ligorio, 2010), all human beings continually take up different *I-positions* as they communicate and interact with others. This means that students may position themselves and be positioned quite differently in different situations. Moreover, we also wish to analyze how the students' literacy practices become expressed through different *voices*, a concept inspired by the dialogical philosophy of Bakhtin (1981), which here refers to the students' "assimilation, reworking, and reaccentuating of other voices" (Sperling & Appleman, 2011, p. 74).

## Methodological Approach

The development and research related to spiljournalist.dk follows the methodological approach of design-based research (Barab & Squire, 2004). This means that the pilot study is a part of an ongoing series of design interventions, which aim to generate local theories and refine the use of spiljournalist.dk through iterations between web design processes, implementation of the concept in classroom settings, students' writing and publishing journalistic texts, data analysis of student texts, and redesign of the website. Moreover, the spiljournalist.dk concept is a part of a larger research project titled GBL21: Game-Based Learning in the 21st Century (2017–2022), which aims to implement the use of spiljournalist.dk together with other game-related learning resources at 20 different Danish schools (gbl21.aau.dk).

The data for the pilot study were based on use of spiljournalist.dk in two different classes (one seventh grade and one eighth grade) at two different secondary schools. After the students had written their articles, the two teachers were interviewed about their choice of student texts to be published. Moreover, interviews were conducted with the six students from the seventh grade about their gamer habits, their articles, and their experience of writing game journalism. The six selected students were interviewed in pairs. All interviews and student texts were analyzed using thematic analysis (Braun & Clarke, 2006) in order to identify key categories and analytical themes relating to the students' voices as writers of game journalism.

## Analysis

Based on the thematic analysis of all the students' texts and the interview data, we have identified three analytical themes in relation to how the students positioned themselves through different voices as writers of game journalism. The first theme relates to writing about games as experienced from a gamer or insider perspective. The second theme relates to being able to write critically about games and game culture as seen from a nongamer or outsider perspective. The third and final theme relates to those students who explicitly identified with the process and identity of journalistic writing. The three themes are explored below through three examples with three different students.

### Analytical Theme #1: Writing Through the Voice of a Gamer

The first theme emerges in relation to those students who wrote articles from a *gamer perspective.* By this term we refer to students who had considerable game experience and were explicitly interested in games and game culture. Going through all articles from both classes as well as the interviews with the six students from the seventh-grade class, the gamer voice was most strongly represented among boys, who often wrote enthusiastic columns or reviews about game technology and games they liked, such as *FIFA* or *Rocket League*.

Louis's column is a good example of a student writing journalism from a gamer perspective. In his column about "Game communities," Louis writes about how it can be fun to play multiplayer computer games and how this might evolve into friendships, where everybody learns and knows how to play the same game. At the same time, he emphasizes how gaming communities may also lead to negative experiences, especially when strangers become "nasty" and use toxic language toward newcomers in a game.

When interviewed, Louis described how his column was aimed at different aspects of multiplayer gaming communities. Louis regularly played shooters (*Call of Duty* and *Battlefield*) and casual games (*Hay Day*). However, he did not have much experience with communities and friendships surrounding multiplayer games such as *Counter-Strike*, which can create a strong sense of team spirit but often require players to deal with toxic language. He used the column as an opportunity to find out more about the topic by interviewing one of his classmates who played *Counter-Strike* a lot and he also conducted online research by searching for information to include in his column.

In summary, Louis's text is written through the voice of a gamer as he clearly identifies positively with games and game culture. In this way, he used the assignment as a welcome opportunity to write about something that interested him, that is, the friendships and communities of multiplayer gaming, and as a way to do research and learn more about the topic.

### Analytical Theme #2: Writing Through the Voice of a Nongamer

The second theme concerns those articles written by students who either had limited game experience or did not identify with games or game culture. Writing from an outsider's perspective, the nongamer students often based their articles on experiences and observations of the gaming habits of their relatives, friends, classmates, or stories found on the Internet. Most of the students writing in the nongamer voice were girls. Their articles often presented a quite negative or critical attitude toward game culture—for example, by criticizing other students for their "hidden" gaming activities during class or interviewing their grandparents about the dangers and lack of meaning involved in playing *Pokémon GO* on the streets.

We will exemplify the nongamer or outsider perspective with Ása's column "Waste of life!," which presents a rather harsh critique of game culture. Her column is based on the provocative statement that gaming is basically "a waste of time" as it makes young people "sit in front of a screen all day." Ása is well aware that she is being quite provocative; as she sums up her criticism: "To most people at my age, this probably sounds like mumbo-jumbo. I would be lynched if the boys in my class read this!"

In the interview, Ása said that she did not play video games on a regular basis but had tried to play *Call of Duty* several times with her cousin. She was very critical about her classmates' collaborative game activities and her negative attitude had made it difficult for her to get started on her article. After being encouraged by her teacher to use the negative attitude for an article, Ása then decided to fuel her critical stance into a provocative column about game culture. She did see some positive aspects in playing in groups or "leagues," as this can be seen as a form of "group work" and "might even learn them something, which can be used later on.” However, as she concludes in her column: “But in a workplace it won’t work to talk in acronyms or just keep flaming other people.”

In summary, Ása’s text is written through the voice of a nongamer, in which she mostly identifies with negative aspects of games and game culture. Moreover, she uses the column as an opportunity to express her own opinions and deliberately make fun at her game-playing classmates in order to position herself as a provocative writer.

### Analytical Theme #3: Writing Through the Voice of a Journalist

The third theme concerns those students who directly identified with the aim and criteria for writing journalism as a professional practice. These students were actively engaged in the various steps of the journalistic writing process—for example, by making sure to select an interesting topic and journalistic genre, finding the right angle, conducting valid research, quoting different sources correctly, and working with the language of their articles. Some of these students went on field trips to game stores or board game cafés in order to do research. This group of students involved both boys and girls and the group was not so divided in terms of gender as the two previous themes.

As an example of a student writing with an explicit journalistic voice, we will focus on Madison’s feature story “Women ALSO know how to play.” The feature is about the stereotypic views on gaming among boys and girls. It centers on a visit to the local game store and an interview with a sales clerk about his views on games for girls and for boys. The sales clerk is quoted as saying that only few girls come to the store to buy games and that he categorizes the girl gamers as “tomboys.” Similarly, he also categorizes the boys who buy “unisex games” such as *Just Dance* or *Sims*. The article critically discusses the gender gap by asking: “What does it take to break this division?” In order to emphasize the problem, Madison has included a photo from the store, where she has added a “STOP—NO GIRLS” sign (see Figure 2).


*Figure 2. Madison's manipulated photo for her feature story.*

Madison's article further challenges the stereotypic view of female gamers by acknowledging that there are also girls who clearly identify with being gamers. The article mentions "Cupquake," who is a YouTube gaming commentator famous for her game videos on *Minecraft* and *The Sims*. The article describes how Cupquake acts as role model to many girls—for example, by communicating that it is unfair that girl gamers should necessarily be seen as tomboys.

In the interview, Madison described how she used to play *The Sims* and *Grand Theft Auto*, but that she was not particularly interested in writing about games and game culture. Instead, Madison expressed a clear interest in becoming a journalist and describes herself as somewhat "perfectionist" when it comes to making a great article. It was very important for her to take her own photos for the article, create a great layout, and conduct thorough research through interviews and online searches. Moreover, she made sure to involve several of her classmates to give feedback on her article in order to improve the language. In this way, Madison clearly positioned herself as writing more through the voice of a critical journalist than either a gamer or a nongamer.

## Discussion

Following Bakhtin (1981), the analytical themes illustrate how the students' texts are "hybridized" in that the students' different voices bear traces of different discourses across both in- and out-of-school domains. According to Bakhtin, all texts are created out of borrowed language, but writers play a unique role in shaping their own words and texts:

> The word in language is half someone else's. It becomes one's "own" only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention. (pp. 293–294)

In this way, the students' voices as writers of game journalism can be considered as a repertoire or a unique combination of different discursive resources. As each of the students takes on the new discourses he or she takes ownership of these voices by assimilating, reworking, and reaccentuating them into texts, which may serve both to position them as gamers, nongamers, or as journalists. The texts also show that the choice and affordances of specific journalistic genres was quite important. Thus, several of the students such as Ása and Louis chose to write columns as the least difficult choice, as they could directly express their own attitudes and opinions. It was clearly more demanding, but also satisfying, to write feature stories as Madison did, as this required field trips and nuanced reportage.

The analytical findings indicate that the students' voices as writers often developed around their interest in the social aspects of gaming. This sometimes involved the development of positive social relations such as friendships, knowledge sharing about games, and being able to work in groups. At other times, the students focused more on negative aspects around gaming, such as the use of toxic language, the risk of exclusion by other players, games as a disturbing element in class, or seeing gaming as a meaningless escapism. These findings indicate that games and game culture represent powerful affinity spaces (Gee & Hayes, 2010), from which the students have experiences with both being included and excluded. Many of the students' articles can be seen as an exploration of positive and negative aspects of game culture, which are predominantly written through the voice of either gamers (primarily positive) or nongamers (primarily negative).

The findings also show a clearly gendered difference between how the boys and girls approached the task of writing game journalism. The boys generally showed more positive attitudes toward the topic than the girls. It is well documented that boys in this age group play games more than girls (WHO, 2016). At the same time, it is problematic to reduce this difference to a matter of gendered game preferences. The interviews with the teachers and the students made it clear that many of the girls had considerable game experience—for example, with playing casual games, *The Sims*, or *Grand Theft Auto*. The main difference was that the girls to a lesser degree identified themselves with gaming activities and game culture in the same way as the boys. As Madison's article and interview showed, the girls feared that a strong identification with games and game culture would make them be seen as "one of the boys." This finding corresponds with other empirical studies of female gamers—for example, of women who are dedicated players of *The Sims*, but who still do not identify with being "gamers" (Gee & Hayes, 2010), or female online gamers, who develop various coping strategies in order to respond or avoid being harassed by male players (Cote, 2017). Another explanation for why the girls in the pilot study showed more negative or critical attitudes toward games may be that they to a lesser degree viewed gaming as a "serious" or meaningful activity. In that sense, their articles focused more on meeting the aims of the disciplinary domain of L1 as well as the aims of journalism as a professional practice.

## Conclusion

In this paper, we have explored how students' game journalistic writing is expressed through different voices, which refer to different knowledge practices across in- and out-of-school domains. The findings indicate that the students generally become engaged in writing about games and game culture, whether their engagement is based on interest in games, critical attitudes toward gaming, or an overall identification with writing journalism. At the same time, the findings also make it clear that it is important to focus on social aspects of games and challenge gender stereotypes when working with the topic. These findings will inform further development and large-scale implementation of the spiljournalist.dk concept, which we hope can provide students with a meaningful context for their writing activities within Danish as L1 subject.

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# The Force Will Be With You...Always

## Studying the *Star Wars* Transmedia Storyworld

**Trent Hergenrader (Rochester Institute of Technology)**

**Abstract:** Since Disney's 2012 purchase of Lucasfilm, connected stories set in the *Star Wars* galaxy have exploded across media, including feature films, fiction, comic books, television, and games. This paper discusses the development of a college course taught in 2017 that leveraged existing student interest in the *Star Wars* franchise to teach a broad range of media literacies, including the critical analysis of films, TV, comics, print fiction, and games. The course focused on analyzing different aspects of *transmedia storyworlds*, or narratives that span multiple media and target different generations of audiences. The paper also discusses a second course to be taught in Spring 2018 that uses the *Star Wars* galaxy as the setting for role-playing and fiction writing. Far from pandering to students with pop culture, these courses position them to become critical consumers and active producers of media content in the 21st century.

### Media Literacy, Participatory Culture, and Transmedia Storyworlds

The call to expand traditional notions of literacy to include different forms of media goes back at least 20 years, with perhaps the New London Group's (1995) *Pedagogy of Multiliteracies* being the most prominent encouragement for educators to engage with various forms of print, audio, and digital media in their classrooms. More recently, Jenkins (2009) and others have emphasized the importance of developing 21st-century skills such as problem solving via collective intelligence, navigating transmedia environments, and negotiating multiple diverse perspectives in our highly connected world. This "participatory culture" also encourages more active learning through collaborative projects, performance, and play (Jenkins, 2009, p. 3).

The question for proactive educators becomes how to square the pressures of traditional disciplinary concerns with a rapidly changing media environment. As an English professor, I can attest that this tension is keenly felt in English departments, as expressed in articles such as Anthony's (2017) "Harry Potter and the Chair's Dilemma," in which the author frets over declining English enrollments and the rise of student interest in popular culture rather than the traditional Western literary canon. Views such as this regard the teaching of popular culture as a way to pander to student interests in order to keep enrollment numbers healthy. Rarely do such skeptics consider that popular media franchises provide an opportunity to build media literacy skills and critically examine contemporary storytelling trends.

My interests in teaching media literacy, participatory culture, and the rise of transmedia storyworlds gave me the idea to design two courses that connected explicitly to the *Star Wars* franchise. The first course, taught in Fall 2017, focused on the critical analysis of the *Star Wars* transmedia storyworld, while the second, taught in Spring 2018, would concentrate on participatory culture and creative production via a tabletop role-playing game (RPG) set in the *Star Wars* galaxy.

### From Media Franchises to Transmedia Storyworlds

A long time ago, in a galaxy far, far away, only a few major multimedia franchises existed, and they certainly did not exist in the ubiquitous way they do in 2018. Characters and their stories have always skipped between media, with superspy James Bond being one prominent example, a character who originated in Ian Fleming's novels and short stories in the 1950s but soon found his way to radio, comics, television, and the big screen. However, connected cross-media storytelling was limited. Stories about characters and the worlds they lived in tended to be associated to a single storytelling medium and whenever a franchise entered a second media, it tended to be by way of an adaptation of some other source material. When storytelling forays across media did produce original stories, the different media streams operated in parallel, rather than in the same, time lines. For example, the events of the *Star Trek* films were not required to be consistent with the *Star Trek* television series or the many *Star Trek* novels, and the comics and novels of Indiana Jones also operated as stand-alone stories that did not follow a single coherent time line or advance a specific story line.

The first concerted effort to carry a unified story across several forms of media came with the Wachowskis' film *The Matrix* (1999), as the duo sought to bridge the film's sequels with a series of comics, games, and short films (Jenkins, 2006). The films were financially successful and the ancillary transmedia products built a sizable fan following (Bain, Jensen, Sangruengkit, Silman, & Zi, n.d.) but the concept never found a firm foothold in the wider culture. This could be attributed to the films' R ratings that limited them to an adult audience or the lack of a sufficient marketing budget to promote each of the many media strands. However, *The Matrix* helped lay the groundwork for the development of a broad transmedia marketing strategy around a story unfolding across different media. Abetted by the proliferation of high-speed Internet and ubiquity of mobile devices that allowed instant access to streaming content, transmedia franchises would come to dominate the decade of the 2010s, beginning with the film *Iron Man* (2008) that kicked off the expansive Marvel Cinematic Universe. This franchise now totals over 20 films, 10 television series, and dozens of tie-in comics, all with more on the way ("Marvel Cinematic Universe," 2017).

2012 saw another major development in transmedia storytelling as Disney purchased rights to the *Star Wars* franchise for a staggering $4 billion (Krantz, Snider, Della Cava, & Alexander, 2012) and two years later it made another bold move by shelving 25 years of Star Wars Expanded Universe material to start anew with a fresh, internally consistent canon ("The Legendary Star Wars Expanded Universe Turns a New Page," 2014). At the end of 2017, just three years after this announcement, the *Star Wars* franchise has turned out three feature films, over a dozen original adult novels, a few dozen young adult (YA) and young reader novels, 85 episodes of a young adult television series, a few hundred comics, a web series, and a number of videogames. This commercial juggernaut shows no signs of slowing, with a new *Star Wars* trilogy of movies announced as well as a live-action television series (Guardian Staff, 2017). Fans are also looking forward to a greater *Star Wars* presence at Disney theme parks, including a *Star Wars*–themed hotel (Fickley-Baker, 2017). Today, the marketing for *Star Wars* content is virtually inescapable. The Force will very much be with you always—whether you like it or not.

The overwhelming success of today's franchises suggests that, historically, audiences consumed popular media faster than the creators could make it, and audience demands far exceed what a single author can produce. To service this demand, formerly single-media–dominant franchises are consciously transitioning to ever-expanding *transmedia storyworlds*. Jenkins defines a transmedia storytelling as:

> a process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience. Ideally, each medium makes its own unique contribution to the unfolding of the story. (Jenkins, 2007)

Transmedia storytelling is distinct from *adaptation*, or converting a story from one medium to another, where little if any new material is introduced. In transmedia storytelling, each story strand adds original material to the world (Jenkins, 2011). Jenkins also notes how, in this phenomenon, the emphasis shifts from individual characters and single plot arcs to the fictional world itself, which serves as the common link between the different stories across media. In *Building Imaginary Worlds*, Wolf (2012) extends this, saying that large-scale storyworlds must be transauthorial as well, meaning that the storyworld necessarily has multiple authors working in different media. In fact, there can be dozens if not hundreds of artists involved in the production of stories in a single unified storyworld.

## Transmedia Storyworlds: The *Star Wars* Course

Admittedly, *Star Wars* stories on the whole might not contribute much to "high culture" from an artistic perspective, but they provide an unparalleled opportunity to delve into a wide variety of topics relevant to anyone interested in trends in 21st-century storytelling. With this in mind, I designed a 300-level honors course that was taught in Fall 2017 and enrolled to capacity with 20 students. The 15-week course met twice weekly for 75-minute sessions that consisted entirely of instructor-guided discussion. Course content included nine films, two television series, four graphic novels, four books (two young adult novels and two middle-grade novels), and a tabletop role-playing game. Students also read some media theory and excerpts from other *Star Wars* novels. Discussion was focused on recurring themes and character arcs in the storyworld, as well as the affordances and limitations of specific storytelling media. Finally, we also examined the question of intended audiences for each entry into the storyworld. The complete syllabus and schedule can be found here: ritstoryworlds.wordpress.com.

The course was intended to teach students how to be media-literate critical consumers as well as active producers of their own content in an age when we are bombarded by media franchises. Below are concrete examples of the topics discussed during the course.

### Chronologies and Continuity in Storyworlds

The Disney *Star Wars* canon has a consistent time line but no longer has official eras. It can be informally broken into four broad time periods into which all canonical works fit: the Fall of the Republic (aka "the prequel era"); the Age of the Empire (aka "the *Star Wars Rebels* era"); the Galactic Civil War (aka "the original trilogy [OT] era"); and the New Republic (aka "*The Force Awakens* era").

The course proceeded chronologically along the in-world timeline, with about half of the course in the first two eras. This is partially because the two television series, *Star Wars: The Clones Wars* and *Star Wars Rebels*, both fall within those eras, but also because the nonfilm media from these eras establish important, but lesser known, background information for the stories of the latter eras. My assumption that fewer students would be familiar with those eras was borne out by a precourse survey that asked students about their familiarity with the Disney *Star Wars* canon materials. The survey confirmed that most students were somewhat familiar with the films but little else.

We began the course with the first story in the canon in the Fall of the Republic era and moved forward chronologically through the fictional world's time line. This revealed several quirks unique to studying transmedia storyworlds, particularly the differences between the fictional time line and the release dates of the story materials. The fictional time elapsed in these works is approximately 13 years ("Timeline of canon media," n.d.) but they were released in scattershot order over a period of 17 years. We began with the film *Episode I—The Phantom Menace* (1999) followed by the graphic novel *Obi-Wan and Anakin* (2016) and then continued to *Episode II—Attack of the Clones* (2002), followed by *The Clone Wars* animated film (2008) and 12 episodes of *The Clone Wars* animated television series (with selected episodes having aired in 2009, 2010, 2012, and 2013), and finally concluded with *Episode III—Revenge of the Sith* (2005). On top of it, all of this material is based on the original trilogy films, which themselves were 16 years removed from the first prequel.

This mix of chronological times and release dates provided an entry point to discuss terminology that transmedia storyworlds naturally complicate. The *Obi-Wan and Anakin* (2016) comic that takes place between the first two prequel films (Episodes I and II) is technically an *interquel*, or a work that takes place between two other works. But what happens when new material comes before the first prequel? Marvel Comics now has four issues of *Star Wars* (#26 through #30, published in 2017) and a five-part *Darth Maul* series (also published in 2017) that take place before the *first* prequel film. Is the whole prequel trilogy now in fact an interquel trilogy? And in the future, Disney is likely to add stories set even earlier in the time line, or even insert a whole new prior era, into the canonical time line.

The correct use of inexact terminology is less important than introducing the concept of why the language that was serviceable for decades is now inadequate. *Prequels* and *sequels* are terms that require a single point of origin, which was useful for more linear storytelling that focused on individual characters and their plot arcs in a single medium. However, in the landscape of transmedia storyworld, these terms begin to fail. With the explosion of storytelling strands that span multiple media, it would seem that new terminology may be required to talk about current and future developments in storytelling. Will *interquel* enter the popular lexicon? Will we need to refer to the postprequels or pre-interquels? It seems unlikely. Perhaps a new vocabulary will emerge to better describe the chronological relationship of stories in transmedia storyworlds. Only time will tell.

Other questions pertaining to this chronology have to do with *continuity* of the wider fictional world. The prequel films were widely derided for introducing inconsistencies into the *Star Wars* galaxy and failing to provide a convincing character arc for Anakin Skywalker's descent into becoming Darth Vader. However, works that were made long after the prequels—notably the comic series *Obi-Wan and Anakin* (2016), *The Clone Wars* TV series (2008–2014), and the novel *Dark Disciple* (2015)—have addressed some of the inconsistencies by providing new information about character motivations and the fraught politics of the storyworld in this era. This is known as *retconning*, or adding retroactive continuity. While it is not unusual for multiple authors to flesh out a character—think of all the authors who have put their own spin on the character of Sherlock Holmes—it is unique that Disney is the sole owner of this intellectual property and has a vested interest in ensuring each piece of the storyworld is compatible with all the others. The sheer scale of this type of narrative project is unprecedented and will grow more complicated with each new story added to the world.

### Themes and Character Arcs

At the start of each class, I drew columns on the whiteboard for six broad categories: Politics, Jedi/Force, Characters, Media, Themes, and Audience. The goal for our discussion was to consider the material assigned for the day and attempt to fill up each column with new information students had gleaned about the storyworld. Discussion was free-form and any kind of input was welcome, including partially formed ideas, questions, and tentative conclusions.

With very little prompting or guidance, the students were able to fill the whiteboard with ideas, connecting elements of the storyworld to experiences in their personal lives and to current political events. The fascist nature of the Empire in the *Star Wars* galaxy is anything but subtle, yet our discussion steered toward more nuanced understandings of totalitarian regimes. We discussed state-sponsored misinformation campaigns, the role of propaganda plays for empires, and the plight of moral individuals serving unjust institutions. This conversation easily bridged to the fraught political landscape of 2017, and how the United States' war on terror has lasted most of their lives. We pondered moral questions as we discussed the four-part young reader series *Servants of the Empire* (2014–2015) and the young adult novel *Lost Stars* (2015), both of which tell in-depth stories of sympathetic characters who are affiliated with the Empire. When watching episodes from Season 5 of the *The Clone Wars* (2012) and the gritty film *Rogue One: A Star Wars Story* (2016), we discussed the differences between "rebels" and "terrorists" when atrocities are committed on both sides. Such political questions are further complicated by the fact that the foreign policy actions of the United States often resemble those of the Empire rather than of the Rebel Alliance.

Other important themes included the tension between individualism and being a member of a collective. Major institutions repeatedly fail the characters in the *Star Wars* storyworld, and the implicit criticism extends as much to the infighting Jedi Order and the gridlocked bureaucracy of the Republic as it does to the overtly oppressive Empire. This theme, clumsily handled in the prequels, is handled with sophistication in the lesser-known canon media, with works providing no pat answers for their audience and inviting us to question our own relationships with our society's institutions. Students also noted that this abject failure of institutions is a much more compelling reason for Anakin Skywalker's turn to the Dark Side than the heavy-handed reasons given in *Episode III—Revenge of the Sith* (2005), where skillful retconning almost redeems the subpar prequel film.

## Audience

Intermingled with these discussions was the recurring question of audience. At the start of the semester, most students were inclined to say, "*Star Wars* is for everyone," but they soon noticed how certain parts of the storyworld were leveraged to appeal to specific audiences. They also discovered that comics, television, and novels often delved into character arcs that had nothing to do with the Skywalker family saga that occupies so much of the films. Many of the nonfilm canon materials deal with teenage and young adult characters who are leaving home for the first time, echoing the call to adventure experienced by Luke Skywalker in *Episode IV—A New Hope* (1977), but who are not destined to save the entire galaxy. Episodes of *The Clone Wars* (2008–2014), the comic series *Kanan: The Last Padawan* (2014) and *Kanan: First Blood* (2014), the young adult novel *Ahsoka* (2016), the middle-grade *Servants of the Empire* (2014–2015), the television series *Star Wars Rebels* (2014–2018), and the young adult novel *Lost Stars* (2015) describe situations where young protagonists are thrust into a complicated situation without parents or other adults to guide them. These works are often concerned with issues of maturity and learning from one's mistakes while also navigating more mundane aspects of a young person's life, such as maintaining long-distance relationships and experiencing homesickness, all within the context of the *Star Wars* storyworld. While we concluded college students are slightly older than the target audience for these works, the students saw themselves at a similar crossroads and being faced with similar momentous life choices. Many students were surprised that these topics were handled with refinement, given their target audience of young teens and tweens, a fact that in turn made them rethink the marketing categories of "middle grade" and "YA" for print fiction.

Another important audience observation had to do with character representation in canon media over time. The original trilogy from the late 1970s and early 1980s featured predominantly Anglo actors and mask-wearing aliens, and the protagonist was a young White male of noble lineage who was destined to save the galaxy, a structure typical of Campbell's (1968) now-familiar hero's journey. While the original trilogy lacked racial and ethnic diversity among the actors, Lucas famously came under fire in the prequels for depicting alien species using offensive racial stereotypes (Gottlieb, 1999). Since Disney's acquisition of the *Star Wars* property, however, the question of representation is clearly an important consideration. *The Force Awakens* (2015), *Rogue One* (2016), and *The Last Jedi* (2017) all feature strong female protagonists and a diverse cast of actors of many races and countries of origin.

Age-appropriate programming is another area where Disney appears to be making more deliberate efforts. The pre-Disney *Star Wars: The Clone Wars* (2008–2014) animated TV series was broadcast on Cartoon Network with episodes featuring adult themes and graphic violence that might disturb younger viewers who might not expect something so intense from a cartoon. Disney's *Star Wars Rebels* (2014–2018), however, aired on Disney XD, a channel with a stated target market of "kids age 6-11, hyper-targeting boys (while still including girls)" ("Disney Channels," n.d.). Therefore it comes as no surprise that two of the show's main protagonists, Ezra Bridger and Sabine Wren, are teenagers who have been separated from their parents, and the show often depicts the crew of the rebel ship as a semidysfunctional but loving family. While *Star Wars Rebels* does not shy away from serious subject matter, it feels more consistent in terms of age-appropriate content, style, and tone than its 3D animated predecessor *The Clone Wars*.

## Media Analysis and Commercialism

Throughout the discussion of thematic content, specific character arcs, and likely intended audiences, we discussed the affordances and limitations of specific storytelling media. I used a few short summaries from film and visual studies to scaffold our discussion with additional short readings on basic terminology and narrative concepts. From there, I wanted students to make their own observations about the different storytelling media with the expectation that their observations and analyses would grow in sophistication over time.

On the whole, this strategy worked as most students showed marked improvement over the semester in the specificity of examples used in their blog posts and midterm projects. In general, students seemed most at home with film analysis and were comfortable discussing things such as scene composition and how the score helped to intensify the mood of certain scenes. Their weakest area of analysis tended to be the 3D television series, where many students had difficulty identifying aspects of serial television storytelling that makes it distinct from film. Some students, however, did note things such as the storytelling limitations of 22-minute episodes, or the flexibility to explore a character's development across episode arcs, seasons, and the entire series. In future versions of this course, I plan to incorporate more readings from television studies to improve their overall ability to analyze the unique affordances and limitations of this storytelling medium.

Perhaps the greatest gain in terms of media literacy was in their improved understanding of the comic as a sophisticated visual medium. Several students admitted they came into the course dismissing comics as a simplistic form at the start of the semester, but by the end of the course they were able to explain how the composition of panels across the page can lead the reader's eye in interesting and unexpected ways, or how comics are especially suited to evoking memories or portraying the passage of time. Many proclaimed to be comics converts and expressed interest in reading more comics and graphic novels in the future.

Another major success was students' increased understanding of print fiction, specifically in terms of marketing fiction to different audiences. Most students understood very quickly that one major benefit of fiction is the access to characters' innermost thoughts and feelings. However, they soon began to bridge that to specific audiences, concluding that coming-of-age stories such as those of *Ahsoka* (2016) or the *Servants of the Empire* (2014–2015) series were particularly suited to the medium of print fiction. Most of the characters' struggles are internal and lack the sweeping, planet-hopping scope of the films and television series. Students also developed a more nuanced understanding of the indistinct marketing categories separating middle-grade, young adult, and adult fiction, noting that the themes and language might be more accessible for younger audiences but were by no means simplistic.

Throughout, we also discussed the marketing and commercial side of the transmedia storyworld phenomenon, noting that the strategy works best when ancillary canon material adds greater appreciation to another storyline but is not necessary for understanding it. *Rogue One* (2015) features both successes and failures. The character of Saw Gerrera confused viewers who were unfamiliar with *The Clone Wars* (2008–2014) series, and the vague references to the history between him and Jyn could be construed as a crass ploy to drive audiences to buy the young adult novel *Rebel Rising* (2017). In contrast, there were several subtle nods in the film toward the TV series *Star Wars Rebels* (2014–2018) that brought an unexpected delight for those in the know, rewarding them for their knowledge of the larger canon without confusing the larger popular audience who missed those references.

### Participatory Culture and Play

The final assignment, to be completed on their own time during finals week, was to play one version of the *Star Wars* role-playing Beginner Games, published by Fantasy Flight Games. The RPG system has three overlapping sets of rules: One is titled *Edge of the Empire* and is geared for smugglers and other ne'er-do-wells; *Age of Rebellion* is for the conflict between the Rebel Alliance and the Empire; and *Force and Destiny* deals with Jedis and the Force. The flexible system allows players to create a character in any of these three core systems but they can all still play in the same campaign. This resembles the original trilogy, as the core five characters in *Episode IV—A New Hope* (1977)—Luke, Obi-Wan, Han Solo, Chewbacca, and Princess Leia Organa—translate to this system as a pair of Jedi, two smugglers, and a prominent diplomat of the Rebel Alliance, and the core story of destroying the Death Star would fit most comfortably within an adventure campaign using the *Age of Rebellion* system.

As Mackay (2001) has argued, RPGs are a type of performing art that allows players to become active producers, rather than passive consumers, of popular culture. I asked students to play the RPG and then reflect on how much their game session felt like an authentic part of the *Star Wars* transmedia storyworld, and whether their expanded knowledge of the world was or was not useful for the game. Overall, the game session proved to be an eye-opening experience for many of the students, especially those who had never previously played a tabletop RPG. They reveled in the open-ended collaborative storytelling of the RPG, and one common complaint was that the Beginner Game confined their play too much (in fairness, the goal of these Beginner Games is to introduce the rules, not provide a full-fledged campaign experience). Several also wished that they had the opportunity to create their own unique character rather than using the pregenerated characters included in the beginner sets. Many also said that they wanted even more of a *Star Wars* feel to the game so they could better leverage their knowledge and, if and when they play again, they plan on using scenarios that were more steeped in the lore and history of the storyworld.

### Conclusions and Other *Star Wars* Courses

This special-topics course on transmedia storyworlds was a success for the students and instructor alike. On a 5-point scale for the student course evaluation, *Advanced student knowledge* received a 4.7 and *Would recommend the course* received a 4.9, both exceptionally high scores, even for popular courses. Many students remarked that they learned far more than they expected from what sounded like a "fun" general education elective course. The proposal for a permanent transmedia storyworld course is working its way through administrative channels and I hope it will be on the books for 2018–2019. The course description is broad enough to accommodate the study of any transmedia storyworld, and the explosive growth of Disney's *Star Wars* canon across media means that any instructor who chooses that storyworld can freely adjust the course to focus more on certain plotlines, characters arc, or forms of media as desired.

Based on my previous research on using tabletop role-playing games to teach creative writing, the second *Star Wars*–themed course I designed is an upper-level fiction course to be taught in the Spring 2018 semester. This course is paired with a course in Interactive Games and Media taught by my colleague Dr. David Simkins. His game-design students will study the art of game design, effective game-session management, and how to provide players meaningful choices. His students will run the game sessions for my students, who will then write fiction based on their characters' experiences.

These two courses were supported by an internal grant for innovative teaching methods. Specifically, the grant funded the purchase of all available *Star Wars* media on DVD and a complete set of the Fantasy Flight Games' *Star Wars* core rule books and sourcebooks, all of which are held at the library on reserve. This trove of information allows the game masters and fiction writers the opportunity to delve into any part of the time line in this massive *Star Wars* galaxy as they design game sessions and develop their characters, yet they may still adhere to a consistently applied set of universal rules. The use of this familiar fictional setting also lowers barriers of entry and increases participation and engagement with the course objectives. This course has not yet started at the time of writing, but preliminary conclusions will be available by the summer of 2018.

Transmedia storyworlds are an important part of our contemporary media ecology and, based on the recent successes of franchises such as Marvel Cinematic Universe and the *Star Wars* galaxy, they will not be going away anytime soon. As more commercial properties expand across media, we need to understand how transmedia storyworlds unfold, how to critically analyze stories across media, and teach students how to find avenues for their own individual participation and creative production. Far from pandering to students' lowbrow pop culture interests, studying transmedia storyworlds develops the kind of media literacy skills that are essential for 21st-century audiences.

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# I Had the Slime of My Life

## No, I Never Felt This Way Before

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**Abstract:** Since its release in 2010, Ito et al.'s hanging out, messing around, and geeking out framework has been widely used to describe youth digital production on a variety of platforms from Facebook to YouTube. However, the recent influx of slime tutorials demands a new framework that incorporates maker practices, as through video production youth simultaneously make and document making. Our paper lays the groundwork toward a framework that accurately reflects the practices youth engage in while creating and producing slime videos; examines slime creators as a community of practice; and provides insight into the intersection between media production and maker practices.

### The Year of Slime

Since late 2016 and 2017, slime has become a sensation on social media, as well as in online shops such as Etsy. Millions of videos on Instagram and YouTube show slime makers oozing, stretching, pulling, crunching, and mixing slime. Some attribute the popularity of slime to their ability to trigger therapeutic and relaxing feelings of autonomous sensory meridian relief (ASMR), another growing Internet media trend (Barratt & Davis, 2015; Sagner, 2017). It is also a pathway to youth entrepreneurship, with slime makers, often called *slimers*, selling slime to make money for new slime supplies, and in some cases turning their slime into big business, as is the case with "Slime Queen" Karina Garcia, who makes more than six figures a month from sponsorships on her slime videos and sales of her slime kits.

Instagram videos, limited to one minute in length, tend to focus on a first-person point of view of playing with slime and engaging with followers around questions such as "What's a country you want to travel to?" YouTube videos allow slimers to make longer content in which they can describe their process through tutorials, play with the slime by themselves or with others on camera, and engage the audience with more content-specific prompts. These videos provide a space for youth to consume slime content and engage with slime makers. More significantly, the slime craze has sparked a new form of video production, in which YouTubers' making becomes the critical core of the content.

Our research documents the process of the making, producing, and sharing youth engage in through slime production. Our work builds on Ito et al.'s (2010) theory of creative production and Brahms and Crowley's (2017) definitions of maker practices, offering a new framework that accurately reflects the practices youth engage in while creating and producing slime videos.

### Creative Production

In their foundational ethnographic research, Ito et al. (2010) describe youth engagement with creative production as a nonlinear fluid movement between the genres of hanging out (getting together and being together), messing around (characterized by experimentation and play), and geeking out (an intense commitment and engagement with media and technology). The flexibility and scope of the hanging out, messing around, geeking out model can easily be applied to creative production, the imaginative and expressive work shaped by youth choices and available media (Lange & Ito, 2010, p. 245), in a wide range of media from Facebook to virtual gaming to YouTube. YouTube, a “networked public” (boyd, 2017; Ito et al., 2010), is an ideal platform for video producers as it allows creators the opportunity to engage in their hobby and connect with others “who have greater expertise than they do, and conversely, where they can mentor and develop leadership in relation to less experienced participants” (Ito et al, 2010, p. 20).

Slimers on YouTube follow much the path described in Ito et al.’s 2010 model. They begin by hanging out: They comment on other slime videos, they create profiles, and they begin to ask questions about recipes. Movements such as personalizing YouTube channels and publishing videos lie at the boundary between hanging out and messing around genres of participation (Ito et. al, 2010, p. 255). Slimers often take this first step by testing out recipes from peers’ videos or recipes found online. Personal media creation is “often a starting point for broadening media production into other forms, a transition between hanging out, friendship-driven genres of participation and messing around and geeking out” (p. 261). Moreover, this initial media creation serves as the “jumping-off point for entry into more challenging forms of creative production” (Lange & Ito, 2010, p. 261). Those slimers who “geek out” begin making their own slime recipes, creating their own unique video style and specialty (Lange & Ito, 2010, p. 268), and, in some cases, begin promoting and selling their own products.

What is unique about slime videos is that the creative production centers around documentation of making: They are testing recipes, tinkering around with various ingredients, adding to or correcting recipes, developing understanding of how ingredients work together to get a desired result, innovating on new ways to customize their recipes, and sharing this information with other slime makers.

This process is unlike so many other YouTube sensations as youth engage in scientific inquiry and elements of maker education, “characterized by interest-driven engagement in creative production at the crossroads and fringes of disciplines such as science, technology, engineering, art, and math” (Brahms & Wardrip, 2014). The slime craze lives at these same crossroads and fringes: Youth mess around with science and in turn produce media to share their unique recipes.

Beyond evidence of maker practices in their tinkering, there is evidence of a new media-engagement framework, where the documentation of the make is the critical content of the video. Where the hanging out, messing around, geeking out model shows how youth fluidly move from consumption to production practices, slime videos are an example of a integral midpoint in these practices—the documentation of the make. In slime videos, video producers are not only telling a story or communicating an idea, they are demonstrating—and documenting—maker practices as the content of the video. We see a new model as a result (see Figure 1).

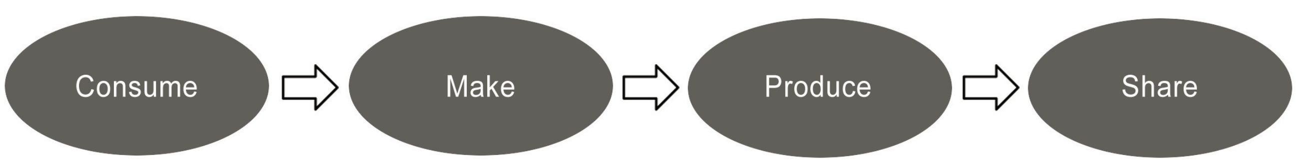


*Figure 1. Model reflecting creative production witnessed in slime videos.*

## Maker Practices

Makers, or diverse groups who come together and are "motivated to learn with and from one another how to use and combine materials, tools, processes, and disciplinary practices in novel ways" (Brahms & Crowley, 2016) are part of a movement seen in formal and informal learning spaces, across classrooms, fab labs, makerspaces, and online spaces. Brahms and Crowley (2016) developed a set of definitions of maker practices based on article analysis of *MAKE* magazine, chosen not to solely represent making or makers, but as "a useful benchmark for identifying and characterizing the qualities and behaviors of this emerging community" (Brahms & Crowley, 2016, p. 2). Using one year's worth of articles from *MAKE* magazine, their analysis revealed seven core learning practices associated with the makers in the *MAKE* magazine community: Explore and question; tinker, test, and iterate; seek out resources; hack and repurpose; combine and complexify; customize; and share (Brahms & Crowley, 2016). While Brahms and Crowley's analysis was tailored for magazine articles, we found these maker practices to be common to other forms of making, including slime making.

To understand the intersection of creative production and maker practices, we draw on both to analyze slime makers' YouTube videos through a lens of maker practices. Our work explores three research questions:

- What production practices are youth engaging in as they document the making of slime? What maker practices are youth engaging in as they make slime?
- How do slime videos exemplify an intersection between youth media production and maker practices?
- How do slime makers differ from "makers" of other mediums?

## Methods

### Data Collection

As there are millions of slime YouTube videos, we used purposeful sampling to ensure that the situation and participants would provide information most relevant to our research questions (Maxwell, 2013). We limited our case to YouTube slimers who have a strong following or dedicated slime channels and are among the top channels in a YouTube search for slime tutorials. Purposeful sampling creates the opportunity to obtain representativeness and typicality (Maxwell, 2013), which provides more confidence that conclusions are representative of the specific community.

For our preliminary study, we narrowed our search to four slimers who have been recognized in the slime community, who have documented the making of slime in at least two slime tutorial videos, who have at least 4,000 subscribers, and who have been creating YouTube videos for at least six months. To ensure that our four creators are representative of the larger slime community, we chose video creators of various ages and genders as well as videos made both by individuals and teams.

### Data Analysis

We employed a mixed-methods approach to data analysis. While documenting the occurrences of maker practices legitimized the making occurring in slime videos, we used qualitative analysis to champion the individual practices demonstrated in slime creators' videos.

We transcribed participants' videos and analyzed these videos using the maker practices Brahms and Crowley (2016) used to identify common practices found in *MAKE* magazine articles: Explore and question; tinker, test and reiterate; seek out resources; hack and repurpose; combine and complexify; customize; and share. Because of the difference in medium, and because the "make" was centered on one central idea, slime, rather than maker practices in general, it was necessary for us to adjust Brahms and Crowley's definitions of these practices to better match the content of these videos (see Table 1).

| **Maker Practices** | **Brahms & Crowley (2017) Definition** | **New Definition** |
|---|---|---|
| Explore & Question | Interrogation of the material properties of the context in order to find inspiration or to determine intention for a process or project. | Interrogation of material properties used in slime production to find inspiration or intention for a process or project. |
| Tinker, Test, & Reiterate | Purposeful play, experimentation, evaluation, and refinement of context. | Purposeful play, experimentation, and evaluation of recipe. |
| Seek Out Resources | Identifying and pursuing the distributed expertise of others, includes recognition of one's own not-knowing and desire to learn. | Identifying and pursuing distributive expertise of others, including recognizing one's own not-knowing and acknowledging from whom or where one's inspiration originated. This often involves a "shout out" to other slime creators. |
| Hack & Repurpose | Harnessing and salvaging component parts of the made world to modify, enhance or create a product or process. | Reusing, incorporating or building from other recipes or slime creations to create a new product or purpose. This also involves acknowledging the inspiration for ideas or recipes. |
| Combine & Complexify | Developing skilled fluency with diverse tools and materials in order to reconfigure existing pieces and process and make new meaning. | Developing skilled fluency with scientific materials, trying new ingredients or comparing use of ingredients in different contexts to determine new processes and meaning. |
| Customize | Tailoring the features and functions of a technology to better suit personal interests and express identity. | Tailoring recipes to better suit personal interests and express identity. This includes tailoring slime recipes to feature unique colors/scents/add-ins chosen by the maker. |
| Share | Making information, methods, and modes of participation accessible and usable by members of the community. | Making information such as recipes available for other members of the community including specific prompts to the community for feedback as well as sharing and educating others through their making. |

*Table 1. Definitions of maker practices.*

To determine the extent to which slimers engaged in the various maker practices, we used deductive coding based on our revised definitions and analyzed each video, counting the frequency of maker practices. We met regularly to interpret findings and to ensure for intercoder reliability (Creswell, 2013).

Furthermore, we examined the demographics of slimers. Because most of the slimers are youth, their exact ages are not known (for online privacy in some cases) but we can assume the makers of these videos are between 14 and 24 years old. This age range reflects the demographics of slime producers on YouTube. While youth as young as 6 have embraced the craze, the majority of slimers have been identified as “tweens” who identify as female (Carlyle, 2017; Lieberman, 2017; Sostek, 2017). Demographics such as race, socioeconomic status, and education level were not readily available.

## Results

Our initial data suggest that slimers are engaging in a variety of maker practices throughout their 5–15-minute YouTube tutorials. Similar to Brahms and Crowley’s (2016) analysis of *MAKE* magazine, we found that videos contained several practices per video, suggesting that “the practices may be commonly part of a repertoire that characterizes making, or participation in the community of makers, as opposed to specialized practices that some makers use and others do not” (p. 4). All of the videos (100%) engaged in three practices: Tinker, test, and reiterate; seeking out resources; and sharing; and 75% of the videos engaged in exploring and questioning; hacking and repurposing; combining and complexifying; and customizing. For each maker practice, we identified an example from the video data to provide context for our new definitions (see Table 2).

| Maker Community Practice | Percentage of Videos Exemplifying Practice | Number of maker practices per video |
|---|---|---|
| Explore & Question | 75% | Video 1: 1<br>Video 2: 3<br>Video 3: 1<br>Video 4: 0 |
| Tinker, Test, & Reiterate | 100% | Video 1: 13<br>Video 2: 15<br>Video 3: 8<br>Video 4: 1 |
| Seek Out Resources | 100% | Video 1: 4<br>Video 2: 1<br>Video 3: 2<br>Video 4: 1 |
| Hack & Repurpose | 75% | Video 1: 6<br>Video 2: 6<br>Video 3: 1<br>Video 4: 0 |
| Combine & Complexify | 75% | Video 1: 0<br>Video 2: 3<br>Video 3: 2<br>Video 4: 1 |
| Customize | 75% | Video 1: 3<br>Video 2: 2<br>Video 3: 2<br>Video 4: 0 |
| Share | 100% | Video 1: 2<br>Video 2: 4<br>Video 3: 2<br>Video 4: 1 |

*Table 2. Number of maker practices present in videos.*

For each maker practice, we identified an example from the video data to provide context for our new definitions (see Table 3).

| **Maker Practices** | **Examples from Data** |
|---|---|
| Explore & Question | “I think it's a lot easier to pour in your glue first and then add the color because if you have to try to add the color after you add your slime activator it might not take to the full like color. You see how green this is and how pink? See, show them.” |
| Tinker, Test, & Reiterate | “I'm going to add a little bit of glue to yours a little bit more glue yeah just because to thicken it up some yeah. See, this is all trial and error. Just basically keep adding more of your slime activator and your glue and until you have the perfect consistency.” |
| Seek Out Resources | “if you guys are like me any time you try to DIY something that's been done in a YouTube video it never quite turns out how it looked in the video, so that's why I’m going to be testing some of those popular slime recipes and letting you guys know which one's work and which ones don’t!” |
| Hack & Repurpose | “And all the recipes that I will be trying today have two ingredients or less so they're super easy to make and you can find most of these ingredients in your house.” |
| Combine & Complexify | “White glue works best to make smooth cloud slime but to make it pigmented you have to add a lot of pigment.” |
| Customize | “This one is cool because you can get like any flavor you want so you can get any scent that you want essentially...be careful with this one because this one doesn't have any like fruit pieces in it but I know some of the other you'll play with do. I don't know how that would affect it.” |
| Share | “We're going to have to do this again. For sure. If you have any slime ideas leave them in the comments below.” |

*Table 3. Examples of maker practices witnessed in videos.*

Tinkering, testing, and reiteration most often involved taking a recipe found online or from other YouTube videos, testing whether the recipe worked, and participating in a pattern of trial and error such as adding various amounts of ingredients. Tinkering, testing, and reiteration are the predominant maker practice witnessed in the video and reflect the iterative nature of maker practices: Makers try, fail, and try again and successful iterations provide “an opportunity to develop applicable skills and grow relative knowledge for oneself and for the community of makers” (Brahms & Crowley, 2016, p. 7).

We found that tinkering was often tied to seeking out resources as slimers mention or give a “shout out” to original recipe creators. While the process of sharing is woven into the mere practice of making and posting YouTube videos, slimers often encourage further sharing such as asking followers to provide input about the kinds of slime videos they would like to see next.

Exploring and questioning was interwoven throughout videos as slimers pondered how various properties would affect slime texture or consistency. Slimers are constantly hacking and repurposing household items to create new slime recipes or to find ways to replace toxic ingredients such as Borax with safer ingredients. “Slime Queen” Karina Garcia has become famous for introducing recipes that include new and unusual items such as Hot Cheetos and coffee.

Most slimers customize slime recipes, adding glitter and paint of different colors or foods and household items that add auditory elements, but we also see slimers customizing their videos so that their videos stand out from the millions of other slime videos online. Perhaps the most sophisticated practice involves combining and complexifying as youth gain fluency with ingredients’ properties and are able to transfer that knowledge to create more complex products. As young creators learn more about the properties of activating agents such as Borax, they may begin to experiment with safer, less toxic materials such as laundry detergent or contact solution.

## Discussion and Conclusions

### Intersection of Practices

Slime creators work in the crossroads of media production and maker practices. They constantly engage in production techniques, weaving back and forth between messing around and geeking out. They continually produce and consume slime videos, seeking out inspiration from other members of their community. They repeatedly tinker around with materials, and they test hypotheses. They succeed and fail only to pick up and try again. This iterative process easily places the slime craze into the maker movement, but it does not answer the question of what it is about slime that has created this shift in production practices. The answer rests in the unique nature of the medium itself. Slime, unlike other moldable media—such as clay, Play-Doh, papier-mâché, or silly putty—is not meant to take a form. The final, malleable product is an experience. The art of slime is in the making of the slime itself.

Our preliminary data show that in the slime maker community, there is evidence of a new production model, in which an emphasis on making is at the core of media consumption, production, and sharing. Furthermore, slimers show evidence of engaging with maker practices, commonly seen as practices of fab labs and makerspaces. By reshaping definitions of maker practices with an eye toward the unique affordances and practices of YouTube and social media, we found that slime makers indeed engage in maker practices. Beyond maker practices, slimers engage in creative production, producing quality videos, and engaging their fans. The slime community stands in contrast to those who are often identified as makers in contexts such as *MAKE* magazine, with its own community of practice.

### Slime “Community of Practice”

Brahms and Crowley generated their maker-practices definition based on the community of practice framework (Lave & Wenger, 1991; Wenger, 1998), which suggests a process of social learning in which learners participate in community practices to move from peripheral participation to mastery, with the assumption that makers belong to such a community of practice.

We work from the same assumption, that slimers belong to a community of practice, where newcomers move from consuming videos and learning how to make slime to becoming slime makers and experts with a following. We see evidence that slimers are learning from each other on YouTube and engaging in the practices of this particular community, both across social media practices (including things such as shout-outs, or encouraging comments or likes) and across production norms such as how slime is mixed and played with in these videos. These practices of the slime community blend maker practices with the informal, friendship-based practices common to online socialization and personal media creation.

The participants in the slime community differ greatly from those who published the *MAKE* articles analyzed by Brahms and Crowley, a sample they describe as

> a primarily adult, male, well-educated and affluent population of makers who, through wide distribution and esteem, have come to represent a broad movement of individuals whose ages, genders, educational aspirations and financial situations vary far more than those selected for representation in the pages of this publication. (2016, p. 2)

In contrast, of the initial sample of videos we reviewed, the makers were 83% female and ranged in age from 14 to 24 years old.

This informal community of practice around slime is exciting because this diverse group is employing maker practices found in other disciplines, but leveraged in new ways. This particular form of making and sharing leverages youth media practices and trends to create an interesting example of how youth learn, create, and share with one another in participatory spaces.

### Future Directions

To further explore the unique properties of slime production, we will analyze up to 30 additional slime videos using the same deductive codes. We will expand our sampling size to include new, novice slime makers, as well as a larger variety of ages, genders, and race/ethnicities to obtain a sampling size that is more representative of the wide variety of slime makers.

In addition to further exploring the intersections of media consumption/production and maker practices, we may explore how audience engagement differs on different platforms, how slimers use new and novel approaches to grow their audience and business, and how slime video makers critique their own making processes and video production. Furthermore, we aim to find other video trends and documenting of the make outside of slime. In this way, we will determine whether other video-production processes follow this similar model or whether our model must be expanded to incorporate other video trends.

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# Sites of Collision for Arts Education, the Maker Movement, and Neoliberal Agendas in Education

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**Abstract:** This article draws on a 3-year empirical study of a public library system's arts-based maker program called *Bubbler.* In this article, I will introduce the maker movement and review literature on making. I will use discourse analysis of interviews and workshops with public librarians to highlight how neoliberal ideology collides with educational theories incongruent with this economic vision for how and why people learn and make. Finally, I will suggest possible implications for how learning through the arts can be undermined by neoliberal logics. This study contributes to conversations about learning through art making in educational settings across the United States.

Artists have always considered themselves makers; visual artists are makers of artifacts (paintings, sculptures, etc.), while performing artists are makers of experiences (dances, plays, concerts). In recent years, though, the term *making* has been claimed by what is coming to be known as "The Maker Movement" in education (e.g., Halverson & Sheridan, 2014). Propagated, in part, by for-profit companies (i.e., *MAKE,* Etsy) and mainstream literature such as Hatch's (2014) *The Maker Movement Manifesto,* the movement stresses that access to tools will enable the democratization of production. Many of the movement's most prominent leaders glorify Steve Jobs and hark on the myth that hobbies can be transformed into wealth-generating endeavors (Hatch, 2014). Furthermore, they often strip the arts and aesthetics from the core of what it means to do "making," focusing instead on entrepreneurial, production-oriented components of creating things.

Moreover, these makers do not come from a tradition of craft and artistry, but rather from a background in computation and engineering. In 1972, Stewart Brand published an article in which he popularized the term *hacker* as disruptive and creative, distinct from unimaginative technocrat planners, the white-collar workers following orders. For Brand, when computers became accessible, hackers could take over: "Ready or not, computers are coming to the people" (Brand, 1972, p. 1). To the maker movement leaders, this dream, beginning in Stanford's then-remote foothills near Palo Alto, has come: People are becoming "hackers" and accessible technologies and changes in economic conditions have opened the opportunity for "the largest explosion of creativity and innovation the world has ever seen" (Hatch, 2014, p. 8).

Research on the movement has defined making broadly as participation in the creative production of physical and digital artifacts (Halverson & Sheridan, 2014). As practitioners expand and diversify maker activities, the "revolution" has been critiqued as advancing a narrow, corporatized, gendered depiction of what counts, invoking images of young, White males and their fathers engaged with 3D printing and robotics (Brahms & Crowley, 2016). Concerned that the movement may align with corporate over social values, there is a burgeoning public counternarrative (see Morozov, 2014). Recently, alternatives to the "neoliberal rationality" have been put forward by Vossoughi, Hooper, and Escudé (2016). Yet despite the growing sophistication with which researchers understand the culture and culturing of the maker movement, to those looking to frame their educational programs within this trend, "making" has become a catch-all for all types of hands-on activities, including art making.

## Maker Education and Arts Education

Educational institutions are at the cross fires of varying ideological agendas carrying significant material consequences. Recently, the maker movement has begun to permeate the educational enterprise (Halverson & Sheridan, 2014). Public and private sectors, from Silicon Valley to the White House, claim making is a vehicle for education reform: a potential to build job skills in the science, technology, engineering, and math (STEM) workforce. The research arm of the Department of Defense has spent upward of 13 million dollars toward making with high schoolers, establishing TechShops for its agenda to stimulate innovation (Morozov, 2014).

Educational researchers see potential in the movement to offer more expressive tools to children (Blikstein & Worsley, 2016) and suggest that making provides playful and imaginative activities that can foster dispositional and constructionist open-ended learning (DiGiacomo & Gutiérrez, 2016). People are advancing their own varied educational agendas by self-identifying with the movement to attain the resources. This includes spaces such as museums and libraries, which offer opportunities to tinker and play (Bevan, Gutwill, Petrich, & Wilkinson, 2015).

Meanwhile, the arts are being systematically excluded from formal education and increasingly offered through alternative organizations. As art education theorist Darras points out, art education is characterized by a constant struggle to convince the educational authorities of its necessity (2015, p. 58). Today, the arts are being incorporated into STEM through initiatives for STEAM (science, technology, engineering, *arts*, and mathematics; Honey & Kanter, 2013). Thus, making, as something that can check off all the STEAM boxes, becomes the nom de jour for all activities, including art.

Policy, research, and professional literature have begun to communicate the same trope: 21st-century learning requires not just the consumption of knowledge, but the production of new ideas and artifacts. This aligns well with the maker movement's position that makers produce rather than consume. Students both acquire and create knowledge using a variety of communicative tools. In negotiating new tools and activities, many educators are orienting their learning goals around a more active view of learning wherein knowledge production is prioritized over acquisition. This aligns with a prioritization on learning by doing, which has been prevalent in arts education. Important for this discussion, while art education is entangled in many perspectives and cultures, the basic premise remains: "Through art we learn" (van Heusden & Gielen, 2015, p. 11). From conservatories to studio art classes, many types of arts education embrace a constructivist perspective that people learn by doing.

### The Public Library's Bubbler

This study takes place throughout a vibrant library system. As a publicly funded site that does not turn a profit, a basic representation of social democracy, the library offers the potential for resources, access, and opportunities to make art. In the Madison Public Library (MPL) system, Bubbler (the arts and maker programming of MPL) serves the system's nine libraries and various outreach locations. In the system's largest branch there is a dedicated Bubbler room and media laboratory that house portable equipment such as circuit board kits, a large range of art supplies, and iPads, as well as permanent equipment, including a recording studio and up-to-date, powerful desktop computers. Bubbler promotes arts creation, engagement with digital and analog technologies, and hands-on making. This is achieved through artist-in-residency programs, monthly gallery openings, and workshops in activities varying from screen printing to poetry. Staff members frame their work as both arts education and maker education, which has opened multiple collegial and funding communities. Bubbler has created a unique program, defined by one librarian as “the hippie cousin of the maker movement,” because, unlike many makerspaces, the program is free, is not set in one specific location, and is focused on the arts, rather than on science and technology. As part of a multiyear effort by researchers and library staff to understand how a systemwide approach to making might work, this article examines how library staff involved in Bubbler define and discuss making, the arts, and learning. MPL staff use the terms *artist* and *maker* somewhat synonymously and refer to art-making activities as simply *making.* Gaining insight into how learning in and through the arts is perceived at Bubbler provides a rich example of how discourse around making fits into current conceptions of learning through the arts. It is a fascinating and contested place where a blurring of frameworks is visible. Furthermore, as librarians seek to more thoroughly integrate theories of learning through making, libraries hold possibilities to provide unique learning opportunities. However, learning theories examined by the library staff in this study seem to have incompatible objectives, leaving the potential for underexamined influences to redirect learning goals in unintended ways.

## Research Methods and Analysis

This article is part of a collaborative project in which three researchers, along with core Bubbler staff, investigated a systemwide makerspace and the learning therein. This study is part of a multiyear ethnography and design-based research project. Design-based research encourages continued investigation of “designed innovations,” which include activities, organizational structures, artifacts, scaffolds, and curricula (DBRC, 2003). Unlike jointly negotiated research (see Bevan et al., 2015), we did not cocreate the research questions, nor conduct research with the librarians co-designing the programming. Alongside the librarians, we sought to develop sustainable systemwide programs. In addition, the researchers investigated the social, political, and educational contexts of the program. Throughout the project, to explore our questions and assess designs, we included a variety of data-gathering techniques including: participant observation and field notes of Bubbler workshops, team meetings, informal drop-in making sessions; work produced by makers during the range of sessions; documentation from professional-development workshops; and transcripts from semistructured interviews. In contrast to many linear methodologies in which projects begin with data collection and end with analysis, this style of research employs collection, analysis, and dissemination throughout. Below I describe in detail the data sources I draw on for this specific inquiry.

For this article, I focus on *formal and informal interviews* conducted with 24 library staff aimed at understanding how MPL staff was defining *Bubbler, making* and *learning* in regards to perceptions about the program, and the maker movement more generally. The first round of unstructured interviews began 18 months after Bubbler was officially launched. Then, through an emergent process, the research team collaborated on a semistructured protocol for a set of scheduled standardized interviews to better analyze across participant responses. These 20–45 minute interviews were conducted, recorded, and transcribed over the next several months. I also collected documentation from two *professional-development workshops* (conceived of collaboratively in accordance with our designs). In all workshops, Bubbler staff have paid time to participate. In one of the workshops, participants were asked to explore their own definitions of making. During the first hour, participants had time to write personal definitions of making before and after reflective group exercises. The workshop design sought thoughtful articulation using prompts based on interviews and popular definitions of *making.* We used techniques from process drama such as spectrum of difference, in which participants arranged themselves in a spectrum from "agree–"disagree" in response to statements such as "all making is hands-on." Participants explained where they were on the spectrum, inciting dialogue about their views. These sessions were videotaped, and participant definitions were collected. In the second workshop, participants mapped out the role of learning in Bubbler. Responses were created via group diagrams on a large whiteboard. This session was audio recorded and photos were taken. After this, the documents, videos, field notes, and transcriptions were analyzed through the same coding processes. Findings were compared to the interviews, looking for commonalities among making and learning, and discussions ensued about the relationship between making and learning. Evident in the discourse of Bubbler staff regarding the purpose for maker programming (see Table 1), there were incongruences between learning and making. This article will focus more exclusively on making, but for an extended explanation of data collection and methods of analysis, as well as an analysis including how participants discuss learning, please see a version of this article published in *Journal for Learning through the Arts.*

| Learning | Making |
| --- | --- |
| Disposition<br>For well-being, enlightenment | Skill<br>To make money, *be* a career |
| Ongoing<br>Toward no predetermined end | Finite<br>Intended for a specific outcome |
| Social<br>Process oriented | Individual<br>Product oriented |

*Table 1. Librarians' comparison of learning and making.*

## Make and Making

As I analyzed, I noticed that participants talked about "learning by doing" and cocreating learning dispositions such as "feeling excitement about learning." Making, on the other hand, was described by participants, not as something you experience, but as something you do through methods such as being "taught," "told," or "shown" a skill. This contrast in the language around "learning" versus "making" gave warrant to further analysis. Thus, this article takes a closer look at the incongruent relationship between learning and making to provoke "big picture" thinking regarding this discourse and its wider sociohistorical context. The following section focuses on the way participants discuss making.

When talking about making, the activities became "events where participants learn a skill and leave with a final product." What delineated these activities were the tangible outcomes. Making was defined as "a project that will result in an object" (such as a screen-printed T-shirt) or "putting elements together to make a finished thing" (this could be sonic or digital as well, such as a musical album). In the workshops, the concept of "make-and-take" was referenced, a program design where people come to participate in activity where "you make something, you take it home, you have it." This emphasis on the outcome categorized making as "about the end product" and turning "an idea into a format you can consume."

In this analysis, I found that participants switch from dispositional to skill-based learning with a focus on product: "working on a skill to have an end product." In conversations about making, open-ended processes are pushed to the margins and what becomes important is making *something*, a means to an end. The power is given to the object. Moreover, the language of the participants implies that participants see making as an individual and linear process that begins cerebrally and then is imposed by the individual on the material world. It is a personal endeavor "about using your own skills" where patrons take an "idea that's in your head and turn it into a reality." This stark contrast from the rhetoric of learning led me to apply a critical lens to investigate their discourse about making and its resonance with the broader sociolinguistic patters in the maker movement.

**How do librarians' understandings of making, the arts, and learning interface with neoliberal agendas for education?** The concept of creativity acts as a bridging construct between making, the arts, and neoliberal agendas in education wherein neoliberalism and dominant educational philosophies reside in our conceptions of creativity. Neoliberalism aims to liberate "entrepreneurial freedoms and skills" (Harvey, 2005, p. 2) through "self-sufficiency" by weakening the power of labor, deregulating industry, and advocating for profit making through free markets (Harvey, 2005). The 1970s marked a contemporaneous rise of neoliberalism and constructivism in education. As these theories collided, creativity became not only identifiable, but teachable and mediated through sociocultural factors. Neoliberal rhetoric *feels* logical, and its hegemony in discourse has widespread effects on the "common-sense way many of us interpret, live in, and understand the world" (Harvey, 2005, p. 5). Moreover, creativity offered a potential attribute to succeed in the market.

In arts education, scholars argue that neoliberalism has "replaced the arts with 'creativity,' understood in terms of technological and economic – entrepreneurial creativity" (van Heusden & Gielen, 2015, p. 11). Founded in the belief that anyone can, and should, achieve success by competing in the marketplace, arts education can become co-opted to build "industry creatives" rather than provide opportunities for open-ended or reflective experiences (van Heusden & Gielen, 2015). In informal educational settings creativity is now categorized as a marketable skill. Yet, as Blikstein and Worsley argue, this economic rhetoric is "fundamentally incompatible with a culture of democratic, equitable, and deep learning" (2016, p. 65). Learning to attain a career turns computer programming, for example, from an expressive tool to a way to "get kids into computer science" (Blikstein & Worsley, 2016, p. 67). Similarly, many arts education theorists, however unintentionally, promote an implied opinion that arts education's main objective should be to produce young artists.

The contrast between learning and making found in this analysis illuminates how art education can be discursively placed in relation to a neoliberal ideology, exemplified by a disproportionate orientation toward economic benefits, individuality, and outcomes. When asked about the reason for art in Bubbler, the manager of the program conjectured,

> Art has changed my life and how I see things and do things. I think it's really important for people to kind of slow down and create things just as part of their own kind of mental health and well-being.

Yet even if art is thought of as exploratory and looking toward well-being, this set of values is not integrated into language about making across the system. When I asked about the role of the maker movement in public libraries, answers instead exemplified dominant neoliberal discourse, such as:

> I think it's incredibly instrumental for libraries to offer maker-based programming just mainly because we are kind of living in an age where people are graduating from school, high school, they're going to college, they're learning skills and a lot of people aren't necessarily knowing how to apply certain skills to a viable workforce.

**Making toward career.** In the context of making, participants shift from dispositional qualities to developing certain skills, often justified in economic terms. Arts-based learning is for well-being, but making is to enhance marketable skills. In several interviews, maker programs were described as useful, because, as one participant said, a patron may "discover something new" and "make a career out of it." The narrative of discovering a future career appeared several times. More than one person rationalized access to art making as valuable because a patron might become a successful artist. One interviewee mentioned an ideal hypothetical patron's saying, "I wanna be a filmmaker; I wanna quit my day job and go be a filmmaker" which would "be awesome and great." Another interviewee shared the following anecdote:

> One summer there was free theater in the park. A father, hesitant to take his child, assumed the kid would be bored. Yet because it was free and convenient, he decided to go. [The interviewee is drawing a parallel to Bubbler, also free and convenient.] The child had a wonderful time and it became a regular family activity. Years later the child became an actor.

Following from the logic in this analogy, success from a Bubbler program would be a patron discovering what he or she wants to *be.*

The fact that the achievement in the story is that the child became an actor is telling. Alternatively, the experience may have sparked wonder, provided practice stepping into a hypothetical world of possibility, or even provided space each summer to feel love from his father and appreciate being in the outdoors. Furthermore, this ideal of discovering a career as the best outcome for learning in an arts program undermines the rest of the experiences, for example, having an enjoyable time or even discovering a hobby outside the economic realm. In the neoliberal paradigm, future is conflated with an individual's economic future. This may be well intentioned as educators strive to take the future into account. In this version of preparation, educators often lose sight of learning through experiences as opposed to acquiring skills for future ones and value individual advancement in lieu of well-being. Moreover, even if a patron does want to become a professional, career goals direct learning goals toward economic success and solving problems. To embrace the artistic culture of problem posing, not problem solving, it is irrelevant what you want to *be* if arts education aims to teach *how*.

**Making as finite.** As discussed earlier, participants aligned with social constructivism emphasizing learning as "not by yourself," but about "connecting" and "interacting" through relationships among humans. When speaking about making, however, tools were rarely discussed in the context of learning by making, or from a constructionist perspective. Tools were used in service of a product, potentially to practice a skill, but not as materials with which to play. Making was characterized by "individuals tinkering," providing people with the opportunity to "figure things out for themselves." Socializing applied to human processes; tools and materials applied to finished products. Throughout this project, interviewees reiterated that people make on their own yet they learn together.

As opposed to an ongoing process, many participants depict making as something that invites a learning process that is linear, finite, and cerebral. Making happens when something "pops into my head" and is carried out. However, researchers warn that creativity may be suppressed if a process is inflexible and made of stages assuming "a linear progression from start to finish" (Martinez & Stager, 2013, p. 46). To participants, this predetermined outcome is cerebrally conceived and then executed. Yet rushing ahead to solve a predefined problem undermines open-ended exploration.

As participants emphasize artifact production, material production is left out entirely. The interviewees embrace the do-it-yourself, artist-as-entrepreneur ethos, but they never mention thinking critically about how work is shared through digital platforms and the ways in which they participate in that market. Hatch's *Maker Movement Manifesto* (2014) emphasizes reclaiming the tools of production, invoking a Marxist egalitarianism; yet here we see people provided with tools to make but not provided with ownership of what is produced. Neoliberalism claims what is created in common spaces as private enterprise, and in this case, there is no space for critical thinking in regard to this tendency. The artists create the music, but the question of learning about who owns that music is out of scope.

In the interviews, "originality" and uniqueness can be conflated with successful art making. Indeed, researchers at the Exploratorium's Tinkering Studio observed that to museum facilitators, learning was visible when they saw a child create something different from his or her peers (Bevan et al., 2015). This aligns with ideals in artistic modernity (i.e., the avant garde), which have proceeded from romantic individualism to embrace originality and critique (van Heusden & Gielen, 2015). Yet these concepts have been appropriated in the dream of individual financial success. In our current economic climate, it is not unreasonable that library staff/interviewees think that *original* means *marketable* and that a "free program for the community to help them like with entrepreneur stuff is super awesome."

**Making as something new.** Many staff are excited about the program's newness: "We're on the cutting edge." However, newness/excitement implies an oldness/dullness in past programming. This led to tensions among staff who saw their previous programs left behind—for example, the knitting circle. As one participant said: "I'm a little bit miffy about the word *maker* because I've been doing this when this was something Grandma did." Most staff describe the program both as something completely new *and* something done for years, referencing craft artistry as "something humans have done forever." To some, making ideals seem tied to self-sufficiency characterized in doing-it-yourself ways such as "fixing your own clothing" or "canning your food." Bubbler aspects that work with new media are referred to as on the vanguard, but individual craft programs are part of a traditional canon, a nostalgic return to cottage industry.

Participants made few references to external influences leading to this rhetorical paradox. However, unlike the rest of the staff, managers recognized the neoliberal logics as outside their own programmatic goals, but they excused the use of neoliberal justifications to get what they need from top-down forms of support (interview, September 12, 2016). Managers were aware of the juxtaposition between the language used to promote and rationalize the maker programming and the language they use to speak about learning outside of that context, and one even expressed fear that this might slowly undercut the program's commitment to arts education in the service of STEM or robotics (interview, October 3, 2016).

In this hierarchical system, the managers interface directly with funding and mediating the pressures of neoliberalism (Barniskis, 2015). When asked why this was called maker education as opposed to arts education, the manager who oversees programs across the system candidly confessed,

> I don't know that it [Bubbler] would have been able to take off in the same way. Because it's all about framing, and if we were just like, oh, we are a visual art program and we do artist in residence … was that going to get the grants … the smart thing was to align it this way.

In this regard, another manager acknowledged the influence of the maker movement in garnering support, saying,

> We have to focus on what we can win. Maker stuff can be powerful in that landscape. Or if we could talk about maker as part of job creation, or that you're learning about skills that are important for entrepreneurs, you know, workforce development. … We need to be mindful of how, like what opportunities there are at a national level, with respect to advocacy and also funding.

Like Barniskis's findings, this study reveals a "struggle between inclusive discourse and what they believe funders want to hear" (2015, p. 1). In this study, managers articulated their choice to take on neoliberal rhetoric as strategic; however, at no point did they mention that it may undermine or contradict other goals. While there are incongruences with artistic, open-ended learning and this version of making, an understanding of maker discourse as strategic is the first step toward deeper awareness of this language, its impacts and effects, and how to move beyond this toward a consciously anti-neoliberal framework that promotes alternative values.

## Economic Discussion

Advocates of the maker movement proclaim that the movement is concerned with democracy and anticonsumerism, and authors champion that greater access to tools may diversify participants (Peppler, Halverson, & Kafai, 2016). However, for those hoping that the movement will be economically revolutionary, the predominance of this "access-to-tools mentality" without questioning political and social structures is likely ineffective (Morozov, 2014). Furthermore, the iconoclast makers seem to align with a neoliberal agenda of decentralization via privatization. While they fear that the movement's institutionalization may suppress the emergence of entrepreneurial spirit, they seem unconcerned about the control of private corporations. While access to tools may provide opportunities for more people to participate in production, that is not the same as sharing the economic benefits. Thus, concerned that the movement may align with corporate over social values, there is a burgeoning counternarrative. Recently, alternatives to what Vossoughi et al. (2016) refer to as "neoliberal rationality" have been put forward by calling for sharper focus on equity-oriented pedagogies.

In line with Vossoughi et al. (2016), who assert that prominent voices in the U.S. maker movement "describe the artifacts young people make as 'products'" (p. 224), the participants' language about making echoed this tendency, an indication that the struggle between the dominant incompatible narratives underscored in this study of how people learn and why they create is indicative of globally powerful structures. Figures such as Dale Dougherty promote making as part of an "exceptional element of American identity," invoking "U.S. power and control … characterized by economic growth" (Vossoughi et al., 2016, p. 208). This confluence of nationalism and the regime of truth brought on by free-market economics is inherent in mainstream versions of making. Thus, while it seems unintentional, participants mirrored language of this concept of making, tapping into a broader sociocultural phenomenon that determines what types of artistic engagements are encouraged and deemed worthwhile. Furthermore, implicitly economic narratives also became apparent via the value placed on by-products. For example, in the talk about making, creativity became part and parcel with a view that creativity meant entrepreneurial ingenuity, a myth naturalized in the business community. In arts education, learning goals demand complexity. Therefore, if we strive to foster creativity, we need to examine its meaning and purpose to promote making that matters beyond the boundaries of capital.

This study looks to questions of discourse around learning and making in informal arts education, examining educational theories and corresponding conceptions of learning and making. It seeks to understand how those who enact arts education talk about learning and making, and the ways in which neoliberal discourse veils contradictory views from those often engaged in arts education. As the maker movement increasingly becomes a conveyer for artistic activities, there is great potential to foster important transferable dispositions, social awareness, an understanding of becoming, and an appreciation of the material world. Yet as this study suggests, neoliberal doctrine embedded in the maker movement may fragment and distort rhetoric about learning toward economic instrumentalism. This could, in turn, lead arts education to squander its most promising feature: the facilitation of comfortable risk taking, which supports creating personally meaningful and constructive responses to the world.

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# Digital Tools for Peer-Based Reading Recommendations

## A Case Study of Bookopolis

**Cindy K. Lam (Stanford University) and Brigid Barron (Stanford University)**

**Abstract:** Learning to read is a fundamental academic skill that begins developing in early childhood. While there is extensive existing research that examines reading development as an individual skill, there is less research on how to nurture motivation and engagement to sustain reading development. In this mixed-methods study, we address this gap in the research by investigating 2 case studies of classrooms that use an online literacy tool, Bookopolis, to foster enthusiasm for reading in 3rd graders. Using analysis of both qualitative interview data and quantitative online recommendation data, we investigate questions of (a) what pedagogical choices teachers make to support the uptake of Bookopolis in their classrooms, (b) what Bookopolis features teachers found most useful, (c) how Bookopolis impacted students' early literacy engagement from the perspective of the teacher, and (d) what are the patterns of peer-to-peer engagement in the classroom. The findings suggest that teacher pedagogy and peer support are central to how Bookopolis is used in the classroom to foster engagement in reading.

## Introduction

> I saw kids choosing books differently. I saw kids who didn't read chapter books start to read chapter books, because their friends encouraged them. And because they were seeing what other kids were reading, they wanted to read what their friends were reading.

—Ms. R, third-grade teacher

> Literally, that whole social aspect, I can't even tell you the fire it ignites. I don't want to say chaos and pandemonium it brings to a classroom, but it's like the classroom can be dead and then, it's coming alive like it's a carnival because they're all on Bookopolis.

—Ms. B, third-grade teacher

### Background

Learning to read is a fundamental skill that is critical for academic success. It is also a challenging skill for many children to acquire, despite extensive research on its development. The most recent data from the National Assessment of Educational Progress showed that 64% of students score below proficient in reading (NAEP, 2015). Of that percentage, students from minority backgrounds or less affluent socioeconomic backgrounds obtain even lower scores on standardized reading assessments. To address this gap, basic reading skills such as phonological awareness are often a primary target of intervention (National Reading Panel, 2000). However, once competence develops in decoding, building expertise as a reader requires sustained engagement in the activity of reading both for pleasure and as a resource for learning. Recent data suggest that this is an important area to work on: The National Center for Education Statistics' (2013) long-term trend assessment obtained a large national sample of students and asked how often they read for fun, using the same question format to measure changes over time. This study found that the amount of time that young children spend reading has been dropping, and other research suggests that variability in time spent reading is related to a number of factors, including the availability of books and reading partners (Common Sense Media, 2014).

Much of the research on reading has focused on its development as a skill (National Reading Council, 1998). There is less research on how to nurture motivation and engagement to sustain a child's reading development into eventual expertise, both as an individual capacity and as a shared activity within a wider community, despite studies suggesting that interest-driven reading can support learners with persistent difficulties in reading (Fink, 1995). There is also a particular need to understand the role of peers in supporting engagement in reading (Cooc & Kim, 2017). Previous research shows that engaging in collaborative, peer-based learning supports cognitive development, social development, and transfers in learning (Cohen, 1994; Olivera & Strauss, 2004). Further, peer collaboration can play a mediating role in enhancing learning and development for students who are lower performing (Cooc & Kim, 2017).

The following study addresses these gaps in the literature by investigating two case studies of classrooms that use online peer-recommendation tools to foster enthusiasm for reading in third-grade students. This study uses insights from the learning sciences and sociocultural perspectives to examine the role of one online tool, Bookopolis, in how children engage with reading across setting and time as it pertains to social interaction, meaning making, and interest development in a classroom community. Both teacher interviews and online peer-recommendation data are analyzed to provide portraits of the interacting roles of teacher pedagogy, peer interaction, and the affordances of Bookopolis in supporting engagement in reading.

## Theoretical Framework

This paper will examine engagement in reading through the sociocultural approach, which considers three foci of analysis in research: personal, interpersonal, and community processes (Rogoff, Radziszewska, & Masiello, 1995). Rather than framing reading development as a passive activity contained within the individual, this study assumes that learning to read is constructed across all three planes. Furthermore, Rogoff's sociocultural framework defines the unit of analysis as an activity or event "with active and dynamic contributions from individuals, their social partners, and historical traditions and materials and their transformations" (Rogoff, Radziszwska, & Masiello, 1995, p. 1). This study will examine the individual, interpersonal, and community aspects of activity of using Bookopolis in the classroom.

Complementing sociocultural theory are ecological perspectives on learning and development (Bronfenbrenner, 1974) that highlight the multiple and sometimes complementary settings for learning that children spent time in. Networked technologies extend the possible contexts for learning activities, leading to elaborations of ecological frameworks to acknowledge that an individual's learning ecology encompasses "the set of contexts found in physical or virtual spaces that provide opportunities for learning" (Barron, 2006, p. 195). This learning-ecology framework further underscores the interrelated nature of learners and their environments in the process of developmental change, highlighting the role of interest in driving the creation of new activity contexts when resources are available (Barron, 2006). This study will examine the learning settings in two specific classrooms and the physical and digital resources intertwined in activity of engaging in reading for pleasure.

## Research Questions

Using both qualitative interview data and quantitative web-usage data, this study will feature two illustrative case studies to investigate the following research questions:

- What pedagogical choices were made by teachers to support the uptake of an online literacy tool such as Bookopolis?
- What features of the online literacy tool do teachers believe support peer-based learning in their classrooms?
- From the teacher's perspective, how does the use of an online reading community impact the early literacy engagement of young children?
- What evidence of peer-to-peer engagement do we see from the online data?

## Methods

### Study Context

This study was conducted through a research partnership established with the founder and CEO of Bookopolis, Kari Riedel, who enabled participant recruitment and data collection. Bookopolis is an online reading community similar to Goodreads, but it is directed at children aged 7–12. On the "About" page of the website, Bookopolis is described as a "safe and fun online place for elementary and middle school kids to connect with other young readers about books and reading" (Bookopolis, 2017). Bookopolis offers online tools to serve the needs of both educators and students. For students, the features include: the capacity to make and receive book recommendations; maintaining digital bookshelves of books they have read, want to read, or are currently reading; a point-based system that tracks and rewards reading achievements; and an online reading community. For teachers, Bookopolis allows them to create a classroom community with the capacity to view bookshelves, book recommendations, book reviews, and other forms of online student activity.

### Sampling

The research partner connected us to teachers based on geographic diversity, previous interest in being part of a Bookopolis study, and active website participation from their respective classrooms. Four teachers volunteered to participate with the understanding that no compensation would be offered since this is an exploratory study. We purposefully sampled two participants from these four teachers (Patton, 1990). This was done to focus more on the research questions around the social dynamics of Bookopolis and literacy engagement using similar cases. The selected teachers, Ms. B and Ms. R, both emphasized the in-class social nature of their Bookopolis experiences more prominently relative to the other two teachers. Ms. B and Ms. R also shared similarities that would make them more easily comparable as case studies, as they both taught self-contained classrooms of third- and fourth-grade students from socioeconomically diverse communities. In contrast, the nonfocal teachers had unique teaching situations in religious and affluent communities.

### Characteristics of Focal Teachers and Their Settings

Both teachers, Ms. B and Ms. R, have extensive experience as classroom teachers. Both of their schools are situated in Northern California in different public school districts. They taught similarly sized classrooms of about 30 students, typically to a proportion of students who were socioeconomically disadvantaged and a proportion of students who were English learners. This information was extracted from interviews and validated using the School Accountability Report cards of the respective schools for the 2016–2017 academic year. More details can be found in Table 1.

| | Ms. B | Ms. R |
|---|---|---|
| *Teacher characteristics* | | |
| Grade taught | 3rd, 4th | 3rd |
| Amount of experience | 25 years | 12 years |
| Average classroom size | 26-30 students | 30 students |
| Classroom makeup | English Only & English Learner | English Only, English Learner, & Special Day |
| *School characteristics* | | |
| Total students | 496 | 700 |
| Grades served | TK-5 | K-8 |
| Proportion of students identified as socioeconomically disadvantaged | 45.1% | 33.8% |
| Proportion of students identified as English learner | 12.7% | 22.4% |
| Proportion of students identified as those w/ disability | 9.8% | 13.4% |

*Table 1. Characteristics of case study teachers and their schools.*

### Qualitative Data Collection and Analysis

Four teachers were interviewed for about an hour, either in person or over the phone. Interviews were audio recorded and transcribed, resulting in nearly 100 pages of transcript. Each focal teacher was interviewed for about one hour, resulting in 42 pages of transcript. Interview questions were designed to be open ended and cover multiple topics: the teacher’s personal learning trajectory in using digital reading tools, the teacher’s experiences with Bookopolis, and the impact on student learning.

We began the data-analysis process by discussing and refining research questions with our research group. These research questions would be used to broadly frame the qualitative analysis that followed. We exhaustively open coded the transcripts in Dedoose, highlighting and memoing interesting points in the interviews that related to the research questions. After our first pass through the transcripts, we reviewed the codes that emerged, combined redundant codes, and organized them into parent codes by category: teacher pedagogy, student engagement and growth, student ownership, online features supporting social interaction, and community. With this preliminary codebook, we conducted a second pass of open coding through the transcripts. In order to conduct inductive thematic analysis, we exported and printed all codes and their associated excerpts from Dedoose. After systematically reviewing convergence and divergence in the data within code categories, we organized these iterations of convergence and divergence into larger categories. From that, we extracted the primary themes presented in the Results section of this paper.

### Quantitative Data Collection and Analysis

Our community research partner provided extensive Bookopolis web-usage data from each teacher's class during the 2016–2017 academic year. For the purposes of this study, we analyzed a subset of the quantitative data that was most relevant to our research questions and to themes that emerged from the qualitative analysis. The social features of Bookopolis were a focal point both in our research questions and in the qualitative themes, so we examined the web-usage data indicating peer interaction—the data of the book recommendations that users made to each other within their online classroom communities.

The book-recommendation data listed every instance that a user recommended a book to another user during the 2016–2017 academic school year. For each instance, we received information on the date of the activity, the unique anonymized ID of the user who sent the recommendation, the unique anonymized ID of the user receiving the information, the message included with the recommendation, and the Amazon ISBN of the book. We used Gephi, a social network–data visualization tool, to examine the recommendation data. The purpose of these social network graphs was to illustrate the connectedness of peers within the online class communities based on their recommendation activity (Easley & Kleinberg, 2010). In this paper, we present the graph produced to illustrate reciprocal recommendations within students, in which the same students both send and receive recommendations to and from each other.

## Results

Three primary themes emerged in the qualitative coding: the importance of pedagogical choices, the social features of Bookopolis, and significant changes in students' ownership and agency of reading and sharing books. The following case studies illustrate two ways that Bookopolis can be used in the classroom to not only accomplish pedagogical goals, but also to engage students with literacy practices at the individual, interpersonal, and community levels. They further provide illustrations of the learning ecologies of Bookopolis in the classroom. Table 2 summarizes key findings according to the research questions framing this study.

### Case 1: Ms. B

Ms. B is a third-grade teacher of 25 years. When recalling her personal learning trajectory as a reader, Ms. B described growing up in a "dirt-poor" socioeconomic environment, identifying as a struggling reader until she found a book she loved, was able to access books via the local library, and socially engage with peers around that book. Ms. B's experiences paralleled her pedagogical choices, as she strongly believed in creating a love for reading by being nonpunitive, tying into students' interests, and offering them physical and digital resources for reading within those interests. In line with these goals, Ms. B sought out Bookopolis as a social networking tool for students to explore their interests in reading and socially connect to their peers in a reading community. To accomplish her teaching goals, Ms. B used practices of dedicated unstructured time, a combination of physical and digital tools, and providing multiple points of access to physical books. She found that the peer-recommendation features of Bookopolis were pivotal in achieving these goals and facilitating a peer-collaborative classroom, as students used Bookopolis recommendations to coordinate in-person joint activities around reading. Ms. B also found that social networking features of Bookopolis resulted in increased agency, ownership, and accountability in her students. As readers, her students felt empowered to be able to choose, recommend, and rate books. As writers, her students felt accountable to the audience and peers they could influence through online discussion of these books.

### Case 2: Ms. R

Ms. R is a third-grade teacher of 12 years. Before teaching, she worked in the health-care industry with a focus on technology training and support. These experiences reflected her philosophy that technology needed to be more than a replacement for something in the classroom, but rather a meaningful tool with a contextual goal. As a result, her pedagogical goal for using Bookopolis was to use technology to meaningfully engage with reading in her classroom community, particularly to provide a more meaningful use for reading logs. To accomplish her teaching goals, Ms. R used practices of dedicated unstructured classroom time to using Bookopolis, using reading logs, and giving feedback to students based on online contributions. She found that the peer-recommendation features were central in helping her students to explore more genres of reading, and that reading log features anchored more in-class discussion and engagement around reading. As a result of using Bookopolis, Ms. R observed profound differences in the way that her students engaged with Bookopolis as they took more ownership of their reading activities, more actively discussed reading in the classroom, and demonstrated improved writing. Like Ms. B, Ms. R found that the social networking features resulted in students’ feeling more ownership as readers and empowerment as writers contributing to an online community.

| | Ms. B | | Ms. R | |
|---|---|---|---|---|
| *Theme* | *Subthemes* | *Selected Quotes* | *Subthemes* | *Selected Quotes* |
| Peda-gogical choices | • Provide students with books relevant to their interests to spark love for reading<br><br>• Dedicated unstructured classroom time to using Bookopolis<br><br>• Combination of physical and digital tools<br><br>• Access to physical books | "That's important to know what's out there for reading for your kids, to be able to recommend a book based on a certain genre that they're interested in. If you're not doing that, you don't know about those books, then you can never create that passion in your students if you don't know what is out there." | • Teach students to use technology in a meaningful way<br><br>• Dedicated unstructured classroom time to using Bookopolis<br><br>• Meaningful reading logs<br><br>• Feedback for students based on online contributions | "And the kids are expected to read for 20 minutes, and then they're expected to write a sentence or two. And then their parent signs it, and they bring it to me. And I personally have just always been really frustrated with that. I've not ever really seen the purpose behind it, and I've not seen a benefit. And so time for students is really precious in their homes, and I was looking for a way to make that time more valuable. And then in addition, one of the Common Core standards is to be using technology in a meaningful way. And so my thought was maybe there's a way I could pair those two things together." |
| Book-opolis features used | • Website book recommendation<br><br>• Peer book recommendation<br><br>• Visibility of peer and teacher bookshelves | "They'll message you. I love how they'll send an instant message to each other or I can send you a book recommendation. I can tell you, 'Oh, you know, I'm reading *It's Raining Cats and Dogs*,' or whatever book I could recommend to you, you know, *The Day the Crayons Quit*. I could recommend books to you or I could just be on there looking at your bookshelf without you even messaging me about a book or me messaging you." | • Website book recommendation<br><br>• Peer book recommendation<br><br>• Reading logs | "They could search for books in different genres, and I thought that that was all really powerful, because kids at third... Well, I think any grade, they get really stuck. They're stuck on *Wimpy Kid*. They're stuck on *Captain Underpants*. They're stuck on graphic novels. And I thought this is a way that their peers could say, 'Hey, I just read this book. I think it's great.'" |
| Student out-comes | • Genre exploration<br><br>• Excitement about reading<br><br>• Ownership and agency as readers<br><br>• Increased accountability in writing | "Yeah, that accountability factor was like an eye-opener for them and I think it made the caliber of their writing better. It made them put more effort in. That was powerful for them to see books that I had read and rated as well." | • Genre exploration<br><br>• Classroom reading community<br><br>• Ownership and agency as reading<br><br>• Increased accountability in writing | "And it seemed like it just gave the kids ... You know, because initially there's that silliness, but then they found the power. As you were saying, they found the power of their own words and their own opinions. They were able to share those with people. They could share them with me. Also this was their first year using Chromebooks, so it gave them a legitimate reason to be on a computer and to see the power, that they could use it for a communication tool." |

*Table 2. Summary of qualitative themes with selected quotes from interviews.*

## Peer-Based Reading-Recommendation Data

To investigate quantified measures of peer interaction on Bookopolis, we examined the peer-recommendation data for Ms. B's and Ms. R's classes from the academic school year of 2016–2017. For Ms. B's classroom, the date ranges showing recommendation activity were 9/6/16–10/6/16 and 4/18/17–6/2/17. For Ms. R's classroom, the date ranges showing recommendation activity were 3/30/17–6/1/17. The data collected online show extensive recommendation activity in both classes: Ms. B circulated 169 books with 3,215 recommendations, and Ms. R's class circulated 137 books across 1,743 recommendations; 100% of students in both classes sent recommendations to their peers. However, not all students were included in receiving recommendations. In Ms. B's class, 82% of students had mutuality in their peer book recommendations, and in Ms. R's class, 81% of students had mutuality. Furthermore, there was huge variation in the amount of recommendations that students received or sent (see Table 3). Variations in these patterns are visualized using social network visualization (Figure 1).

| | Ms. B | Ms. R |
|---|---|---|
| Book recommendations sent | | |
| Range | 53-105 | 12-137 |
| *M* | 85.52 | 59.00 |
| *SD* | 10.71 | 20.10 |
| Book recommendations received | | |
| Range | 0-635 | 0-279 |
| *M* | 97.12 | 67.04 |
| *SD* | 138.36 | 96.49 |

*Table 3. Range, mean, and standard deviation of book-recommendations activity.*

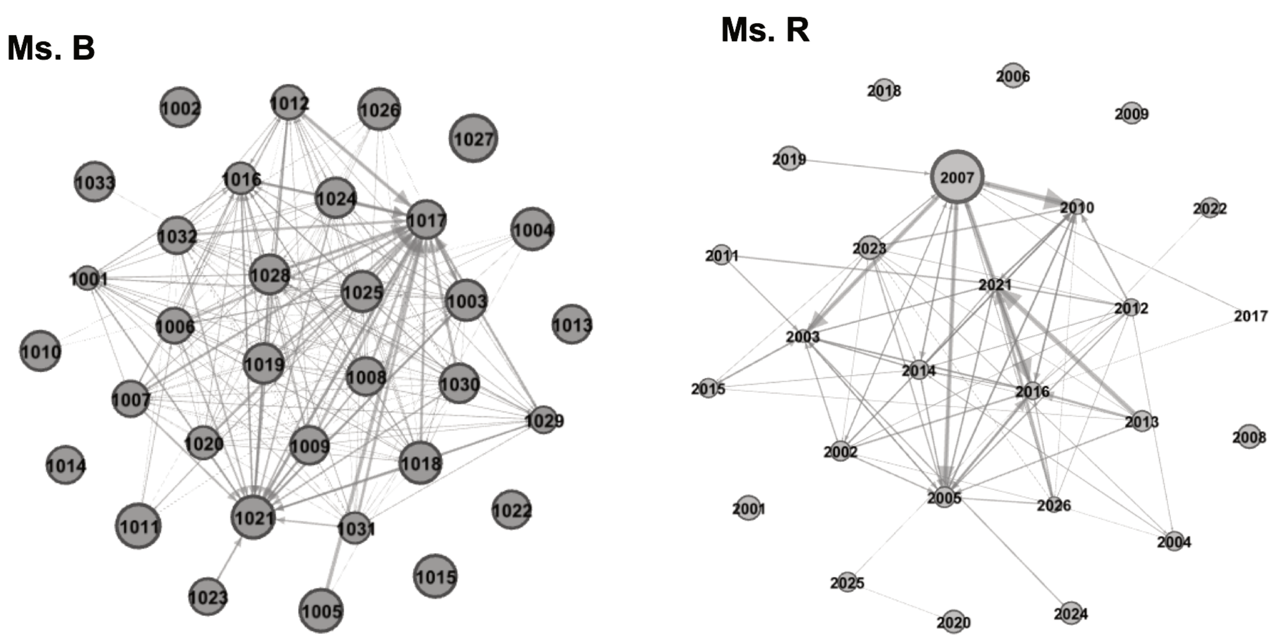


*Figure 1. Social network recommendation visualizations of mutual book recommendations.*

Individual students are represented as nodes with anonymized labels. A larger node means that this student received larger number of recommendations. The range for the node size is set as 2–60, meaning that students with fewest mutual recommendations are represented with a size of 2 and students with the most mutual recommendations are represented with a size of 60. The links between nodes represent the recommendations sent out, with the head of the arrow pointing at the recipient. Links are displayed only if students have a reciprocal recommending relationship.

## Discussion, Limitations, and Conclusions

In this paper, we presented two case portraits of teachers using Bookopolis as an online reading tool to achieve their respective pedagogical goals. The analyses highlighted the critical importance of peer interaction and the role of the teacher in supporting an online reading community. According to the qualitative results, Ms. B and Ms. R observed shifts in how their students engaged with literacy, mainly because Bookopolis was used to foster a peer collaborative learning environment both in person and online. These teacher interviews also revealed that social media tools such as messaging, sending recommendations, and viewing each other's bookshelves encouraged students to have meaningful and exciting social interactions around reading in the classroom. Bookopolis was not a stand-alone tool; the pedagogies of Ms. B and Ms. R framed the rich learning ecologies that emerged from using Bookopolis in the classroom. Further, as a result of the combination of teacher philosophy and the social affordances of Bookopolis, both teachers perceived that students took on more ownership and agency as readers, as reflected in the way students engaged with reading through discussion, book selection, genre exploration, and writing. The analysis of the peer-recommendation data showed that students were active as recommenders and receivers, though there was wide variability in this activity. This variability is possibly driven by friendship groups, or popularity and perception of reading levels or interest in reading (Cooc & Kim, 2017).

The results point to social digital tools such as Bookopolis as promising means for creating a social reading community within a classroom and nurturing sustained motivation and passion for reading in students, coupled with the appropriate teacher pedagogy. However, this study is not without limitations. The small sample size did not showcase how Bookopolis might be used with different pedagogical choices or with more diverse learners. Additionally, limited collection of online usage data prevented deeper social network analysis of peer-to-peer recommendations. Future research will recruit a larger sample of more diverse classrooms, as well as examine the role of peer interaction and how it influences students' uptake of books on Bookopolis.

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# Same Game, Different Impact

## Diagnosing the Successes and Failures of One Game-Based Intervention Across Four Schools

**Andreas Lieberoth (Aarhus University), Thorkild Hanghøj (Aalborg University), and Morten Misfeldt (Aarhus University)**

**Abstract:** A game-based learning approach may work in 1 school, but fall flat in another. This paper details how 1 intervention led to different outcomes and analyzes these differences in terms of the social and cultural characteristics of 4 schools. The intervention for 3rd–5th graders included a mix of commercial-off-the-shelf gameplay, classroom exercises based on the game, and gamification aimed at classroom conduct. General effects were observed for intrinsic and external motivation using the children's locus of causality scales (c-PLOC), plus teacher-assessed learning and well-being. Yet very different practical outcomes were observed in the 4 different schools taking part in the project. This study used an explanatory mixed-methods analysis to dive deep into the qualitative characteristics of 1 classroom where the intervention took a definite hold, concluding that successes were significantly determined by a combination of support for the teachers in the schools, visible positive results, and the specific needs at play in each classroom. Specifically, we find that, although the intervention had several kinds of positive impact, simpler gamification elements worked best with younger students and/or for teachers who struggled to maintain focus in their classrooms.

### Introduction

Commercial off-the-shelf games hold promise for curriculum learning, development of noncognitive skills, and fostering collaboration among players (Barab, Gresalfi, & Arici, 2010; Gee, 2003; Hanghøj, 2017; Lieberoth, 2017; Squire, 2006). With the rise of esports as an after-school activity, and emergence of both grade- and high school esports programs, researchers and teachers also are experiencing an increased impetus to identify a place for "real games" in school settings and to develop pedagogical practices around them (Lieberoth, Fiskaali, & Spindler, 2018; Lieberoth & Hanghøj, 2017). Yet a recent mixed-methods intervention study showed us that there can be a notable difference in how a game-based intervention impacts students depending on their social positioning and individual learning needs (Hanghøj, Lieberoth, & Misfeldt, 2018).

Through the lens of between-schools differences, we here combine statistics and ethnographic evidence to exemplify what we believe to be critical characteristics of effective and problematic implementations of games in new classrooms.

From field observations, it became clear that all schools and classrooms had unique characteristics, which led to variations in the implementations. Teachers had different motivations and opportunities. Students had different needs, social backgrounds, and existing foundations to build upon. Even technical practicalities came to determine the interventions. As an example, one school was haunted by practical problems, including an impromptu staff replacement after teacher training had been conducted, which lessened staff ownership and led to a less rigorous implementation of the scheduled activities, both in terms of curriculum integration and classroom elements. In another school, teachers originally felt very frustrated, but their principal supported them admirably, to a point where they became highly motivated converts to game-based learning. This mélange led us, after the initial data analysis, to ask the question: Did the botched implementation observed early leave a measurable mark on the students as measured though the children's perceived locus of causality) (c-PLOC) scales (Pannekoek, Piek, & Hagger, 2014)? While this initial hypothesis was rejected, a statistical analysis of between-schools differences combined with ethnographical accounts reveals interesting patterns mainly related to intrinsic motivation and external regulation (as per Ryan & Deci, 2000) in creating new spaces for game-based teaching practice.

Here, we zoom in on an underprivileged school, where the implementation appears to have been especially successful in order to identify key routes to impact. We also discuss the methodological challenges to assessing the effects of multilayer interventions, and we hope to have demonstrated that these and other methodological limits can be somewhat mitigated using mixed methods.

### The Four Schools

The four schools were spread out across Denmark, but were all situated in or close to larger cities. None of the teachers who participated in the intervention had prior experience with multiplayer games in their classrooms.

The four schools got involved with the project for different reasons, so some differences between them were related to the degree of commitment invested by the school management, support from colleagues who already advocated games, and the overall interest of the project teachers in using the "school at play" method.

The *Inner City School* (37 students, third and fifth grade, 20 female) was situated in a poor area with a high concentration of immigrant students. The school management at Inner City was eager to be involved in order to explore new methods that might help include their high rate of at-risk students. The teachers were at first reluctant to participate, and even experienced severe breakdowns in the process, but after diligent support by management, they experienced positive effects on their students, which led to great enthusiasm. In the end, the teachers continued to use games after the intervention.

*The Mixed Urban School* district overlapped a high-income area and some poorer immigrant blocks (44 students, fourth and fifth grade, 24 female). Management did not display strong commitment, and participation in this intervention was mainly seen as one project among many. This negatively influenced the teachers' relation to the project.

*Suburban Schools 1* and *2* were quite similar in their locations and middle-class demographics. Suburban School 1 (55 students, fifth grade, 26 female) wanted to participate in the project as a way of trying out their new computers, but management did not pay much attention to the aims and results of the project, which made it difficult to continue the project at this school. On the contrary, both management and teachers at Suburban School 2 (55 students, fifth grade, 28 female) were highly interested in the project, mainly because of other teachers who advocated games at the school and could share positive experiences, but also align expectations, in their classes.

## The Intervention

The school at play intervention departs in the core idea of using a selected video game as a linchpin for social activities and themed classwork, while also instituting a gaming "tone" into the overall classroom experience through metaphors such as quests, progress bars, and levels. This mirrors the ambitions for some high-school esports programs (Lieberoth et al., 2018). Its methodology was conceived by a duo of special education teachers, who would later found a consultancy based on their experiences and tools and apply for funding to expand the technique into normal classrooms, with us as research partners. Sixteen teachers were introduced to the method though two rounds of four one-day courses, with eight teachers in each round. The teachers were given templates to customize classroom tools, and they were actively involved in building curriculum assignments around the themes and mechanisms of a chosen game. Since the intervention was developed in the context of special education, a significant strand of our research, as well as the intervention activities, centered on the promise of creating inclusion opportunities for at-risk students as much as on reframing curriculum activities for everyone.

### *Torchlight II* and Game-Related Assignments

The school at play method uses digital games off the shelf to create contexts for collaboration and learning, as students explore themes, mechanics, and strategies, and connects these to curriculum elements (in this case within math or Danish classes) that may grant advantages in-game. For instance, equations, percentages, and fractals are explored in *Torchlight II* through math assignments related to *time* to swing a weapon and the amounts of *damage* dealt by each swing, relative to an enemy's total life points (for an example, see Figure 1). Through this mapping of math onto gameplay, students may discover more efficient in-game attack combinations. Similarly, students wrote guides to the game for other players in Danish. The hope is that in doing these exercises, students come to identify more with the usefulness of math or clear writing in their real (gaming) lives (see Figure 2). After the *Torchlight II* experience, teachers tried implementing games of their own choosing for a few weeks. In the considerations below, we will focus on an inner-city school where the teachers tried their hand with *Minecraft*.

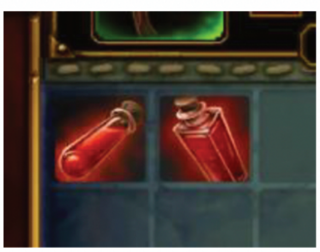
| | |
|---|---|
|  | A Health Potion gives 900 health within 8 seconds. A Big Health Potion gives 1.800 within the same time span.<br>How much health pr. second do you get from 1 Health Potion?<br><br>How much health pr. second do you get from 1 Big Health Potion?<br><br>Imagine that you are running away from a group of skeletons and have 200 out of 500 health. Which potion do you drink? Why? |

*Figure 1. Math assignment for Torchlight II.*

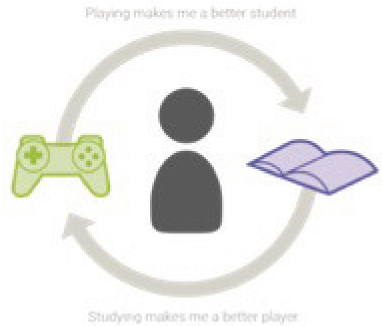



*Figure 2. The loop between game activities and curricular activities envisioned by the intervention's originators.*

Classroom Gamification

To support the overall process, wall charts and gamification activities are used during lessons. Students, for instance, move their names on a *progress bar* as they solve assignments, with the additional option of progressing up to 150%. Higher- and lower-performing students are given differentiated challenges to ensure equal progress for the same amount of effort. Another "classroom game" aims at classroom conduct by making specific social *virtues* visible and rewarding related behaviors with points, of which the cohort can then be traded in for shared benefits (e.g., more game time, finishing up early to play outside, etc.).

Summing up, the goal of the school at play intervention is to create new social spaces and playfully facilitate student identification with social virtues of conduct, teamwork, and inclusion, and the goals of school subjects. As researchers, we did lend support to designing the training process that would allow teachers to adapt the method. This development perspective gave the whole process a twist of design-based research and action research, as we were automatically viewed as representatives of the method when training teachers and doing field observations. A core tenet was, however, to keep the intervention similar across schools.

## Previously Reported Results of the Intervention

The intervention was studied using both qualitative and quantitative methods, at various points zooming in on students, teachers, the training of teachers, and subgroups of students. This left a large and rich pool of data that could not easily be collated into a single analysis. The process had the traits of a parallel mixed-methods intervention design (Creswell, 2013; Creswell & Plano Clark, 2011).[1] Still, some strands of the data became separate bracketed components, which have yet to be integrated into the overall evaluation story as of this writing.

After a brief summary of initial results, we report statistical between-schools differences. We measured effects of the intervention using both teacher assessments and the children's perceived locus of causality

1. Maxwell and colleagues (2015) emphasize that descriptive models of mixed-methods designs often become useful only at the end of the process, when the different data strands have fully materialized.

scale (C-PLOC), which assesses five different motivational dimensions, including intrinsic motivation, identification with the value of the learning activity, and external pressure to participate.

Elsewhere (Hanghøj et al., 2018), we have reported on the fairly complex pattern of individual change seen in the 190 students, as well as unique patterns for students identified as being at risk. By way of summary, FDR-corrected ANOVAs (see Figure 3) revealed changes on most variables, which included clear differences between patterns for students' motivation for Danish and math: Of desirable effects, we might mention that general *participation/thriving* rose, while *amotivation* for Danish class and *external* regulation for math fell. On the other hand, intrinsic motivation and identified regulation also dropped. In contrast to simplistic notions that "games make learning fun, and fun makes learning better," the pattern revealed here is complex. Bidirectional findings and differences between c-PLOC variables such as intrinsic and identified regulation for Danish and math show that motivation to participate cannot easily be reduced to one factor, and that it can be tough to pick up such complexities with quantitative measures alone.[2]

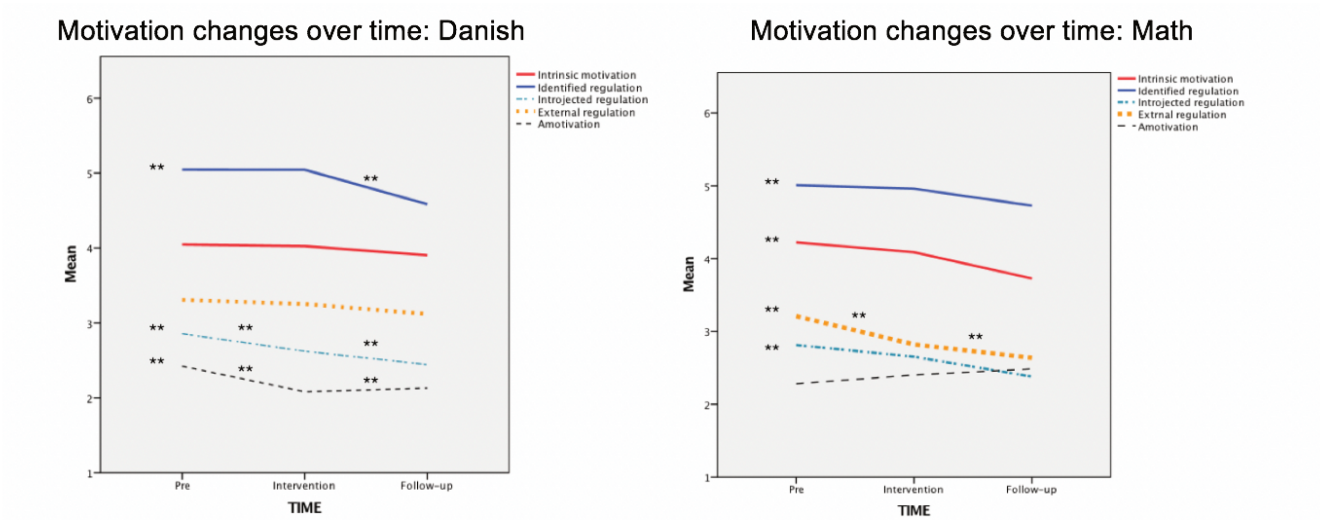



*Figure 3. C-PLOC motivations over time: ** p < .01 change between two time points; ** at the beginning of the line denotes change from pretest to posttest.*

## New Hypotheses

One school experienced substantial disruptions, including technical issues and a teacher's being replaced midintervention, which led us to expect that the integration between game and subjects (Danish/math) was weaker, and that (H1) motivational impact toward the school subjects as experienced though the game would probably be less here compared to the other schools. Second, we wanted to know to what extent between-schools differences affected the overall over-time results previously reported (Hanghøj et al., 2018). We expected that significant between-schools differences during the implementation would also affect long-term outcomes (H2).

After this traditional hypothesis testing, we adopt an explanatory analytic approach (Creswell & Plano Clark, 2011), using our field knowledge of practical and social between-schools differences to also understand between-schools differences found in statistical results. Zooming in especially on the Inner

2. The first analysis of the data did not use school as a multilevel factor, as the data set contains too few observations for reliable multilevel analysis, and because our fist publication focused on selective effects on at-risk students compared to their peers.

City School, this brief mixed-methods analysis will be an expansive and strand-challenging reflection on the process as a whole (Greene, 2007; Maxwell, Chmiel, & Rogers, 2015).

## Between-Schools Statistics

In order to identify differences between schools as the intervention unfolded, a one-way MANOVA compared the four schools on the c-PLOC scales. The multivariate test showed significant between-school differences: Pillai's Trace = .31, $F$ (30, 474) = 1.83, $p < .01$, $\eta_p{}^2 = .10$ during the intervention. Univariate analyses revealed that the significant between-schools differences were to be found in two places: on the *intrinsic motivation* subscale for *both* mother-tongue education—$F$ (3, 166) = 8.33, $p < .01$, $\eta_p{}^2 = .13$—and math—$F$ (3.66) = 5.44, p < .01, $\eta_p{}^2 = .09$—and on *external regulation* for math—$F$ (3, 166) = 14, 45, $p = .04$, $\eta_p{}^2 = .10$. No effects were found for the remaining three c-PLOC subscales (see Figure 4).

The Bonferroni post-hoc test revealed that the differences in *intrinsic motivation* were to be found between one school and two others ($p < .01$). We expected that the Mixed City School would fall below the others because of difficulties during the implementation of the intervention. This hypothesis (H1), however, was not confirmed. Instead, the Inner City School scored significantly over ($M$ = 4.78, $SD$ = .19) the two suburban schools ($M$ = 3.75, $SD$ = .16 and $M$ = 3.65, $SD$ = .16). The Bonferroni test did not reveal a significant difference on *external regulation* between any specific schools, however. As can be seen in Figure 4, this might be due to a pattern where pairs of schools (one urban and one suburban) cluster very closely.

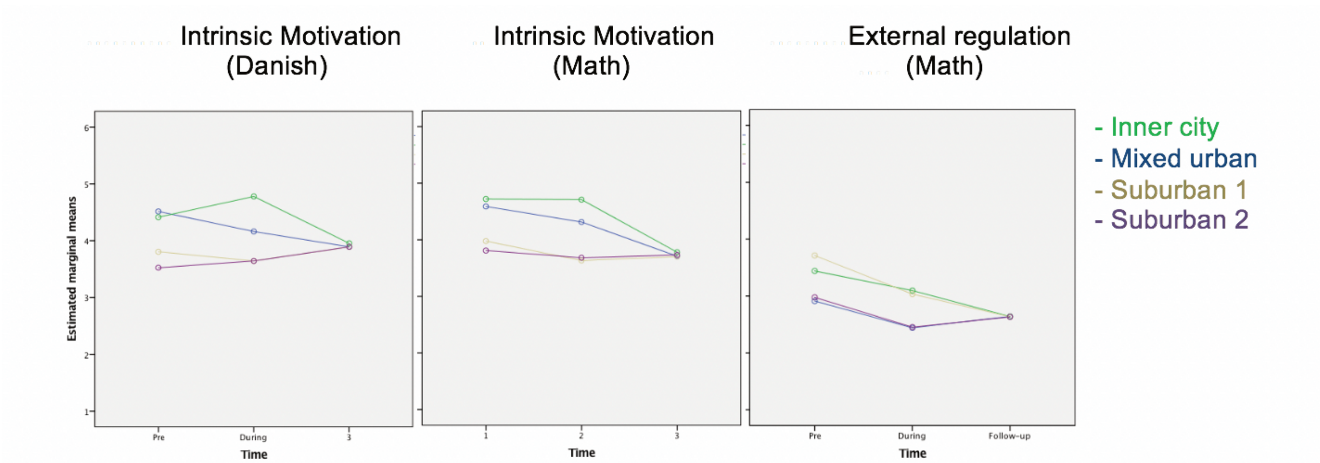



*Figure 4. Different change over time for each school on c-PLOC motivation variables.*

Next, we examined whether observed between-schools differences were also visible in change from before to after the intervention (see the Previously Reported Results section).[3] For *Danish* the interaction between school and intrinsic motivation, $F$ (6, 270) = 6.29, $p < .001$, $\eta_p{}^2 = .12$, accounted for a small but significant part of the observed variance, which rendered the change first observed over time nonsignificant: $F$ (2, 270) = 2.02, $p = .14$, $\eta_p{}^2 = .02$. For *math* the interaction between school and intrinsic motivation was also significant, $F$ (5.88, 264) = 3.91, $p = .001$, $\eta_p{}^2 = .08$., but the change over time remained significant, $F$ (1.89, 264) = 15.39, $p < .001$, $\eta_p{}^2 = .10$ (both Hynh-Feldt corrected), with the interaction accounting for a slightly smaller proportion of the variance than the main effect of time.

3. See note 2.

Finally, for extrinsic motivation (math) no interaction effect for school was discovered, $F$ (6, 264) = 1.61, $p$ = .11, $\eta_p^2$ = .04, and so the effect over time remained significant: $F$ (6, 264) = 14.59, $p$ < .001, $\eta_p^2$ = .11.

In summary, differences between schools were visible in terms of student *intrinsic motivation* and *extrinsic pressure*, confirming H2, and going some way toward explaining the psychological impact of the intervention over time. The most positive general effect of the intervention would seem to be a lessened feeling of being forced into participating through outside pressure, whereas intrinsic motivation for Danish varied significantly by school. Notably, the Inner City School stands out as a success in terms of motivational effects.

## Explanatory Ethnography

The process of mixed-methods analysis often involves a conversation between lenses, with one set of initial results, resulting in queries into other types of data. In this case, the statistical analyses left the question: What made the Inner City School special?

Statistical examination of differences between the schools did not confirm the hypothesis that motivation levels for students in the Mixed City School would be significantly worse than in the other locations because of its botched implementation. Indeed, the school did not figure as significantly different from any of the other three schools, revealing that the tumult surrounding the introduction of a new teacher who had not been trained on the intervention method had not rubbed off on the students' engagement with the games and curriculum assignments in a statistically discernable way—at least when looking at c-PLOC scores. If anything, this reveals that the "fun" component of game-infused learning environments can be retained regardless of teacher training, and that any teacher can jump into a game-based teaching regimen if it is clearly structured and he or she has basic skills.

The statistical analysis indicated that students in the Inner City School experienced a significantly higher degree of intrinsic motivation during the intervention than did the other schools. Students also reported high degrees of intrinsic motivation to begin with, which is puzzling, as the teachers report difficulties pertaining to learning and conduct alike in these classrooms. This challenges (as per Greene, 2007) the reliability of the c-PLOC instrument somewhat: Could it be that students simply overreported intrinsic motivation, or was there a genuine surge of engagement? Or could it be that the younger third-grade classrooms or relatively more disadvantaged students simply found the intervention more appealing? Based on teacher interviews as well as observations, it was clear that the Inner City School *did* experience stronger positive effects of the intervention than the other schools. When interviewed, teachers emphasized several positive changes for the at-risk students in relation to using commercial games, gamification, and game-related assignments. As one teacher remarked: "I can feel that the students are much more excited when writing their game guide. Normally, they don't write much, when writing nonfiction. But here they wrote loads and loads in a very short time."

The teachers at the Inner City School emphasized how students benefited from the classroom game. Two teachers of the third grade mentioned several examples of how boys became motivated by being awarded tokens for positive behavior. As an example, one of the at-risk students, who often displayed impatience and aggression, had been so motivated by the tokens that he had told his mother that the project had made him turn from "hating school" to "loving school." The two teachers had at first been very reluctant to use the classroom game, which they viewed as a behavioristic "dog training" (as e.g., voiced by Kohn, 1999), but after they began using the tool, they experienced a more positive mood in class, which also meant that they “did not have to shout” at the students.

The teachers also described how the use of *Minecraft* and *Torchlight II* allowed at-risk students to take on new roles in terms of helping others, asking for help, and being seen as “experts.” The teachers’ observations of positive changes with computer games were mostly related to the boys, but a teacher also mentioned how some of the girls experienced positive effects. As an example, one girl, who was diagnosed with dyslexia, become very engaged not only in playing *Torchlight II*, but also in writing a lengthy guide for the game in Danish, which was addressed at other potential players. This aspect of engaging the at-risk students in curricular activities through game-related assignments is further elaborated elsewhere (Hanghøj, 2017).

In the end, the teachers at the Inner City School became so fond of working with games that they went on to design their own game modules involving *Pokémon GO, Hearthstone,* and board game design. This suggests that interventions such as the school at play approach may provide the most value where they can make the most difference for at-risk students, who generally have low intrinsic motivation working with the school subjects.

## Discussion

In our first analysis, we found the impact of the school at play intervention to be fairly complex, because it operates on multiple levels: the curricular, the social, and the behavioral. In our first dissemination we unpacked some of this complexity by looking at at-risk students. In the present analysis, we focused on observations of what made each school different. In summary, we see evidence for the same general conclusion in both studies: Reconfiguring school experiences with an array of game elements appears to *most strongly benefit those who otherwise struggle to participate* through a combination of social repositioning and clear new modes of interacting with classmates, teachers, and curriculum. This is the case whether discussing effects at the individual level or the between-schools level. However, we also diagnosed factors that mediate effect:

First, our analysis illustrates how there is no one-size-fits-all solution, and how the successes and problems in each iteration of the same game implementation may depend on factors including age group and whether behavioral, social, or curricular needs are an issue to begin with. Second, the role of leadership backing, as well as the benefits of having other more experienced game teachers available as models and allies, illustrates the benefits of a supportive climate.Third, based on this comparison between schools, we find evidence that different elements of an intervention may become the main springboards for successful implementation in different classrooms. Specifically for our case, this also suggests that the school at play method, which emerged from special needs education, may have had the strongest impact in schools with poorer or younger students who displayed more conduct difficulties but also responded well to simple gamification incentives. Finally, and perhaps most important to the self-determination theory (SDT) framework, the successful case of the inner-city implementation shows that teachers as much as students are motivated by the experience of immediately positive outcomes. As it were, the bar for improvement at this school was low, but after initial pushback, the teachers were among the most dedicated. There were clear signs of learning in all schools (Hanghøj, 2017; Hanghøj et al., 2018), yet changes in terms of conduct and engagement were also most prevalent in the Inner City School—changes that appear to, in turn, have been necessary for *learning* opportunities with games to arise in a positive space for the teachers to ply their craft.

It is puzzling that no effect was found for internalized regulation, which should basically have hinted at the students' identification with the usefulness and meaningfulness of the game-related curriculum assignments. As such, it may be that the school at play intervention's main strength is to motivate and socially reposition students, or simply that the c-PLOC failed to pick up the learning dimension. Indeed, all c-PLOC registers is the students' subjective impression of how the implementation felt, not what it actually did to them. Given how much information was gleaned from observations and interviews, we wish to make the case for more mixed-method work and analysis aimed at understanding *what we study* when we study game-based interventions at scale.

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# Is Making All About Tinkering?

## A Case Study of High School Students' Activities in Biomaker Workshops

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**Abstract:** Most research on K-12 educational making has focused on tinkering with tangible and digital materials and processes within STEM disciplines such as computing and engineering. Despite the growing fields of bioengineering and synthetic biology, far fewer studies have explored educational making possibilities in these realms. In this study we explore students' engagement with biomaking, in which people can make new materials and artifacts by genetically manipulating microorganisms. We examined 34 high school students' experiences and reflections on making biologos by growing color pigments and making biosensors by creating fluorescent reactions. Through observations of workshop interactions and focus group interviews, we found that biomaking primarily engages students with assembly, or step-by-step, processes rather than experimentation or tinkering with materials. In the discussion we address the potentials and affordances of assembly practices in promoting rich learning experiences not just in biomaking, but also in other K-12 maker contexts.

## Introduction

The growth of the maker movement during the last decade has engaged children and adults as makers inside and outside of school around the globe (Dougherty, 2013; Peppler, Halverson, & Kafai, 2016a, 2016b). Much research has focused on developing and researching the affordances of construction kits and tools that facilitate the making of digital, tangible, or hybrid artifacts (Blikstein, 2015; Resnick & Silverman, 2005), which vary from personal robots and drones to online games and animated movies. It is only recently that the maker movement has expanded into the fields of bioengineering and synthetic biology, in which people engineer bacteria and use them as tools for designing applications by generating novel outcomes that are not normally found in nature, varying from lab-grown leather (Modern Meadow) to mushroom-based building bricks (Ecovative).

Making with biology, however, is quite distinct from making with electronics or craft materials in several ways. First, biological processes are irreversible and do not involve reconfigurable and replaceable solid parts. Biology outcomes are not immediately apparent or visible because it often takes hours or days for growth. Likewise, biomaking is not as customizable or personalizable as electronic and craft making because of lack of ready-to-use construction kits on the market. Finally, most biologically designed materials cannot be used directly by makers because of government regulations. These particular constraints therefore challenge many of the insights that have been gained in previous research on educational making, which considers the quality of hands-on activities—in particular tinkerability—as key to generating interest and motivating learning (e.g., Blikstein, 2013; Martinez & Stager, 2013). This difference is further highlighted by the centrality of assembly, or step-by-step, practices within biomaking. Within the maker movement, tinkering is often foregrounded above assembly, since it seemingly goes against constructionist learning by requiring rote repetition rather than experimentation (Resnick & Rosenbaum, 2013). For many forms of making, however, it is important to master the craft and skill required for assembly before participating in productive tinkering. With this in mind, we therefore consider how assembly and tinkering are equally important in considering the depth of making at large.

In this paper, we present our educational efforts in biomaking, paying attention to opportunities and challenges for assembly and tinkering. Within our classroom-based workshops, students manipulated single-cell organisms (bacteria) to produce a desired product such as color pigments or fluorescence and then developed applications for these products, including a bacteria-painted logo (biologo) or a glowing water sensor (biosensor). We analyzed our classroom observations and focus groups interviews in order to address the following questions. In what ways could assembly-focused practices be considered a maker activity? What role does assembly play in helping novices learn skills and an understanding of materiality? In the discussion, we consider how the answers to these questions help to expand current definitions of making with an eye to how both tinkering and assembly approaches can create opportunities for greater learning and growth.

## Background

*Tinkering* is often considered one of the central features of educational making and describes how people mess around with different materials for the purposes of experimentation and play (Honey & Kanter, 2013; Resnick & Rosenbaum, 2013). Rather than proceeding from a top-down set of instructions, construction here is built upon bottom-up modifications that unfold over time. Here, makers learn through the process of “bricolage” (Turkle & Papert, 1992), or ongoing negotiations with materials and contexts, rather than rote, logical procedures and practices. In order for one to tinker, a few factors are usually required. First, one needs to have modular elements that can easily be moved around and changed in order to produce new outcomes (Resnick & Silverman, 2005). Second, the feedback of these changes must be discernible in some way, whether through sight, sound, or otherwise (Resnick & Rosenbaum, 2013). And finally, tinkering requires enough knowledge to guess how changes to elements in an artifact may affect the outcomes. One might not know the exact outcomes but one should have or work to develop a sense of what might happen through these modifications. Thus, a project made through tinkering requires sophisticated knowledge and understanding of the processes.

While tinkering is often touted as the gold standard of making, we argue that the act of assembly—or engagement with predetermined step-by-step processes—is just as important. Far from unusual, this approach can be seen in a range of related maker contexts, whether in craft practices such as carpentry and sewing, or skilled trade work such as plumbing and welding (Rose, 2004). Here, the act of becoming more skilled over time often requires following existing routines and procedures in order to become more familiar with tools, materials, and practices—for example, following a sewing pattern to tailor a shirt or using a checklist to diagnose a plumbing issue. Only through repeated practice can one acquire this database of “tactile knowledge” that allows one to eventually become an expert within a field. Indeed, this assembly approach might be seen as the foundation of apprenticeships, in which beginners are coached through a series of highly delineated activities—modeled and scaffolded by some authority—along the way toward becoming a competent creator (Collins, Brown, & Newman, 1988; Lave 1988).

Likewise, assembly is often an essential entry point in the maker movement, since it is how people can gain the basic skills or knowledge they need in order to later create things of their volition. This can be seen within most commercial maker kits—for example, an air-rocket construction kit or a *Star Wars* Lego kit that contains clearly defined directions. Consider the creation of a circuit diagram when making a robot; there are predetermined rules for how components need to connect to yield a desired result. Similarly, in using maker tools such as a 3D printer or a laser cutter, there are diverse projects one can create with these objects, but there are still particular rules and protocols governing how these are appropriately used. Following directions therefore allows one with little to no skill or knowledge to jump into producing an artifact. While some have argued that such assembly can become a rote practice that does not support rich cognitive engagement (Blikstein, 2013; Espinoza, 2011), we consider how assembly approaches still lead to rich experiences that support becoming an efficient maker.

## Methods

We implemented two consecutive biomaking workshops to high school students in two STEM-elective courses in a public charter school in a Northeastern city in the United States. Participants were 16 juniors and 18 seniors, among whom 55% of students self-identified as White, 24% Black, 9% other, 6% Latino/a, and 6% Asian. In terms of gender, 76% of students self-identified as female and 24% as male. The participating teacher at the charter school (a trained biologist) and two lab technicians led the workshops. Students were arranged in groups with two to five students. Both groups (juniors and sensors) participated in both workshops.

Our research team (including researchers, biologists, and designers) worked with the classroom teacher to develop the two biomaker workshops. Each workshop focused on the creation of a different product (see Figure 1). In the first workshop (biologo), students first designed a team logo and then created three different forms of the logo using bacteria-created pigments. These included a 3D logo where the pigment was encapsulated into shapes using sodium alginate, and two 2D logos painted on petri dishes using two different techniques (one using filter paper as a base, and one without). In the second workshop (biosensor), students learned about different environmental water detectors, and then re-created a version of these detectors using bacteria that glowed in response to arabinose (sugar) in water. Both workshops included a fabrication phase and an application phase. In the fabrication phase, students engaged with the process of bacterial transformation. This involved inserting foreign DNA into *E. coli* cells to produce a desired substance, whether colored pigment or glowing proteins. In the application phase, students used these substances to create final artifacts, whether the logo forms or the water sensor. Within both phases, students followed predesigned procedures, which were developed by our team. The biologo workshop lasted for four days, while the biosensor workshop lasted 8–10 days.

In order to answer our research questions regarding assembly and tinkering, we looked at the design and implementation of the biomaking workshops, as well as student reflections on these activities. For each day of the workshops, we videotaped instruction and activity sessions, wrote class observations (field notes), and photo documented artifacts. After both workshops, we held four separate focus groups (about 20 minutes each) with randomly chosen students (3–4 per group). Here, we asked students to reflect on their experiences creating the sensors and logos. Looking across the data, we identified where students had opportunities to engage with *assembling*—engagement with step-by-step directions in service of creating a final artifact, and *tinkering*—iterative, experimental engagements with physical materials and tools. We looked at where and why these opportunities arose (or did not), as well as student reflections and perceptions of these activities. We highlight some themes of the analysis below.

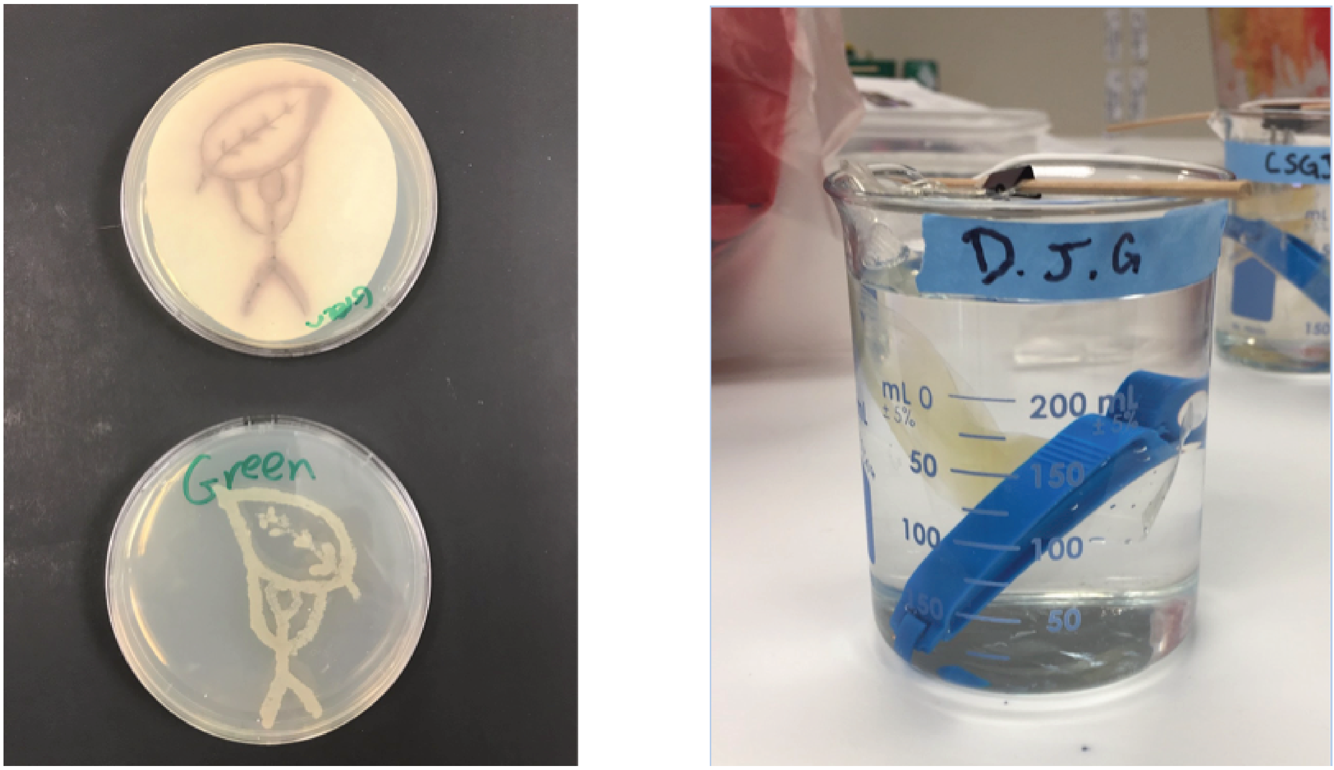


*Figure 1. (Left) different painted logo forms using bacteria pigments for the biologo activity; (right) water sensor using arabinose-detecting bacteria that glowed for the biosensor activity.*

## Findings

### Assembly in Biomaking

In our workshops, students had many opportunities to engage with biomaking assembly. One reason for this was the inherent nature of biomaking. First, dealing with living materials necessitates specialized procedures and environmental conditions (e.g., adding the appropriate level of nutrients and maintaining an ideal temperature for growth), and second, biological processes often require a long amount of time to see results (e.g., waiting 24 hours for bacteria to reproduce and deliver the desired substance). For this reason, it is often easier for biomakers to follow predetermined steps for known processes rather than allowing them to tinker from the start. For the fabrication phase of the workshop, students were engaged with known procedures of genetic transformation of bacteria that included: heat shocking and cooling the bacteria to open and close their pores for the new DNA to enter the cell, providing nutrients to the bacteria, and letting them incubate at a steady temperature for many hours to allow for growth and replication. In order to facilitate in-class results, our research team developed a lab protocol for students to follow. Steps were highly specific; for instance: “Incubate cuvette in warm water bath at 42ºC for 90 sec” and “Fit and twist syringe tip into cap and aspirate contents of cuvette. Keep pulling plunger until ~6mL line.” Interestingly, while our team had to tinker with lab procedures beforehand to develop this checklist, students were expected to follow these directions exactly in order to produce the desired result.

Despite the fact that students were not given freedom to play around with the material, they still gained a high amount of knowledge through this process. First, students acquired some amount of tactile ability with the different lab tools and materials, whether using a syringe to move liquids from place to place or the appropriate method of using a warm-water bath. Mostly, this was accomplished through hands-on engagement with the tools, as well as active guidance and scaffolding from our lab instructors. For example, while delivering the nutrients to their bacteria samples, several groups had trouble adding the prescribed amount of the nutrient Lysogeny "L" broth (1 ml) into the cuvette (a container that held the bacteria). Our instructional team helped with this process by premeasuring the appropriate amount of broth (once they realized that students had difficulty with this) and also giving them tips for how to collaborate with the tools (e.g., "How about one person holds the cuvette and the other uses the syringe [this way]?") (see Figure 2, left) (field notes, 2/6/2017). By the second workshop, we observed that students were more comfortable with the procedures and tools, often moving through the steps independently without much support (field notes, 3/13/2017). This is not a trivial matter considering the important role of physical craft—that is, knowing how to handle or use different laboratory tools and materials efficiently and appropriately—in becoming a competent bench scientist.

Through guided assembly, students also gained a greater understanding of biological processes underlying the given procedure. This was supported through our instructional team, who not only modeled each step to students, but also simultaneously explained the reasoning behind these steps. Because students were going through these preordered actions together, they had opportunities to talk about these processes at greater length. For example, during the step of inserting the L broth, students had several conversations with the instructors about why this was necessary, something that led to jokes about making the bacteria "happy" and "comfortable" by feeding them something like "chicken cutlets" and "hamburgers" (field notes, 2/6/17, 2/7/17). Sometimes this extra conversation was even used as a basis for changing how students engaged with the materials. During the biologo workshop, two groups talked with the instructor about the purpose of the warm-water bath, which allowed "pores" of the bacteria to open up to allow for the intake of the new DNA. After hearing this, one team member noticed that her cuvette was not fully submerged and modified how it was sitting within the flotation device so that all of the bacteria would be appropriately warmed (field notes, 2/6/2017). Throughout the workshop and in focus groups, students referred back to this idea of feeding the bacteria and opening its pores, therefore illustrating how their ongoing conversation reinforced the concepts behind the process. From this perspective, students' engagement with assembly practice was a useful scaffold in helping them to become effective at biomaking, which relies heavily upon understanding and implementing prescribed procedures of biological lab work. Through gaining tactile knowledge of how to use tools and equipment in tandem with knowledge about why and when to use these techniques, the students were therefore on the road to become more efficient and effective biomakers.

*Figure 2. (Left) two students collaborate on how to use a cuvette and syringe after being given guidance from the instructor; (middle) figuring out where to clip the dialysis bag to suspend the bacteria in the "mystery" solution; (right) painting logo with bacteria on filter paper (right).*

### Tinkering in Biomaking

Though students did not have opportunities to tinker in the fabrication phase, they had slightly more freedom to play with materials during the application phase. In this phase, students built artifacts using the products they grew out of their genetic transformations. In the biosensor workshop, students were given dialysis tubing, wooden sticks, plastic clamps, and binder clips to build a water detector that would glow in the presence of arabinose in a "mystery" beaker of water (see Figure 1, right). While students were given a list of directions for building this device, their physical interactions with these materials were less determined than in the fabrication phase. Again, this was supported through instruction. After being given the dialysis bags, groups were asked to clip them to create a little container to hold for the transformed bacteria. Different groups chose to clip their bags in different spots (e.g., toward the bottom, toward the middle). When they asked about which method was best, our instructor replied: "I guess we'll see," thus trying to make clear the experimental nature of the process. When they continued to ask for clarification about other steps, the instructor did not direct them on what to do, but instead explained what the purpose of the step was such that students could make their own decisions. For instance, after clipping her bag, one student asked how she should attach this device to the stick when suspending it in water (see Figure 2, middle). The instructor explained that it was important for the bacteria to be entirely submerged in the water to react to the arabinose. Based on this comment, the student worked on her own to calibrate the right height of the bag such that it would be appropriately covered and so she could see it clearly during the next phase of the project (field notes, 3/15/17).

Within the biologo workshop, there was even more variation on how students dealt with materials. Partially, this was due to the fact that students were purposefully asked to work on three versions of their logos using different techniques. Two of these logos were flat designs that involved "painting" with bacteria on petri dishes either directly onto nutrient agar or on filter paper placed on top. The third logo was three-dimensional. This required encapsulating the transformed bacteria into sodium alginate shapes (a gelatinous substance often used in cooking), which were then kept in place using hot glue gun outlines. Unlike the fabrication phase, in which steps were highly delineated, how students dealt with these materials differed according to preference. For instance, when trying to figure out how to "paint" on the filter paper, different groups used different techniques, including: (a) attempting to "free" draw their logo onto the filter paper without any physical guides, (b) tracing the logo off their predrawn designs by placing them underneath the petri dish, and (c) drawing in pencil on the filter paper and redrawing this image with the bacteria (see Figure 2, right; field notes, 2/2/2017). Other moments of tinkering that occurred involved figuring out the actual tools for painting (using a Q-tip or an inoculation loop), and how to create the most effective hot glue gun outlines for the 3D logo. While some students used the hot glue gun to trace around each drawn line of their logos, others completely redesigned their images in order to make them into solid silhouettes that were easier to outline (field notes, 2/8/2017).

Despite the fact that students were experimenting with different ways of interacting with the materials during the application phase, it is arguable whether this activity could count as a legitimate form of tinkering. In tinkering, one important element to consider is how students iteratively engage with the materials based on feedback they receive as part of the process (Resnick & Rosenbaum, 2013). Here, the lack of immediate feedback from the process (because of the time required to actually see an outcome) makes it unclear how intentional students' modifications were. As one student noted: "I think the tracing over the bacteria at least for my part was kind of difficult, because it didn't really feel like I was doing anything when I did it" (Dino).[1] Because it would take another 48 hours of growth before there would be a large enough concentration of bacteria to be able to see the color, students could not see how well their individual tinkering influenced the final outcome. This was true about all the other modifications that students made; where they clipped their dialysis bags or whether or not they used pencil on filter paper was usually less a matter of trying to shape their projects' outcomes than what was easier or more comfortable to them at the time.

### Reflections on Assembly and Tinkering in Biomaking

In the focus groups, students reflected about their experience with assembly and tinkering. About the entire process, students reinforced that they had primarily engaged with the assembly making. About making the biologos, James stated, "There were directions and we followed them," with Yoana and Giovanni, respectively, describing these processes as "straightforward" and "just … follow[ing] the rules." In general, students liked having these directions available to them, stating that that made the process more accessible, especially considering that this was an unfamiliar context and their "first time actually experiencing something like this" (Laila). About the benefits of having directions, Caroline further added: "The thing we did … on the second day where we heat the bacteria and then we froze them. It was pretty cool just because it was easy and I understood it."

Laila further explained that it is difficult to tinker in an unfamiliar context: "I follow [directions] very well but I can't adapt myself with [the] little bit [we experienced of] such stuff." As Yoana stated, this difficulty of tinkering was further pushed by not knowing what the outcome of these projects was supposed to be: "We didn't really—we knew what the color should have turned out [to be], but we didn't know how much of it would grow, like exactly what to expect." Thus, one big reason having directions was helpful was in getting actual results, that is, actual color or a glowing biosensor. This is true especially considering the limited time in the classroom, as well as students' limited knowledge and prior experience with these processes. Giovanni, for instance, describes the moment of having a working result: "It worked … and I was like, I was really excited and wow, it's really interesting."

This does not mean, however, that students did not want more opportunities to tinker. Though we outlined steps for students to follow in order to produce successful results, a number of the projects within both workshops did not turn out as expected because of the unpredictability of living organisms

1. This and all following names are pseudonyms to protect confidentiality of participating students.

and growth processes. For instance, several of the different pigments that students created could not clearly be identified as the intended color (e.g., green, purple), and instead were nearly clear and/or nearly black. About this, Caroline stated:

> Well, I did the one where we had to build the wall with the hot glue and the agarose in it. So my plate didn't turn out the way I expected to. It's not green, I can't really see the design, and it's sad—it's disappointing to see it. But, I'm interested in finding out what I did wrong and why what happened happened and how I can fix it.

Similarly, Giovanni stated: "Two of [our logos] didn't work. So, that's our challenge I guess now to see how it would work and to fix them," whereas Yoana suggested adding more time to the workshop to aid in tinkering. From this perspective, the desire to tinker comes after gaining some basic knowledge and experience acquired through the assembly process. Even though biomaking does not naturally lend itself to tinkering in the same way that other more "typical" maker activities do (e.g., electronics, programming), there is still a need to incorporate tinkering into the activity as a way of engaging students authentically.

## Discussion

Our findings illustrate how biomaking can be considered a form of making but one that includes more assembly than tinkering practices. While tinkering is essential in developing greater expertise and understanding of a field, assembly is often a key first step in acquiring this ability over time within more traditional crafts or trades (Rose, 2004; Lave, 1988). With biomaking, the affordances of assembly as an entry point become even more prominent since producing viable outcomes in and of themselves requires some basic knowledge, time, and experience. Here, engagement with step-by-step processes can help students feel comfortable and successful within the unfamiliar context of biomaking—something demonstrated through our student reflections. Thus, while tinkering may work better at introducing novices to more familiar context such as electronics, gaming, or crafting, assembly might be a more ideal starting point for novel or new contexts such as biomaking.

That said, our findings also point toward the importance of increasing opportunities for tinkering. Following Resnick and Rosenbaum (2013), some important aspects of tinkerability are modularity of elements, as well as how easily people can receive feedback from their changes—factors that are less present in biomaking. One potential way of addressing this difficulty is to allow for simultaneous tinkering; in other words, have students create multiple iterations of a project at once and wait to see the outcomes for each of these iterations at the same time. In some respects, this is what we attempted to do with the biologo workshop in which students created three forms of their logo. In another version of this activity, it might be useful to be more explicit about how these multiple forms can be connected to tinkering. Another potential solution would be to focus more on tinkering in the application rather than fabrication phase. The latter—which includes genetic transformation—is a more rigid process and requires a greater depth of background and experience to modify. The application phase—when students actually construct artifacts using the biologically fabricated products—falls in line with more typical maker practices and therefore lends itself to greater amounts of in-the-moment modification. Adding tinkering here would involve giving students more opportunities to experiment in building their final artifacts. In the biosensor workshop, this might mean abandoning parts of the predetermined procedure (i.e., clamping the dialysis bag to the wooden stick using the binder clip In the prescribed manner) and instead providing a range of possible materials that students could use to create their own custom contraptions for suspending their transformed bacteria in arabinose water. Rather than abandoning opportunities for tinkering in biomaking altogether, we can therefore create small openings for experimentation *in between* the assembly approaches that are required for novices in this arena.

Our analyses of biomaking experiences and reflections revealed that making comes in many forms, materials, and processes. Only by giving students opportunities to engage with both assembling and tinkering can we begin to advocate for biomaking as a true form of making. However, this goes both ways—rather than privileging tinkering practices at large, researchers should consider how assembly approaches can supplement what students are already doing as makers, even in those areas of computing and crafting that tend to privilege experimentation and play. There, approaches that include mastery and skill through thoughtful and reflective repetition might also supplement the kind of learning that occurs through tinkering. Only by looking at the balance between these two approaches can we truly support young makers in gaining more mastery and expertise across diverse domains of creation.

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# Learning Projects in Glocal Networks

## The Emergence of a Formal and Informal Peer Culture

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**Abstract:** The digital age has provided new possibilities for the creation of glocal peer cultures that stretch beyond the boundaries of the immediate community. To better understand these opportunities in the school context, this study aims to examine the co-creation of an international learning ecosystem of 2 classes organized around a shared object of inquiry. The participants in this study were 1 Finnish 6th-grade class ($N$ = 17) and 1 American 7th–8th-grade class ($N$ = 16) who communicated through blogs and Skype. Using deductive content analysis on their transcribed Skype meetings, the students' digital artifacts, and a questionnaire, we aim to describe the learning ecosystem that emerged. The preliminary results of the study indicated that during the academic learning process, an informal peer culture started to emerge through students' mobile devices and applications such as Skype, FaceTime, and Snapchat. Conclusions are drawn about the hybrid ecosystem that connected friendship-driven, interest-driven, and expertise-oriented participation.

### Introduction

The digital age has provided new possibilities for learning. The youth of the digital era spend much time online, networking, searching, sharing, and creating information (Kafai & Peppler, 2011). This kind of networking allows youth to become active members of a variety of formal and informal glocal communities, thus preparing and supporting them in adapting to their role as lifelong learners (Jenkins, Ito, & boyd, 2016; Roth & Lee, 2004). Jenkins et al. (2016) characterize the three different forms of participation as *hanging out* (friendship-driven), *messing around* (interest-driven), and *geeking out* (expertise-oriented). According to previous research (Hietajärvi, Seppä, & Hakkarainen, 2017; Ito et al., 2010; Jenkins et al., 2016), the friendship-driven activities of hanging out are also linked to the notion of belonging to a community or group, whereas messing around is used for experimental and more interest-driven activities, and geeking out usually involves fewer students, thus meaning that their participatory activities are targeted toward more specialized knowledge.

Although connected learning networks may comprise experts, enthusiasts, family members, and peers (de Haan, Leander, Ünlüsoy, & Prinsen, 2014; Roth & Lee, 2004), recent research has shown that these communities are typically made up of friends or relatives—people whom the youngsters know and whom they are also in contact with when "offline" (de Haan et al., 2014; Hietajärvi et al., 2017). To develop the skills and ways of knowing needed in the 21st century, Ito and colleagues (2013) argue for the need for connected learning that allows school students to link their academic work with society, family, and community through interest-driven and inquiry-oriented activities. Furthermore, the students should also be supported in becoming globally competent citizens who can collaboratively solve wicked problems and improve the collective well-being of current and future generations (de Haan et al., 2014; Organisation for Economic Co-operation and Development [OECD], 2016). Consequently, teachers and educators face the challenge of developing networked practices that will arm students with these new kinds of mind-sets and competencies needed in modern society. To meet these challenges, this study aims to examine the co-creation of an international learning ecosystem of two school classes organized around a shared object of inquiry.

## Theoretical Background

The theoretical background of this study originates from Vygotsky's (1978) sociocultural perspective in which the learning activities are in connection with the surroundings, people, and tools mediating them. Given this insight, the learning ecosystem (see Figure 1) is understood as a participatory network that connects the subjects (the community participating in the activity), the object of their activity (the learning task), and the tools (for making, communicating, thinking), and resources as mediational means (digital, nondigital) (Liljeström, Enkenberg, & Pöllänen, 2013). As argued by Vartiainen (2014), through open-ended learning tasks, the students have the opportunity to connect with and use the afforded community, technology, and information resources in an interest-driven manner. As with activity systems (Engeström, 1987), the elements of the ecosystem are not static, but are continuously interacting with each other, through which they define the emerging connected learning system as a whole.

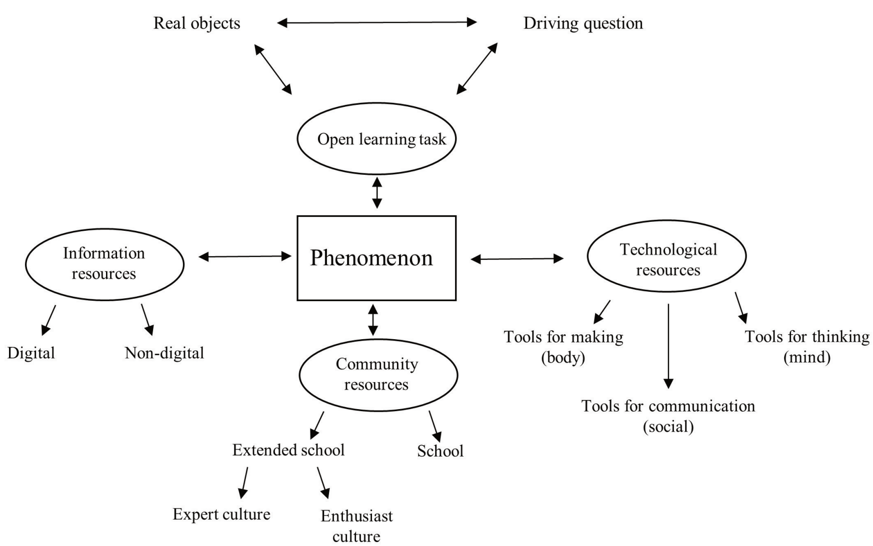


*Figure 1. Conceptual structure of the afforded learning ecosystem (Liljeström et al., 2013).*

In relation to the creation of the connected learning ecosystem, the learning activities should highlight the following principles (Vartiainen, Liljeström, & Enkenberg, 2012; Jenkins et al., 2016): (a) connecting learners in the pursuit of shared learning tasks (object); (b) connecting through diverse technological tools for producing, creating, and experimenting with peers (tools and resources); and (c) facilitating interest-driven participation in openly networked and generative communities (community). Accordingly, when the core pedagogical principles are actualized through the co-creation of an international learning ecosystem, novel learning activities and forms of participation are also likely to emerge.

## Method

The present work is part of a long-term design-based research (DBR; Design-Based Research Collective, 2003) study in which the aim is to develop international learning networks.

### Participants

The participants in this study were one sixth-grade class ($N$ = 17) from Finland together with their class teacher ($N$ = 1) and one seventh–eighth-grade class ($N$ = 16) from the United States together with their science teacher ($N$ = 1). The two classes formed peer groups and were required to (a) design, implement, and document a connected learning project, and (b) share their progress and findings with their peer classes. The language used during the learning activities was English.

This learning project was a part of normal learning activities in school and no additional ethical review was needed. We respected the participants' autonomy by seeking consent for both participation and publication from the students' guardians, and we have followed the ethical guidelines of the Finnish Advisory Board on Research Integrity (2012) during the research.

### Data Collection

During the project, three Skype meetings were organized and recorded. Two of these meetings were between the teachers and one meeting was between the peer classes. In all, the recorded data consisted of 101.57 minutes of conversation, equaling 55 pages of transcribed text (Arial 11, spacing 1.15) for analysis.

Both school classes had blogs where they reported their progress during the projects. These two learning blogs (consisting of text, video, and pictures) are also analyzed for this study and are used as supplementary data. This provided researchers with the opportunity to gain more information about the themes emerging in the Skype conversations.

Furthermore, students answered a questionnaire ($N$ = 29) at the end of the project. By using different data sources in the analysis, we aim at ensuring data triangulation (Patton, 1999).

### Data Analysis

In this qualitative study, we used deductive content analysis for analyzing data consisting of different formats (Mayring, 2000). In the first phase of the analysis, one researcher transcribed the recordings and became familiar with the data. In the second phase, the data were preliminarily analyzed through the framework represented in Figure 1 by one researcher. The aim was to preliminarily depict the main emerging elements (community, object, tools, and resources). The unit of analysis (Chi, 1997) in this study varied from single words to whole sentences describing an idea or suggestion. In the next phase, we continued the analysis by using two independent coders to analyze the emerging informal peer culture and to increase the reliability of the study (Burla et al., 2008; see Campbell, Quincy, Osserman, & Pedersen, 2013; Krippendorff, 2004).

## Preliminary Results

The preliminary results of this study reveal that both classes created a unique ecosystem that connected them through the shared learning task (see Figure 2).

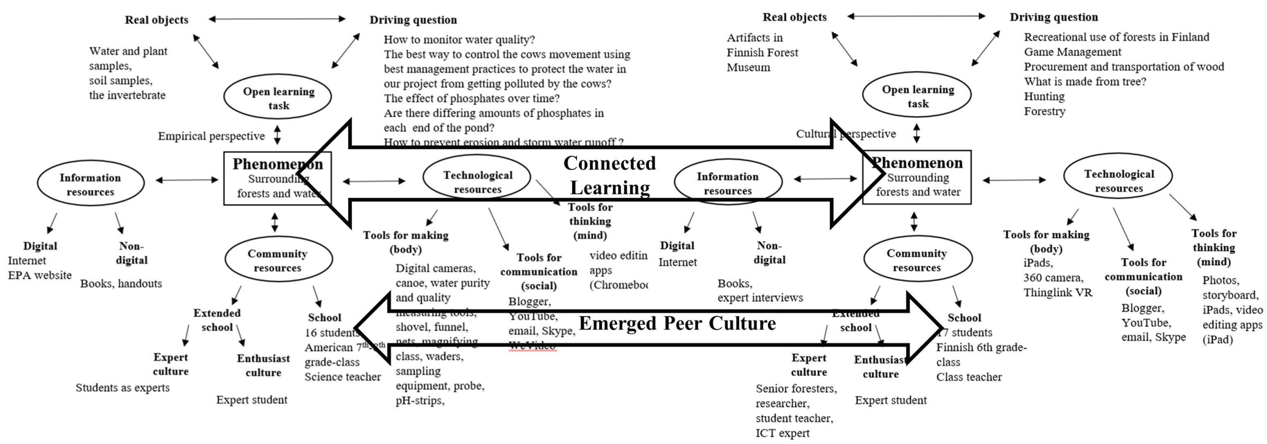


*Figure 2. Conceptual structure of the connected learning ecosystem based on Liljeström et al. (2013).*

The shared phenomenon of the peers' classes was the surrounding forests and water. The Finnish students focused on a cultural approach toward the recreational use of forests, game management, and the procurement and transportation of wood. The Finnish students studied real objects in a forest museum and used the expertise of senior foresters in solving their learning challenges. They also had the possibility of consulting an information and communications technology (ICT) expert and a researcher.

The American students were interested in developing experiments on water quality and soil samples. They collected and studied water and plant samples from a nearby pond, soil samples from a parking lot next to the pond and forest, and the invertebrates living in the pond. In the American school class, the students were acting as experts by presenting the empirical studies to their peers through educational videos.

Both school classes used multiple and diverse technological tools that can be divided into three further categories: tools for making (iPads, Chromebooks), tools for communication (Blogger, Skype), and tools for thinking (photos, video-editing apps). The information resources used by both peer groups during these projects were mainly digital (Internet), but nondigital resources were used as well (books, expert interviews).

The students created an academic peer culture through negotiating and sharing information on the project's progress and aims. In addition, the students began to connect with their international peers in their free time through mobile devices and applications such as Skype, FaceTime, and Snapchat.

## Conclusion

The aim of this study was to examine the co-creation of an international learning ecosystem of two school classes organized around a shared object of inquiry. The preliminary results of the study indicated the emergence of a hybrid ecosystem that connected friendship-driven, interest-driven, and academically oriented participation. Students' academically oriented participation was mediated through the use of various digital and non digital information resources, technologies, and expert tools for creating solutions to their own interest-driven questions. In addition, a friendship-driven peer culture started to emerge as the learners expanded their communication to their free time. Accordingly, it seems that the co-creation of international networks opens up the possibility for the emergence of glocal peer cultures that stretch beyond the boundaries of students' immediate community (c.f., de Haan et al., 2014; Hietajärvi et al., 2017). Furthermore, the students were supported in developing their skills in becoming globally competent and aware citizens who could use local networks and expertise to create solutions to globally relevant tasks (OECD, 2016). Likewise, teachers benefited from collaboration with their peers in co-designing connected learning practices that will enhance their skills and understanding needed in the increasingly globalized world.

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# Social Talk and Constructing Solutions

## Comparing a Teen and Proxy Player in an Educational Alternate Reality Game

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**Abstract:** An affordance of alternate reality games (ARGs) is that players play as if they were in the game world themselves. Human game-runners (proxy players) interact with participants as characters within the game's fiction, guiding and modeling gameplay. In this paper we employ a method of analyzing gameplay called epistemic network analysis (ENA), which creates relational network graphs between actions within a game space. We found that key players exhibited behavior like proxy players, but also diverged from them in meaningful ways. We present case studies of 1 active player and 1 proxy player that demonstrate the power of ENA to model ARG play. We describe ways in which ENA reinforced the design insights that guided our original creation of proxy players while also allowing us to analyze the implications of those design choices in practice. We conclude by enumerating some research and design benefits of employing ENA in other learning contexts.

### Introduction and Theoretical Framework

An alternate reality game (ARG) is a type of pervasive game that takes place across multiple media platforms, where players co-construct a narrative through play. ARGs often create a feeling of "this is not a game," where play is treated as if it were happening as a part of real life (Bonsignore et al., 2012). The complex and multilayered play experience of ARGs also requires collaborative problem solving (Bonsignore, Hansen, Kraus, Visconti, & Fraisat, 2016). These characteristics give ARGs unique power as a platform for meaningful and authentic learning that is directly situated in players' day-to-day lives (Bonsignore et al., 2013).

Drawing on a growing body of design literature, our team created an educational ARG called *DUST*, which ran in spring of 2015. To help ensure that our game remained authentic and meaningful to a target audience of teenagers (13–17 years old) who are traditionally underrepresented in STEM fields, we co-designed many of its elements with them, including the focus for this paper, the game's fictitious characters (Pellicone et al., 2017). In designing our characters, we drew upon the idea of a *proxy character*, referring to the intentional design of in-game characters "who interact with the player community as insiders and often, player role models and guides" (Bonsignore et al., 2016, p. 82).

In an ARG, a proxy player plays an invaluable role: serving as a guide, a model, and a friendly face to players who may be unaccustomed to the challenging gameplay offered by a new game genre (Bonsignore et al., 2016; Pellicone et al., 2017). A key design goal for *DUST* was to create proxy players who were effective at scaffolding scientific inquiry, but who also acted, looked, and talked like our teenage players (Pellicone et al., 2017).

A firm understanding of user roles is a valuable tool in the design of sociotechnical systems (Jahnke, 2010; Welser et al., 2011) and specifically within ARGs (Dena, 2008). A learning modeling methodology called epistemic network analysis (ENA) has been fruitfully employed in previous cases to understand activity within a specific epistemic domain by drawing connections between distinct discursive actions that comprise that domain, which is to say that domain's "epistemic frame," in a way that not only describes action, but also presents that action relationally in a network format. In ENA, actions are coded within an epistemic frame—meaning the set of beliefs, dispositions, and behaviors associated with a social practice. Through calculation of co-occurrences of codes, ENA results in a network model of a particular epistemic frame, where nodes (referred to as *projected points*) represent varying types of behavior within that frame (Shaffer & Ruis, 2017). Therefore, by evaluating DUST's gameplay with ENA we have the opportunity to understand the function of proxy players within a larger context of game activity. In this paper, we explore three related, guiding questions:

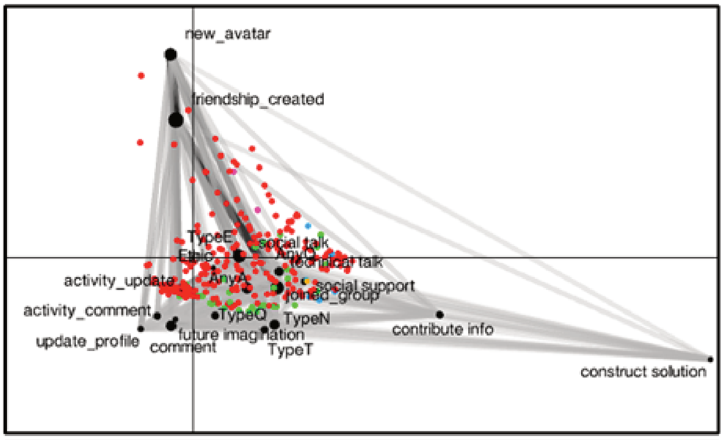
- How can ENA be used to identify and represent gameplay signatures of different types of players, and what do those signatures look like in *DUST*?
- How do proxy players designed to engage in specific epistemic practices compare to real players in terms of their gameplay signatures?
- What are the design implications of these similarities and differences?

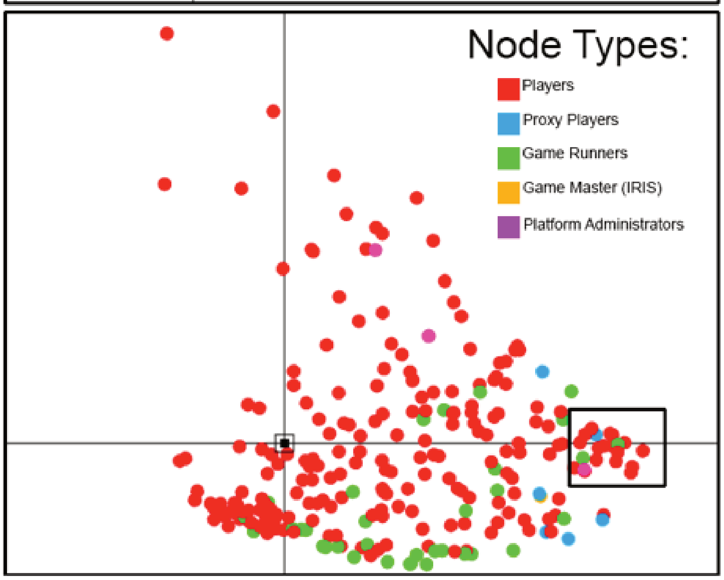
## Data Collection and Analysis Methods

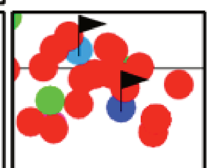
Our ENA was based on gameplay actions that were automatically recorded (e.g., friending a player; updating a profile; commenting), as well as "utterances" (i.e., a discursive gameplay unit showing up when players posted free-text) coded by authors 3, 7, and 8 into semantically meaningful categories (see Figure 1). These codes collectively represent a *scientizing epistemic frame*. *Scientizing* (Clegg & Kolodner, 2014) is the process by which young learners come to recognize that science is not just something that happens in the rarefied space of the research lab but is instead a compelling and vital part of everyday life. It thus subverts common cultural stereotypes about what counts as science, what science looks like, who does it, and where it takes place. We configured our unit of analysis to be the entire game—meaning that data is not chunked into episodes; rather, all gameplay activity is considered over the full course of the game (Siebert-Evenstone et al., 2016). Therefore, our resulting ENA graph (Figure 1) shows a broad, comprehensive view of gameplay. This approach gave us an exploratory snapshot of the overall structure of gameplay, revealing points of interest for deeper qualitative analysis (Rotman, Preece, He, & Druin et al, 2012) and also signaling future work that will include stanza-based ENA for more nuanced, in-depth readings of player interaction at key story beats.

***Right:*** A table of our codes describing the Scientizing epistemic frame for DUST's gameplay. Semantic codes were human coded, and database generated codes were derived from post types and automatically recorded entries regarding social activity.
***Below:*** The equiload graph of our network, showing the relative positions of each coded epistemic action.

| Semantic Codes: | Database Generated Codes: |
|---|---|
| **Questioning and Answering (AnyQ, AnyA)**: We coded posts that players made in the DUST game to signify whether the post posed questions or provided answers to key problems posed in the game. | **Type Q, T, E, N:** Posts on the Co-Lab website are categorized as Questions, Theories, Evidence, or Narrative. |
| **Technical Talk**: Posts that discussed technical solutions to problems (e.g., constructing a tool or using a tool to solve a game problem). | **Friendship Created:** A successful friend connection between two players through the social element of the site. |
| **Social Talk**: Talking socially about topics not directly related to gameplay. | **Joined Group:** Joining a work group on the site, e.g. Neurology or Astronomy. |
| **Social Support**: Providing coaching and encouragement to other players. | **New Avatar**: Changing one's avatar. |
| **Contribute Info**: Providing summaries or links to outside informational resources. | **Comment**: Commenting on a QTEN post. |
| **Ethics**: Discussing the ethical ramifications of action within the game. | **Activity Update:** Posting a status update to one's profile. |
| **Construct Solution**: Providing an answer or solution to a problem or obstacle in the game. | **Activity Comment**: Posting a reply to another player's status update. |
| **Future Imagination**: Imagining the future in terms of either the player's reality, or the fictive world of the game. | **Update Profile**: Updating any of the fields of a user's social profile. |



***Left:*** A view of each active player node in the game. We used this graph to understand player roles in terms of their relationship to discursive actions within the game, and used this graph as a guide to further qualitative understanding of player roles. The black box is the area shown in the zoomed in view above.
***Above:*** A zoomed in view of the qualitatively described 'constructing solutions' cluster, referring to the proximity of these players to the 'construct solutions' outlier node. Both CoolQuark (the darker dot) and Jay (the ligher dot) have been tagged with flags, indicating their relative positions, and proxminity to one another.

*Figure 1. A graphic showing (from top left to bottom right): the equiload graph of DUST's scientizing epistemic frame, a table of codes describing both semantic and automatically coded discursive actions, a graph showing only player-projected points color coded by type, and a zoomed-in view of the qualitatively defined Constructing Solutions cluster (named for its proximity to that particular outlier point).*

Using the graph above, we selected a cluster of players who were aligned toward the Constructing Solutions code on the graph (an outlier projected point in the lower right quadrant). This cluster of players had high levels of activity (allowing for rich qualitative data), had all agreed to interviews (allowing us to check our emerging assumptions against their own thoughts and experiences), and were co-located with one of our proxy player characters (fitting the theoretical concerns of our research questions). Because of the correlational method through which ENA graphs are constructed, proximity of points on a graph is indicative of similar aggregate approaches to gameplay (Schaffer & Ruis, 2017).

## *DUST*'s Design

*DUST*'s narrative revolves around an apocalyptic event in which nearly all adults on the planet have collapsed after a meteor shower that has spread an unknown substance throughout the atmosphere. Teen players must take charge, understand the circumstances of the collapse, and reverse its effects before they too succumb to the mysterious effects of The Collapse. Our proxy players were all teens present at Kennedy Space Center on a field trip before The Collapse, and who gained access to the data and specialized tools of the center. They were accompanied by IRIS, an artificial intelligence, who served a game-master role, helping tell the story, introduce scientific tools (web or mobile apps), and sets of activities for the week. Teen proxy players and real players shared information (text, images, videos), coordinated activity, and solved problems using a fictional NASA science-collaboration platform called *the Co-Lab*. *DUST*'s initial run lasted for around three months—from January to March of 2015 and enrolled more than 1,000 players, around 300 of whom are accounted for in the analysis described in this paper.

*DUST* and its design goals and methodologies are described elsewhere in more detail (e.g., Pellicone et al., 2017). Our focus in this paper is on the role of proxy players and how they compare to regular players. The main goal in designing the proxy players was to scaffold learning, help coordinate activity, highlight player contributions, and help players relate to characters with different dispositions toward science. Our diverse cast of proxy players allowed us to differentiate the epistemic actions they engaged in, such as asking questions or contributing solutions, to suit their personalities. *DUST* was also designed to capture the trace activity of players, including their actions and words in the Co-Lab and elements of their participation such as friend connections, post types, and profile changes (Pellicone et al., 2017). The data provided by this design consideration allowed us to collect structural data (see Figure 1) of participation, which is valuable in analyzing user roles (Welser, Gleave, Fisher, & Smith, 2007) and important in constructing ENA graphs (Shaffer, Collier, & Ruis, 2016).

## Findings

We selected CoolQuark for analysis in this paper because of the richness of data associated with her case, her theoretical relevance to our larger research program, and both the quantitative and qualitative data that comprised our initial analysis while the game was running, as well as through the preliminary ENA, described above (Rotman et al., 2012; Yin, 2009).

### Focal Player: CoolQuark

CoolQuark (her screen-name pseudonym) joined *DUST* one week into the game, shortly after the adults had collapsed in the in-game fiction. She was a key player, providing several major breakthroughs in the game and acting as an information resource for her fellow players. At the time of the game, CoolQuark was a 16-year-old high school junior. She self-identified as being interested in science and as loving mysteries and puzzle solving, which was a major factor in her gameplay in *DUST*. CoolQuark described her fascination with science as an investigative practice as such: "So I really like science. I've always really liked it. But I'd never for sure solidified what things I like in science, I just loved investigating things and being like a detective." Because *DUST*'s gameplay was flexibly structured, allowing individual efforts to gather data and team efforts to construct evidence-based solutions from that data, CoolQuark could act as both a solo investigator and resourceful teammate.

CoolQuark mentioned an initial wariness toward the social elements of gameplay and mentioned in her interview a desire to "get out of her comfort zone" in terms of online socializing. However, she quickly established herself as a strong collaborator, as reflected in what she noted as her first major contribution to the game, a Cryptobiosis theory that she posted on the Co-Lab (see Figure 2). As the game progressed CoolQuark wanted more collaboration from her fellow players, and so made use of the Co-Lab's "Groups" feature. *DUST*'s Co-Lab groups provided a common hub for discussion around specific in-game areas of interest and inquiry, for example, microbiology and ethics. In the Neurology group, CoolQuark constructed two "explainer" posts, collating and presenting copious, relevant scientific information for the game. In her interview, she explained her drive to create these posts.

> I saw a lot of people were confused, and I wanted to make sure that if we're all working together, all collaborating, we gotta make sure that we're on the same page. That was basically running through my head: "In order to get the information that other people can find out on their own, they have to know what's going on. They have to be up on the same level as everyone else."

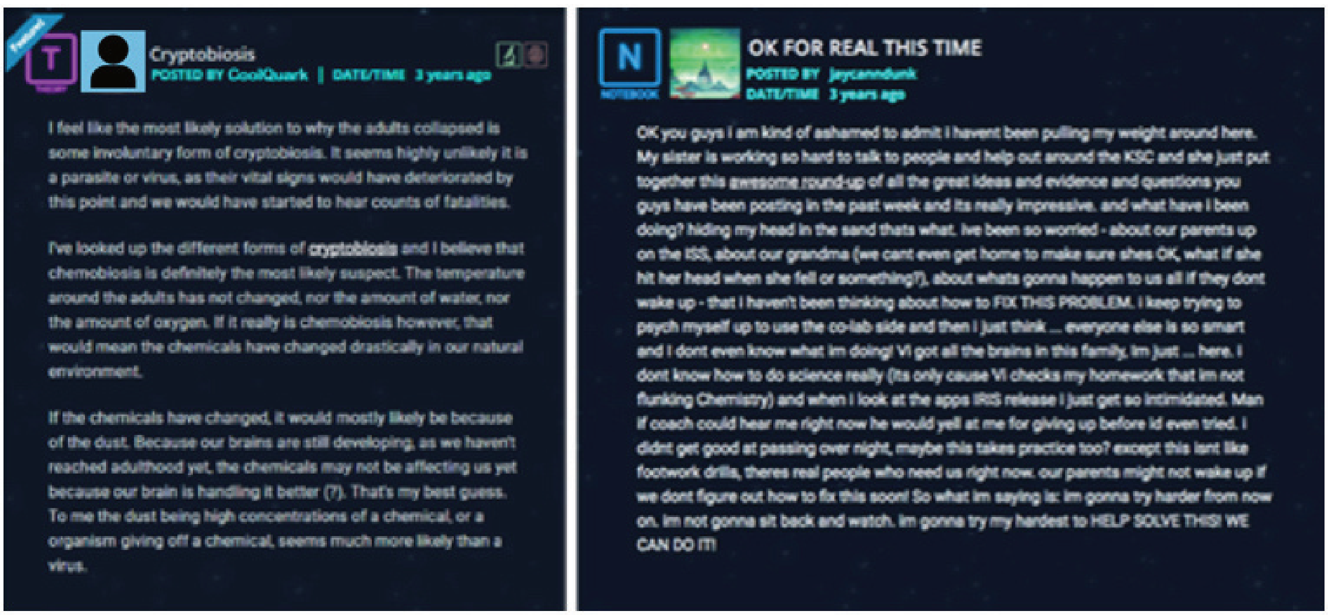



*Figure 2. Two screen captures of in-game activity: (left) a post of CoolQuark's initial correct theory of Cryptobiosis, and (right) an example post by Jay, showing his hesitance toward the scientizing frame.*

### Proxy Player: Jay

Like many of the back stories for characters in *DUST*, fundamental parts of Jay's personality emerged from character ideas generated by our teen co-design partners. For example, one teen collaborator imagined Jay as a member of his school's football team and the child of an astronaut stranded on the International Space Station during The Collapse. While the "jock" is a familiar character trope in teen narratives, Jay's identity as an athlete did not preclude an interest in science; he was also a member of the science club in school and liked to hang out with his dad's colleagues at NASA Mission Control.

Character writer Author 9 distilled ideas such as these to create James ("Jay") Cannon, brother to Violet Cannon ("Vi"). Making Jay the older half of a sibling pair was important to establish his personality and motivations. He feels responsible for caring for Violet while both his astronaut parents are away in space, giving his leadership qualities a new emotional register. At the same time, the erudition of his parents and Violet's natural aptitude for science make him feel inadequate. Drawing from one teen co-designer's description of Jay as "a natural leader" who still fears "failing others" and "sharing leadership," Author 9 crafted Jay as a student who struggles in several academic subjects, and whose biggest fear is: "He's afraid he'll never make anything of himself—that he won't make his parents proud, that he'll let the team down, that he won't be a successful [basketball] player after high school. Essentially, he's afraid of mediocrity." Jay avoids asking for help to hide his failures and masks his fears by teasing Violet; he often uses humor to defuse tense situations. He fails to see that his experience as an athlete—training and caring for his body by eating well and exercising—gives him a basic foundation in biology and human anatomy that will aid the teens as they attempt to discover what has afflicted the adults. Ultimately, Jay demonstrates a strong growth mind-set and a narrative arc showing increased confidence and interest in science, the very traits and learning dispositions we aimed to inspire in *DUST*'s target player base.

In terms of playing style, Author 9 envisioned Jay as a representative of the human biology/neurology track who would be more of a cheerleader than a content expert: "I think James might operate primarily as a facilitator—he doesn't have the specialized knowledge of [other proxy players], so he can't necessarily answer questions, but he can ask good questions, solicit data, make connections, and encourage players." To this end, Jay made very few posts: four notebook posts in total, where he described his own emotional reactions and self-doubt and continually exhorted players to work together, conveying that with collective effort all the problems could be solved. In one early post, Jay essentially gave himself a pep talk to get past his imposter syndrome (see Figure 2). This honest assessment made Jay much more relatable to the players who did not themselves identify as being good at science and provided an example of how to transfer attitudes from other areas of competence (such as sports) into these unfamiliar areas.

Rather than constructing solutions himself, Jay engaged in social activities such as friending, liking, and commenting on player posts that helped other players connect information and solve problems. He started a Co-Lab group called Study Hall and introduced it by asking people to help each other out: "OK i cant be the only one who feels overwhelmed or wants help. join if you have questions about doing science or using the site or are just SUPER NICE and want to help answer other peoples questions." When CoolQuark posted her explanation of the brain, Jay made sure to thank her for her contribution, commenting: "this is awesome! like i really really appreciate this cause i definately find myself getting overwhelmed with all the jargon and medicl terms and stuff. THANK YOU SO MUCH!!! [misspellings were a deliberate narrative move to indicate character emotion, and have been preserved in this quotation]." He followed up this compliment by posting in the Study Hall group, pointing players toward CoolQuark's post, to ensure it received greater attention. Other players also took to commenting on CoolQuark's explanatory posts, thanking her for helping them understand difficult concepts and reinforcing the idea of collective effort. As a proxy player, Jay Cannon served as a model not of the scientific-thinking skills needed to tackle these problems, but of the dispositions needed to progress and persevere. By encouraging everyone to help one another; by establishing personal connections; and by circulating valuable content produced by other players, he demonstrated leadership, fostered a strong sense of community, and facilitated collective problem solving.

### Signatures of Play and Role Comparison

In previous work, role signatures have been developed based on quantification of player activity (Jahnke, 2010; Welser et al., 2007). Such quantification is also the basis behind ENA, where player activity is coded and then analyzed in terms of co-occurrence of elements within a larger epistemic frame (Shaffer, Collier, & Ruis, 2016). Therefore, in taking counts of the player activity matrices that define our ENA graph, we can also develop a signature for those players, visualizing their actions within the game and providing insight into how the ENA graph is constructed. Presented in Figure 3 are the signatures for both CoolQuark and Jay, whose projected points share a common region in the ENA projection space, as seen in Figure 1.

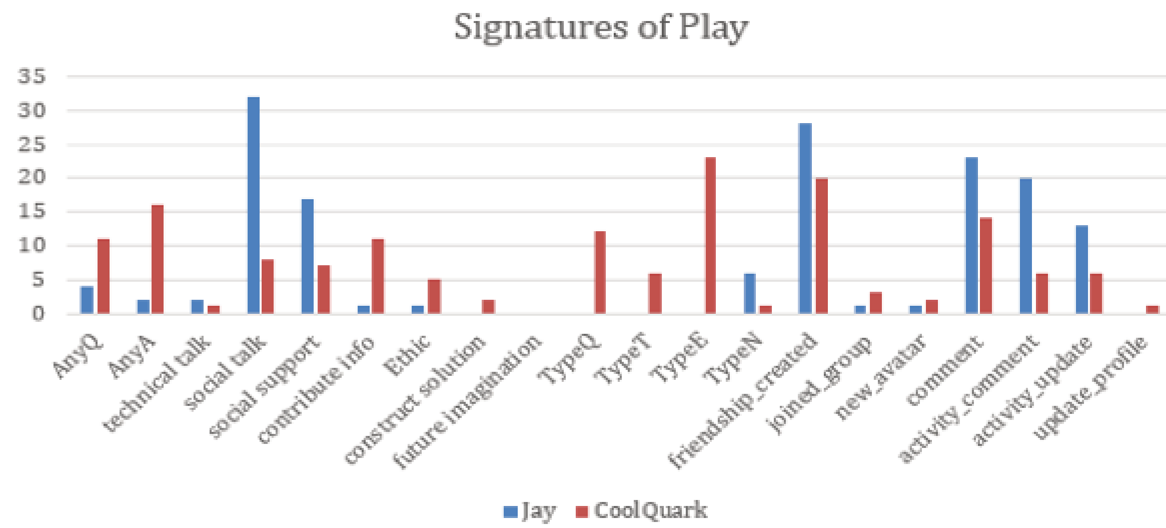



*Figure 3. A comparison graph of CoolQuark's and Jay's total coded activity within the game.*

Applying our own knowledge of *DUST* as game-runners, and using the insights gleaned from both our design process and player interviews, we can understand Jay and CoolQuark in terms of similarities and differences. In terms of similarities, both players engaged in a relatively large amount of *social talk* and *social support*. That is, they engage in conversation around gameplay that does not necessarily further a specific scientific goal, but rather provided emotional and social support to the efforts of other players. Both players also created a comparatively large number of friendships within the game, which led to information sharing through the "feed" feature of the user profile (which shows friends' posts as they are made). In terms of post types, both players also made heavy use of the "comment" feature of the site. However, CoolQuark *also* started original threads in addition to posting comments, which helps to explain the distance between their projected points on the graph. Similarly, a major difference comes from CoolQuark's role as a problem solver within the game–she posted many questions and answers to main problems, contributed information (e.g., her explainer posts), and led the effort to construct a major solution within the game.

Considering the relative position of both projected points in the ENA graph, we can see that CoolQuark takes on many of the coaching behaviors that were a designed aspect of Jay's character: creating a network of players to share information, chatting and discussing the game in a social manner, and providing support for the efforts of other players. CoolQuark then builds upon these activities, engaging with the challenges of the game in order to use the scientific process to solve problems and find answers. CoolQuark herself recognized the dynamic at work in Jay's character and mentioned him by name in her interview, saying,

> That was really nice, where you had one [proxy player] who was struggling, like every time I was confused I didn't feel left out. Like there was someone else I could connect with. I really liked that, [sarcastically] I mean obviously not that I was struggling at all [laughs]!

## Conclusions

Given our exploratory findings above we present two primary conclusions given our guiding questions, and two design considerations for future work.

- **Q1, ENA provides a powerful lens by which to understand player activity and identify and characterize player roles:** Understanding user roles helps us not only to identify and analyze productive player types (Dena, 2008), but also to further design systems that accommodate, promote, and modify those roles (Jahnke, 2010; Welser et al., 2011). The approach of taking large bodies of data, using ENA to map and visualize the relationships within that data, and then doing deeper qualitative analysis of the individuals who comprise that data presents great promise for future work in learning analytics (Rotman et al., 2012; Shaffer & Ruis, 2017). In *DUST* we were able to better understand what the epistemic signature of a major contributor to gameplay looks like. CoolQuark takes on elements of a supportive coach: providing information, making friend connections, sharing information, and providing support to other players. Through those coaching activities she also works with others to construct solutions to problems and bring together a wide variety of evidence and ideas necessary to tackle *DUST*'s complex problems.
- **Q2, We can confirm design intuitions through ENA and qualitative data**: The design of our proxy players was informed by perspectives from young learners that helped us to understand real teenagers' dispositions toward science. Given the strength of ENA in describing Jay's role as a coach, and confirmed through CoolQuark's recognition of his trepidation toward science, we can see that our design methods paid off fruitfully with Jay, who was both behaviorally similar to and emotionally resonant with one of our strongest players. The divergence of Jay's projected point from CoolQuark on the ENA graph is due to our conscious design decision to keep proxy players low on the X-axis for Construct Solutions. While we wanted hesitant teen players to receive the strong support that is characteristic of collaborative, scientific problem-solving teams, we did not want to feed them solutions; rather, we wanted them to do the work of construction on their own. Our hope was that Jay's strong emotional support of others, despite his own diffidence in offering solutions, might spur players to take action. Consequently, a player such as CoolQuark, who may have initially felt like Jay, was primed to make Construct Solutions contributions, which she did, many times over.

From these conclusions we present two primary design considerations as an answer to our third guiding question:

- **Q3, Player Templates:** Given our success in modeling Jay's role as a proxy player, we believe that future work to develop templates of player types would aid educational technology designers in creating authentic characters for a wide variety of experiences, including future ARGs. Furthermore, that typology could be applied to players themselves, allowing game-runners to understand play dynamics more clearly and providing concrete steps to encourage deep and rewarding play experiences. Player templates can essentially function as a methodological affordance, giving researchers an inroad to analyzing data by helping them identify real players who are co-located with proxy players on the ENA graph, indicating a similarity in play style.

- **Q3, Real-Time ENA Modeling:** Recent methodological work with ENA has provided proof-of-concept that automated coding of data sets is indeed possible, and that it can be done in close to real time with high levels of interrater reliability with human coders (e.g., Chesler et al., 2015). We can imagine how, in future game designs, the collaborative platform of the ARG could be configured to look for important discursive moves by players and automatically type them along certain theoretically significant roles within the game.

The work presented above is the first step in a larger research program involving epistemic analysis of *DUST*'s gameplay. Although this analysis was focused on the game as a whole, we plan to use the moving-stanza-window (Siebert-Evenstone et al., 2016) approach in subsequent analysis in order to understand how play changed and evolved over time. Additionally, since we were fortunate to have several hundred active players of *DUST* we have identified other theoretically interesting groups of players. A similar approach to what we have outlined above could instead be turned toward understanding near-peer undergraduate-aged game-runner characters and other models of proxy players (for example, Jay's scientifically inclined sister, Violet), or players who focused on narrative and ethical thinking instead of scientific problem solving. However, even given the early stages of analysis, we forward that ENA, and the models of learning it can be used to uncover, are valuable tools for educational designers seeking to make authentic, inclusive, and responsive learning environments.

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# Open Web Annotation as Connected Conversation in CSCL

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**Abstract:** Research has yet to explore how the social and technical affordances of open web annotation (OWA) can mediate connections among educators in service of their professional learning. This study examined educator participation in the Marginal Syllabus, a computer-supported collaborative learning (CSCL) environment that encouraged connected conversation via OWA. Multiple quantitative methods, including text sentiment analysis and social network analysis, were used to discern key discursive characteristics among the 9 conversations of the 2016–2017 Marginal Syllabus (1,163 annotations authored by 67 participating educators). Key discursive characteristics of educators' connected conversations include: (a) generally positive sentiment; (b) educators who annotated most prolifically also authored the greatest percentage of annotations with neutral sentiment; and (c) conversations of at least 4 annotations tended to demonstrate a greater percentage of negative sentiment. The sentiment trends and study limitations are addressed in the final discussion.

## Annotation as Connection

From handwritten scholia atop Homer's *Iliad* to layered Talmudic commentary, the act of annotation has notable historical roots that precede our digital era. Annotation, according to Sanderson and de Sompel (2011), is "a pervasive activity shared by all humanity across all walks of life" (para. 1). Inspired by the centuries-old practice of adding marginalia to printed texts, the need for digital forms of annotation appeared in Berners-Lee's (1989) proposal for an information system linked by hypertext—what we know as the World Wide Web—and was a feature of Mosaic, the first web browser. Today, *web annotation* allows a reader to comment upon, correct, highlight, and categorize online text. According to Udell (2017):

> If we think of the web we've known as a kind of fabric woven together with links, the annotated web increases the thread count of that fabric. When we weave with pieces of URL-addressable documents, we can have conversations about those pieces, we can retrieve them, we can tag them, and we can interconnect them. (par. 11)

Web annotation serves as a means of connection; more specifically, it can serve as a process mediating connected conversation among people, their ideas, and fine-grained linkages to online content such as phrases, sentences, and data.

Today, connected conversations mediated by web annotation appear in journalism, legal education, scientific research, and scholarly publication. Within the field of education, a growing body of research has examined web annotation in relation to students' reading comprehension and critical thinking, the development of domain-specific knowledge, and as a form of collaboration (e.g., Johnson, Archibald, & Tenenbaum, 2010; McNutt, 2014; Su, Yang, Hwang, & Zhang, 2010). However, educational research has yet to robustly examine how the social and technical affordances of web annotation might mediate connections between educators in service of their interest-driven and professionally relevant learning. Under what conditions might educators leverage web annotation to have connected conversations about their teaching practices and professional interests? What may be the discursive qualities of this conversation? And, ultimately, why would such conversation matter? Given the relevance of *connected* *learning* (Ito et al., 2013) to both educators' classroom practices (i.e., Garcia, 2014) and emerging models of connected teaching (Mirra, 2017), this study examines educators' connected conversation via open and collaborative web annotation as a form of professional learning.

## Open Web Annotation Mediating Educator Connected Conversation via CSCL

Given growing interest in open educational movements, practices, and values (i.e., Cronin, 2017; Wiley, 2016), as well as the proliferation of open educational resources (OER) in both K-12 and higher education settings (i.e., Baker, Asino, Xiu, & Fulgencio, 2017; Hilton, 2016), we examine educators' connected conversation as mediated by *open web annotation* (OWA; Kalir, in press). OWA is defined by a standardized technical architecture (Web Annotation Working Group, 2017), interoperability, and open-source software. Moreover, OWA content may be publicly licensed (i.e., Creative Commons attribution) and, like blogging or online social networking, may encourage an "ethos of transparency" (Havemann, 2016) about open educational practices. While there is growing interest in and use of web annotation in educational contexts (e.g., Novak, Razzouk, & Johnson, 2012), the use of OWA remains scarce (an exception is Chen, 2018) and is a motivator of this study.

This study leverages OWA to help architect a computer-supported collaborative learning (CSCL) environment for educator learning. According to Kirschner and Erkens (2013), the three key elements of CSCL are *pedagogical*, *social*, and *technological*. Pedagogy, in CSCL, is intended to support cognitive and metacognitive tasks; by authoring open annotations, for example, an individual can make his or her thinking available to others, aiding the visibility of group cognition (Stahl, 2006) and public accessibility of knowledge resources. The social element of CSCL refers to collaborative interaction; while OWA systems are not, by definition, social networks, OWA-enabled learning environments can become a social medium, as evident by OWA use in academic communities of practice (Kalir, in press). The final element of CSCL is technological, or the computer supports that "facilitate the collaborative cognitive and social learning processes" (Kirschner & Erkens, 2013, p. 3). The technical affordances of OWA can create an "anchored environment" (Gao, 2013) for collaboration that supports multimodal expression, the addition of descriptive metadata (i.e., tags), and the curation of and cross-context linkages among distributed resources. More specifically, the OWA platform featured in this study, Hypothesis, includes various technical affordances that facilitate collaboration, including replies, sharing individual annotations via social media, and public annotations attributed with a Creative Commons license to be reused by others. In consideration of these pedagogical, social, and technological elements, this study builds upon research about CSCL environments supporting educator learning (e.g., Lockhorst, 2004) and makes a novel contribution to the CSCL literature by investigating the role of OWA in mediating educator learning via connected conversation.

## Study Context: The Marginal Syllabus as a CSCL Environment

The context of this study is a CSCL environment for educator learning that has been iteratively developed and implemented by a multistakeholder partnership among: university researchers; K–12 educators and administrators; authors and publishers of academic content; Hypothesis, a nonprofit organization building an open-source web annotation platform; and the National Writing Project, the nation's premier literacy-education organization that provides professional development for educators. Launched during the 2016–2017 academic school year, the Marginal Syllabus is a CSCL initiative that sparks and sustains conversations about educational equity via OWA. The project embraces a political and technical double entendre; the Marginal Syllabus partners with authors whose writing may be considered marginal—or contrary—to dominant education norms, and online conversations among educators and authors occur in the margins of digital texts using web annotation.

The 2016–2017 syllabus featured nine conversations with 10 partner authors about topics such as critical literacy, curricular co-design, the business of educational technology, and culturally relevant pedagogy. Sixty-seven educators participated in these public conversations by generating a corpus of 1,163 annotations. The 2017–2018 syllabus, hosted by the National Writing Project, was organized around the theme "Writing Our Civic Futures;" it featured eight conversations with 12 partner authors. Eighty-nine educators participated in the eight public conversations of the 2017–2018 syllabus and generated a corpus of 1,137 annotations. The Marginal Syllabus initiative includes: a project website; two sets of curated, open-access digital texts contributed by multiple authors and scholarly publishers; public layers of Hypothesis OWA dialogue; blogs authored by project partners; and webinars (most featuring text authors) hosted by the National Writing Project.

Research about web annotation in educational contexts has seldom focused on educator learning. In response, this study suggests OWA may be a promising means of creating open, publicly accessible CSCL environments within which educators might exercise political agency through connected conversation, question dominant schooling narratives, and critique inequitable educational practices (Kalir & Perez, in press). The research question guiding this study asks: *What are key discursive characteristics of educators' connected conversation as mediated by OWA in a CSCL environment?*

## Methodology: Examining Connected Conversation

A persistent methodological challenge in CSCL studies is the definition of a unit of analysis to meaningfully describe participatory patterns. Stahl (2006) stated the problem simply: "I work and I learn in innumerable ways and modes," and added, "Working and learning with other people mixes these ways into yet more complex varieties. Technology multiplies the possibilities even more" (pp. 2–3). In a CSCL environment such as the Marginal Syllabus, learning not only occurs at the level of the individual educator (i.e., reading and annotating a text), it also occurs with and around a group of educators via their conversation (i.e., annotation replies). Puntambekar and colleagues (2011) suggest the methodological challenge of including individuals and groups in a CSCL study is akin to a sliding scale: "Smaller segments in data provide finer grained analysis but little contextual information. On the other hand, larger units of analysis help create context but with the loss of detail" (p. xii).

We adopt multiple quantitative methods to examine *connected conversation* as the unit of analysis relevant to educator learning in the Marginal Syllabus as an open CSCL environment. We analyzed multiple discursive characteristics of connected conversation during all nine conversations of the 2016–2017 Marginal Syllabus, a corpus of OWA data associated with 1,163 Hypothesis annotations authored by 67 participants. To systematically investigate patterns of interaction and connected conversation in the Marginal Syllabus, we used an array of quantitative methods that included text sentiment analysis, social network analysis, time series analysis, as well as visual representations of data. We then applied these analytic methods at multiple levels of granularity including individual educators, annotation discussion threads, and discussion spanning all nine conversations. This study's quantitative analysis of the entire 2016–2017 Marginal Syllabus complements a smaller-scale discourse analysis of a single conversation (August, 2016) that found the Marginal Syllabus helps to organize—across multiple sociopolitical texts and contexts—professionally relevant learning opportunities for educators that amplify political dimensions of talk (Kalir & Perez, in press).

### Sentiment Analysis

The first phase of our analysis measured the sentiment of educators' individual annotations. To perform this analysis, we used a tool called VADER (Valence Aware Dictionary for sEntiment Reasoning), a rule-based model for sentiment analysis, that returns a sentiment value of polarity and intensity. The sentiment value is returned as a continuous number between -1 and 1, with 0 indicating the text has neutral sentiment. VADER outperforms other sentiment analysis techniques in testing social media text (Hutto & Gilbert, 2014). In our assessment, VADER was an appropriate tool given that Hypothesis annotations and replies resemble social media messages in size. Among the 1,163 Hypothesis annotations analyzed, the mean word and sentence count per annotation was 37.7 and 2.4, respectively. VADER was also useful regarding the lexicon of the annotation corpus. For example, in measuring sentiment, VADER is capable of accounting for educators' use of emoticons (i.e., ? ) and phrases such as "+1" to indicate agreement.

### Social Network Analysis

Unlike typical social media networks in which users define their own networks by selecting other users with whom they share a connection (Kane, Alavi, Labianca, & Borgatti, 2012), Hypothesis users form no explicit networks between other users. Rather, Hypothesis users form networks implicitly through their annotations. In projects such as the Marginal Syllabus, a reply to an original annotation becomes a discussion thread; such connections are central to educator interactions via OWA. In order to analyze the structure and patterns of the educators' connected conversations, we used a network analysis tool called NetworkX. Each annotation contains data that determine whether the user is referencing the source document, known as the anchor text, or whether the user is replying to an existing annotation. By using a directed graph—where each annotation is analyzed and represented as a node, and each reply is a directed edge to another node—we are able to analyze conversation threads as treelike structures generated from Hypothesis's underlying social network characteristics.

For this second phase of analysis, we focused on *threads* of connected conversation. Threads, in this study, were generated when a participating educator's original Hypothesis annotation elicited at least one reply from another educator. To initiate this analysis, we discarded all annotations from the nine 2016–2017 Marginal Syllabus conversations that did not generate any replies from other participants. As an example, consider a thread of connected conversation initiated by educator *bali* from the October 2016 conversation; the annotation generated eight replies from five different educators (see Table 1). Social network analysis of this conversation reveals different discussion patterns of connected conversation mediated by OWA. For example, Figure 1 illustrates: (a) bali showed reciprocity of posts, replying to two educators who had replied to the initial post (left); (b) most annotations had positive sentiment scores (center); and (c) bali's reciprocity applied, in particular, to the first two subsequent posts made within 7.45 minutes. After the initial exchanges of this particular thread, bali did not return to the conversation (right).

| Anchor text: *writers should write the books they wish to come upon.* |
|---|
| 1 *bali*: Love this. I sense it's not enough but it's sthg i can gst behind [sic]. Should academics try to write articles in voices and on topics they would wish to read? How do academia and publishing processes get in the way of that? [October 26, 2016 15:57 MST]<br><br>1A *[blinded]*: That's a real tension. The so-called objectively of academic research certainly diverges from the motivation of some authors (such as those who write fiction). Paul Beatty, who just won the Booker prize, noted: "I'm just trying to create space for myself. And hopefully that can create space for others." [October 26, 2016 16:03 MST]<br><br>1A1 *bali*: Love that! And something I have thought of before. Persisting in dissent can make room for others to try [October 26, 2016 16:40 MST]<br><br>1B *LauraRitchie*: I've just done this! Wrote my first non-fiction book - and I have no clue about the publishing... started sending letters to publishers. ...may be a bumpy road ahead! [October 26, 2016 16:04 MST]<br><br>1B1 *bali*: Wow! Good luck! And bravo [October 26, 2016 16:40 MST]<br><br>1B1A *[blinded]*: +1 [October 26, 2016 16:44 MST]<br><br>1C *BMBOD*: Such important questions. I wish academic publishing was more accessible in this way. [October 26, 2016 16:39 MST]<br><br>1C1 *ssimpson_01*: I think this is a beautiful sentiment. Everything is always better with passion; including writing and education. When you are truly passionate about your subject is when you can write something that is truly enjoyable *and* useful to others. #ED677 [February 19, 2017 11:51 MST]<br><br>1D *traceydean*: As an art teacher, I try to create lessons that I'd want to explore; media/technique/artists #ED677 [February 19, 2017 18:45 MST] |

*Table 1. Sample thread featuring anchor text, original annotation, and subsequent replies.*

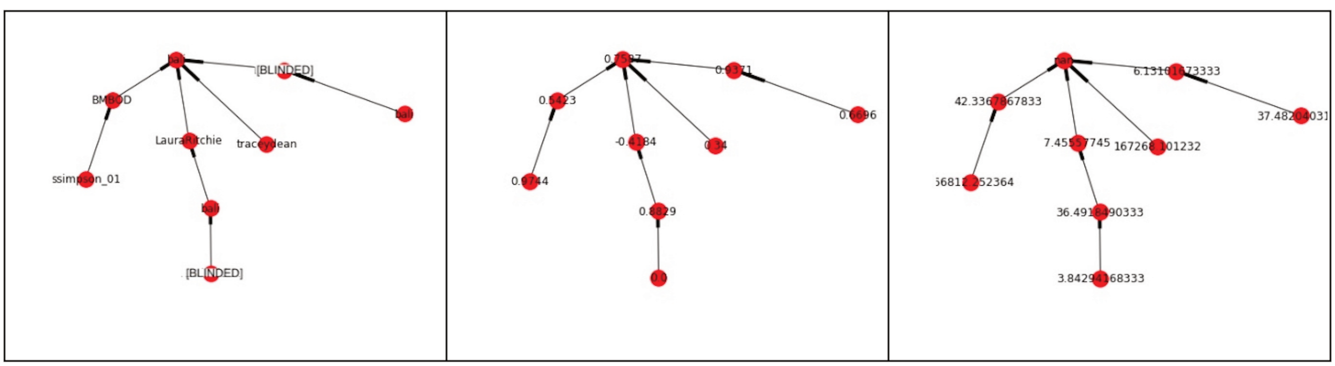

*Figure 1. Network graphs of sample Marginal Syllabus thread with different labels, including usernames (left), sentiment score (center), and delay of reply in minutes (right).*

In summary, data collection and analysis began at the lowest granularity—individual annotations collected via Hypothesis. Through our analysis, patterns among connected conversations emerged to provide a perspective on educators' interaction in the Marginal Syllabus as an open CSCL environment.

Social network methods provided the analytic tools necessary to better understand the social and collaborative elements of CSCL within the 1,163 Hypothesis annotations comprising the entire 2016–2017 Marginal Syllabus. Both sentiment analysis and social network methods measured patterns of educators' collaborative interaction, allowing us to move from the scale of individual activity in a learning environment to examine broader discursive characteristics of connected conversations that supported educators' professional learning.

## Findings

Sentiment analysis of OWA authored by educators during Marginal Syllabus conversations indicates educators' connected conversations were generally positive (59%). Table 2 summarizes all 1,163 annotations of the 2016–2017 Marginal Syllabus: The left column reports annotations organized according to three count ranges; "Educator Count" organizes the 67 educators within a range based upon their OWA authorship; and three columns report the mean sentiment of all annotations.

| Annotation Count | Educator Count | Positive | Negative | Neutral |
|---|---|---|---|---|
| ALL | 67 | 59.0% | 9.0% | 31.9% |
| 1-4 annotations | 26 | 63.1% | 8.0% | 28.8% |
| 5-16 annotations | 21 | 56.6% | 9.8% | 33.6% |
| 16+ annotations | 20 | 56.4% | 9.5% | 34.1% |

*Table 2. Sentiment analysis of 1,163 annotations in 2016–2017 Marginal Syllabus.*

Just under one third of educators (20 of 67) authored more than 16 annotations during their Marginal Syllabus participation, about one third of others (21) authored between four and 16 annotations, and just over one third of educators (26) authored fewer than four, but at least one, annotations. The 20 educators who authored 16-plus annotations produced content with sentiment that was, on average, less positive (56.4%) than annotation content authored by other educators. The group of most prolific annotators also authored the greatest percentage of content with neutral sentiment (34.1%), as illustrated by a sample annotation from the October conversation:

> I wonder sometimes if some instructors don't make explicit the narrative of their course in part because they think it's obvious, because they put it together. When do we give instructors the time or permission or whatever to say to their students, "This is why I am assigning these works, in this sequence." (dlanclos)

Trends in the sentiment of educators' connected conversations also appeared in an analysis of thread length, or the number of replies to an original annotation (i.e., eight replies in the Table 1 example). Table 3 summarizes threads in the 2016–2017 Marginal Syllabus: The left column reports the number of annotations within a thread; "Thread Count" organizes the 266 threads according to the number of component annotations; and three columns report the mean sentiment of annotations within a thread.

| Annotation Count | Thread Count | Positive | Negative | Neutral |
|---|---|---|---|---|
| All | 266 | 58.8% | 7.7% | 33.5% |
| 2 (1 annotation & 1 reply) | 189 | 60.5% | 6.2% | 33.3% |
| 3 (1 annotation & 2 replies) | 31 | 50.0% | 11.3% | 38.7% |
| >4 (1 annotation & 3+ replies) | 46 | 57.7% | 11.6% | 30.7% |

*Table 3. Sentiment analysis of 266 conversation threads in 2016–2017 Marginal Syllabus.*

All threads were generally positive in sentiment (58.8%). Threads that featured three or more replies (17%; 46 of 266), while a minority of the overall data set, evidenced the greatest percentage of negative sentiment (11.6%). In other words, connected conversations of at least four annotations—despite occurring in only about one fifth of all threads—tended to demonstrate a greater percentage of negative sentiment. The finding that threads with large annotation counts (> 4) evidenced a higher percentage of negative sentiment may, in part, be explained by Figure 2, which illustrates that the likelihood of a reply from another educator decreased in relation to more positive sentiment. An annotation with negative sentiment (VADER value -1) was replied to in 48% of all educator interactions, whereas the likelihood of a reply to annotations with both neutral sentiment (0) and positive sentiment (1) dropped to 39% and 37%, respectively. This trend in educator interaction might explain why the 46 conversation threads of greatest length evidenced the highest percentage of annotations with negative sentiment.

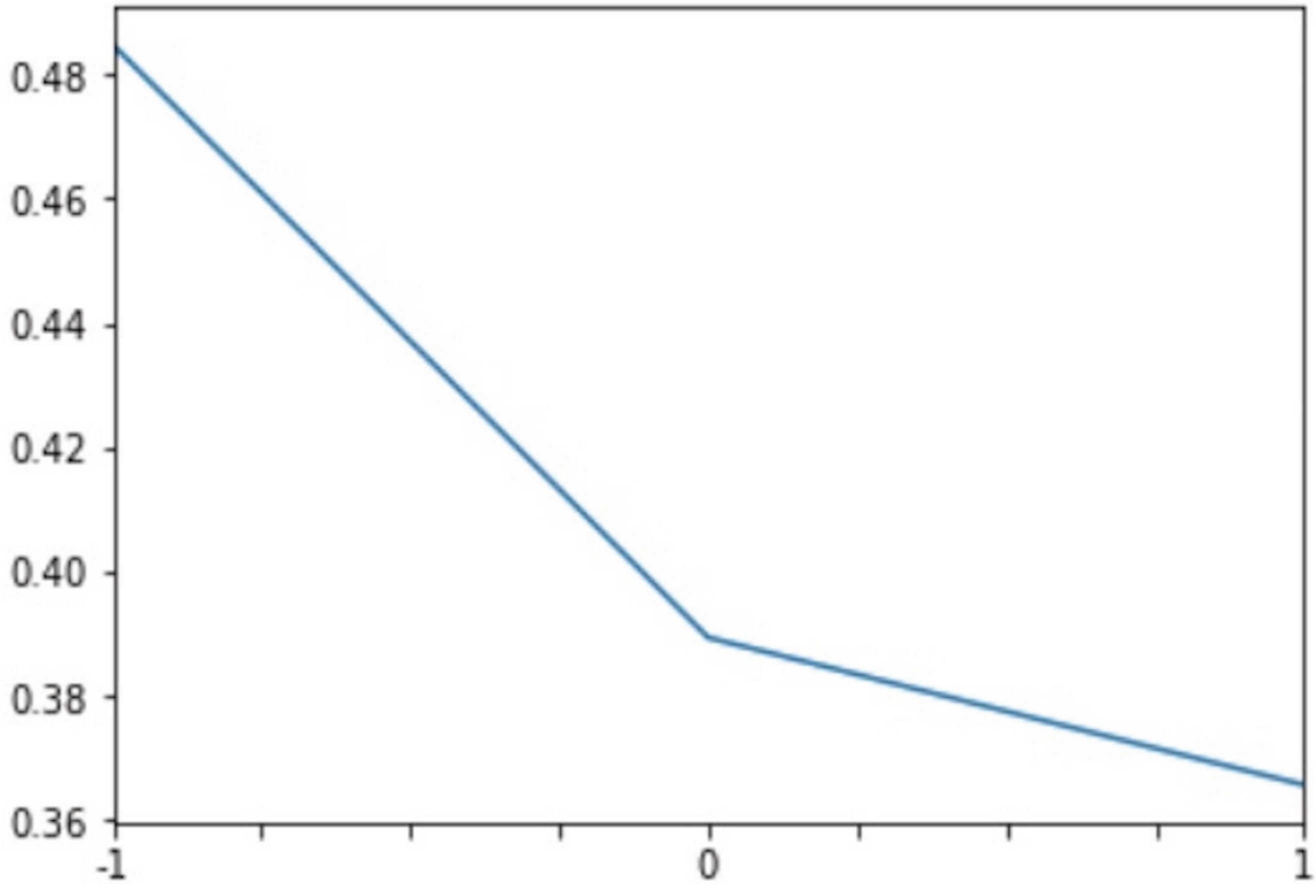


*Figure 2. Likelihood of reply to annotation as measured by annotation sentiment.*

## Discussion

This study has described a number of discursive characteristics associated with educators' connected conversation as mediated by their use of OWA in the Marginal Syllabus, an open CSCL environment organized around conversations about educational equity. In this brief discussion we address two key characteristics of educators' connected conversation: (a) sentiment trends in individual educators' annotations; and (b) trends in the sentiment of threads.

First, it is noteworthy that the group of most prolific annotators—nearly a third of Marginal Syllabus participants (20)—authored the greatest percentage of OWA content with neutral sentiment (34.1%). Perhaps these educators' sustained participation in Marginal Syllabus conversations led them, over time, to write more balanced commentary about important topics—such as pedagogical transparency, as indicated in the sample annotation by dlanclos. Alternatively, perhaps this neutral sentiment can be attributed to an awareness of social norms. Given these educators' more pronounced presence in Marginal Syllabus conversations, perhaps neutral annotations were more regularly contributed so as to keep the conversation "moving forward," or so as not to inadvertently offend another participant. Future study of connected conversation in the Marginal Syllabus as a CSCL environment should contextualize such trends in annotation sentiment by, for example, interviewing educators about their intent when authoring annotations, replying to others, and participating in such open learning.

A second notable discursive characteristic was that educators' lengthier connected conversations (4-plus annotations) evidenced the largest percentage of annotations with negative sentiment. To better understand this dynamic, we consider Kadushin's (2005) assertion that sentiment affects interactions within networks and small groups and that, generally, "Positive sentiments lead to further interaction and negative sentiments lead to less interaction" (p. 2). Yet this was not the case for some connected conversations in the Marginal Syllabus. However, a more recent study by Backstrom and colleagues (2013) suggests that participation patterns in social network conversations (i.e., commenting on Facebook) are inversely patterned to those that are primarily task oriented (i.e., editing *Wikipedia*). This may help us to understand why, as connected conversations in the Marginal Syllabus grew, annotations with negative sentiments made up a larger percentage of those OWA conversations, demonstrating an inverse effect of Kadushin's (2005) socially focused findings. In other words, sentiment patterns associated with the Marginal Syllabus's longer connected conversations indicate that these interactions among educators may have been more task oriented (and less social).

Finally, a limitation of this study concerns the methodological challenge of attributing social network characteristics to Hypothesis, a system that affords social and collaborative interaction via annotation but is not expressly designed as a social network. The social network methods we applied allowed us to identify and pattern educators' participation in the Marginal Syllabus by providing a structure to our unit of analysis—connected conversations—based upon Hypothesis's underlying data structure of annotations and replies. The social limitations of using such an annotation system for connected conversation are also apparent from a participating educator's perspective; having authored a Hypothesis annotation, an educator is only notified of a subsequent reply to his or her annotation via email. This may limit an educator's capacity to sustain or reenter a conversation as he or she may be unaware that a connection has occurred. Such challenges may suggest there may be benefits to facilitating synchronous OWA conversation atop a text, as well as the limitations associated with mediating educator professional learning via open—but primarily asynchronous—CSCL environments.

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# Exploring How Student Designers Model Climate System Complexity in Computer Games

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**Abstract:** We present results from a design-based research project in which 8th-grade teachers and students explored climate change by designing computer games using Scratch. We analyzed 174 games based on (a) systems complexity and (b) triadic game design (TGD). The analysis of system complexity shows that two-thirds of the students designed systems using 1-directional linear connections, while one third designed complex systems based on multiple connections and included feedbacks, or loops. TGD analysis shows that the most frequent topics were human choices that impact climate change (54 games) and actions that mitigate climate change (53 games). The majority of games were based on a quiz (32), shooter (31), action (27), or pong (29) genre of gameplay. The underlying teaching purpose of the games fell into 2 categories: (a) teaching about climate change directly through text or indirectly through gameplay, or (b) raising awareness by having players make responsible choices in-game (e.g., walking, not driving). Choices of teaching purpose and gameplay entailed important design considerations for students; this result has implications for how game-design tasks within particular domains such as science might be framed in future.

## Introduction

The Building Systems From Scratch project is developing, implementing, and studying an intervention that integrates computer-game design and climate science in an eighth-grade curriculum unit taught by science teachers. Using a systems and socioecological approach, students create computer games using Scratch to teach other students about climate change. Given the demonstrated affordances of game design in supporting systems thinking, we conjecture that immersion in a design task to create a game that teaches others about climate change will result in students' learning skills in specific science and computational practices—systems thinking and modeling. In this paper, we analyzed a body of student games from Year 2 of this project to consider how they modeled systems in their games.

## Theoretical Framework

**Computational thinking practices.** Wing (2006) has described computational thinking (CT) as a general analytic approach. First defined in the context of computer science, CT also includes a range of practices central to other scientific and mathematical disciplines. In addition to widely recognized computational practices such as decomposition, iteration, and algorithmic thinking (National Research Council [NRC], 2011), scientific practices such as modeling and simulation, and systems thinking, can be considered as CT (Weintrop el al., 2015). In the context of this project, we describe CT as "CT practices (CTP)" since student data reveal thinking only in the context of what students say and do.

Teaching CTP has become increasingly familiar in K–12 education (Denner, Werner, Campe, & Ortiz, 2014; Grover & Pea, 2013). Coding, or programming, is often used to teach students CTP (Grover, Pea, & Cooper, 2015). Sengupta, Kinnebrew, Basu, Biswas, and Clark (2013) review the synergies between CT and other disciplines that have been identified by various researchers since 1988, but they point out that CT has not been systematically integrated into K–12 curricula, despite the fact that calls for integrating programming with curricular domains such as science and math have been made for some time (ACM K–12 Taskforce, 2003). We will report data on student CTP more fully elsewhere; in this paper, we focus on systems thinking, including practices such as defining a complex system, understanding system relationships, and managing complexity, and on modeling, including designing and constructing a model.

Modeling complex systems has been a foundational tool in the development of scientific understanding of current and future impacts of climate change. As Wilensky and Jacobson (2014) observe, the science of complex systems "provides both a framework and a context for the practice of computational thinking" (p. 328). We use Ingham and Gilbert's definition of a model as a simplified representation of a system, which concentrates attention on specific aspects of the system at the expense of others (Ingham & Gilbert, 1991). When constructing a model, the designer must make many decisions—defining the boundaries of the system, deciding what to include, and conceptualizing the behaviors of components in the model. Then, the learner integrates information about the structure, function, and causal mechanisms in the system, including only features that are important to understand the system being modeled (Weintrop et al., 2015; Windschitl, 2013). Game design requires many modeling practices, such as representing processes through abstractions and deconstructing problems into a series of ordered steps. Furthermore, game design can be effective in teaching about systems (Puttick, Strawhacker, Bernstein, & Sylvan, 2014; Puttick & Tucker-Raymond, 2018; Puttick, Tucker-Raymond, & Barnes, 2017).

**Learning through game design.** Game design as a tool for teaching programming and CT has grown in the past decade or two with the advent of visual programming tools such as Alice and Scratch (NRC, 2011). Game design has proved to be highly engaging at middle and high school levels (e.g., Aydin, 2005; Reppening, Webb, & Ioannidou, 2010), facilitating creative thinking, social cooperation, and broader participation (e.g., Denner, Werner, & Ortiz, 2011). However, programs that use game design to focus on areas of STEM are only now growing more prevalent (e.g., Denner et al., 2014; Puttick & Tucker-Raymond, 2018; Salen, 2007; Tucker-Raymond, Torres-Petrovich, Dumbleton, & Damlich, 2012).

We drew on the theory of triadic game design (TGD) in designing this project. TGD suggests that the successful application of games in education requires an interdisciplinary approach in which three interdependent paradigms should be considered (Harteveld, 2011). *Reality* represents the connection between the game world and the real world, suggesting that any game contains an underlying *model of reality*, often deployed through the representation of real objects (e.g., cars) or the implementation of real-life physics and mechanics. *Meaning* represents the underlying message of a game (either intended or perceived) to the player, for example, entertainment, education, or awareness. Finally, *Play* represents the *genre* of a game, which often defines the characteristics of the gameplay, and the challenges players undertake (e.g., shooting at targets, deflecting objects, etc.). In the curriculum, each paradigm included specific criteria that need to be considered and balanced. Equally, we expected students to keep these three paradigms in mind as they conceived of and designed their games.

In this paper, we address the research question: To what extent can student designers model climate system complexity in computer games?

## Methods

### Design Context, Participants, and Data Sources

The data for this study are taken from Year 2 of a larger design-research project on teaching climate systems and CT through the design of computer games. Seven eighth-grade science teachers at two separate middle schools in a Northeast U.S. suburb adjacent to a major city taught four sections of approximately 22 students each. There were 21–28 days of instruction in classes of 50 minutes.

Instruction was conceptualized in terms of systems modeling and game design. The curriculum asked eighth-grade students (13–14 years) to create computer games using Scratch, a graphical drag-and-drop programming language (https://scratch.mit.edu), through which others could learn about climate change. Students explored climate systems and climate change through constructing physical models, exploring visual interactives and animations of climate systems online, and through concept mapping. They discussed game genres (e.g., arcade, adventure, multiplayer), played and critiqued a sample of online games related to climate change, and then became familiar with Scratch through various activities developed by the Scratch education community (scratched.gse.harvard.edu). Student pairs chose the topic for their game and used a design template based on TGD to create a design sketch. Finally, they programmed their games in pairs while engaging in rounds of play testing and critique. All games ($N$ = 174) were archived in studios set up by the teachers on the Scratch website (scratch.mit.edu).

### Analysis

**Reality, Meaning, and Play.** To quantify the TGD model in each game, two researchers qualitatively applied the three codes shown in Table 1.

| Code and Definition | Examples |
|---|---|
| Reality: The climate change domain, topic, or content | Albedo, transportation choices that impact climate, the greenhouse effect, capturing CO2 emissions |
| Meaning: The purpose of the game, described in text in an introduction or end comment, or in gameplay | "Learn the reason why the ice caps are melting," "Ditch the green energy idea, let's make money by using fossil fuels," "Make decisions with the goal of saving the environment" |
| Play: The genre or type of game (e.g., Arcade, Narrative, Strategy) which defines gameplay and player input | Arcade: Deflecting CO2 with an onscreen object, clicking objects randomly appearing on screen. Narrative: Player progresses through a game "story." Strategy: Player participates in a real-life scenario with realistic interactions among the components |

*Table 1. Triadic game design coding scheme.*

**Systems complexity.** To quantify the complexity of the climate system in each game, two researchers mapped the system components as a concept map, including the components both in descriptive text and in gameplay. With arrows, we connected components that had causal connections in the game. We then counted (a) the number of system components, (b) the number of individual causal connections between any two components, and (c) traced out the longest chain of causal relationships and counted the number of connections in it. We included the player-as-avatar as a system component if the avatar had a real-world counterpart that has a role in the climate system being modeled in the game. All games were consensus coded.

## Results

Overall, games represented Reality by depicting the fact that human choices affect climate change (*n* = 54) through choices about daily actions (Table 2). These games typically included causal connections but less complex systems overall. However, games that countered human impacts with game actions that mitigate climate change (*n* = 53) obviously treated more than one climate topic at once. For instance, games to capture $CO_2$ often required the player to counter deforestation with reforestation, while games about transportation impacts posed alternative transportation choices to these such as cycling or taking the bus. Games in this second thematic category typically tended to have more complex systems and could include feedbacks. A third category of games addressed climate phenomena directly (*n* = 47) through depicting some of the impacts of climate change, for example, rising sea level, extreme weather, or how albedo or the greenhouse effect impact global temperature. These games also tended to have more complex systems and could include feedbacks. Finally, games that involved making trade-offs (*n* = 20), for example, making political decisions that had policy impacts, or making investment decisions, tended to have multiple interacting components and multiple feedbacks.

| Thematic category | Reality (Primary Climate Topic) | # | Play (Game Genre) | # |
|---|---|---|---|---|
| **Human choices affect climate change (n = 54)** | Multiple (e.g., energy use, transportation, diet) | 39 | Quiz | 32 |
| | Transportation only | 8 | Shooter | 31 |
| | Deforestation only | 7 | Action | 27 |
| **Actions that mitigate or adapt to climate change (n = 53)** | $CO_2$ mitigation (e.g., plant trees) | 47 | Pong | 29 |
| | Renewable energy | 4 | Platform | 14 |
| | Other (e.g., geoengineering) | 2 | Competitive/Multiplayer | 14 |
| **Phenomena central to understanding climate change (n = 47)** | Impacts of climate change | 14 | Storytelling | 11 |
| | Albedo, solar radiation, greenhouse effect | 27 | Maze | 6 |
| | Carbon cycle, fossil fuels, energy use | 5 | Building | 4 |
| **Making trade-offs (n = 20)** | Green energy vs. fossil fuels, forests vs. buildings | 18 | Strategy | 3 |
| | Political | 2 | Reverse Whack-a-mole | 3 |

*Table 2. Results of TGD analysis for Reality (left) and Play (right).*

Regarding Play, the most frequent genre was *quiz* games (*n* = 32), in which gameplay structure was based on posing questions related to Reality climate topics that the player could answer by selecting among two to four to possible choices (Table 2). Other games involved more action-oriented gameplay, such as *shooter* (*n* = 31) in which the player has to shoot $CO_2$ molecules and clouds to clear the atmosphere in a short period of time, single or multiplayer *pong* (*n* = 29) games, or *platform* games (*n* = 14), in which the player has to jump to avoid objects that are bad for the environment (e.g., methane, $CO_2$, cars, nonrecyclable items) and has to try to collect “good” objects (e.g., trees, recyclables).

Regarding Meaning, the games were divided in two main categories: (a) *teaching* and 2) *responsible choice*. Teaching was achieved (a) *directly*, by showing text or graphical tutorials to players that explicitly instructed them on topics related to climate change, or (b) *indirectly*, as the player learns from feedback provided by the game itself (for instance, see *Albedo Pong*). Players were asked to make responsible choices in two ways, by either (a) *making responsible choices*, for instance by sorting different kinds of garbage in appropriate collectors (e.g., recycling, nonrecycling), or (b) *making irresponsible choices*, for instance by cutting down trees to see the effect of deforestation on the climate. The category of irresponsible choice is interesting in using reverse psychology, making game players do bad things to learn positive concepts.

The body of games taken as a whole revealed a considerable range in the complexity of systems represented in Reality, both in terms of the average number of systems components defined by student designers, and in terms of the numbers of connections they made between and among components (Table 3). An example of a game with three components (e.g., *$CO_2$ Project*) might involve the player using a tree to capture $CO_2$ molecules being randomly emitted from a factory smokestack, while a game with 19 components (e.g., *Save the Earth*) might involve the player in making trade-off decisions among many energy-related options to optimize resource use and minimize climate impacts. Many students found ways to connect all of the system components to at least one or two other components (an average of 5.38), while the longest continuous chain that students made ranged between 1 and 8 (average 3.2).

| Average no. of components (range) | Average no. of single connections (range) | Average no. of connections in longest chain (range) |
|---|---|---|
| 5.69 (3 -19) | 5.54 (1 - 38) | 3.20 (1 - 8) |

*Table 3. Components and connections in games (N = 174).*

**Three cases.** We report three games from our analysis as representative cases of how the games designed in the classroom-studios ranged from simple to complex systems. We report the following three cases in order of system complexity: (a) *Albedo Pong*, (b) *Carbon Clicker*, and (c) *Government Simulator*, and describe how the three cases map to the TGD model.

*Albedo Pong* has six components, six connections, and one feedback loop. It uses the structure of an *arcade* game, in particular the popular pong game from the 1970s. Through a simple ponglike gameplay, the game teaches the player about concepts such as ice-albedo feedback and rising ocean level, both of which phenomena are central to global warming. We consider this game to have a *simple* system complexity, in that it includes five components linearly connected. Yet it provides immediate feedback to the player, who learns about the effect of ice-albedo feedback directly on his or her avatar. In fact, the player uses a platform-paddle made of ice, which shrinks every time solar radiation enters the ocean (see Figure 1, left); this is a simple yet powerful example of an in-game reinforcing feedback loop. Besides the paddle shrinking, the ocean level rises when solar rays strike its surface because of thermal expansion as the effect of warmed-up water. *Albedo Pong* is a good example of how students can create a complex systems representation based on simple, yet elegant, interactions, by using few key components (i.e., a sun ray, an ice-paddle that melts, the ocean that rises, a temperature gauge).

*Carbon Clicker* uses the Play structure of *storytelling* to simulate the environmental impact of current economic and technological progress in our society. We consider this game to have moderate system complexity, since it includes seven components that are connected linearly, yet overall it presents a solid systems view based on how the components are interconnected (Figure 1, middle). Likewise, the TGD analysis shows visual and rhetorical power.

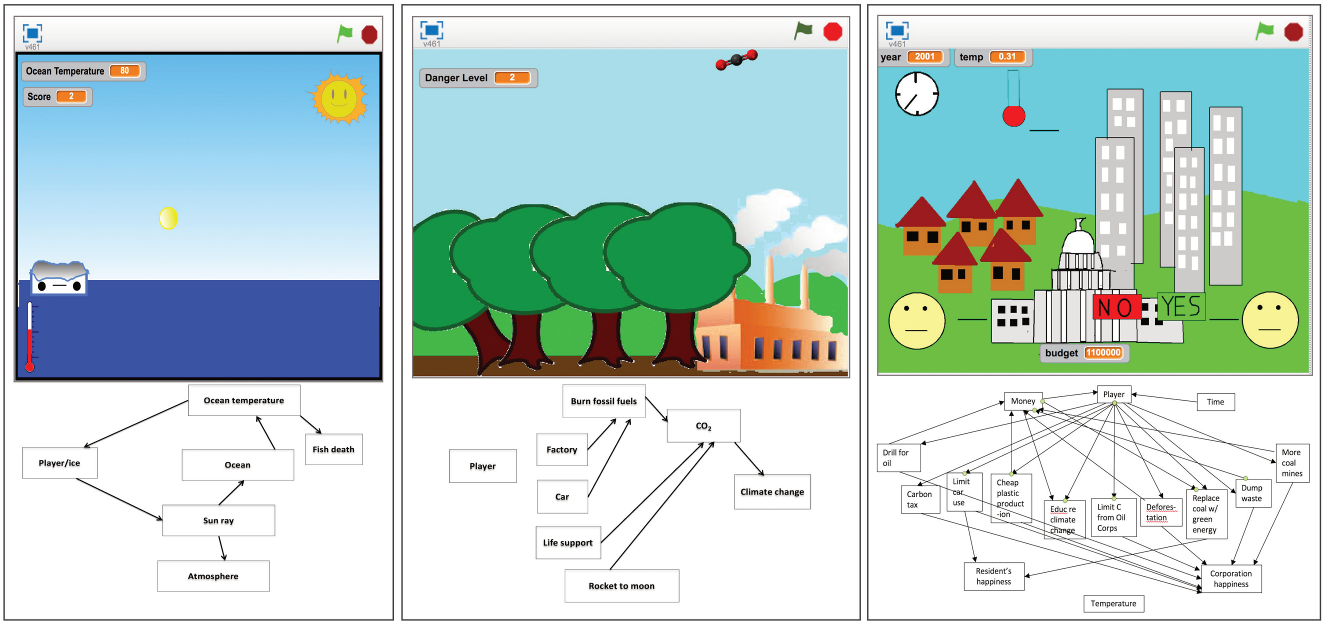


*Figure 1. Screen shots (top) and coding for system complexity (bottom) for Albedo Pong game (left), Carbon Clicker game (middle), and Government Simulator game (right).*

*Carbon Clicker* represents aspects of Reality such as deforestation, factory building, the intensive use of medical devices to support dying humans, and the use of cars. It demonstrates how these technologies accumulate $CO_2$ in the atmosphere and gradually endanger the life of humans and of Earth. The Meaning of the game is about raising awareness about the consequences of irresponsible use of technology, which results in unsustainable $CO_2$ emissions; this always leads to dramatic consequences at the end of the game—Planet Earth will overheat beyond tolerable levels and eventually die. Regarding the gameplay, the player is guided through the game and presses specific keys for advancing the story plot. In the final level, the player can choose between two possible endings: (a) provide life support to a dying human and go on a rocket to the moon, or (b) do not provide life support and let the human die; in both cases Earth becomes uninhabitable and dies as a consequence of global warming. Although *Carbon Clicker* has just one more component than *Albedo Pong*, the system representation in-game is more complex in that it displays a wider variety of phenomena that are related to climate change.

*Government Simulator* uses the Play structure of a *strategy* game in which the player acts as a politician (i.e., a government official) and makes political and economic decisions that impact the environment. The system is what we consider complex—it features 38 individual connections among the 16 climate-related components in the game, with six feedbacks, three of which are balancing and three of which are reinforcing (Figure 1, right). The game connects the player with Reality by letting him or her make decisions that resemble the ones politicians must take in real life, and the player can see their effect over time. Specifically, the player decides how to spend public money on resources and invest in either fossil-based or renewable energy; decisions affect the satisfaction of both local residents and corporations as well as global temperatures. Feedbacks from these decisions either reinforce the climate impacts (e.g., investment in fossil-based energy increases money with which to make further investments) or balances climate impacts (e.g., imposing a carbon tax results in less fossil fuel investment, which feeds back to lower temperatures). The Meaning of the game is to raise awareness of how political decisions impact the environment over time, and how to make responsible choices. The Play structure is simple: While the years pass (the game features a clock in the upper left corner that shows the annual flow of time), the player clicks buttons to decide between two possible choices at a time (e.g., investing in building more factories vs. planting more trees). Ecofriendly decisions make the population happy and lower the global temperature. On the contrary, less ecofriendly decisions are more profitable and make investors happier but raise global temperatures because of higher $CO_2$ emissions. This game represents a good example of a complex game that has many components, and it incorporates interactions in such a way as to demonstrate ways in which the behavior of complex systems can be emergent.

## Discussion

When designing their games, students were confronted with a suite of decisions, as is true for all modelers (Wilkerson-Jerde, 2014). They defined system boundaries, concentrated attention on specific system aspects, and conceptualized system behaviors. They drew on the climate science they had learned, and they had to integrate it with considerations of what they wanted the player to learn from playing the game, and of what the player experience would be like.

We began our analysis with an assumption that simple games would necessarily model simple systems. However, a third of the students either included at least one feedback or a loop connecting two related phenomena, thereby modeling more complex aspects of systems behavior. There are many possible reasons why, for many, feedbacks were not realized in their game designs. First, programming the logic operations and setting up the variables necessary to create feedbacks are advanced programming skills. Many students began participation in the unit not having had any prior Scratch experience and may not have had sufficient time to develop these skills. Second, the task of balancing Reality, Meaning, and Play is a complex one that even seasoned game designers struggle with (Salen & Zimmerman, 2004). Third, students were empowered to choose any topic within the general area of climate change; for some, it is possible that the Play consideration dominated their choice of topic. Hence, arcade-type games, in which the player races the clock to complete a task such as making $CO_2$ molecules disappear, or navigating a maze, or dodging obstacles, were the most frequent genre of game. Future research will enable us to elucidate these possible explanations and further refine instruction so that systems complexity can be taken up by the majority of students.

On the other hand, the three cases we discuss in this paper all demonstrate that simplicity of Play does not necessarily mean that the system Reality being modeled cannot be complex. For example, the designers of *Albedo Pong* carefully chose a few systems components, yet created a game that powerfully demonstrates the functioning of the important phenomena related to climate change. Despite the apparent simplicity of the game, the designers modeled a climate feedback, which is a central feature involved in polar warming and important in many other aspects of the complex global climate system as well. In this, their modeling represented mature practice, as described by, for example, Ingham & Gilbert (1991) and Windschitl (2013).

The curriculum framed the design task—designing a game to teach others—with the rationale of making game design an authentic task about an important and complex problem that has global ramifications, one that is meaningful to young people everywhere. The careful attention that these student designers paid to the Meaning aspect of their games attests to the success of this approach. It has implications with regard to framing the design task for others who would include game design as a tool to teach science. Finally, the results we present here continue to persuade us that game design has the potential to support systems thinking. Future research will elaborate how curriculum can be further refined, and how students can best be supported to represent their understanding of complexity in climate systems.

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# A Video Is Worth a Gagillion Words

## Enhancing Student Skills and Self-Efficacy Through a Video-Based Peer-Review Assignment

**Rabindra Ratan (Michigan State University), Stuart Braiman (TechSmith Corporation), Taj Makki (Michigan State University), Joseph Fordham (Michigan State University), and Chimobi Ucha (Michigan State University)**

**Abstract:** In order to elucidate how to improve active learning and collaborative engagement in large and online course contexts, the present exploratory research employed a mixed-method study examining a video-based peer-review assignment designed to help students advance their own video-creation skills and self-efficacy. Student participants ($N$ = 255) responded positively to the platform and feedback process but were critical of classmates' engagement and own video skills. Video production self-efficacy increased from pre- to postsurvey, especially for individuals with less previous video production experience. Further, students' intent to use video persuasively increased from pre- to postsurvey for those with less previous video-sharing experience. Overall, results suggest that education technology developers and practitioners could use similar approaches to facilitate active learning, but researchers should continue exploring the implications of such video-based assignments.

Active learning strategies—such as collaborative group work—are highly effective at facilitating student learning (Ertmer et al., 2007). However, large class sizes impede the potential for effectively incorporating active learning into course design by reducing the opportunities for meaningful interactions between students and with instructors (Cuseo, 2007). This is especially problematic for online courses and is perhaps one reason that the quality of online education is questioned (Gaskell & Mills, 2014). While many education tools facilitate interactions online centered around course material, using video for active learning is promising but impeded by uneven video literacy. Ultimately, such tools are understudied.

This research examines the potential for student-created videos to facilitate collaborative engagement and active learning in a large-course context. Students are often assumed to be media literate enough to navigate the technologies of video production and sharing—a digital camera and YouTube—but students are often less technically adept than expected (Lehman, DuFrene, & Lehman, 2010; Watson & Pecchioni, 2011). However, just as with traditional written-word literacy, students can be guided in their development of these skills in ways that will enhance their educational pursuits across many domains.

To this end, the present exploratory study focuses on the specific question of how to guide a student-created video assignment in a large class to help students advance their own video-creation skills—and their self-efficacy related to those skills—as a means of enhancing their active learning in the course through engagement with their peers. The mixed-method study presented here is based on a collaboration between university and industry researchers, using a novel video-feedback platform in its prerelease stage. Findings are applicable across a wide range of education and training contexts and provide insights relevant to researchers, education technology developers, and practitioners.

## Video-Based Peer Review: An Opportunity and Challenge

This research examines how video can be used to increase student engagement while also enhancing learning and success in the medium itself. Specifically, peer review (or peer assessment)—the process of producing and receiving feedback with fellow students (Nicol, Thomson, & Breslin, 2014)—facilitates active learning through collaboration and also increases personal motivation, content understanding, and, ultimately, student learning (Ballantyne, Hughes, & Mylonas, 2002; Vickerman, 2009). The cognitive process of providing constructive feedback to peers—as well as parsing the feedback from peers—is more involved than working in isolation, and thus helps students improve the quality of their own work, especially when given the opportunity for revision (Ertmer et al. 2007; Liu, Lin, Chiu, & Yuan, 2001).

Video-based peer review can harness the advantages of this type of assignment while facilitating online interactions that address challenges posed by large and/or online classes. However, such technology-based projects may require a significant investment of student time and effort, as these projects push students to engage in self-directed activities that differ from the traditional types of learning to which they are accustomed (Atkinson, 1994). Students' prior experiences, skills, and level of comfort with technologies can serve as challenges to this type of assignment (Groff & Mouza, 2008). Further, students may feel underqualified to provide consistent and fair feedback to their peers, especially when they are unfamiliar with the technologies being used (Ertmer et al., 2007). Nonetheless, students are capable of constructing the understanding and skills required to effectively engage in assignments based on novel technologies if they are sufficiently supported through the learning experience (Groff & Mouza, 2008).

## Video-Review Platform for Peer Review

The present research guided students through a video-based peer-review assignment that was designed to minimize student anxiety and maximize engagement. This multistep assignment required students to engage in an iterative process of drafting, providing and receiving feedback within a small group, and revising their videos based on that feedback. The assignment structure is consistent with the general structure of a peer-reviewed written essay assignment. However, while tools used to facilitate text-based feedback are commonplace (e.g., in-line commenting), the analogous tools for video editing are not.

A primary contribution of the present research is thus to test the effectiveness of a novel, video-review platform designed to efficiently facilitate peer review. This prerelease product, developed by the research team's industry partner, allows comments on videos to be linked to specific time points of the video. All group members are able to add to the threaded discussions initiated at these time points. This structures the feedback temporally and topically, which we expected would make the process of both providing and parsing feedback more efficient and effective. We predicted that many students would benefit from and thus appreciate this approach, but we also knew that some students might dislike it for various reasons (e.g., novelty, frustration, etc.). In order to better understand the students' perspectives, we examined the following research question: *RQ 1: What do students like and dislike about a video-based peer-review assignment with a video-review platform that facilitates threaded discussions?*

In addition to their general perceptions, we are interested in how such an assignment influences students' competence beliefs. To the extent that expectancies focus on future behavior, competence or ability beliefs (i.e., perception about own level of skill or competence regarding a particular task) focus more on present ability (Durik, Vida, & Eccles, 2006; Wigfield & Eccles, 2000). Several researchers have established a strong relationship between competence beliefs and performance such that when students are confident in their abilities, they tend to perform better (Wigfield & Eccles, 1992; Wigfield, 1994). Further, competence beliefs are closely related to self-efficacy—an individual's confidence in her ability to meet goals and overcome challenges—which is an essential element of the learning process (Bandura, 1977). This confidence arises in part from previous domain-specific experiences and accomplishments and in turn influences goals chosen and determination to attain those goals. Self-efficacy is thus a powerful predictor of future behavior across different domains (Bandura, 1986). Providing students with opportunity to increase self-efficacy in the domain of interest (e.g., video production) should, in turn, encourage them to pursue higher goals for their use of the technology toward their learning. Because the video-based peer-review assignment allowed students the opportunity to gain experience with a novel behavior, we expected that the assignment would contribute positively to students' video-production self-efficacy. *H1: Participation in a video-based peer-review assignment leads to increases in video-production self-efficacy.*

Bandura (1977) posits that past performance and mastery experiences with a specific behavior lead to a strong sense of self-efficacy for that behavior. People with less past performance have lower self-efficacy but also a greater potential for gains. For a video-making class assignment requiring minimal expertise, students with little previous experience would be expected to start out with lower self-efficacy but then display greater gains after the assignment. Thus, we hypothesize the following. *H2: Increases in video-production self-efficacy following a video-based peer-review assignment are greater for individuals with less previous experience in video production.*

In addition to self-efficacy, we are interested in whether such an assignment influences students' persuasive use of video, an important skill for media students specifically and communicators in the digital age more broadly. Given the hypothesized increase in self-efficacy for students with low previous video-production experience, we would expect an increase in persuasive use of video for students who have low previous video-sharing experience in their personal lives. Thus, we hypothesize the following. *H3: Increases in persuasive uses of video following a video-based peer-review assignment are greater for individuals with less previous personal video-sharing experience.*

## Methods

This institutional review board (IRB)–approved study was conducted in an undergraduate introductory media course with in-person lectures twice per week at a Midwestern American university. Participation was optional. Only those who provided consent were included in the analysis. The course instructor, a coauthor, did not have access to the data until after final grades were submitted. Of the 355 enrolled students, 166 men, 88 women, and one nonbinary student consented to participate (Note: only two survey participants chose not to consent).

This study focused on a class project for which students read a research article on culture differences related to media use and then interviewed another student from a different national or cultural background on the article's topic. Students presented their findings in five-minute videos. Using the industry partner's video-review platform (see Figure 1), students viewed each other's videos and left feedback at specific moments for at least five peers' videos within randomly assigned groups of 9–10 students. After providing and receiving feedback, students revised their assignments. Pre- and postsurveys were distributed immediately before and after the assignment start and finish, respectively.

This class project had been assigned to students in four previous semesters but with a written essay as the output. By transitioning the assignment to a video essay, we retained the original learning goals (i.e., encouraging intercultural communication and understanding between students) while adding a media-literacy component to the assignment.

Note that students were randomly assigned an instruction (homogenous within groups) to self-present in their videos either (a) formally, (b) semiformally, or (c) casually. This manipulation did not statistically influence any dependent variables examined at present and is included only as a control variable.

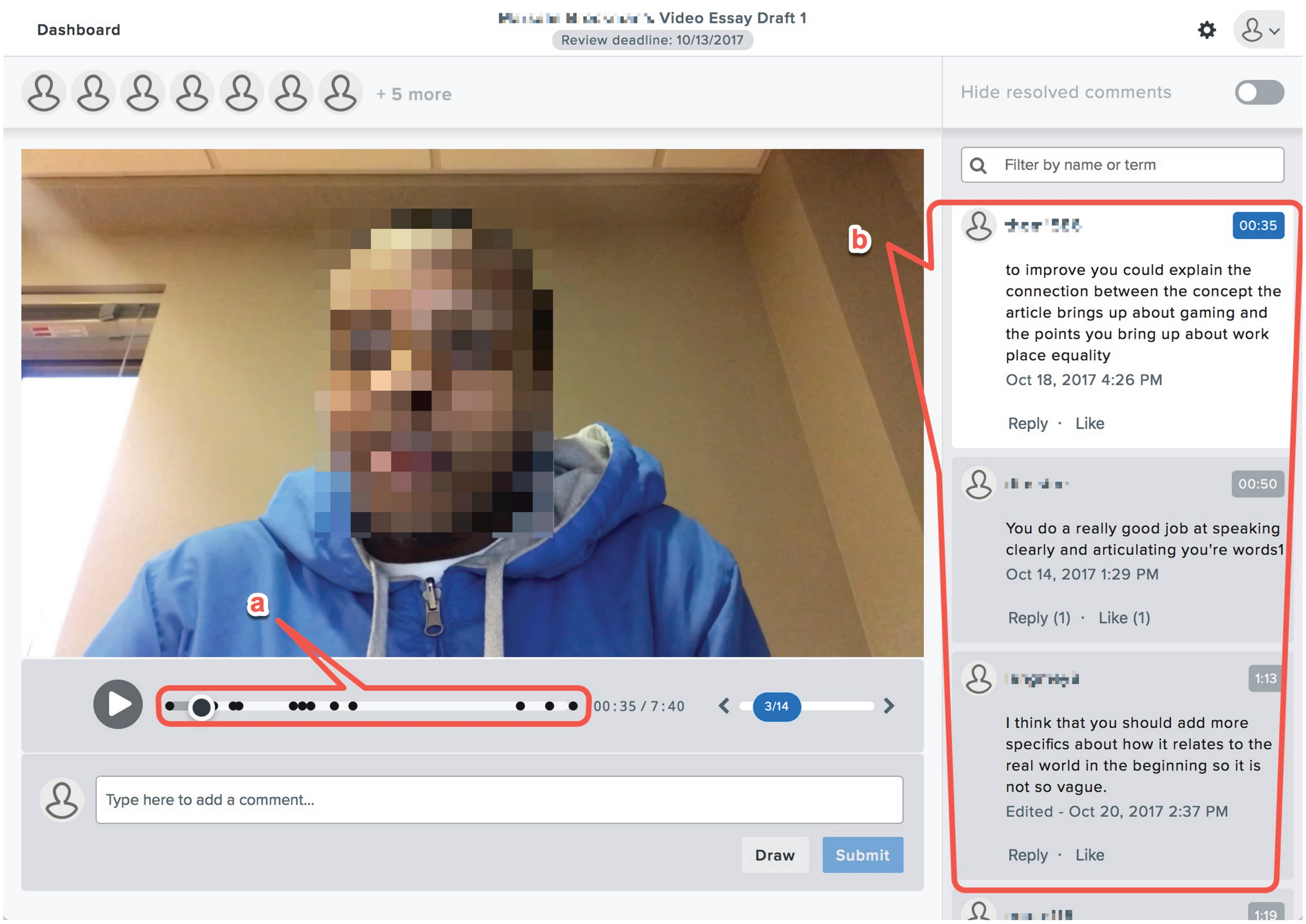


*Figure 1. Video-review platform in which participants enter feedback at precise locations timeline (a), generating a thread for multiple comments on the right side of the screen (b).*

## Measures

As the study's only qualitative measure, the postsurvey included open-ended prompts requesting thoughts about each assignment stage (draft, feedback, final version) and future video-making plans.

All remaining measures were quantitative and used a 7-point Likert-type scale ranging from *strongly disagree (1)* to *strongly agree (7)*. *Video-production experience* reflects the extent to which the students had been involved in general video-making tasks in the past. It was measured on the presurvey using seven items developed by the research team, such as "I have made videos to inform people about something" and "I have produced videos with a group of people." A composite measure was derived from item means ($\alpha = 0.84$, $M = 3.05$, $SD = 1.47$). *Video-sharing experience* reflects how often students share videos with others and was based on three presurvey items developed by the research team, such as "How often have you shared videos that you have made with others on social media" and "How often have you streamed a video of yourself or your actions (e.g., twitch)?" A composite measure was derived from item means ($\alpha= 0.71$, $M = 2.31$, $SD = 1.47$). *Video production self-efficacy* reflects students' beliefs about how competent they are in their abilities to make or edit videos. It was measured on the pre- and postsurvey with six items developed by the research team, including, "I am confident/knowledgeable at making videos" and "I am confident/knowledgeable about editing videos." Composite measures were derived from item means (presurvey $\alpha = 0.95$, $M = 2.92$, $SD = 1.78$; postsurvey $\alpha = 0.94$, $M = 3.38$, $SD = 1.58$). *Persuasive video use* reflects the extent to which students would "choose video over other channels (e.g., pictures, text)" in order to "persuade others about something." Descriptives for this single item were as follows (presurvey $M = 2.81$, $SD = 1.86$; postsurvey $M = 2.96$, $SD = 1.93$).

## Results

To examine what students liked and disliked about the video-based peer-review assignment (RQ1), three research team members identified the most poignant positive and negative open-ended responses that represented clear themes. Only two out of hundreds of comments directly addressed the video-feedback platform itself. Both were positive, one offering a general compliment ("The program is awesome! I would love to use that more") and one addressing the feedback mechanic ("I like how you can comment at specific times in the video & I found the feedback to be very helpful"). One additional comment indirectly addressed the platform ("I am a huge fan of criticism. This provided a structured platform for criticism"). Overall, we infer that the platform contributed productively to the experience.

The value of feedback in this assignment was a clear positive theme, exemplified by comments such as:

- "It was also nice to see where other students were in their projects. The peer feedback model is really effective when used correctly."
- "Feedback really helped, as it provided a perspective that would not be biased."
- "Going through other individuals' videos also allowed me to see what I wanted to improve on mine, and making sure that I would not have the same mistakes."
- "Giving others feedback was really nice because helping others is a good way of getting better."

However, some valid critiques of the feedback process were raised (e.g., "I do wish that my classmates would have been more helpful with their comments. To be clear, all of my classmates were supportive and encouraging, but that did not always translate to helpful criticism"). Such critiques reflect disappointment in classmates' engagement in the assignment, but a more overwhelming self-critical theme emerged (e.g., "I did not feel comfortable about giving feedback to others because I felt hypocritical as my video was done extremely poor for a first draft"). Most consistently, students expressed a lack of confidence in this domain (e.g., "Everyone's drafts looked much better than mine, which was a little discouraging"), which impacted their perception of the feedback (e.g., "It was intimidating and a little stressful since I have little-to-no video experience.") These comments support this study's fundamental assumption that many students are uncomfortable in this medium and thus need guidance to improve their skills and confidence. Some comments suggested that our assignment fulfilled this need (e.g., “As I got use to the situation, it became easier and I felt more relaxed.”), as did the quantitative analyses.

To test the expectation that the video-based peer-review assignment led to increases in video-production self-efficacy (H1), especially for individuals with less previous experience in video production (H2), we conducted a repeated measures ANCOVA with pre- and postsurvey video self-efficacy as the dependent variable, video-production experience as the independent variable, and student gender and self-presentation instructions as control variables. Video-production self-efficacy significantly increased from pre- to postsurvey $F(1, 204) = 42.56$, $p < .001$, $\eta_p^2 = .17$, supporting H1. There was a significant interaction between time and previous video-production experience, $F(1, 204) = 38.94$, $p < .001$, $\eta_p^2 = .16$. Estimated marginal means with median-split video experience suggest that people with lower previous experience gained video-production self-efficacy at a higher rate than people with more experience, supporting H2 (see Figure 2, left). The control variables had no statistical effect.

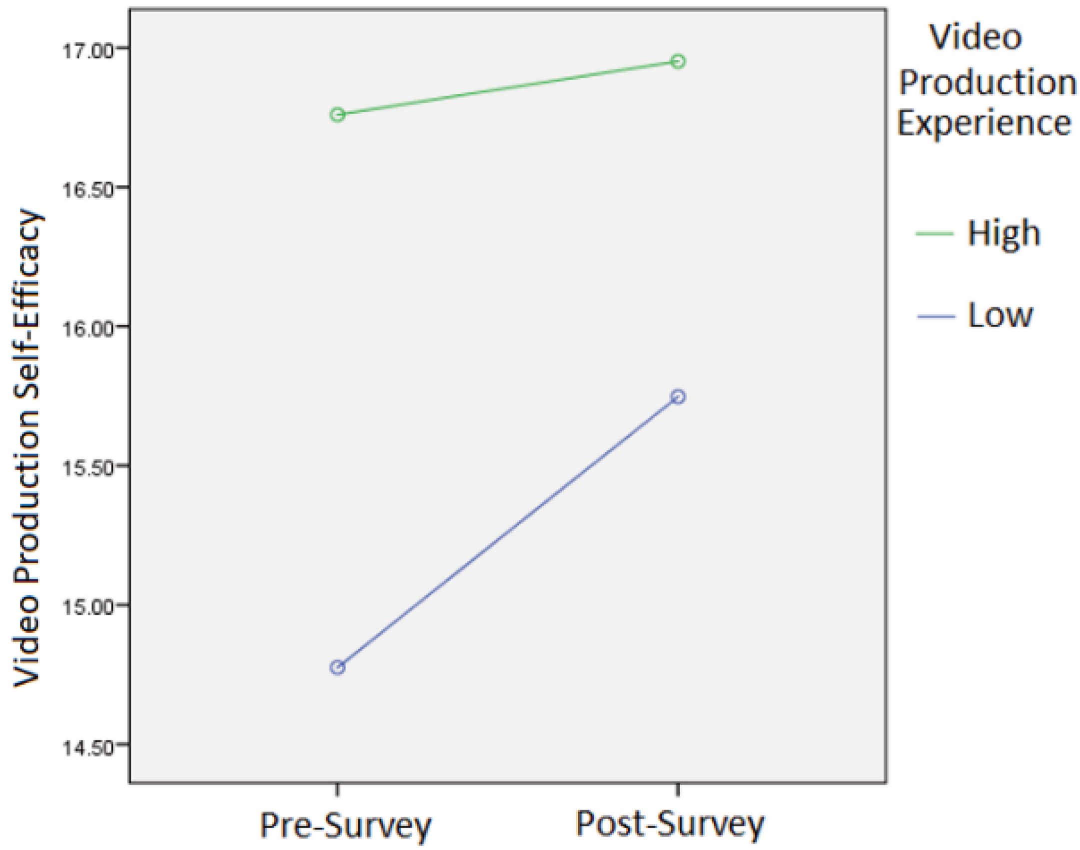


*Figure 2. Estimated marginal means of video-production self-efficacy, from pre- to post-, by median split video-production experience (left) and estimated marginal means of persuasive video use, from pre- to post-, by median split video-sharing experience (right).*

To test the expectation that people with less previous personal video-sharing experience exhibit greater increases in persuasive use of video following the assignment (H3), we conducted a repeated measures ANCOVA with pre- and postsurvey persuasive video use as the dependent variable and video-sharing experience as the independent variable. In addition to gender and self-presentation instructions, previous video-production experience was included as a control variable because of the previous test's findings and the potential correlation between this variable and video-sharing experience. The main effect of time on persuasive video use was marginally significant, $F(1, 200) = 3.59$, $p = .06$, $\eta_p^2 = .02$. More important, there was a significant interaction between the time factor and previous video-sharing experience, $F(1, 200) = 19.08$, $p < .001$, $\eta_p^2 = .09$. Estimated marginal means with video-sharing experience as a median-split variable suggest that those with less experience reported a greater increase in persuasive video use after the assignment relative to those with more experience (see Figure 2, right), supporting H3.

## Discussion

In order to elucidate how to improve active learning and collaborative engagement in large-course contexts, the present research examined a video-based peer-review assignment designed to help students advance their own video-creation skills and their self-efficacy related to those skills. Students responded positively to the video-review platform as well as the feedback process in general, though some were disappointed in their classmates' engagement. Many students were self-critical, expressing low confidence in their video skills and thus discomfort with the feedback process, but their engagement in the assignment helped to alleviate this. As quantitative evidence for this, video-production self-efficacy increased from pre- to postsurvey, especially for individuals with less previous experience in video production. Further, students' intent to use video for persuasive purposes increased from pre- to postsurvey for those with less previous personal video-sharing experience.

The present study advances our understanding of classroom technology use and peer assessment in several ways. Existing peer-review research has focused mainly on peer assessments of written works (e.g., van den Berg, Admiraal, & Pilot, 2006; Vickerman, 2009), with sparse prior work of which we are aware examining the peer-review process in multimedia contexts (i.e., video feedback). Furthermore, existing literature on video projects and the potential value of these projects tends to focus on students studying English as a second language (e.g., Aksel & Gürman-Kahraman, 2014; Ting, 2013), and has received less attention as an alternative to written assignments among primarily English-speaking students. Thus, the present research contributes a unique understanding to an understudied context.

This study's limitations should be noted. This study was conducted in a media course in which participants presumably have relatively high video literacy, potentially reducing generalizability. However, many reported low video-making self-efficacy, and thus we expect that the findings would be replicable in other college-age samples. Also, the class instructor was directly involved in the study, which may have influenced participant performance. We believe that instructor involvement did not affect any of the patterns observed in this study, though future research should be conducted in contexts where the primary researcher is less involved with the participants. Further, students were assigned to group sizes of 9–10 for logistical reasons, but future research could experiment with smaller group sizes in order to reduce social loafing and increase the mutual responsibility of each student. Also, the course was conducted in person, and while the assignment of interest took place online, the larger offline course context may have influenced students' experiences in ways that limit generalizability to purely online courses. Finally, many students complained that the feedback they received was vague or uncritical. Future research should examine how to encourage students to move past their politeness and hesitation to offer actionable, constructive feedback, which might be more challenging in video than written formats because of social norms. Overall, the results presented here suggest that education technology developers and practitioners could use similar approaches to facilitate active learning in large-course contexts, but researchers should continue to explore the implications of such video-based assignments.

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# Exploring Authenticity and Playfulness in Teacher Practice Spaces

**Justin Reich (Massachusetts Institute of Technology), Yoon Jeon Kim (MIT Teaching Systems Lab), Kevin Robinson (Massachusetts Institute of Technology), Dan Roy (Massachusetts Institute of Technology), and Meredith Thompson (Massachusetts Institute of Technology)**

**Abstract:** Teacher practice spaces are learning experiences, inspired by games and simulations, that allow novice teachers to rehearse for and reflect on important decisions in teaching. Practice-based teacher educators use various approaches to simulation in methods courses, and these simulations often attempt to holistically replicate the complexity of teaching conditions. In this research, we present a range of practice spaces that do not attempt to replicate teaching but explore design spaces with varying levels of authenticity. We define 4 dimensions of authenticity in teaching simulations: authenticity of complexity, of situation, of role, and of task. We discuss how these dimensions of authenticity intersect with playfulness in the examination of 4 case studies of teacher practice spaces. We hypothesize that authenticity of task is essential to most teacher practice spaces, but interesting new design spaces can be found by moving away from other dimensions of authenticity.

## Introduction

Every great teacher knows that skill development requires practice (Ball & Forzani, 2009); ironically, teachers themselves have limited opportunities to practice important teaching moves in low-stakes settings. In a comparative study of teachers, social workers, and therapists, Grossman and colleagues (2009) conclude that "prospective teachers have fewer opportunities to engage in approximations that focus on contingent, interactive practice than do novices in the other two [helping] professions." Currently, novice teachers primarily learn in two types of spaces: Socratic seminar rooms in teacher-education programs (or lecture-heavy workshops for in-service professional development) and practicum classrooms. The former affords discussion and the latter affords immersion into the challenges of teaching, but a third space—a practice space—is needed that combines an authentic experience of teaching with carefully designed scaffolds that support the development of teachers' skills and identity. In our research, we design teacher practice spaces, inspired by games and simulations, that allow teachers to rehearse for and reflect upon important decisions in teaching.

The word *practice* takes on multiple meanings in teacher education—practices are the set of activities that teachers employ in their work and practice is the rehearsal and preparation required to expertly deploy those activities in classrooms (Lampert, 2010; Schön, 1987). The last decade has seen tremendously productive design research into this line of inquiry. For instance, Kazemi, Franke, and Lampert (2009) define a cycle of enactment in which teacher candidates participate in lessons with particular instructional activities as students, and then candidates analyze the lesson, identify strengths and alternative pathways, prepare a plan for teaching with the protocol, and then take turns rehearsing their lesson with other candidates acting as students. The Sposato School of Education promotes similar cycles of scripting instructional moves, practicing in simulations with colleagues, and then receiving coaching from peers and mentors. Field-mediated experiences are another innovative approach to practice, where entire methods classes visit the classrooms of cooperating teachers for immersive coaching experiences with small groups of K–12 students (Horn & Campbell, 2015).

In addition to the program- or course-level practice-based curriculum design, researchers have created stand-alone simulations that aim to replicate the complexity of real moments of teaching. For instance, Mursion is a mixed-reality medium in which teachers practice in front of a computer monitor with a series of student avatars (Mursion, 2017). The student avatars are controlled as “digital puppets” by a remote actor who can see and hear the teacher through networked video cameras. Dotger (2013) designs clinical simulations, adapted from medical education, for preservice students. Teacher-learners interact with in-person actors who are trained with the background story and motivations of a parent, student, or colleague with some particular problem or dilemma. Through preparation, role-play, individual reflection, and peer discussion, novice teachers rehearse for challenging situations in low-stakes settings. Self (2016) has adapted Dotger’s model to address issues of culturally responsive teaching. Research into pedagogies of enactment shows promising results in helping novice teachers be prepared with specific techniques and strategies as they begin classroom teaching.

We observe that most efforts at practice in teacher education aim to approximate as completely as possible the experience of classroom teaching. To borrow an analogy from sports, most of these simulations are like “scrimmages,” which are close analogues to the complete game. We believe that interesting design spaces can be found by exploring what “drills” for teacher education might look like, where we engage teacher-learners in nonteaching activities that help them develop skills and dispositions that are useful for teaching. When training young violinists, music teachers often use bow games: silly songs where violin learners sing and vigorously wave their bow with specific motions while maintaining the correct grip on the bow handle. Young soccer athletes play games such as keep-away to develop ball-handling skills. A violinist will never wave her bow maniacally above her head in a recital, and a soccer player will never play keep-away during a match, but these drills isolate particular skills for development that are then reintegrated—ideally with greater competency—into the complex assemblage of the whole activity. Our teacher practice spaces aim to introduce new kinds of drills into teacher education, and if these drills prove successful, then they could be placed alongside discussions of theory, holistic simulation, and field placements in the repertoire of teacher educators. Our work is driven by two overarching design questions: (a) What are the affordances and constraints offered by different dimensions of authenticity in the design of teacher practice spaces, and (b) what new design opportunities open up when relaxing constraints of authenticity?

## Background and Context

Grossman and colleagues (2009) define a three-part framework for learning in the helping professions (teaching, social work, etc.): *representation, decomposition*, and *approximation.* Teacher educators share representations of teaching (examples of lesson plans, videos of teaching) and then decompose and highlight important elements (pacing, classroom-management strategies, questioning techniques) from those representations. Teacher-learners then approximate these practices in a variety of ways, such as writing sample lesson plans or teaching mock lessons. The development of strategies for incorporating these approximations in teacher education are sometimes called *pedagogies of enactment* (Kazemi et al., 2009).

Within pedagogies of enactment, one dimension of authenticity that has been well theorized can be called *authenticity of complexity.* As Grossman et al. (2009) explain, one of the tensions with pedagogies of approximation is how much to approximate. Teaching requires deploying skills simultaneously in a complex assemblage—in a real classroom a teacher is simultaneously watching the clock, evaluating student attentiveness, drawing on knowledge about student relationships and competencies, and making decisions about pacing, behavior management, and student agency. Each of these teaching decisions is intimately entangled with the others, so a tension emerges between isolating skills out of the complex assemblage for practice (since the isolated skill is easier to address than the whole assemblage) and recognizing that none of these elements is actually isolated in real classrooms. Some of Mursion's virtual teaching scenarios attempt to embrace this full complexity by having teachers teach lessons in front of a set of students with differing levels of understanding and classroom-management issues. Dotger's scenarios elide some of these issues by focusing on very realistic scenarios from teaching that are less complex than classroom teaching, such as talking to a single parent.

A parallel set of dimensions of authenticity can be called *authenticity of situation*, which we can break down into three subdimensions: *authenticity of setting*, *authenticity of role*, and *authenticity of task.* As noted above, most examples of pedagogies of enactment have taken authenticity of setting as a given: Most approximations in teacher education take place in realistic settings such as classroom teaching or meeting with parents. From the literature of game-based learning, there are good reasons to believe that games and simulations can support learning in fabricated settings that feel realistic. Games, like much of teacher education (Nolen, Horn, & Ward, 2015), are fundamentally grounded in theories of situated cognition (Brown, Collins, & Duguid, 1989). Gee (2004) posits that well-designed games can situate players perceptually, narratively, and socially in a way that leads to empathetic embodiment for complex systems. Within these deeply situated contexts, teachers can develop new skills, confront prior understandings, and work through problems in an embodied way (Gee, 2007).

Teacher educators, in part of out of logistical necessity, have regularly experimented with differing approaches to authenticity of role. To help one novice teacher role-play as a teacher, other novice teachers need to role-play as students, parents, or others. Beyond this logistical value, advocates of role-playing in teacher education have noted the value of role-playing as students, to understand people from diverse perspectives (Gay & Kirkland, 2003), empathize with the challenges of adolescence, or to remember the particular difficulties that novices face in understanding instruction from experts. Identity has also been a major consideration among game-based learning researchers. Games create opportunities for "projective identities," in which the identities and play decisions adopted in a game space are shaped by learners' beliefs outside the magic circle (Gee, 2007). As players reflect on their real and adopted identities, they have the opportunity to rethink their beliefs and empathize with others.

Authenticity of task can be defined as the degree to which a given task is an approximation of the real work of teaching, independent of whether or not it takes place in the real setting of teaching. In the violinist's bow game, authenticity of task is maintained by having the correct bow hold be the central objective of the game, even as authenticity of complexity is minimized (the violinist need not read music nor bow the strings) along with authenticity of setting (as bow games are designed for practice rather than performance). In teacher practice spaces, authenticity of task means that teachers are deploying realistic reasoning or technique, even as they engage in playfully unrealistic activities.

Our design hypothesis is that moving away from one or more of these dimensions of authenticity opens up a wider design plane for teacher practice spaces with more opportunities for including playfulness. In our design work, we view playfulness as a worthy aim in its own right. Playfulness leads to intrinsic motivation, enjoyment, and engagement (Hamari et al., 2016). From a game-based learning perspective, playfulness creates opportunities for exploration of new identities, beliefs, or techniques in a low-stakes setting. And as Grossman et al. (2009) pointed out, in the context of teacher education, the medium is the message. That is, we believe that if novice teachers can learn how to become effective teachers in a playful and engaged way, they will continue to carry out the same approach to learning with their own students.

Over the past two years, we have used design-based research methods (Easterday, Rees Lewis, & Gerber, 2014) to develop a diverse set of practice spaces. In our design process, we typically begin with construct development, in which we identify a skill that we want novice teachers to develop and then consider what the skill looks like when expertly deployed in the classroom. Put another way, we often begin development by considering what an authentic task looks like when expertly deployed. We then prototype playful experiences that allow novice teachers to enact these skills or practices. The ideal design team includes a combination of teachers and teacher educators with a deep understanding of the targeted constructs along with game designers who bring encyclopedic knowledge of existing game mechanics. We iteratively improve new practice spaces through frequent playtests among our lab members along with regular lab-based playtests with preservice teachers, in-service teachers, and teacher educators. We refine our practice spaces and develop curriculum within which to embed them through field tests in teacher-preparation programs or in-service teacher professional development. In the projects discussed below, our field test partners include the MIT Scheller Teacher Education Program, West Virginia University, the College of St. Scholastica, Code.org, Exploring Computer Science, Mobile CSP, and the Hartford Magnet School in Connecticut, all of which have provided invaluable feedback on the projects.

In what follows we briefly describe early research on four of our practice spaces, and then we provide some examples of how different practice spaces address issues of authenticity, and how dimensions of authenticity interest with playfulness. Playable demos, game materials, curriculum suggestions, and other resources for all of the practice spaces described below can be found at tsl.mit.edu/practice.

## Authenticity and Playfulness in Teacher Practice Spaces

### *Baldermath*

Math-education research shows that novice teachers typically engage in three unhelpful practices when looking at student work: fixating on whether the answer is correct, making assumptions about the demographics or intelligence of the student, and making assumptions about the quality of instruction received (Pershan, Kim, Thompson, & Reich, 2017). By contrast, the most useful practices are looking closely at specific details of student work and making inferences and hypotheses about student thinking and understanding, the kind of thinking provoked by Notice and Wonder protocols.

*Baldermath* is a bluff-the-judge game about looking at student work (Pershan et al., 2017), co-designed by the author of the MathMistakes.org blog (Pershan, 2017), an online space where teachers discuss interesting errors from math students. To play the game, a judge leaves the room, and four players are given a homework problem taken from a fourth-grade classroom. One contestant is given an actual piece of student work for the problem, completed by a student with an incorrect or incomplete understanding of the problem. This contestant copies the work in her own hand and then invents a rationale for why the student thought she or he was correct. The other contestants invent incomplete or incorrect answers to the problem as well as their own rationales. The judge returns to the room, and the contestants role-play as students and explain their concocted rationales along with details of their (fabricated or real) student work. The judge then guesses which is the “real” student work. As with *Balderdash* or the *Wait, Wait*

*Don't Tell Me News Quiz*, correct guesses are fun for the judge and incorrect guesses are fun for the winning contestant.

In *Baldermath*, the game mechanic naturally encourages players to adopted productive practices of looking at student work while eschewing the unhelpful ones; the game is fun and winnable only by thinking carefully about student representation of thinking. In debriefing the game experience, facilitators can show teachers how the practices developed playfully during *Baldermath* can be productively applied to looking at student work in homework and classwork settings. Early evidence from near-transfer tasks suggests that game participants notice more details in student work and comment on them more after playing the game.

The design of *Baldermath* is anchored in an authentic task, looking at student work, where expert practice is well understood by math-education researchers. Aside from authenticity of task, the game avoids other dimensions of authenticity. The setting of fabricating student work is an artifice, no player acts in the role of a teacher, and the complexity of looking at student work in a classroom in real time is reduced by the game format. Abridging these dimensions of authenticity seems essential to allowing the playful elements of the game to emerge: Participants enjoy trying to think and write like students, and they enjoy employing mathematical reasoning in the service of bluffing and detecting.

### TeacherMoments

TeacherMoments is a simulation designed for handheld devices, in which participants are immersed in short vignettes of teaching life rendered in text, animation, or video, and participants respond to scenario "triggers" with text or improvisational audio responses (Owho-Ovuakporie, Thompson, Robinson, & Reich, Manuscript submitted for publication). In live-actor clinical simulations used in teacher education (Dotger, 2013), actors are trained to portray parents or students in a specific situation. Briefing books given to actors include the background of the character and situation, as well as a series of "verbal triggers" that actors are supposed to include in the conversation (such as "You only called me out because you are racist" or "But what will do you when my [autistic] son hugs someone at an inappropriate time?"). Since these actors are meant to create standardized situations, TeacherMoments tests the viability of encoding these interactions entirely in text and video. For instance, Dotger (2013) has developed a series of parent simulations, including one in which a parent is upset because a class is too hard; in TeacherMoments, we record six video sequences of an actor playing this parent. Novice teachers participating in the simulation are required to provide improvised audio responses after each recorded conversational turn. In Dotger's live-actor role-plays, his four goals for participants are that (a) they experience the interaction as authentic, (b) the scenario generates a feeling of cognitive disequilibrium, (c) participants demonstrate an ability to remain calm under pressure, and (d) they can articulate some element of their teaching philosophy in response to the verbal triggers. Our playtests suggest that these four goals are met within the experience of TeacherMoments, even though our "actor" is prerecorded rather than live. Given that teachers may never meet a parent during their practicum experience, this application of TeacherMoments gives teacher-learners a chance to practice an important dimension of teaching before their induction period.

TeacherMoments is designed so that teacher educators can create different kinds of scenarios and case studies to rehearse different competencies. We have created a series of scenarios that help students address equity-teaching practices in computer science (CS) instruction (Robinson & Reich, 2018). Integrating culturally responsive pedagogies in computer science classrooms requires attention to curriculum design and classroom practices and routines, but the "last mile" of equitable teaching is the in-the-moment decisions made by teachers. Equity-teaching practices that can shape in-the-moment teaching decisions include addressing preparatory privilege (the advantages of experience that many students, especially white and Asian boys, bring to CS classrooms), acknowledging students' intersectional identities, and adopting asset framings. Pedagogies of enactment, such as TeacherMoments simulations, are particularly effective for surfacing what Dotger and Ashby (2010) call "conditional inclusive ideologies." These are beliefs about equitable teaching that novice teachers espouse in discussions but often fail to act upon in specific circumstances. For instance, in one of our equity scenarios, two students are assigned a paired activity and one student asks to be allowed to move on to more advanced work rather than work with his disengaged partner. Even participants who articulate concerns about preparatory privilege in general may choose in the scenario to be more concerned with providing additional challenging work for the advanced students rather than addressing how his behavior may be marginalizing his partner. We find, following Dotger and Ashby, that pedagogies of enactment and participating in our interactive case studies are effective mechanisms for surfacing teachers' conditionally inclusive ideologies and opening up new conversations about the competing values that shape teacher decision making.

Most participants do not experience any of our implementations of TeacherMoments as particularly playful. In part, this is a function of the topics that we have chosen to explore—it may be that examining issues of marginalization and inequity should rarely or never be playful. However, it is also the case that TeacherMoments maintains authenticity of task, of role, of setting, and some degree of authenticity of complexity. Teacher-learners find the experience worthwhile, but not necessarily playful.

### *Eliciting Learner Knowledge (ELK)*

*Eliciting Learner Knowledge (ELK)* is a two-person online game, with one person role-playing a teacher and another role-playing a student (Thompson, Roy, Wong, Reich, & Klopfer, 2018). In the *ELK* platform, players have a conversation through a text-based, chatlike interface. This format has two potential advantages over in-person role-plays: The transcript of the conversation allows for immediate reflection on specific, documented details in the exchange, and the conversation can occur when two people are not in the same location, as will be increasingly common as more teacher education happens online. Each round of the game focuses on a conceptual topic in science such as chemical reactions, evolution, or energy, or a topic in mathematics such as rational numbers, fractions, and proportions.

At the beginning of the game, each player receives instructions and a brief overview of the game; the person role-playing the teacher receives a learning objective and the person role-playing the student receives a learner profile with details of the conceptions and misconceptions held by the student being role-played. Players review the profiles, engage in a synchronous seven-minute conversation, and then both players take the same true/false quiz as if they were the "student." To encourage collaboration and communication between the players, the quiz is scored on (a) how well the student portrays the student profile, and (b) how well the teacher estimates the student's understanding. *ELK* has two goals: to help preservice and in-service teachers understand questioning strategies and to learn about possible student misconceptions.

*ELK* reduces authenticity of complexity by focusing on a single student–teacher interaction and by asking participants to set aside considerations of the student–teacher relationship and goals for advancing understanding to focus entirely on eliciting student thinking. It maintains authenticity of task, authenticity of role, and authenticity of setting. *ELK* has more game elements than TeacherMoments, such as points, goals, and a timer, but it also rarely gets described by participants as playful.

### *Committee of N*

*Committee of N* is a design-based card game for exploring education history and policy through school design (Haas, Reich, Feely, & Klopfer, 2016). Participants play as consultants charged with designing elements, such as classroom design or graduation requirements, of a new high school. Each *Committee of N* deck includes eight of these design elements, along with different sets of "value cards" representing belief commitments from the fictional new school. Participants work in pairs, and each round they are dealt hands that include one school-design element, and then three school values. Values can include purposes of education (e.g., assimilating immigrants or career/college readiness), theories of learning (e.g., behaviorism to constructionism), instructional methods (e.g., apprenticeship or flipped classroom). A pair might be asked to design the bell schedule for a school inspired by behaviorism, committed to vocational education, and enamored of project-based learning. Pairs create four to eight of these design elements, and then join up with several other pairs to create a school out of their elements. Teams then pitch these joint schools to a panel of "school committee" judges.

For many novice teachers heading out into the field for observations, the elements of a school seem fixed and immutable. *Committee of N* helps novice teachers see that every practice, every fixture, every routine within a school was designed at some point in history by people who held a set of values, and if we no longer hold those values we can design new school elements to match our new values. Not every change is equally easy—extracurricular activities can be redesigned easily whereas most communities can build a new school building only every few decades. Nonetheless, recognizing that school elements were once designed empowers novice teachers to imagine how they might be designed anew. Many students adopt the heuristic of describing the "value cards" underlying the practices and fixtures they see in their school observations. The game mechanic underneath *Committee of N* is essentially the same mechanic as a Tarot reading: Players create stories about the future guided by a series of arbitrary constraints, and by imagining different possible futures, players can reflect on which futures they would like to try to bring about in the world.

In some respects, *Committee of N* moves furthest from authenticity: The situation is far afield from teaching, participants play as consultants, the task is one that first-year teachers are unlikely to encounter as teachers, and even if the thinking work is complex, the work of consulting is orthogonal to the complexity of teaching. Participants do typically find the experience playful. They enjoy the creative enterprise of imagining new schools, and they especially enjoy developing school elements based on absurd combinations of elements. What feels authentic within the task is the practice or disposition of assuming that school elements embody values, and that decoding those values can reveal how school elements fit together, neatly or uncomfortably.

## Design Conjectures: Authenticity and Playfulness in Teacher Practice Spaces

Drawing generalizations from small data sets is always a risky endeavor, but nevertheless in the section we set forth three design conjectures that we adduce from our set of four cases.

First, authenticity of task is the preeminent consideration in the development of teacher practice spaces. *Baldermath* and TeacherMoments are both rich experiences for novice teachers because the intellectual work in the practice space develops skills and dispositions that support good teaching. Anchoring on authenticity of task may allow for more flexibility in changing other dimensions of authenticity. Even in *Committee of N*, which seems far afield from the work of teaching, players engage in thinking patterns—imagining different kinds of schools or connecting school elements to their underlying values—that prove valuable in both understanding school environments and navigating change within them.

Authenticity of task is essential, but other forms of authenticity may be obstacles to playfulness. In our set of four practice spaces, TeacherMoments is the least gamelike and the most simulationlike, and most teachers do not find the experience playful, even if they do find it meaningful and worthwhile. While the interaction in *ELK* is quite authentic, players experience the chat interface as artificial. This allows some element of playfulness, yet it still does not feel like a game to most teachers. By contrast, a practicing teacher will never need to fabricate incorrect student work as in *Baldermath.* Yet because of this, teachers' experiences with *Baldermath* are more playful. We find in our feedback across playtests of these different environments that typically the closer an activity replicates authentic teaching practice, the less likely it is to feel playful and fun. It may still feel authentic, challenging, and worthwhile, but novice teachers typically do not experience practice spaces that maintain authenticity of setting as playful.

Finally, within practice spaces, we see varying approaches to embedding "good practice" or "expert practice" within the design of gameplay. The game-development process for *Baldermath* began from a clearly defined construct for looking at student work—with well-defined productive and unproductive practices, and the mechanics of the game naturally guide participants away from unproductive practices and toward productive ones. A simple debrief at the end of the experience may be sufficient for novice teachers to consciously adopt these new practices. *Committee of N* does not scaffold a specific teaching skill per se, but participants learn a useful heuristic—the idea of values underlying a school design element—that can help them better understand the constraints of their context. Our hypothesis is that teachers will improve their assessment practices because they empathize more closely with how students experience rubrics and recognize more deeply the tensions in designing effective rubrics. So within the notion of authenticity of task, we see divergence into experiences that deliberately guide players toward expertise versus those that encourage players to "admire the problem." We see promise in exploring both pathways.

In future work, we plan to continue to explore these dimensions of authenticity and playfulness and explore new ways for preparing teachers with specific skills, dispositions, and knowledge that they can integrate into the complex work of classroom teaching. While player feedback from these games suggests that novice teachers find them enjoyable, provocative, and useful, another important dimension of research will be to evaluate whether and how they work in actually improving teaching practice. In future research, we plan to observe novice teachers before, during, and after playing with practice spaces to see whether participation in practice spaces leads to meaningful changes in teacher practice.

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# A Participatory Evaluation of an Innovative Technology-Based Program for Adolescents With Autism

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**Abstract:** Autism spectrum disorder (ASD) is defined by sociocommunicative difficulties and restricted, repetitive behaviors and/or focused interests. Focused interests can motivate people with autism to obtain expertise in their interest areas, which are often expressed through a systematic approach to learning and an affinity for computers, mathematics, and science. Created with the goal of bolstering science, technology, engineering, and math (STEM) skills among teens with ASD, Tech Kids Unlimited (TKU) provides previously unavailable opportunities for youth with ASD in New York City to develop authorial computing skills. The current study, an initial evaluation of TKU's summer curriculum for adolescents with autism, highlights program design, students' own goals for the future, and successful instructional techniques to facilitate learning. A curriculum adaptation based on evaluation results is presented.

## Introduction

Autism spectrum disorder (ASD) is defined by symptoms that limit functioning in two domains: social communication and restricted, repetitive patterns of behavior and/or focused interests (APA, 2013). As individuals with ASD enter adolescence and adulthood, many struggle with establishing independence, advocating for themselves, and developing social relationships (Kapp, Gantman, & Laugeson, 2011). However, ASD is associated with notable strengths, including heightened attention to detail (Mottron, Dawson, Soulieres, Hubert, & Burack, 2006) and an enhanced ability to recognize and create patterns and systems (Baron-Cohen, 2009).

People with ASD often express their focused interests through a systematic approach to learning and a strong affinity for computers, mathematics, and science (Baron-Cohen, 2009; Jordan & Caldwell-Harris, 2012). This paper presents data from a participatory summerlong study of an informal technology-based educational program designed to help youth with ASD transition into science, technology, engineering, and math (STEM) fields. The primary aim of this study is to use student and parent perspectives to assess and adapt a maker-based technology curriculum. A secondary aim is to explore if connecting to a community of neurodiverse individuals through a shared interest in technology influences self-understanding and perceptions of autism. A curriculum model, informed by results of this summerlong evaluation, is presented as a working example of future program directions.

## Background

The specific skills and interests exhibited by many individuals with ASD should make them well suited to meaningful careers in STEM fields. Nevertheless, the employment outcomes of people with ASD often fail to reflect their potential. Data drawn from a nationally representative sample of youth receiving special education services in the United States revealed that 44.9% of youth with ASD had never obtained any form of paid employment in the six years after college (Shattuck et al., 2012). Young people with ASD remain chronically underemployed (Nord, Stancliffe, Nye-Lengerman, & Hewitt, 2016; Taylor & Seltzer, 2011) despite their heightened interest in computers and in STEM fields (Gillespie-Lynch, Kapp, Sane-Simpson, Smith, & Hutman, 2014; Wei, Jennifer, Shattuck, McCracken, & Blackorby, 2013) and the growing need for professionals who specialize in STEM fields (Bureau of Labor Statistics, 2015; West, 2012). This gap between the potential that people with ASD have to contribute to society and the difficulty they face attaining opportunities to do so is particularly striking given the large number of people affected by ASD. The current prevalence estimates of ASD in the United States range between 1 in 45 and 1 in 68 young people (Christensen, 2016; Zablotsky, Black, Maenner, Schieve, & Blumberg, 2015).

## Technology Programs for Students With ASD

Given that increased aptitude and affinity for technology is common in autism (Baron-Cohen, 2009; Wei et al., 2013), technology-focused programs for youth with ASD may help them transition into meaningful careers by increasing their technological skills and providing networking opportunities, including friendships based on common interests. However, evidence-based programs to help youth with autism develop authorial technology skills are not readily available. This leaves a large gap in evidence-based programs to help youth with ASD turn an interest in technology into marketable skills that will help them succeed in higher education and obtain and maintain competitive employment.

As one of the few available programs to help students with disabilities develop *authorial* computing skills, the nonprofit TKU currently provides a supportive environment rich in technological instruction for students with ASD. Adolescents attend one-week summer camp workshops where a specific theme (e.g., website or game design) is explored in a stimulating, project-based environment. This informal education organization is unique in that it uses a maker-based curriculum wherein students create, interact with, and present their own creations after project-focused workshops. While TKU continues to grow and students often return to attend numerous workshops, a formal assessment of successful programmatic elements and potential areas for improvement had not previously been conducted. A primary aim of the present study was to conduct a pilot *participatory* (i.e., autistic adults were involved in study design, assessment, and manuscript development) program evaluation informed by the perspectives of students and parents in order to adapt the curriculum based on student needs and interests.

## Technology as a Tool for Community Building

The opportunities to communicate in unconventional ways provided by computer-mediated communication have led to alternative ways of conceptualizing and enacting disability such as the neurodiversity, or autism rights, movement (Kapp, Gillespie-Lynch, Sherman, & Hutman, 2013). A central tenet of the neurodiversity movement is that people with autism should be included in the development of autism supports. If the research community hopes to build quality supports that are well aligned with the needs and interests of people with autism, involvement of self-advocates in the research process is essential for producing resources with social validity. Therefore, a college student and a college graduate with autism, one of whom is an author of this manuscript, helped conduct this study.

Given evidence that adults with autism often learn about the neurodiversity movement and develop more positive ways of thinking about autism via the Internet (Kapp et al., 2013), our research team was interested in examining if in-person neurodiverse communities centered around a shared interest in technology could also foster positive viewpoints on autism among adolescents on the spectrum. Understanding one's own neurodiverse identity may be aided by participation in group activities with other neurodiverse individuals, especially when such interactions are enhanced by curricula tailored to specific interests and strengths. A secondary aim of this study was to examine if students' understanding of autism and their own identities improved after participation in TKU. We hypothesized that exposure to a group of neurodiverse individuals might create a community-based learning environment conducive to improved disability identity and self-advocacy skills among TKU students.

## Research Methodology

This study design includes open-ended in-person interviews with student participants between the ages of 13 to 20 ($N$ = 20, $M_{age}$ = 15.9) at the beginning and end of one-week summer workshops and surveys distributed to parents (online) and instructors (in-person). Interviews assess students' learning goals/outcomes, current skills and career goals, perceptions of challenges they may encounter entering STEM fields, and helpful elements of the TKU curriculum. A hands-on construction task was introduced to participants to assess collaborative problem-solving techniques in practice. Participants were asked to build a 25-centimeter-long bridge/tower with a confederate with ASD using mini marshmallows and toothpicks.

Parents answered similar questions to those their children answered and filled out the Social Responsiveness Scale-2 to assess autistic symptomatology in their children (Constantino & Gruber, 2002). TKU instructors completed a survey at the end of each week about effective teaching strategies, learning objectives, challenges, and their plans to improve instruction in the future. Observations of classroom instructional techniques and student engagement were conducted to evaluate student engagement and commonly used teaching strategies to inform program design and further curriculum adaptations.

## Results

### Aim 1: Program Evaluation—Addressing Student Needs and Interests

Student participants had a mean age of 15.9 years, mean parent-reported SRS *t*-score of 65.4, and 15% were female. Three participants completed only a pretest survey due to absences ($n$ = 2) and dropout ($n$ = 1). Students (via in-person interviews) and parents (via online surveys) were asked similar questions to assess the curriculum in relation to students' needs and goals for the future.

**Career goals and skill learning.** When asked at pretest, "What job would you like to have in the future?" student participants cited technology fields such as game designer or programmer/developer. Overall, 86% of students indicated STEM careers in their response to this question. A STEM career was coded to include job titles such as game designer, computer programmer, animator, and video editor. When asked at pretest how they were preparing to get a job in the future, few students (42%) provided a specific employment-preparation strategy. When asked during pretest interviews what they would *like* to learn at TKU, only 26% of students identified specific job-related skills they hoped to learn while 80%

of students indicated general excitement about working with technology. When asked what job he would like to have and why, one student replied,

> I've always thought about being a computer programmer or developer. I've been fascinated by technology all my life and have a passion for helping others. … I want to maximize the user experience for apps that could make a significant difference in people's lives.

His response shows a clear affinity for technology and a recognition of the impact technology has on others.

When asked what they had learned at the end of one week at TKU, most students (82%) indicated technological skills, and 24% indicated social skills. When asked what they had learned that could help them get a job, 47% of students indicated technological skills and 24% indicated social skills.

**Parent and instructor perspectives.** Parents of all teens enrolled in TKU summer programs were invited to participate in surveys about their teens' overall outcomes as a result of participating in a one-week TKU workshop. Using Likert scales, 23 parents indicated that students gained skills needed to obtain employment ($M$ = 5.48 out of 7), technological skills ($M$ = 5.45), social-emotional skills ($M$ = 5.14), and friendships ($M$ = 5.21). Instructors, also surveyed at the end of each week, indicated that summer program participants overall ($n$ = 42) developed technological skills ($M$ = 5.59 out of 7) and were engaged with the curriculum ($M$ = 5.49) and other teens ($M$ = 5.05).

These results indicate that both parents and instructors found TKU's program valuable for teen participants across a number of domains important to the TKU model. Instructors indicated that additional time for each workshop would be beneficial to produce a more in-depth technology project. Both of these concerns are addressed in the curriculum adaptation described below.

**Teamwork and observed skills**. Introduction and reinforcement of collaborative problem solving and teamwork skills are a major goal of TKU curricula. To evaluate possible improvements in these skills associated with participating in a weeklong session at TKU, students were asked the question, "What skills do you need to do teamwork?" at pre- and posttest. At pretest, 95% of students cited at least one teamwork skill such as cooperating (38%), listening (31%), patience (13%), communication (13%), and planning (6%) within their responses. However, when asked at pretest to build a bridge with a partner (an autistic adult confederate who then rated their collaboration skills), only three students were rated as working collaboratively, sharing ideas and asking for input on the design and execution of their bridge. These results represent a disconnect between verbal understanding of the skills needed to be part of a team and demonstrated skills during a collaborative task. At posttest, new words emerged in response to the question about skills needed to do teamwork. Students continued to cite communication (44%) and listening (19%) while collaboration (19%), compromise (13%), and leadership (13%) also emerged within responses. When asked to build a bridge with a partner at posttest, five students were rated as collaborative team members compared to three students at pretest.

**Classroom observations.** Observations of classroom activities to assess types of teaching strategies used and the proportion of students on or off task were conducted during 10-minute intervals at two time points each day. Overall, results of classroom observations show that providing technical/procedural directions was the most common teaching style employed, followed by supporting engagement with peers. When asked how their instructor made activities interesting for them, 56% of students described hands-on activities and 31% described playful humor/games. While these strategies were employed occasionally, coding indicates that more traditional teaching techniques, such as lecture-style teaching using slide shows, were used more often than hands-on instruction. This indicates an area for improvement in future curriculum development.

### Aim 2: Perceptions of Autism

**Self-description.** Students were asked to describe themselves and parents were asked to describe their children. Both student and parent descriptions focused on notable strengths such as heightened skills in working with technology, puzzles, transit systems, and mathematics. “Intelligent” and “caring” were frequently cited character traits ($n$ = 8). As expected given prior research (DeNigris et al., 2017), no students or parents mentioned autism when asked to describe themselves or their children. Together, these findings suggest that the benefits that may come with participation in TKU workshops may be further realized when TKU’s adolescent participants are encouraged to explore, through group-based interactions, not only technology projects but also their own present and desired future identities, as self-understanding is essential for success in higher education and the workplace.

**Descriptions of autism.** When students were asked to define autism at pretest, most teens focused on challenges associated with autism (63%) and many exhibited difficulties defining autism at all (44%). Those who described autism as a challenge focused on its neurological aspects, for example, a “disorder that affects your brain” (24%), or social aspects, for example, a “problem with social interactions” (29%). Very few adolescents chose to link themselves to autism when defining it (24%), which indicates that they were either unaware of their diagnosis or did not wish to self-identify. At posttest, most students continued to define autism in terms of challenges (38%) or reported difficulty defining autism when asked (44%). It is important to note that 25% of students at posttest (compared to 6% at pretest) described autism as an individual difference without a positive or negative valence. This pattern provides preliminary evidence that participation in TKU’s workshops may over time promote improved acceptance of autism and other individual differences.

A follow-up question, “How do you think autism makes someone stronger?,” elicited responses focused on strengths at both pretest and posttest, likely because of the nature of the question. The majority of participants at pretest (82%) cited some strength with the most popular response being perseverance in response to the challenge of having autism (35%). Some participants mentioned systematic thinking/ detail orientation (18%). When asked the same question, one parent stated that “people with autism will be key for furthering innovation and societal advancement in tackling some of the world’s most intractable problems.” These findings indicate that participants are aware of some strengths associated with autism despite their hesitancy to self-identify and their initial focus on challenges when asked to define autism. Together these findings suggest that TKU has a unique opportunity to build community and foster self-acceptance among adolescents who may be new to self-advocacy and the neurodiversity movement. To help students prepare for higher education and the workforce, curriculum during Summer 2018 workshops focused on building self-understanding and acceptance of diversity.

## Future Directions: Model Adaptations and New Curriculum Format

Drawing upon data collected from our comprehensive Summer 2017 evaluation, a number of important programmatic areas of improvement have been identified. A sample curriculum model is outlined below that incorporates many of the changes TKU enacted during the summer of 2018 to create an increasingly participatory and technology-rich environment for adolescent enrollees. Analysis of data from Summer 2018 programming is under way for future publication.

### Affinity-Based Program Themes

It is apparent that enrollment at TKU is highest and students are most engaged in technology learning when the workshop theme is centered around an area of particular interest to our teen population. The most in-demand workshop at TKU is a transit-themed partnership with the New York City Transit Museum. In the past, teens have created informational 3D videos to teach others about subway etiquette. In 2017, the transit theme was centered around creating a transit-based video game using graphic programming software to introduce game-design principles. Some less popular workshops are focused on learning an important skill, such as website design, but have a less exciting client focus. During these weeks, teens are tasked with creating a website for a client such as a personal business or nonprofit. While it is an important professional and employment skill to plan and complete these projects regardless of the theme, curriculum that explores affinity-based themes through higher-level technological instruction may yield the most successful learning outcomes. Based on this assessment, our initial adaptation of TKU's curriculum for Summer 2018 used the transit theme as the primary focus to build upon the students' interests and use their excitement to further learning outcomes.

### Continued Hands-On and Game-Based Instruction

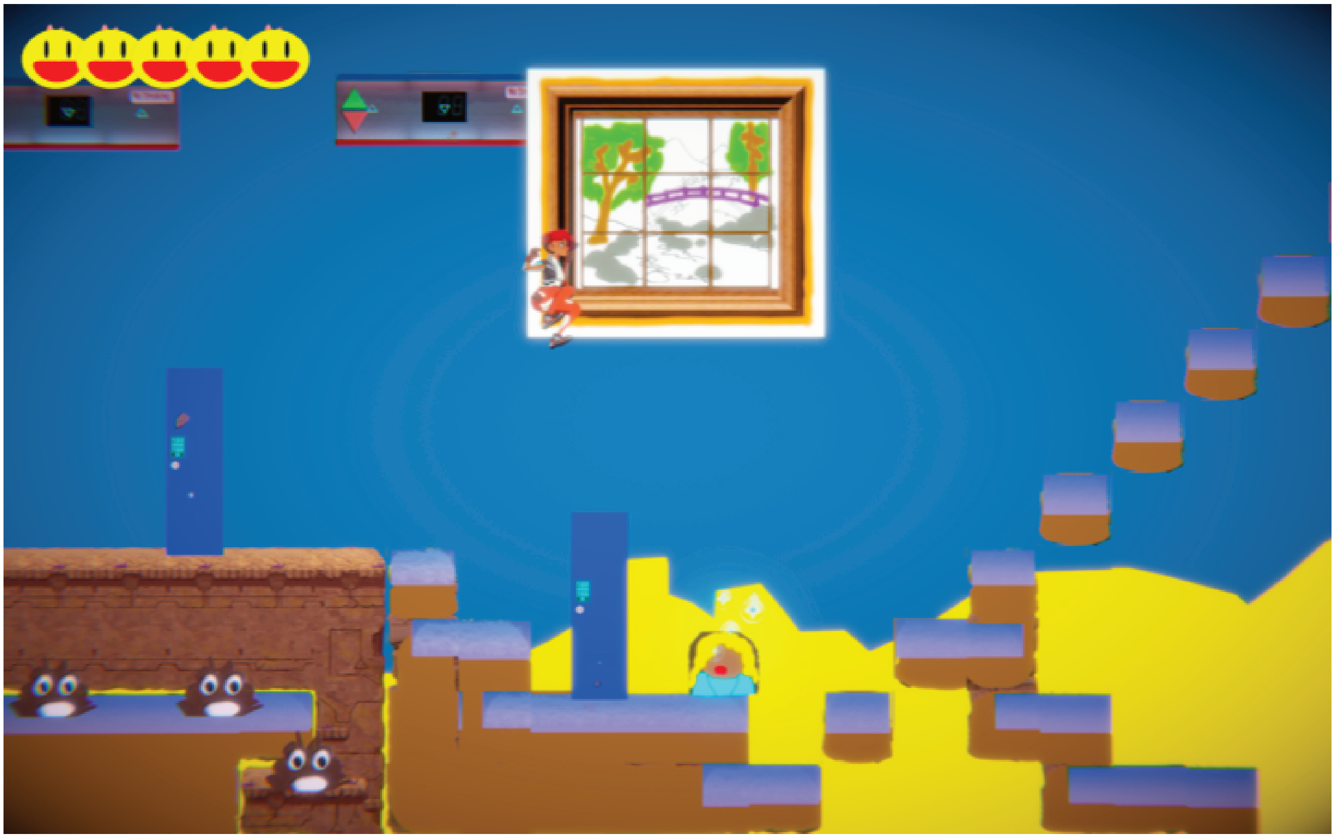
As reported by TKU teens and observed by evaluators placed in the classroom, hands-on instruction is most enjoyable and most effective for this group. Humorous or game-based techniques are also preferred and allow for technology learning to be embedded within a game setting. Students were much more likely to engage with the technology theme and fellow students when a game was introduced as a mediator and/or focus of the workshop. Instructors at TKU are employed on a workshop-by-workshop basis with much of the instructional format determined by the preferences of each instructor. Moving forward, we believe all instructors should be informed of the effectiveness of gamified instruction for this group of adolescents. Increasing emphasis should also be placed on hands-on instruction and demonstration rather than through a traditional classroom teaching model wherein students sit in rows and watch a blackboard or on-screen presentation to learn new skills. This was a key point emphasized in teacher training for the Summer 2018 workshop curriculum.

### Group-Based Projects to Foster Employment Skills

As demonstrated by student in-person interviews, the vast majority of students are interested in STEM careers but very few can name a specific employment-preparation technique or job-search strategy. Students also have difficulty working with a partner to plan and execute a project cooperatively, as evidenced by the bridge-building task. TKU has the opportunity to build important soft skills, which employers cite are lacking among employees with autism, by introducing primarily group-based technology projects. Workshops vary in their degree of group-based participation but adaptations to the Summer 2018 Transit Game Design workshop focused on group work and participation. This group-based environment included small groups of three to four students working on games from start to finish in addition to a classroom-wide game concept developed by all members. Teams that were created based on student interests and strengths developed either specific game elements or visual assets for the classroom-wide game. This team-based approach furthered the participatory nature of TKU and encouraged students to introduce and workshop their ideas, present works in progress to the full class, compromise, and iterate their game design based on group feedback.

### Adaptations to Workshop Length

TKU workshops traditionally span five days for a total of 25 hours of technology instruction per week. Students are given a free hour at the end of each day to foster free play and spontaneous social interaction. Varying by instructor, 10–15-minute breaks are also given throughout the day to prevent fatigue. Based on classroom observation and student project outcomes, we proposed that future workshops comprise a 10-day session, doubling the number of hours dedicated to each workshop theme. Increasing the time each student is allotted to work on his or her project will allow students to design and test multiple iterations of their project or game. This increase in workshop length also allows for projects with increasing complexity. During posttest interviews in 2017, students reported limited time to engage with the theme and increased stress when attempting to produce an ambitious product during the available five days. The Summer 2018 Transit Game Design workshop was the first 10-day workshop design. Results from this workshop are undergoing analysis for future publication. Examples of student work are presented in Figures 1 and 2.



*Figures 1 and 2. Examples of student work coded in Unity to produce a 14-level continuous game. All visual assets were created by students.*

## Evaluation Significance and Conclusion

Despite increasing need, evidence-based services to help adolescents with ASD transition into the workforce are sorely lacking, particularly for youth who are not intellectually disabled. While the number of youth with ASD seeking vocational rehabilitation services to help them transition into the workforce has grown substantially over the past decade, they continue to earn lower wages than most other disability groups and are also costlier to serve (Burgess & Cimera, 2014; Cimera & Cowan, 2009). The pronounced challenges that young people with ASD face in seeking and maintaining employment often stand in stark contrast to their abilities.

Programs such as TKU are needed to address this gap in services and should be supported by rigorous evidence and evaluation of the program model. Through this initial participatory evaluation and the resultant curricular improvements during Summer 2018, we continue to iteratively develop and adapt teaching strategies to help the growing population of adolescents with autism overcome barriers and succeed in obtaining meaningful jobs through which they can positively impact the world. Data-driven and participatory curricular adaptations are essential for strengthening unique programs such as TKU that teach teens with autism vital technology skills while connecting them to a community of individuals with similar affinities. By building upon the existing affinities of students with autism through hands-on and playful instruction in technology, coupled with structured supports for social interaction, we hope to maximize the potential of new technologies to empower and connect neurodiverse youth.

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# Open Questions for Empathy and Games

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**Abstract:** In this paper, we pose questions about the intersection of video games with empathy. To do this, we provide a thematic overview of research related to empathy and games, including investigations on game elements that may be connected to empathy, such as communication, perspective taking, and relationship building. We identify current gaps in the research related to using games for empathy and make recommendations on next steps for this burgeoning field.

## Introduction

In January 2018, the World Health Organization (WHO) identified "gaming disorder" as the latest addition to recognized psychological disorders (WHO, n.d.). This builds on the American Psychiatric Association's (APA) recent move (APA, 2017) to include "gaming addiction" as a condition to research in the *Diagnostic and Statistical Manual of Mental Disorders (DSM-V).* On the other hand, many organizations, such as Higher Education Video Game Alliance (HEVGA), and researchers spoke out against this categorization, explaining that there was limited evidence to support this designation (HEVGA, 2018). HEVGA, for instance, suggested that the actions reflect a sensationalized conversation around games, which often superficially equates games as causing social ills or moral destruction, rather than considers their complexity and variability. In this paper, we want to continue to further the conversation and consider how games may support prosocial attitudes and behaviors, too, such as enhancing connection, engagement in relationships, and perspective taking, all actions associated with empathy (e.g., Belman & Flanagan, 2010; Farber & Schrier, 2017; Isbister, 2016). In other words, can games also empower people to connect with others, take on new perspectives, and express emotions and identities? Can games help people to empathize with others and listen to their stories and ideas? What are the limitations and under what conditions can particular games support empathy? In this paper we will look at three specific areas related to games and empathy: (a) perspective taking, (b) relationship building, and (c) communication, social interaction, and reflection.

## What Is Empathy?

First, what is *empathy?* One conception of empathy is that it involves "being in another's shoes," "understanding what someone else is feeling or thinking," and taking on *our perception* of someone else's lived experience and his or her inner emotional state. Empathy includes "feeling for another person who is suffering" (Batson, 2009, p. 8). This is distinct from other concepts such as compassion and sympathy. With empathy, for instance, we *take on and even feel* others' suffering, joy, heartbreak, or pride, whereas with sympathy and compassion, we value others' feelings and care about their needs without necessarily enacting their feelings or performing their experiences (Bloom, 2017).

Empathy is often characterized as having cognitive, behavioral, and emotional components. Gerdes, Segal, Jackson, and Mullins (2011) identify four core components of empathy, including:

(1) the capacity for an automatic or unconscious affective response to others that may include sharing others'

> emotional states; (2) a cognitive capacity to take the perspective of another; (3) the ability to regulate one's emotions; and (4) a level of self-/other-awareness that allows some temporary identification between self and other, but also ultimately avoids confusion between self and other. (p. 112)

Notably, the second component suggests that perspective taking is a key part of empathy, which involves trying to understand othe people's feelings, experience their viewpoints, enact their stories as they would tell them, and see another's experience as they would experience it, rather than as you would (Brown, 2013). In other words, people who act, think, and behave empathetically see the world as others see it, are nonjudgmental, have an understanding of another's feelings, and can communicate this understanding (Wiseman, 1996, p. 1165).

There are many other definitions and approaches to empathy (Schrier & Farber, n.d.). Furthermore, the salience and usefulness of empathy has been debated (e.g., Marinova, Singh, & Singh, 2018). Bloom (2017), for instance, argues that compassion is more relevant because although empathy leads to feeling what another feels, it does not mean the outcome of decisions and actions are appropriate and effective. Bloom argues that one's empathy can be exploited to disadvantage some groups or further activate people to fight against people they believe to be enemies (Bloom, 2017). Just as empathy can help people connect and bond, it can also make people feel more threatened or anxious, similar to how oxytocin (a "bonding" hormone) may make people judge those they know differently (either much more or much less favorably), depending on their personal attachments and context (Bartz, Zaki, Bolger, & Ochsner, 2011). Empathy may also look and function very differently across cultures.

For the purposes of simplicity, we will focus on empathy for this paper. However, compassion and sympathy may also be useful to consider further in relation to games, gaming, and play. Moreover, empathy should be analyzed in terms of both its possibilities and limits—and all of its complexities—rather than assuming that "empathy" is always desired, and always useful and effective.

## Why Empathy and Games?

We are specifically interested in understanding the relationship between games and empathy for four key reasons.

### 1. Games Are Increasing in Popularity and Pervasiveness

Digital games are an increasingly ubiquitous part of today's popular culture. Games are played in approximately two-thirds of all United States households and almost two-thirds of all households in the United States have at least one person who plays three or more hours of games weekly (Entertainment Software Association, 2017). Games are being played by children but also adults, with the average age being 35 years old (Entertainment Software Association, 2017), with 54% of frequent game players explaining that games help them connect with others, such as friends. People also play with their friends (41% of gamers), family (21%), parents (18%), and partner (17%), according to the Entertainment Software Association (2017). Thus, understanding more about how people are playing games and possibly connecting with others through them is imperative to furthering not only our knowledge of games, but also our understanding of our relationships and society.

### 2. We Need to Reveal the Full Complexity of Games, Rather Than Just Focus on Their Negative Aspects

Compared to “traditional” media (i.e., books, film), digital games are a new medium (Behringer, 2016). As a new medium, it has invited “moral panic.” For instance, games have been viewed as a possible type of psychological disorder (APA, 2017) or a sign of decaying values (Ferguson, 2008). Darvasi (2016) notes that games are often cited and emphasized in terms of antisocial behavior, such as violence, aggression, addiction, and isolation, rather than by their strengths. However, even though video games are “new” we need to explore their contours and experiment with their possibilities, while also realizing their limitations and weaknesses. We need to readdress and reconsider games, even those games made for commercial aims and popular enjoyment, and propel more nuanced conversations about what games can (and cannot) do.

### 3. We Need to Find New Ways to Teach Essential Socio-Emotional (SEL) Skills, Such As Perspective-Taking and Reflection, Which Are Related to Empathy

Games have been implicated in supporting skills and practice in a variety of areas, such as mathematics and history, physics and music, writing and painting (Gee, 2007; Schrier, 2018a). Can games also support socio-emotional learning (SEL) and skills, such as communication, reflection, and argumentation, or identifying and regulating one’s emotions, and engaging in deliberation? For instance, Bréjard, Bonnet, and Gaetan (2016) observed that those who frequently play digital games are more adept at regulating their emotions than those who report occasional play; however, those same players may “express their emotions less than irregular gamers” (p. 347). The ability to be empathetic is a social awareness competency and part of the Collaborative for Academic, Social, and Emotional Learning’s (CASEL) evidence-centered social emotional learning framework (Core SEL Competencies; CASEL 2018). Social awareness includes the ability “to take the perspective of and empathize with others, including those from diverse backgrounds and cultures” (CASEL, 2018, para. 4), and it is a desired 21st-century skill. We need to further test the conditions by which games can and cannot help build other types of SEL skills, such as empathizing and perspective taking.

### 4. Empathy-Related Skills Are Necessary in Everyday Practice

Divisiveness between groups has always existed (particularly between “in-groups” and “out-groups”), but in our increasingly interconnected world, we need to find new ways to reach out, listen to others’ perspectives, and connect with those in all groups (Schrier, 2018b). In fact, incivility may even be increasing. For instance, with the perpetuation of “echo chambers,” where people hear only their own perspectives, ties to “in-groups” may grow stronger, and people may feel more belongingness to their own group. This could even further the divide between the in-group and out-group by helping to “other” the out-group and reinforcing it as outside of one’s own. This then may further discourage people from engaging in civil discourse with others who do not share their views (Yusuf, Al-Banawi, & Rahman Al-Imam, 2014, p. 1). Regardless of whether incivility is actually increasing, or if civil discourse is decreasing, we need to cultivate empathy-related skills so we can, for instance, understand others’ points of view, work together with people with diverse mind-sets and skill sets, and be able to together solve real-world issues and complex global problems (Schrier, 2018b). For instance, how do we mitigate fear among groups, racism, disrespect for others, and xenophobia? How do we manage and de-escalate behaviors such as trolling, online harassment, and cyberbullying? How do we empower people to deliberate effectively, to act respectfully, and to consider others appropriately and ethically online and in public? We need to find novel, innovative ways to help people work together, listen, bridge gaps, engage in civil discourse, connect, gain respect for others, and learn about perspectives and peoples different from themselves (Kahne, Middaugh, & Evans, 2009; Schrier, 2018b).

## Open Questions and Gaps

How might games, specifically, support empathy and related skills and behaviors? To investigate this, we looked at an initial list of possible characteristics, skills, and processes related to empathy and games from previous research (Belman & Flanagan, 2010; Darvasi, 2016; Farber & Schrier, 2017; Greitemeyer, 2013) and identified overlapping elements to consider for this paper. The skills that emerged are: perspective taking, relationship building, and communication and reflection. While there also may be other skills, we will use these initial skills, and current research on these skills, to help guide our identification of open questions and gaps in the research. Future research may consider a more systematic approach to investigating which skills and/or thematic areas emerge at the intersection of games and empathy.

### Perspective Taking

Perspective taking is the act of taking on another's views such that we can better understand them, even if we do not hold these views or agree with them (Farber & Schrier, 2017). Darvasi (2016) explains that perspective taking often involves actively considering those who seem initially very different (an "outgroup") such as by embodying their "mental state, points of view, and motivation" (p. 3). Part of the process of perspective taking involves openness. To take on new perspectives, we need to first value those other perspectives enough such that we want to embrace them and consider them more fully. These new perspectives need to matter to us and we need to be motivated to seek them out. Thus, perspective taking involves being persuaded that other perspectives are meaningful and should be attended to (Cohen, 2001; Darvasi, 2016). It is important to note that Darvasi (2016) suggests that games may be particularly powerful at supporting perspective taking because they combine the enabling of other perspectives with those persuasive techniques (Bogost, 2007).

The process of taking on new perspectives or "perspective taking" has been shown to reduce bias and improve one's attitudes toward people in an "out-group," or those who initially seem different from yourself (Farber & Schrier, 2017). One reason this works is that when you take on the perspective of an "out-group," it ends up seeming more familiar and similar to your own, more like an "in-group" and less like an "out-group" (Darvasi, 2016; Todd & Galinsky, 2014). However, perspective taking can also be ineffective. Darvasi (2016) notes that perspective taking has not been shown to be effective in reducing bias for three reasons:

- If the people doing it identify too strongly with their own group (in-group) such that they feel they cannot ever step outside of it, or consider anyone else's but their own;.
- Relatedly, that they have such low self-esteem that they cannot feel secure enough in their own perspectives to reach out to another's perspective;
- There is a high-stakes or conflict-filled environment, such that people do not feel comfortable and secure enough to take on other's views, or it is too risky to do so.

Moreover, what happens if you take on someone else's perspective so much that you lose sight of other perspectives and cannot see the big picture ("far-sightedness"), or you get so overwhelmed with another's perspective that you cannot see any other views ("short-sightedness")?

A key factor involved in perspective taking is the ability to identify with that perspective, and also to identify with the person or character who holds that view, embodies a type of belief, way of life, or value (Farber & Schrier, 2017). However, when considering perspective taking in relation to a game, this brings up important questions about identity. When playing a game, are players acting as themselves or playing the role of another? If there is an avatar in the game (a digital or virtual representation of the player that the player controls to play the game), to what extent do players keep their own perspectives or take on that of their avatar's? Gee's (2007, 2008) describes the idea of a projective identity, a type of hybrid identity between that of the avatar and player. Do players take on the identities of their avatar, or do they engage in complex negotiations between their own identity and that of their avatar? Do players make choices based on their own perspectives, that of their avatar's, or based on some type of hybrid perspective between the two?

Darvasi (2016) suggests that the "point of view" of a particular digital game also matters in how a player may take on new perspectives or form identities in a game. For instance, he explains that in first-person perspective games (i.e., the player sees exactly what the avatar sees), the player embodies the avatar but does not see the avatar. In the first-person perspective, the avatar is not visible but is implied to be present through its omnipresent voice and/or sometimes the presence of parts that a person may see of him- or herself, such as an arm, leg, or weapon. In this scenario, the player may be less likely to engage in perspective taking, and his or her identity will blur with that of the avatar. However, the player may care about and take on the perspectives of other players or nonplayer characters (NPCs), or virtual characters that are not controlled by another human being, but by the game. Other games enable a third-person (or even a more removed "bird's-eye view–like") perspective on a game. In a third-person perspective, a player still may control a character but can see that character, as well as other characters in the game. In other games, players can switch between perspectives, such as from first to third person. Darvasi (2016) explains that in third-person perspective situations, and in games where players can switch from first to third person, players are more readily able to take on the perspective of that character, as they can see the character and can more easily empathize with its views, needs, and experiences.

Moving forward, more research is required to parse out the specific game elements that support perspective taking. Open questions include:

- What is the relationship among identity, perspective taking, transportation, point of view (first, third, "bird's-eye view,") and empathy in games?
- How do we better cultivate perspective taking through games, particularly those with views different from our own?

### Relationship Building

In the previous section, we discussed how different perspectives can more readily support empathy for a character. Those who embodied their avatar may not have felt "empathy" for that character because *they were* that character. Typically, we feel empathy *for others*, rather than *for ourselves*. This may explain why although players might identify with their on-screen avatars, even stronger attachments may be to the nonplayer characters (NPCs are those characters that are not controlled by the player or by another player). After all, we would not need to attach "to ourselves," because we are ourselves. When players bond with NPCs, this can even possibly evoke similar empathetic emotions as one might experience when building relationships with real people (Harth, 2017; Isbister, 2016).

It may seem surprising to find out that players form attachments with nonhuman virtual objects and characters. However, previous research by Turkle (2011) and Isbister (2016) suggests that human beings can build attachments with nonhuman and virtual characters. For instance, Harth (2017) analyzed how humans socially interact with NPCs and found that players were social with NPCs and exhibited "virtual empathy" for their virtual game companions (Harth, 2017, p. 19). Some participants reported that the empathy formed with NPCs was not as strong as with actual people, but similar to the type of emotional attachment an audience would have with characters in a book or film (Harth, 2017).

Isbister (2016) suggests that an attachment comes from spending time and interacting alongside an interdependent being, such as a virtual character or NPC. For example, in the role-playing game *Fable III*, players play as a prince or princess of the fictional world of Albion and go on missions to help the townspeople (all NPCs). During the main character's training sessions, Walter (an NPC) helps to mentor and train the player's avatar. After the player spends around 10 hours of gameplay alongside Walter, he gets hurt during one of the missions. The player must decide whether to bring Walter to safety or just leave him and escape alone. Schrier (2016) found that almost all *Fable III*–playing participants decided to drag Walter to safety, even though there was no benefit to helping him, and the game eventually forces you to leave him behind (giving you a meaningful choice that ends up having no consequential effect on the story line or gameplay). Participants noted that the reason they tried to save Walter is that they formed an attachment with him and felt emotionally connected to him (Schrier, 2016). However, players were less invested in a superficial friendship that they had with an NPC in the very beginning of the game, suggesting that perhaps time with a character, and having meaningful interactions with it, is important to building attachment and connection, just as it would be with a real person outside of a game (Schrier, 2016).

Thus, we may also question whether game players become too invested emotionally in these relationships or embed themselves so deeply into the perspective of a character such that they make decisions that are not in their or a character's best interest. For example, Bloom (2017) explains that emotion can bias decisions and affect how people think through decisions and choices. Moving forward, designers should consider how best to create emotional attachments through games, such as between players and digital actors, or NPCs, and we need to understand more about design strategies for allowing for these relationships to unfold. Open questions include:

- What is the role of relationship building, even with NPCs, in supporting empathy in games? How can we develop authentic relationships based on intimacy and trust, rather than just points and game rewards?
- How do emotions and emotional interactions in games relate to empathy?
- How do relationships unfold in games as opposed to outside of games? Are factors such as time important? What types of meaningful interactions are necessary for the formation of connections?

### Communication, Social Interaction, and Reflection

Gaining perspectives and views from NPCs can be useful, and interacting with digital characters can build relationships. But communication and interaction with real people can also help to support perspective taking, role-playing, reflection, agency, identify formation, and relationships. For example, studies have suggested the importance of social interaction in practicing empathy-related skills and learning ethics and morality (e.g., Belman & Flanagan, 2010; Farber & Schrier, 2017; Maclagan, 2003; Noddings, 2010; Schrier, 2017).

There are a number of ways in which real people help to teach and communicate empathy skills through social interactions and reflection, such as:

**Modeling.** A key component of learning involves the modeling of behavior (Bandura, 1977) or being able to directly observe how others behave and then also behaving in a way such that others learn from it and enact it themselves.

**Communication, dialogue, and discourse.** People also learn from the act of engaging in dialogue with others. Klein (2012) explains that by listening to other people's arguments and viewpoints, people are able to explore their perspectives and reflect on their own perspective. Nussbaum explains that "critical, elaborative discourse" (Nussbaum, 2008, p. 347) is essential to ethical decision making, which also requires compassion and empathy.

**Expression of emotion and relationship building**. Emotion is also a component of communication and interaction among people. People need to observe and identify each other's emotional states when they are working together and adjust their interactions accordingly (Van Kleef, 2009). People need to be aware of another's emotions, and care about them, to be able to build a relationship, develop intimacy, and communicate effectively to achieve goals or shared purposes. Thus, the practice of communicating and continually identifying emotions and responding to them helps to support and facilitate empathy for one another (Iacoboni, 2009).

**Reflection.** Reflection and reflective practice help people better understand themselves and others because they enable people to think back on their experience and to reconsider new information, relationships, and learning. Reflection in digital games, both at moments during the game, and after one's gameplay, can help to strengthen connections with other people and other characters as well as to frame new knowledge (Schön, 1983).

However, just as communication may be empowering, social interactions can be used for negative means, such as to promote bullying and uncivil behavior, toxic talk, and other problematic activities. Moving forward, we need to more fully consider how to design empowering and constructive communication and reflection. Open questions include:

- What is the role of communication in building relationships and supporting empathy through games?
- How can community features, emergent communities, and cultural contexts support or limit empathy?
- How are reflection and reflective practice involved in supporting empathy?

## Conclusions and Next Steps

In this paper, we sought to pose questions and share initial insights into the intersections among games and empathy. Our discussion was driven by some underlying questions, such as: Is there existing research as to the elements, processes, and/ or actions related to digital games that inspire empathy-related skills? What are any limitations and gaps in our understandings? In this paper, we specifically looked at three key areas identified as being connected to empathy: perspective taking; relationship building; and communication, social interaction, and reflection. We shared recent research and evidence to help share open questions and gaps. Research and empirical evidence in the intersection among games and empathy is limited, so we recommend more research in this burgeoning area and, in particular, more consideration into the specific factors of gaming that may inspire or constrain empathy skills, behaviors, and attitudes related to perspective taking, communication, and relationship building, such as character design and storytelling, choice making and meaning in games, context of play, game content and gameplay, audience, opportunities for reflection, emergent communities around and within the game, and player interactions.

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# Transmedia Literacy in the New Media Ecology

## An International Map of Teens' Transmedia Skills

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**Abstract:** The emergence of new media, devices, narratives, and practices has compelled media literacy scholars and professionals to review their theoretical frameworks and methodological approaches. Based on a new concept—*transmedia literacy*—that moves from traditional media literacy (teaching critical media skills at school) to informal learning and practices of participatory cultures, the research behind the present paper aims to understand how new generations are doing things with media outside schools and how they learn to do the things they do. After a short description of the objectives and the methodology, the paper focuses on one of the outputs of this international research (2015–2018) that has involved 8 countries: a map of teens' transmedia skills developed in the context of informal learning environments' collaborative cultures.

### Introduction

Since the diffusion of personal computing in the 1980s and the expansion of the World Wide Web in the 1990s, digital technology has been a catalyst for social change in contemporary societies.[1] Many researchers, institutions, and professionals argue that while the media system has adopted and adapted to new digital technologies, 20 years after the emergence of the Web, schools still perceived the "digital transition" as a traumatic process (EAVI/DTI/OII, 2011). Although schools have made great efforts to adapt to the new sociotechnical conditions in the past two decades, the general perception is that the social life of children, preteens, and teens is built up around a set of digital technologies—from social media to mobile devices—and new practices that are frequently very different from the educational protocols of schools.

The vast diffusion of digital technologies and new media practices has led to the emergence of new conceptions in the academic and professional conversations about media literacy. As early as 2004 Livingstone proposed that research

> must investigate the emerging skills and practices of new media users as the meaningful appropriation of ICT into their daily lives. … A top-down definition of media literacy, developed from print and audio-visual media, while a useful initial guide, should not pre-empt learning from users themselves. (p. 11)

The emergence of new concepts runs parallel to the emergence of new theoretical frameworks and research methodologies. In 2006 Buckingham asked, "What do young people need to know about digital media?" In this research, another question orientates the reflections: How can researchers get to know and analyze what young people are doing with digital interactive media?

In this new context, social and technological changes have reframed the meaning of lifelong (over

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time) and lifewide (across locations) learning (Sefton-Green, 2003, 2006, 2013; Sefton-Green & Parker, 2000), and the emergence of new participatory practices (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006; Lange & Ito, 2010) has redefined the ways of learning and even the actual concept of "media literacy." In this context the idea of *transmedia literacy* proposes a move from traditional media literacy—understood as teaching critical media skills at school (Potter, 2004, 2005)—to the analysis of practices of participatory cultures, youth-generated contents, and informal learning strategies, and their use inside the formal educational system.

Transmedia literacy is understood as a "set of skills, practices, values, sensitivities and learning and exchange strategies developed and applied in the context of the new collaborative culture" (Scolari, 2018, p. 15). If traditional literacy focused on the written text—it was about teaching reading and writing—and media literacy on the resistance to the television discourse, transmedia literacy places the new digital and interactive experiences in the foreground in terms of the analytical proposal and action. Transmedia literacy does not deny the need to train young people in schools to develop media skills, but rather it expands this framework to include research into the media activities that young people do outside educational institutions and bring this knowledge into the classroom.

### Transmedia Skills

Young people's level of digital or Internet practices and skills has been analyzed in depth in the last years (e.g., boyd, 2014; Ito et al., 2010; Livingstone & Sefton-Green, 2016). Research into teens' digital and Internet skills has been oriented toward mapping the real level of these skills beyond the "digital natives" mythology. For example, EU Kids Online (Livingstone & Haddon, 2009) analyzed 25,000 European 9–16 year-old Internet users' online activities, skills, and self-efficacy. Although the body of available studies continues to grow, the EU Kids Online team concluded that "there are significant gaps in the evidence base" and recommended expanding the research agenda to include, for example, issues such as how young people use the Internet (Livingstone & Haddon, 2009, p. 2). They proposed carrying out more in-depth research into the following skills:

> – Skills of navigation and searching, content interpretation and, especially vital, critical evaluation – all important for media literacy and online learning.
>
> – User-generated content creation and other forms of networking – increasingly important for identity, sociality, creativity and civic participation. (Livingstone & Haddon, 2009, p. 27)

The concept of *transmedia skills* is very close to this research agenda. In the context of the present research, transmedia skills are understood as a series of competences related to digital interactive media production, sharing, and consumption. Previous research in this field (e.g., Jenkins et al., 2006) has identified numerous skills, including playing, performing, appropriating, judging, transmedia navigating, networking, and negotiating. Transmedia skills vary from problem-solving processes in video games to content production and sharing in the context of web platforms and social networks; the creation, production, sharing, and critical consumption of narrative content (fanfiction, fanvids, etc.) by teens is also part of this universe.

## Objectives

The objective of this paper is to present the main outputs of a research carried out in eight countries

(Australia, Colombia, Finland, Italy, Portugal, Spain, the United Kingdom, and Uruguay) with the participation of more than 30 senior and junior researchers. The aim of the research was to understand how young people are acquiring transmedia skills in informal learning settings. This paper will focus on only two of the main objectives of the research:

- To identify the transmedia skills developed by teens;
- To better understand and analyze how teens engage in, develop, and share transmedia skills in informal learning settings.

For reasons of space, other research objectives, such as the identification of informal learning strategies or the analysis of the most popular online platforms where teens acquire new transmedia skills, will not be included in the present paper. The structure of the text is as follows: The Methodology section gives a short description of the qualitative methodology applied; the Results section includes a map of the emerging transmedia skills. The paper finishes with a short set of conclusions and a series of reflections about future initiatives situated at the crossroads where teens, transmedia practices, and learning processes converge.

## Methodology

As in many other ethnographic works with teens, a series of research constraints and requirements prevented us from using conventional long-term ethnography; therefore, the research team moved toward another set of ethnographic methods. In this context, the team was particularly inspired by the notion of "short-term ethnography," which involves intensive explorations of people's lives, "which use more interventional as well as observational methods to create contexts through which to delve into questions that will reveal what matters to those people in the context of what the researcher is seeking to find out" (Pink & Morgan, 2013, p. 352). In this short-term focus, the ethnographer is situated at the center of the action right from the start and engages participants in the project with this intention clearly stated.

The fieldwork strategy for gathering data was carried out in five complementary steps: (a) schools as the starting point for fieldwork, a secure way to obtain the informed consents of institutions, parents, and teens; (b) an initial questionnaire to get to know the teens' sociocultural backgrounds and media uses and perceptions; (c) participatory workshops to explore in an immersive way the teens' transmedia storytelling practices and engage them in media production and gameplay; and (d) in-depth interviews with the most active teens and media diaries to get to know their doings and sayings with media, social networks, and video games. The last phase of the data-gathering process was an online observation of the teens' favorite websites, celebrities, and online communities (netgraphy).

Fieldwork was carried out in the eight participant countries. Thus far, 1,633 questionnaires, 58 workshops (participatory culture and video games), and 311 interviews have been performed, and eight online communities have been observed. The research focused on teens 12–15 and 15–18 years old from different schools (urban/rural, public/private, homogeneous/heterogonous, high-tech/low-tech, etc.). A series of EU-approved protocols were implemented to preserve privacy and ensure the security of personal data; the protocols included the authorization of schools and informed consents signed by teens and their parents. The team relied on NVivo 11 Pro for Teams for data analysis.

## Results

A series of taxonomies of skills were reviewed in the starting phase of the research, from Bloom's traditional taxonomy introduced in 1956 (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) to Anderson and Krathwohl's taxonomy (2001). Other contributions that were considered for creating the map of transmedia skills were Ferrés and Piscitelli (2012) and the very well-known contribution by Jenkins et al. (2006), a researcher who identified a series of skills from the analysis of teenagers' media consumption and activities in the United States (e.g., play, performance, simulation, appropriation, multitasking, etc.).

The research team took into account these previous taxonomies to generate a complete and updated taxonomy, which is one of the most exhaustive maps of skills related to media production, consumption, and postproduction in the context of youth transmedia culture: More than 200 main and specific transmedia skills were identified during the research. After analyzing the emerging skills, the research team decided to create a taxonomy that integrates many of the previous classifications. However, this taxonomy does not reject previous (or future) taxonomies.

The transmedia skills were organized into nine dimensions (see Table 1), each of which included 44 main skills, and in a second level, 190 specific skills.

| Dimension | Description |
|---|---|
| **Production** | This refers to the ability to conceive, plan, produce, edit and/or re-appropriate contents through different media platforms and languages (texts, audio, audio-visual, code…). This set of skills also involves both operational and creative skills. |
| **Content management** | This refers to the ability to manage different media contents through a range of platforms and media: to select, download, organise and disseminate. |
| **Individual Management** | This refers to the subject's ability to self-manage resources and time, and their own identity, feelings and emotions. |
| **Social management** | This refers to the ability to communicate, coordinate, organise, lead and teach while gaming and producing collectively. This set of skills also includes skills related to participating in social media. |
| **Performance** | This dimension includes all kinds of performing media activities using the body, be it in real life scenarios (performing arts) or virtual scenarios (videogames). In the specific case of videogames, this set of skills refers to in-game and individual activities. |
| **Media and technology** | This dimension includes all the skills related to having knowledge about socio-political media economies, a subject's personal media diet, and technological features and languages. This set of skills also includes skills related to taking action regarding this knowledge. |
| **Narrative and aesthetics** | This dimension includes skills related to interpreting storytelling and narrative structures, as well as delving into the narrative construction through the analysis and evaluation of the genres, characters, aesthetic features, etc. This set of skills also includes the ability to reconstruct the transmedia narrative world. |
| **Ideology and ethics** | These skills refer to detecting and analyzing media representations of stereotypes (in terms of gender, race, culture, religion, etc.) and ethical issues related to copyright, cheating (mainly in videogames) and hacking. This focuses particularly on how teens discuss stereotypes, gender issues, and intercultural issues, among others. This set of skills also includes the behavioural sphere through the actions taken in response to these ideological and ethical topics. |
| **Risk prevention** | This dimension includes the skills related to knowing about and taking measures in relation to privacy and security in media (in particular social media). This set of skills also includes skills about managing and reflecting on their own identity, and possible addictions to media. |

*Table 1. Transmedia skills (dimensions).*

Depending on the dimension, the organization of the taxonomy of transmedia skills revolves around texts, subjects, technologies, and processes. The skills were organized, when possible, following a path from writing (*to write short-stories*) to multimodal productions (*to film and edit a video*), from simplicity (*to search content*) to complexity (*to manage social media and blogs to archive content*), from technical (*to take photos*) to critical and ethical practices (*to be aware of the risks of self-exposure on social media*), and from cognitive (*to recognize and describe genres in different media and platforms*) to pragmatic attitudes (*to select and consume/quit a content based on aesthetic and narrative values*). Figure 1 presents the main 44 skills.

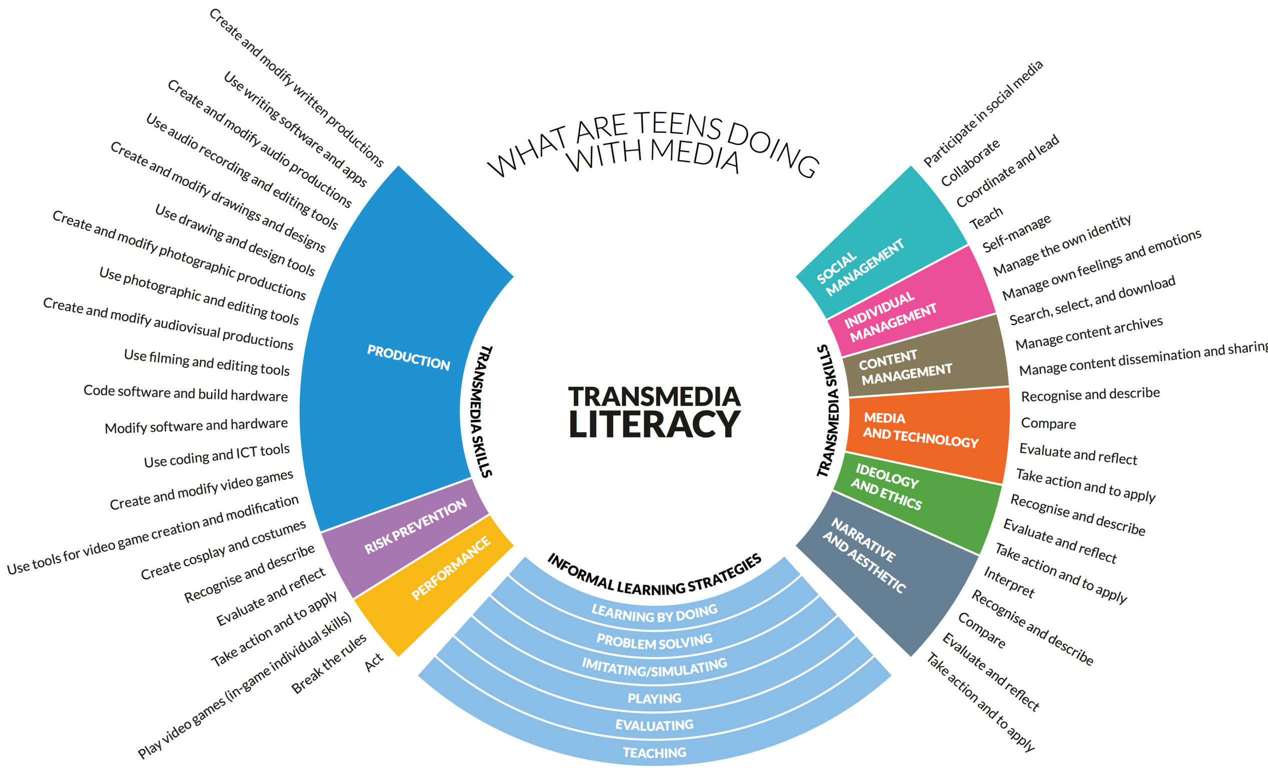


*Figure 1. Overview of transmedia dimensions and main skills.*

As can be seen, the map presents a comprehensive description of the different skills that may be present in teens' practices. It should be remembered that the transmedia skills that have emerged from this research have been obtained from analyzing a wide-ranging selection of settings in eight different countries and highly diverse teen profiles. In the specific case of the interviews and media diaries, the research team focused on the participants who had excelled in the workshops for their dedication and expertise in participatory culture, social media, and video games (e.g., the most active, the geekiest, gamers who have their own YouTube channel or record gameplays, etc.) and who had expressed interest in continuing to participate in the research.

## Discussion

Unlike previous research into the crossroads where teens, media, and cultural practices converge, the present study did not aim to measure the level of teens' Internet or digital skills. Many studies have already done this both in Europe and the United States with high-level research outputs in terms of skill levels, international comparisons, and so forth (e.g., Livingstone & Haddon, 2009). These studies were particularly important for mapping the territory and orienting the corresponding media literacy actions. As the main questions of the present research were "What are teens doing with media and how did they learn to do it?," the study focused on obtaining a better understanding of and analyzing how teens engage in, develop, and share transmedia skills in informal learning settings. The main output of this part of the research was the map of transmedia skills especially designed for orienting future interventions in the context of (trans)media literacy actions. Consequently, the research team activated the production of a series of didactic activities to take up and apply these skills inside the classroom.

The following is a set of critical issues related to transmedia skills that have emerged from the research. In the first place, it should be said that transmedia skills have a diverse and uneven topography. It should be noted that some of the skills detected are very marginal and developed by only a handful of teens (e.g., the skills related to ideology and values), while others are much more widespread (e.g., productive skills). This is important from the perspective of future (trans)media literacy actions: There is a much higher probability of having teens with an elevated level of productive skills in the classroom than teens with ideological or ethical skills. Media literacy strategies should take up the productive skills and recontextualize them in order to promote a critical approach to media production, sharing, and consumption.

On the other side, the research team confirmed that transmedia skills evolve with the media ecology. While some of these transmedia skills change very little over time (e.g., those related to ideology and values), other skills are subject to incessant technological change (e.g., those related to social networks). Therefore, the skills and the taxonomy proposed by the present research team should be periodically updated according to the accelerated mutations of the media ecology.

Another important issue is that transmedia skills are gender biased. Although it was not an initial objective of the research, the team observed gender differences among teens in relation to their transmedia skills. For example, girls use media focusing on relational aspects (social media) and participatory culture, while boys tend to focus on playful aspects (video games). These observations concur with previous studies of media consumption that have already highlighted the persistence of gender differences among adolescents (Livingstone, Bober, & Helsper, 2005; Shaw & Gant, 2002; Weiser, 2004). As stated by Masanet (2016), gender differences in relation to media uses and consumption are worrying because they indicate that there are two stereotyped spheres in media consumption that connect the girls with more intimate, sentimental, and emotional aspects and the boys with action, violence, and humor.

Finally, it has been observed that teens have already acquired what the team defines as *risk prevention skills.* These skills cover a wide spectrum of situations, from the most basic skills (recognizing and describing how privacy and security measures work on hardware, software, and social media) to the more complex ones (managing relations and contents taking into account privacy and security issues).

As many other similar research projects have shown (boyd, 2014; Ito et al, 2010; Livingstone & Sefton-Green, 2016), not all teens have all of these skills. Indeed, the team detected a broad spectrum of situations, skills, strategies, content production/sharing/consumption processes, and alternative uses of media. In this context of rapid mutation of media environments and cultural practices (possibly one of the most challenging research territories but, at the same time, one of the most difficult to deal with), concepts such as *digital native* (Prensky, 2001a, 2001b) should be completely eradicated from scientific discourses. On the other hand, there is a countermovement from “digital natives” to almost “digital dummies” that considers teens to be passive subjects of the “new technologies” (Dans, 2017). Both figures, the digital “native” and the digital “dummy,” have no place in any scientific conversation about teens, transmedia skills, or informal learning strategies. As boyd put it,

> Neither teens nor adults are monolithic, and there is no magical relation between skills and age. Whether in school or in informal settings, youth need opportunities to develop the skills and knowledge to engage with contemporary technology effectively and meaningfully. Becoming literate in a networked age requires hard work, regardless of age. (boyd, 2014, p. 338)

The concept of “transmedia skill” was at the center of the present research. The inclusion of the concept of “transmedia” (Jenkins, 2003, 2006; Scolari, 2009, 2013) for defining teens’ skills is a clear sign of the centrality that collaborative culture and transmedia production, sharing, and consuming practices have in young people’s lives. The same may be said about “transmedia literacy”: It is not just a new name for traditional digital or Internet skills but a brand-new approach that considers the subject as a prosumer (producer consumer) and not just a passive and alienated-by-media person. If traditional literacy was book centered or, in the case of media literacy mostly television centered, then transmedia literacy places digital networks and interactive media experiences at the center of its analytical and practical experience (Scolari, 2018).

The present research confirmed once again that the concept of “digital native,” understood as a young person who “comes with a built-in chip” and who moves skillfully within digital networked environments, shows more problems than advantages. In this context, studies such as the one presented here make it possible to better understand the media world of teens, and also to establish a knowledge base from which to improve (trans)media literacy actions in the classroom founded in the skills that some teenagers *already* have.

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# Learning and Identity in Virtual Learning Environments

## Iterative Design and Implementation of *Philadelphia Land Science*

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**Abstract:** In this study, we developed, implemented, and refined *Philadelphia Land Science (PLS)*, a virtual learning environment (VLE) intended to support high school students' exploration of career roles in environmental science and urban planning as a future possible self. *PLS* was developed using *projective reflection (PR;* Foster, 2014) which frames learning as identity exploration over time to inform the design of games and game-based learning curricula to facilitate intentional change in learners' (a) knowledge, (b) interest and valuing, (c) self-organization and self-control, and (d) self-perceptions and self-definitions in academic domains/careers. *PLS* was built by modifying the Epistemic game *Land Science (LS)*. This paper explicates design iterations of *PLS* that were implemented in a science museum in Philadelphia. This work contributes to the burgeoning area of education research that seeks to unleash the potentials of immersive, interactive, and interdisciplinary media forms such as VLEs to promote learning as an ongoing process of identity exploration and change.

### Introduction

Scholarly contributions from multiple traditions have examined how participation in the ever-expanding media landscapes through formal (e.g., school), informal (e.g., museum) and nonformal (e.g., community) settings has fueled inquiries into the relationship between learning and identity. For instance, Mizuko Ito's (2009) ethnographic study of American youth engaging in participatory activities afforded by various new media settings revealed how participation in communities of practice can support interest development and changes in one's perceptions and competence in a domain. Other researchers have examined how participation in social media applications can serve as a gateway to help young adolescents' identity development in STEM in their everyday lives (e.g., Kitchen Science, Science Kit, Sci-dentity) and to support their aspirations to pursue a pathway in a STEM field (Ahn et al., 2016). These studies on youth, media, and technology are important as they allow fields to cross over and influence how we theorize, investigate, and distill how young people engage in pedagogical relationships with technologies that may have educational significance (Sefton-Green, 2006).

Recent educational research on identity in virtual learning environments (VLEs) such as games is burgeoning given the media's mass appeal and the pedagogical characteristics of games that can stimulate academic engagement and situate learners in personally relevant experiences (Foster, 2008; National Research Council, 2011). For instance, Fraser and colleagues (2014) explored the associations of 1,502 teenagers (14–18 years old) from across the United States among their science identity (i.e., competence with science content, social performance when engaging in science-related activities, and perception of oneself and validation from others as a science person), science understanding, and gaming preferences. There is growing evidence to support the claim that games can support identity exploration (e.g., Khan, 2012), and that the resulting identity changes shape academic learning, motivation, and interest (e.g., Cadely, Pittman, Kerpelman, & Adler-Baeder, 2011). However, this area of research is still in its infancy and lacks empirically tested theories that illuminate (a) characteristics for designing identity-exploration opportunities in games and game-based curricula, (b) different trajectories of identity exploration and change that players may enact, and (c) the role of educators and contexts in supporting such processes (Shah, Foster, & Barany, 2017).

In this paper, we introduce a theoretical framework that conceptualizes identity exploration and change—*projective reflection (PR)*. We then discuss the framework's use in the iterative redesign of the urban-planning virtual environment *Land Science (LS)* into a new experience, *Philadelphia Land Science*, that more closely aligns with PR constructs to promote intentional student identity exploration and change. Our research question asks: How can projective reflection inform the iterative design of the virtual environment *Philadelphia Land Science* to support student identity exploration and change around urban planning and environmental-science careers?

## Projective Reflection

Projective reflection offers one conceptual tool for understanding the way learners engage in self-transformation, or identity change in immersive interactive environments such as games and virtual worlds (see Figure 1). This model integrates a focus on content and on the self through a view of learning as inextricably tied to the self and defines learning and identity in VLEs as the process by which a person engaging in digital gameplay or virtual environment enacts an activity-based identity with the potential to modify the person's learning and identity in this and other domains (Foster, 2014). Projective reflection informs the process of identity exploration as it is measured at repeated points over the course of student learning experiences, thereby tracking learning as identity change across the four constructs of knowledge (Kereluik, Mishra, Fahnoe, & Terry, 2013), interest and valuing (Wigfield & Eccles, 2000), self-organization and self-control (Hadwin & Oshige, 2011), and self-perception and self-definition (Kaplan, Sinai, & Flum 2014), and mapped along six questions: (a) what the learner knows—current knowledge; (b) what the learner cares about—self and interest/valuing; (c) what/who the learner expects to be throughout the virtual experience and his or her long term-future self; (d) what the learner wants to be—possible self; (e) how the learner thinks—self and interest; and (f) how the learner sees himself or herself—self-perception and self-definition (Shah, Foster, & Barany, 2017). These questions are used during measurements of a learner's initial current self, the exploration of possible selves (measured repeatedly over time), and a learner's new self (at a specific end point; Foster, 2014).

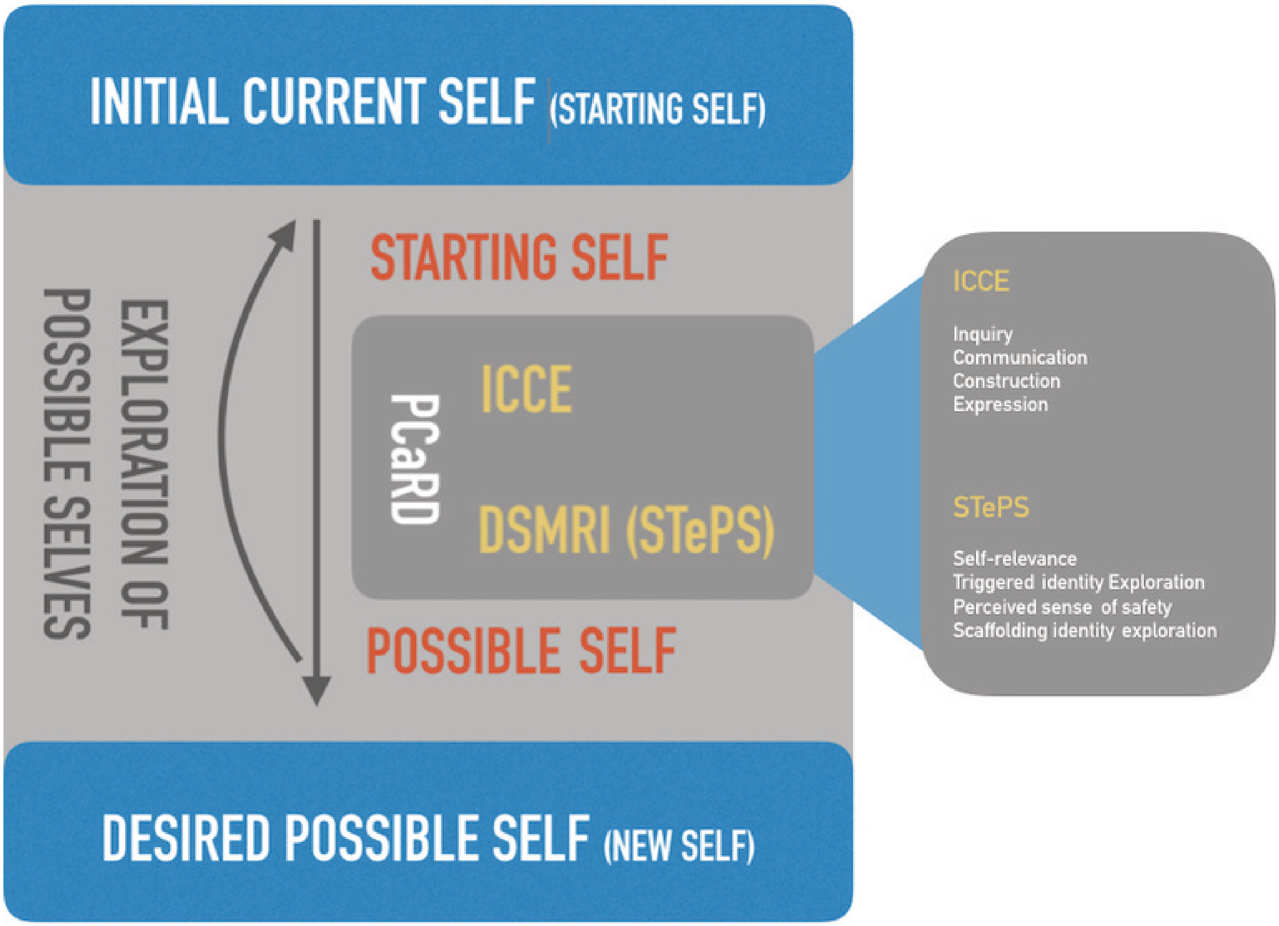


*Figure 1. Projective reflection.*

The Play, Curricular activity, Reflection, Discussion (PCaRD) pedagogical model for game-based learning offers one way of enacting PR (Foster & Shah, 2015b). Since games are conducive for situated learning experiences, learners engage in identity exploration in a game by role-playing a possible self (i.e., urban planner), an identity they may or may not want to strive for in the future (Markus & Nurius, 1986). During play, students' exploration of the role is guided by the design of the game (e.g., content areas covered) and pedagogical supports within and outside of the game (e.g., mentors). Based on elements of players' starting selves and the extent to which a given game allows for individualized role exploration, curricular activities, reflections, and discussions are designed to draw upon students' funds of academic, personal, and in-game knowledge and experiences to make the identity exploration personally relevant to each student (Silseth, 2018). Designed opportunities for inquiry, communication, construction, and expression (ICCE) underlie students' experiences during play-curricular activity-reflection-discussion. Students are engaged, thus making the process of identity exploration a transformative learning experience in a Deweyan sense (Dewey, 1902; Foster & Shah, 2015a). Finally, in order to best support each student in his or her process of identity exploration, game-play and supportive experiences are designed to be dynamic so as to seamlessly but intentionally promote self-relevance and a perceived sense of safety, while triggering or scaffolding exploration in the academic domain (Kaplan et al., 2014).

Projective reflection can serve as an analytical lens to design games and game-based learning curricula or retroactively examine identity exploration in completed play experiences. In the past, the extent to which a game-based curriculum using existing commercial and educational games and facilitated by PCaRD supports for projective reflection has been examined with high school students for science, social studies, and mathematics (Foster & Shah, 2016a). Additionally, *Keys to the Collection (KttC)*, a mobile augmented-reality game, was guided by the framework with the objective of stimulating the interest of 9–13-year-olds in the arts through designed experiences for PCaRD in a museum setting (Foster et al., 2017).

## Methods

*Philadelphia Land Science* (*PSL*) was designed, developed, and implemented from 2014 to 2017 as part of an ongoing five-year NSF CAREER project undertaken to advance theory and research on promoting identity exploration and change in science through interactive and immersive environments such as games (Foster, 2014). Early phases of the project involved characterizing the processes of identity change in known exemplary science games/virtual learning environments (*EcoMUVE*—Metcalf, Kamarainen, Tutwiler, Grotzer, & Dede, 2011; *Land Science*—Bagley & Shaffer, 2015; and *River City*—Ketelhut, 2007) that aim to develop science-related user identities. These environments were selected because of the strong line of research and theoretical grounding that influenced their development, testing, and refinement over several years. From 2014 to 2016, the process involved (a) conducting an analysis of the design of the environments for affording identity exploration and change, and (b) examining existing data from complete studies of participants in the environments to learn science and explore science identities. The analysis was guided by constructs that defined the projective reflection framework: knowledge, interest and valuing, self-organization and self-control, and self-perception and self-definition. The procedure for analysis and the designed affordances and constraints for Land Science were identified as a result (Foster & Shah, 2016b).

From 2016 to 2017, the principal investigator (PI) and his team of researchers collaborated with the Epistemic Games Group (EGG) to design an iteration of *Land Science* using the virtual internship authoring (VIA) tool. This iteration of *Land Science*, named *Philadelphia Land Science*, capitalized on the game's existing technological, pedagogical, and content characteristics to support greater alignment with projective reflection constructs. Furthermore, *Philadelphia Land Science* was customized to reflect Philadelphia, the context of implementation. Over 18 months, the collaboration involved visits to the EGG and weekly meetings to receive training in the use of VIA, creating land parcels for Philadelphia, and playtesting the frameboard. The EGG also hosted *Philadelphia Land Science* on its server and online platform (WorkPro Banner), which logged player data. Additionally, some EGG personnel offered real-time technical support during the implementation of *Philadelphia Land Science* at a science museum from October 2016 to March 2017.

### Research Design

*Philadelphia Land Science* was developed, implemented, and refined using a design-based research (DBR) methodology (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003). DBR supported cycles of design, enactment, analysis, and redesign as the authors implemented the game in a classroom where the game's technological, pedagogical, and content characteristics were adjusted by subsequent interventions. Each time we used *Philadelphia Land Science*, we examined classroom artifacts (e.g., student survey responses and written reflections) and reviewed researcher observation notes to inform game and classroom modifications that could enhance learner identity exploration and change related to environmental science. While modifying the game during interventions was not possible, external aspects of facilitating identity exploration were improved based on insights from the application. That is, the Play, Curricular activities, Reflection, and Discussion (PCaRD; Foster & Shah, 2015b) opportunities were modified as needed in response to participants' experience with the game to better support the process of identity exploration. Thus, game improvement occurred in successive cycles of application.

### Settings and Participants

Two eight-week courses titled Virtual City Planning were offered at a popular science museum in Philadelphia in 2016–2017 to ninth-grade students from a local magnet school emphasizing science learning. The museum partnered with the school to offer four–eight-week-long enrichment courses during an academic semester. Courses were held for 90 minutes on Wednesday afternoons. Thirty-five ninth-grade students participated across the two interventions. Student groups consisted of 19 girls, 14 boys, and 2 nonidentifying students; 34% identified as African American, while other students identified as Caucasian American, Latino/a, or other. Students played the game in a museum classroom using laptops provided by their school. Class structure typically consisted of an overview of activities, followed by engagement with *Philadelphia Land Science* or other curricular activities until a scheduled 15-minute break, at which point mentors would provide in-game feedback. Students then completed related curricular activities for the second part of class, or continued longer projects.

### Roles and Procedure

The team of researchers included the PI, a postdoctoral scholar, three doctoral students, and nine undergraduate students. The PI and the postdoctoral scholar guided all aspects of the project; students modified *Land Science* game content and context to reflect the Philadelphia context, pedagogical structures to further align with PR, and assessments to track identity exploration over time. The overall projective reflection experience was guided by (a) *internal aspects*: in-game experiences within PLS, and (b) *external aspects:* activities that occur in designed spaces outside of PLS, but as a result of gameplay. The PCaRD model informed the design of both internal and external aspects to facilitate the intentional process of identity exploration. Thus, it was essential to design both the internal and external aspects of the study concurrently, ensuring they were in sync. Below we describe design iterations of *Philadelphia Land Science* as a tool for facilitating learning as identity exploration and change in environmental science. *Land Science* is described to familiarize readers with the original game structure, and then characteristics of *PLS* are discussed for iterations 1 (in detail) and 2 (briefly, as it is beyond the scope of this paper).

## *Land Science*

*Land Science* was conceptualized by the epistemic frames theory, which introduces learners to basic skills, habits, and understanding related to urban science (Chesler et al., 2015), such as scientific modeling and real-world problem solving. *LS* was designed to serve as a virtual internship for students exploring urban planning and related environmental, economic, and engineering concepts. *Land Science* features include: (a) a notebook entry tool where players summarize and justify actions through professional emails to a virtual supervisor, (b) a resources page that offers content knowledge about the city, stakeholders, and environmental and economic issues, (c) an interactive city map connecting player rezoning choices to environmental and economic effects, (d) a chat log that hosts cooperative mentor-peer meetings, and (e) intake and exit surveys that gather intern feedback. The design of *Land Science* is typical of immersive virtual environments developed around pedagogical praxis or epistemic frames theory (e.g., *Nephrotex, EcoMUVE*) that emphasize the thinking (cognitive), being (civic), and doing (practical) that is essential to all complex learning (Shaffer, 2006).

## *Philadelphia Land Science*—Iteration 1

The design goals of iteration 1 of *Philadelphia Land Science* (*PLS1)* were the intentional facilitation of identity exploration through designing opportunities for changes in what the players know and think, what they care about, how they see themselves, and what they want and expect to be in relation to urban science and environmental science careers. *PLS1* included changes that personalized the game experience for students and optimized affordances of the museum implementation context.

### Internal Aspects of Content Changes

Given the demonstrated success of *Land Science* in promoting changes in students' content knowledge, much of the existing game content was either retained in *Philadelphia Land Science* or mirrored to reflect a Philadelphia context. For example, *PLS1* maintained the general expression of city zoning codes and scientific/economic output variables but made changes to represent context. Land-use codes described as single-family, two-family, and multifamily residential were renamed as low-, medium-, and high-density housing to offer more flexible definitions of downtown Philadelphia housing density, as almost all residential areas in Center City qualify as "multifamily." New housing-density descriptions aligned more closely with students' lived experiences in an urban center and illustrated the housing-density nuances more precisely.

Scientific/economic output variables on the interactive map were aligned with the Philadelphia context and starting levels (i.e., gallons of water runoff) shifted to reflect current Philadelphia measurements. Environmental variables related to animal populations in Massachusetts were changed to address Philadelphia native species (i.e., Eastern mud turtles). New content descriptions emphasized the local relevance of these species and illustrated how map changes might affect them.

*Land Science* included brochures for four fictional stakeholder groups in Massachusetts that detailed their respective values and provided biographies for individual stakeholders so that students could understand and address their needs. *PLS1* designers developed brochures and biographies for Philadelphia groups that emphasized analogous combinations of economic and environmental values:

- The Bridgeway Community Action Association supported low-income families and emphasized housing and environmental issues.
- The Environmental Council of Greater Philadelphia advised on environmental conservation issues such as wildlife protection and pollution control.
- The Philadelphia Economic Affairs Coalition supported economic growth and valued increased zoning for houses and businesses.
- The Philadelphia Institute for Neighborhood Preservation sought to improve citizen quality of life by balancing environmental and economic change.

While *Land Science* included representative nonplayer characters based on gender, race, and ethnic background, *PLS1* capitalized on opportunities to demonstrate diverse employees and leaders in urban planning. Portraying urban planners with whom players can identify is key to the development of possible selves in the domain, as it encourages players to see themselves in a given role and develop domain-specific knowledge (Foster, 2008). In-game diversity also addressed the museum context, as the majority of players were likely to be members of groups currently underrepresented in STEM fields (women, non-White employees).

### Internal Aspects of Pedagogical Changes

*Land Science* was designed with a cyclical pedagogical structure that scaffolded students' progression from one "room" to the next, guiding students through the process of developing urban-planning proposals that gradually allowed students to explore the motivational, cognitive aspects of being an urban planner. In each of the 12 rooms, students reviewed an email that explained upcoming activities, provided context, and outlined deliverables for players to complete and write about in notebook entries. Students reviewed content resources, participated in meetings, made zoning changes on the interactive map, and reviewed stakeholder feedback on map designs. Each room culminated with notebook entries in which students summarized their activities, which were reviewed remotely by instructors, who accepted or returned student work for resubmission.

*PLS1* maintained much of this pedagogical structure, particularly as its design authentically progressed players through urban-planning processes. Seven new deliverables were added across the 12 rooms (as informed by PR) that prompted students to consider developing (a) interests and values (i.e., submit "a formal summary of the changes you would make to meet your own needs as a citizen of Philadelphia"), and (b) self-perceptions and self-definitions (i.e., "reflect on your role in this internship and your expectations about this role going forward").

Questions on intake and exit surveys in *PLS1* were designed to assess all four PR constructs; items consisted of short-answer, multiple-choice, and Likert-style questions that took about 30 minutes to complete. Intake and exit surveys bookended identity exploration in the game, allowing researchers to assess players' starting selves and new selves at the end of the intervention; game and classroom data tracked changes between these start and end points.

### External Aspects of Pedagogical Changes

Supplemental curricular activities, reflection, and discussion were also designed and implemented in the classroom environment to support a more integrated classroom experience, as supported by PCaRD (Foster & Shah, 2015b). For example, using paper maps and markers, students drew how they would want the city to be redesigned, and then they explained and justified these changes in a whole-group discussion. This activity was designed to foster engagement in the experience and offer an opportunity to construct a rezoned Philadelphia based on individual interests and values. Students also created blog posts to describe the interests and values of one community stakeholder they were working to please. Posts offered advice for peers on how best to meet stakeholders' needs.

Researchers chose to leverage pedagogical opportunities afforded by the classroom space, student proximity, and existing peer relationships. Thus, instead of virtually facilitated meetings structured around a virtual mentor's questions, *PLS1* meetings had in-person facilitators role-playing as urban-planning professionals, who guided meeting topics and discussions around important points and encouraged socially shared regulation among peers.

Opportunities for student reflection were also facilitated in the classroom experience. The most notable example of this occurred when a role-playing urban planner shared a midintervention class synthesis of students' demonstrated changes in what they know, care about, want/expect to be, and how they think and see themselves; students reflected on how they have changed in these areas. Online blog posts (separate from the game) provided further opportunities for self-reflection.

#### Internal Aspects of Technological Change

The *Land Science* interface was designed to virtually simulate the experience of working as an urban planner, and most technological features were retained in *PLS1*. Progression of game activities was moderated by remotely situated real-world mentors who initiated emails from a virtual supervisor, answered questions, reviewed students' work, and provided in-game feedback. *LS* also included a chat feature where players held meetings and communicated with peers and mentors. Though these online meetings were translated to in-person role-plays in *PLS1*, researchers retained the chat feature so that players could connect to online moderators if needed. For example, when a student submitted a notebook entry too early, online mentors coached him or her through its retrieval through chat.

*LS* included example notebook entries that students could reference as they developed skill in professional writing and speaking. Such resources are well suited for the goals of the original game, as they model ways of thinking and acting around urban planning. Review of the *LS* gameplay data showed that students recognized these examples as optimal responses, but some would copy sections of sample text to construct their notebook responses. Given the emphasis on personal reflection and regulated learning practices in *PLS1*, redesign shifted supportive texts from *how* a notebook is written toward *what* players should write in their entries. *PLS1* instead included statements reiterating the deliverables needed for each entry (i.e., "please include a short summary of your experience completing the Entrance Interview").

### *Philadelphia Land Science*—Iteration 2

Gameplay and classroom data from *PLS1* were collected and analyzed to inform the iterative design of the internal and external aspects and further align with the goals of the museum context. *PSL1* built upon existing gameplay structures to add increased opportunities for in-game and in-classroom self-reflection and discussion around possible selves; however, the game with these additions proved to be too long and cumbersome to offer a complete and engaging experience to students in eight class periods. Thus, modifications were designed into iteration 2 of *Philadelphia Land Science (PLS2)* that simplified and streamlined gameplay narratives and processes, while upholding original *LS* goals and developing more targeted intentional shifts in learners across PR constructs. The following list offers an overview of the changes made in *PLS2*:

- *PLS2* included readability changes to in-game text but retained existing content.
- *PLS1* gameplay consisted of 12 "rooms" that iterated student activity through more than 50 distinct "deliverables." *PLS2* streamlined game processes to include 31 deliverables across eight rooms while maintaining intentional alignment with projective reflection constructs.

- Further in-class curricular activities emphasizing reflection and discussion were created with the goal of supplementing game affordances to enhance personal connections, develop contextualized content knowledge, and provide opportunities for student self-reflection. Curricular activities from *PLS1* were also redesigned with this goal in mind.
- To accommodate Internet connectivity issues in the museum, paper versions of all in-game resources, surveys, and activities were developed and included in personalized student work binders.
- Weekly PowerPoints outlined class structure, detailed class activities, and shared technological information.
- Online blog use was discontinued because of time and connectivity constraints.

## Conclusion

Projective reflection is an emerging framework that can serve as a lens to examine existing games and inform the iterative design of games for identity exploration and change. The framework stresses the importance of intentionality and focus on the self as inextricably tied to examining identity exploration and formation, and it can demonstrate to educators, researchers, and designers how games can be conducive to examine this relationship. *Philadelphia Land Science* was designed to build upon the strengths of existing virtual internships, most notably *Land Science*, to facilitate projective reflection, that is, an intentional process of learning as identity change that emphasizes knowledge construction, interest and valuing, regulated actions, and self-perception and self-definitions (Foster & Shah, 2016a; Shah, Foster & Barany, 2017). Explication of the design iterations that structured game development offers insights into how projective reflection can inform the creation of virtual environments to support student identity exploration and change around specific role identities or possible selves (e.g., urban planning career). Future research will elaborate on the impact of *PLS* and supportive curricular interventions for promoting student learning, conceptualized as identity change using projective reflection. Further design iterations may also involve (a) the incorporation of a map of Philadelphia that updates to reflect real-time zoning changes, (b) map and game development around specific city sections and/or of the entire city, and (c) the inclusion of more land-use codes and variables to develop value-driven, personalized learning as identity change.

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# Using Social Network Analysis to Examine Player Interactions in *EvE Online*

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**Abstract:** Network analysis is an increasingly popular tool for the analysis of rich telemetry data from digital game environments. In this paper we apply social network analysis techniques to the massively multiplayer online game *EvE Online* in order to examine patterns of player interactions in the game. Data were collected from a 1-month period of player-versus-player (PvP) interactions in a specific region of the game. In our analyses we conduct analyses of key actors relying on different centrality measures to identify patterns of play in the region. We examine the features and implications of being a "key actor" across these centrality measures in this context as well as explore applications of this methodology toward game design and research.

## Introduction

Network analysis and theory constitute important methodological and conceptual tools that help highlight structure among seemingly chaotic relationships. With the proliferation of geocoded, transactional, and digital game data related to education, researchers have started applying and using network principles to explain patterns and highlight structures among relationships. In a recent study, González Canché (2018) relied on geographical network analysis to measure states that were central providers and receivers of nonresident students (e.g., students who attended high school in state A but enrolled in college in state B). The use of this conceptual and analytic framework enabled inclusion of all geographical facets of the higher education system in the United States. While straightforward, no previous study dealing with student migration patterns and behaviors was capable of including all such components. Similarly, González Canché and Rios-Aguilar (2015) applied network principles to measure the effects of one's peers on credit accumulation in community colleges and found that minority male students were affected more by their peers than nonminority students and minority female students were.

One particular subset of network analysis that is well suited to the types of data being produced by modern digital systems is social network analysis. In social network analysis individuals are modeled as nodes, and the relationships between individuals are modeled as edges. These relationships can include things such as Facebook friends (Backstrom & Kleinberg, 2014; Hristova, Musolesi, & Mascolo, 2014), Twitter followers (Myers, Sharma, Gupta, & Lin, 2014), or academic coauthors (Zare-Farashbandi, Geraei, & Siamaki, 2014). Social network analysis highlights connections between individuals and can shed light on the types and structures of formal and informal communities that take shape around specific practices, such as digital games.

### Using Networks to Study Games

Network analysis and theory have been previously applied to educational game domains. Game environments can provide a rich mix of play possibilities combined with robust data logging and capture that facilitates the construction and analysis of player-system and player-player interaction networks. In short, network analysis enables the possibility of identifying complex patterns of interaction that can arise from rich digital games, simulations, and other contexts. Once these patterns are identified, researchers and designers can more confidently discuss the meaning and importance of centrality measures in this environment and offer recommendations and implications toward game design and research. For instance, Shaffer et al. (2009) developed a method of assessing learner performance and knowledge—epistemic network analysis (ENA)—based on network analysis principles. ENA considers the number and quality of the connections that bind together an *epistemic frame*—the “skills, affiliations, habits, and understandings” (p. 4) that define a given community. Using the games *Digital Zoo* and *Urban Science*, Shaffer and colleagues assessed the relationship between students’ values, affiliations, and interactions over time through the construction of network graphs. Once these graphs were constructed, it became possible to assess the relative *centrality* of each component of the epistemic frame—the relative importance and structure that each component lent to the overall structure of the process of gameplay.

Other forms of network analysis can be used to evaluate game characteristics as well. For example, Kirman & Lawson (2009) applied methods of social network analysis to the social collection game *Familiars*. They evaluated players’ interactions with one another to construct a social network graph of overall participation and found that players could be subset into three player typologies: the “hardcore” player, the “casual” player, and the “peripheral” player. These analyses focused on the participation of groups within the game and did not attempt to identify specific actors in the game or their contributions to and importance within the network.

In this study we apply analytic and conceptual tools of social network analysis to study player interactions in the complex digital environment of the space sci-fi massively multiplayer online (MMO) *EvE Online*. In our social network analysis, we treat individual players as nodes, and we evaluate the relationships between nodes based on the interactions that individuals have with one another in the game. We identify central actors in this network and discuss the implications and significance of being a central actor in the context of the game.

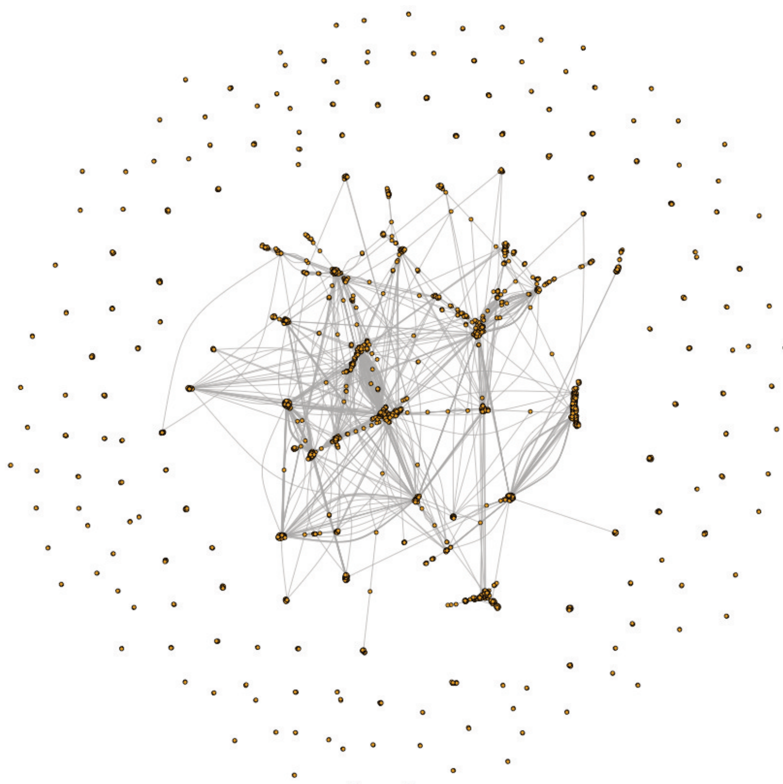
### Why *EvE Online*?

*EvE Online* (CCP, 2004) is a massively multiplayer online space-based science-fiction game. In *EvE*, players assume the role of an immortal capsuleer, piloting spaceships to extract resources, claim territory, and broker the sale of goods between players. *EvE* features regions of space that can be claimed by player organizations, and fights over resources and territory in these regions are a frequent source of conflict in the game. The player-versus-player (PvP) nature of *EvE* is strongly emphasized, and conflicts between players and player organizations are a major draw for the game. *EvE* features a comprehensive application programming interface (API) that allows players to obtain data on many events that take place within the game, and this API has given rise to a number of prominent fan sites in the community that feature their own APIs as well. The availability of detailed, public-facing APIs makes *EvE Online* relatively unique among MMOs and was what made this particular analysis possible.

## Methodology

Data were obtained from the community website *zKillboard.com* (Caphinator, 2015). When a pilot in *EvE* destroys another pilot’s ship, the game generates a “killmail” for the aggressor(s) and the victim—all pilots who attacked the victim are listed. *zKillboard* aggregates these killmails and makes them available publicly for pilots to track their kills, efficiency, value destroyed, and other statistics.

Using *zKillboard*'s API, data were obtained for 5,523 unique pilots and 8,654 unique pilot/pilot interactions. In order to appear in the data set a pilot must have been present on at least one killmail (either as an aggressor or as a victim) during the month of October 2017 in the "Placid" region of space within *EvE Online*. An aggressor pilot is defined as being listed as a contributor on a killmail (by dealing damage or otherwise impairing the victim's ship), while a victim pilot is defined as losing his ship. We constructed two different networks from this data set. In one, we modeled a network of aggressors acting on victims as a *directed*, unweighted network. In the other, we modeled a network of aggressors acting alongside one another as an *undirected*, unweighted network. By using these two graphs we could identify not only patterns in interactions between aggressors and victims, but also patterns of which aggressors commonly played with one another. Graphical representations of both networks are presented (see Figure 1).



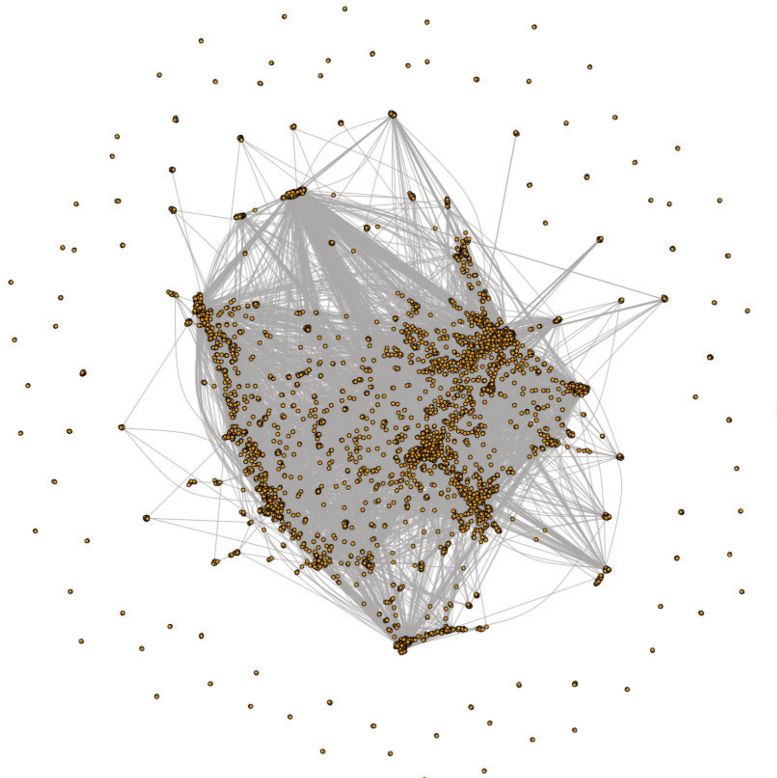


*Figure 1. Aggressor–aggressor network (top) and aggressor–victim network (bottom).*

## Analysis

### Aggressor–Victim Network

The aggressor–victim (A->V) network contained 18,190 unique aggressor/victim edges connecting 5,523 pilot nodes in the data set. We constructed a directed network from these data, with individual aggressors acting on victims. That is, if pilots A, B, C, and D are all listed as aggressors on pilot Z's killmail, the network contains edges for A->Z, B->Z, C->Z, and D->Z.

From this network we calculated four measures of network centrality—betweenness centrality (the number of shortest paths that pass through a given node), closeness centrality (the inverse of the sum of the length of each path), degree centrality (the number of edges that a given node has), and eigenvector centrality (the degree of "importance" of a node's edges; see Table 1).

| Rank | Closeness Centrality | Betweenness Centrality | Degree Centrality | Eigenvector Centrality |
|---|---|---|---|---|
| 1 | BoomBangGone | BoomBangGone | BoomBangGone | Nina Glutdrache |
| 2 | Carnelio Riraille | JEK ROO | dirk boos | Xel'lotath Tier |
| 3 | Xel'lotath Tier | Xel'lotath Tier | Carnelio Riraille | Daemon Koabd |
| 4 | Lt Lunar Lazair | dirk boos | Ildar Nabiullin | oh crap BEARS |
| 5 | kado'tempestas | Carnelio Riraille | oh crap BEARS | Nina Fyrerdrache |

*Table 1. Central actors in the Placid region in EvE Online in the aggressor–victim network.*

For all pilots identified among the central actors in the region, we aggregated some of their public statistics that *zKillboard* tracks, such as their kills (number of ships destroyed), efficiency (their ratio of ships destroyed to ships lost), and value destroyed for October (across all regions of *EvE*, not just Placid; see Table 2).

| Name | Average[a] | Min[a] | Max[a] | St Dev[a] |
|---|---|---|---|---|
| Ship Kills | 383 | 115 | 477 | 111.8 |
| Efficiency | 86% | 71% | 98% | 10.3% |
| Value Destroyed[b] | 15.35 | 5.40 | 41.82 | 11.38 |

[a] JEK ROO recorded no ship kills for the month of October and is omitted from these statistics
[b] values are in billions of InterStellar Kredits (ISK), *EvE*'s in-game currency. 1 USD ~ 80m ISK.

*Table 2. Central actors' aggregate statistics from zKillboard, aggressor–victim network.*

While several pilots appear multiple times as central actors in the A->V network, there are some notable exceptions. For instance, the only common actor between degree centrality and eigenvector centrality is the player "oh crap BEARS." The difference between degree centrality and eigenvector centrality is one of *importance*—degree centrality assesses the number of edges between nodes considering these edges to be equal, while eigenvector centrality assesses the importance of each edge based on which nodes it connects. In this network, then, a higher eigenvector centrality suggests that the actor in question is listed as an aggressor on the killmails of other pilots who are themselves central actors. By comparison, degree centrality is a raw measure of the number of killmails on which the pilot is listed as an aggressor, regardless of the pilot's position and involvement of the victim in the overall network. Therefore, oh crap BEARS is unique in the high degree and eigenvector centrality—this pilot shoots at and is shot at by many different pilots, and those pilots are themselves central actors in the network.

Betweenness centrality is another interesting measure of network centrality for the A->V network. While BoomBangGone is a central actor by multiple measures, JEK ROO is a central actor only in terms of betweenness. JEK ROO was omitted from Table 2 because this pilot has never destroyed another player's ship before. JEK ROO recorded 0 kills and 152 losses in Placid in October, and each ship JEK ROO lost was completely unfit—it had no guns, armor, shields, or any other modules equipped. It is most likely that this pilot was an automated bot account for farming resources, and the amount of time that the bot was online and active led to its being attacked and destroyed by a wide range of pilots. This sort of behavior would lead to a high betweenness centrality, even with no recorded kills, because the pilot serves as a bridge linking two aggressors that may otherwise have not shared any common kills. Examining the connections in the data showed that kado'tempestas, dirk boos, and Jos Manar—all central actors themselves in either the A->V or A-A networks—were listed as aggressors against JEK ROO during October.

## Aggressor–Aggressor Network

The aggressor–aggressor (A-A) network contained 8,692 unique aggressor/aggressor pairs for 3,038 nodes, less than half the connections of the A->V network. This suggests that the network of PvP interactions in EvE is not mutual; many of the pilots who appear in the network appear only as victims, not as aggressors. The A-A network has a much higher density than the A->V network: 0.0009 for the A-A network compared to 0.0005 for the A->V network.

As we calculated for the A->V network, we also calculated centrality measures for the aggressor–aggressor network (see Table 3).

| Rank | Closeness Centrality | Betweenness Centrality | Degree Centrality | Eigenvector Centrality |
|---|---|---|---|---|
| 1 | Quark Dallocort | Lt Lunar Lazair | Nina Glutdrache | Nina Glutdrache |
| 2 | petosorus | Meatwave Heatwave | dirk boos | Nina Fyrerdrache |
| 3 | Pippinthehobbit | Nassen Leto | rus B2K | AlexeyTier Haizenberg |
| 4 | Dancness Aldebaran | Jos Manar | Tainted Nightmare | rus B2K |
| 5 | Sith Sarum | Enderas Tsero | AlexeyTier Haizenberg | Bongo Linvor |

*Table 3. Central actors in the aggressor–aggressor network.*

We also generated summary statistics for these pilots' number of kills, efficiency, and value destroyed for the month of October (see Table 4).

| Name | Average | Min | Max | St Dev |
|---|---|---|---|---|
| Ship Kills | 148 | 10 | 477 | 122.2 |
| Efficiency | 94% | 70% | 99% | 7.3% |
| Value Destroyed | 58.05 | 1.41 | 379.17 | 114.39 |

*Table 4. Central actors' aggregate statistics from zKillboard, aggressor–aggressor network.*

There are several differences present among central actors in the two networks, primarily in that the A->V network and A-A network share almost no common actors. Being a central actor in the aggressor–victim network is typical of pilots who shoot at many different targets; this network represents who is shooting and who is being shot at. For the aggressor–aggressor network, however, a central actor is a player who flies with many different allied pilots; this network represents who you shoot *with*. This is evident in the difference between ship kills and value destroyed between central actors in the two networks. The average central actor in the A-A network recorded 148 ship kills for the month of October, totaling 50 billion InterStellar Kredits (ISK) in damages. In the A->V network, however, the average central actor recorded 383 ship kills with just 15 billion ISK in damages. These differences are likely due to the types of players present in both networks—central actors in the A->V network tend to be focused on PvP content specifically in the Placid region, with most of their ship kills coming from that area of space (but not necessarily being expensive, valuable kills), while central actors in the A-A network appear to travel much farther distances in search of players to fight and in larger, more organized groups, and they end up accruing fewer but more valuable kills.

Interestingly, many of the central actors in terms of closeness in the A-A network are not local to Placid at all. For instance, the pilot Quark Dallocort recorded just two kills in Placid for the month of October, but both of these kills involved a group of 31 players from more than one dozen different player organizations. Another of the central actors in terms of closeness, petosorus, recorded just four kills in Placid, but all of these were with a group of players from the corporation "EvE University," a corporation devoted to training and tutoring new players from across EvE. By comparison, Xel'lotath Tier recorded more than 50 kills and 20 losses in Placid during October—usually in a group of four or fewer players, and frequently by himself.

Both networks are relatively sparse and contain many player participants who are not well connected to the rest of the network. However, the implications of these connection patterns are very different. In the A-A network there are 2,741 pilots who have a degree centrality less than 20 (90%). While this could indicate low overall activity (the fewer kills you have, the fewer opportunities to connect to others on the network), it could also indicate small, tightly knit groups of players who fly together very frequently, but rarely with people outside of their community. On the other hand, in the A->V network, there are 5,083 pilots who have a degree centrality less than 20 (92%), and 1,599 pilots who have a degree centrality of 1 (just one connection in the graph). For the A->V network, where edges are a player destroying another's ship, a low centrality suggests a player who is relatively disengaged from PvP content in *EvE*.

## Interpretation

In this paper we used social network analysis to construct two networks from pilot interaction data in the MMO *EvE Online*. One network assessed directed connections between pilots listed as aggressors and victims from killmails obtained from the website *zKillboard*, while the other assessed connections between pilots listed as aggressors on mutual killmails. We calculated multiple measures of centrality for each graph and found that each centrality measure produced different sets of pilots considered to be central actors. Different centrality measures identified different types of play styles that may be used by each pilot.

In the A-A network, measures of closeness centrality identified pilots who appear to participate in large-scale PvP fleets. These pilots appeared with relative infrequency in Placid, our region of interest, and recorded fewer kills overall than central actors identified by other methods. The defining feature of these pilots was participation in fleets numbering 15–50 pilots, especially fleets from PvP–focused corporations and alliances such as EvE University. In these large fleets, pilots rapidly become connected to other active pilots in the region, moving them closer to the center of their respective networks. On the other hand, in the A->V network, pilots with a high closeness centrality were frequently also high in betweenness centrality and degree centrality. Central actors in the A->V network, by their measures of closeness, were often some of the most active and successful (in terms of scoring kills and destroying ships), while this did not necessarily hold true for the A-A network.

Measures of betweenness centrality identified pilots with a high diversity of kills and losses in both networks. These pilots were indiscriminate in whom they aggressed or were aggressed by, and whom they aggressed with. *EvE Online*'s political landscape is dominated by nonaggression agreements between corporations and alliances, so pilots with high betweenness centrality were likely to be from smaller corporations and groups, or from groups without these nonaggression agreements in place. Additionally, betweenness centrality identified JEK ROO as a central actor despite this pilot recording no kills in the entire data set, something that other centrality measures did not identify for the A->V network.

Degree centrality and eigenvector centrality, as raw measures of connections, identified pilots in the A->V network who are prolific in the amount of targets that they find and destroy in the game. Pilots with a high degree centrality are identified as some of the most active pilots using *zKillboard*'s own metrics of performance (such as ship kills, value destroyed, and efficiency). In the A-A network, on the other hand, degree centrality and eigenvector centrality represent pilots who play with many different people. For example, two of the most central actors in the A-A network in terms of degree centrality are the pilots dirk boos and Tainted Nightmare. Both of these pilots, at the time of data collection, were a corporation named "Toxic Uprising." In looking at these pilots' *zKillboard* histories, and other pilots in Toxic Uprising, we found that members of this corporation rarely played with anyone outside of the corporation. While Toxic Uprising has since disbanded, during the month of October it contained around 70 pilots. This high coherence between pilots in the corporation contributed to the degree centrality of dirk boos and Tainted Nightmare, while the low out-group participation contributed to much lower betweenness centrality and closeness centrality. Members of this corporation shared many common links with one another but relatively few with the broader network of all players within the Placid region.

Central actors in terms of their eigenvector centrality are best characterized as “hunters of hunters” in the A->V network. Eigenvector centrality weights the relative importance of connections in the network based on who is connected to them. While a pilot high in degree centrality may have aggressed many different pilots, that pilot will be high in eigenvector centrality only if the aggressed pilots themselves were more central within the network. Pilots such as JEK ROO seem to be primarily outliers, and the vast majority of pilots identified as central actors are quite proficient at PvP. Therefore, pilots high in eigenvector centrality are pilots who frequently aggress and are aggressed by other central actors in the network. In the A-A network, this interpretation is slightly different—pilots high in eigenvector centrality are pilots who frequently fly with other central actors. As with degree centrality, the central actors for eigenvector centrality are almost all in the same corporation. In this case, the pilot Nina Glutdrache is the CEO of the corporation Conoco, a member of the Caldari Armed Forces alliance, and the pilots rus B2K, AlexeyTier Haizenberg, and Bongo Linvor are all members of this corporation as well. Nearly 2,400 pilots are members of Conoco, and the sheer size and activity of the corporation appears to drive its most active members to a central position in the network in terms of their degree and eigenvector centrality measures. In *EvE Online*, however, shooting at members of the same corporation is generally frowned upon. This, combined with possible nonaggression agreements that Conoco has in place, could explain why its pilots are not similarly high in betweenness or closeness centrality—while they share many connections with one another, they share fewer connections to the rest of the network by virtue of having fewer people that they are allowed to shoot at. In the case of Conoco, large sections of the A->V network are off-limits because a substantial number of actors in the network are in the same corporation.

## Discussion and Implications

We believe that the topography and structure of these networks has implications for thinking about game design as well as game assessment. Network analyses are a popular form of analysis in game environments, and while the literature on the analysis of player-system interactions is rich (Kim, Almond, & Shute, 2016; Shaffer et al., 2009), the literature on player-player interactions is significantly smaller. These analyses offer a template for constructing meaningful analyses and inferences about player-player interactions from rich log data. We hope that by showing how these analyses can be used to interpret players’ interactions with one another, more games (especially in the education sphere) will afford students opportunities to interact with one another and record this data for analysis.

From a game-design standpoint, these analyses raised several interesting questions. First, pilot JEK ROO appears to be a bot-controlled player, which is against *EvE Online*’s terms of service. In fact, this account may have already been banned—JEK ROO has not recorded a loss since September 1, 2017. However, this account also held a central position within the network in terms of its betweenness centrality—many of the shortest node-node paths between aggressors and victims passed through this pilot. Whether betweenness centrality is important to the overall health of the game environment, and whether bot accounts play a role in supporting *EvE*’s PvP community or the communities of other online games, is an open question.

Additionally, we intend to further examine the role that large player groups have in shaping the PvP landscape in *EvE Online*. Two corporations contain nine of the 10 most central actors in terms of their degree centrality and eigenvector centrality (and it is quite likely that the pilot Nina Fyrerdrache is also Nina Glutdrache, based on naming similarities and shared killmails). While Conoco and Toxic Uprising are not sufficiently large to dominate the entire network, this may not be the case in smaller or newer games with less developed communities of players. There are similar questions about the influence that a large number of bot accounts could have in these environments as well.

With its robust API and large player community, *EvE Online* is uniquely situated to facilitate these kinds of analyses. In future work we hope to examine differences in network structure across multiple different regions of space in the game, as well as weight edge connections with different attributes (such as total number of kills rather than number of unique kills, or with value destroyed by aggressing). Additionally, we plan to apply these analyses to education-focused games and digital environments as a means of studying the associations between status as a central actor and position in a social network with learning gains and outcomes.

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# Innovations That Help People

## A Secondary School Computer Science Curriculum

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**Abstract:** In this research study we investigated the impact of a computer science (CS) curricular intervention on girls' interest in the topic. Our curriculum forefronts "Innovations That Help People" as a mode of broadening students' view of computer science. Our research focuses on real-life problems that require CS skills in order to be solved. Using a problem-based learning (PBL) framework, students are presented with practical problem situations and then are guided through a process of discovery and identification of possible solutions until a workable solution is achieved. The entire process is weaved around an ethical component (consequences and benefits of innovation). Data collection includes field notes, artifact interviews, and a focus group interview. Six students (3 girls) attending a private day school in a city in the Northeastern United States participated in the study. Preliminary results indicate that both girls and boys are motivated by the Innovations That Help People curricular approach.

## Introduction

### Current Women's Representation in STEM Careers

There is a dearth of women studying and/or entering the field of computer science (CS; National Science Foundation, 2015). This is true while computer and mathematical occupations are the fourth fastest-growing occupational group between 2014 and 2024, with a projected growth of 13.1%. The Bureau of Labor Statistics (BLS) projects adding 531,400 new jobs between 2014 and 2024 (BLS, 2015). Still, there remains a shortage of people able to fill software-development positions (BLS, 2012). Past research indicates that students begin developing and exploring future identities in middle and high school (Ji, Lapan, & Tate, 2004). Hence, it is important for students to be exposed to computer science education in these school years. Ironically, it is during these same years that many girls begin turning away from technology as an interest (Doerschuk, Liu, & Mann, 2007). One reason this turning away may occur is the strong perception, held by many, that technology and engineering are "male" disciplines (American Association of University Women [AAUW], 2010). In a recent study, Kelley and Bryan (2018) surveyed first-year engineering students to examine why fewer women choose engineering as a career. They discovered that while men do not consider the typical engineer to be masculine, many women do make this assumption.

### Communal Goals

Diekman, Brown, Johnston, and Clark (2010) explain that current research and policy in general focuses on aligning women and girls more closely with men and boys, specifically, increasing self-efficacy and the overall experience of women in STEM areas. However, those strategies do not seem to address all of the possible causes of why girls and women are not pursuing STEM fields. Diekman et al. state that STEM careers may be perceived as incompatible with the notion of communion, described as the desire to help and to be in the presence of others, and the action of putting others before one's self. Traditionally, men have been socialized to occupy leadership or breadwinner roles that usually include aspects of self-orientation and agency, whereas women have been socialized to opt for caretaking roles associated with aspects of communion. Diekman et al. posit that individuals may not be interested in a career if it appears to contradict their own socialized and internalized beliefs about the roles of men and women. Here we tie computer science directly to helping others as a means of overcoming socialized beliefs. We take a PBL approach to introducing CS projects focused on helping people.

### Problem-Based Learning (PBL)

Problem-based approaches are rooted in experience-based education (Savery, 2009). Learning research and theory suggest that when students learn by the experience of solving problems, students will learn both content as well as problem-solving strategies (Savery, 2009). In general terms, PBL can be defined as "the learning that results from the process of working toward the understanding or resolution of a problem" (Barrows & Tamblyn, 1980, p. 1). Ertmer and Simons (2006) propose the following two general goals for PBL: (a) to promote deep understanding of subject matter content while (b) simultaneously developing students' higher-order thinking.

In 2009, Walker and Leary published a meta-analysis of PBL accounting for implementation types, disciplines, and assessment levels. In their analysis, they identified the following four characteristics of PBL: (a) ill-structured problems are presented to students so there can be several causes as well as several correct answers, fostering students' exploration of multiple solution trajectories; (b) student-centered approach is crucial as students will self-assess and identify knowledge areas required to solve the problem(s); (c) teachers as facilitators or tutors rather than lecturers of knowledge; teachers' roles change drastically as they model learning processes that would enable students to solve their problem(s); and (d) educational experiences should be situated in real-life contexts; authenticity is mandatory in order to provide students with relevant and practical applications of their experiences. Our project, reported here, is based on these four characteristics through the curriculum we developed. The research question we addressed in this project is: Does a PBL-based curriculum focused on innovations that help people support girls' interest in computer science?

## Curriculum

The 12-week "Innovations That Help People" curriculum developed for this research project consisted of three distinct projects that introduced students to helping-technology innovations as they work in society: Move It!, Life Alert! and Self-Driving Cars! The participating students were guided to create functioning models of the innovation through use of the robotics materials and the Lego program. In addition, the curriculum also asks students to consider the ethical implications of innovation (e.g., job losses that are due to automation, legal implications of autonomous vehicles, etc.).

The curriculum consists of three problem/projects, including: (a) Move It!—getting a vehicle to autonomously go from point A to point B; (b) Life Alert!—developing a device that allows the elderly to live independently; and (c) Self-Driving Cars!—developing autonomous vehicles able to safely interact with other vehicles. The platform for programming and prototyping was Lego's *EV3 Mindstorms* education set. As a result, the requirements for each project were designed based on the capabilities and features of each Lego set.

Projects were designed to require increasingly sophisticated computational thinking. For example, Project 1 (Move It!) included concepts of algorithmic thinking, iterations, and debugging. Learning was scaffolded by providing students with unplugged programming exercises before programming their devices; students were asked to delineate all of the steps necessary to navigate from one corner of the classroom to the front door. Then students were paired up and assigned one Lego *Mindstorms* robotics kit per team. Each group was tasked with programming their device to go from point A to point B inside the classroom (points were marked using masking tape on the floor).

In addition, students had to measure the distance between objects in the classroom, decide on turning angles, and decide if their vehicles' motion will be determined by revolutions or by time. The class format included minilectures on programming and facilitator support for each team. Each student documented his or her progress in a research journal.

Project 2 (Life Alert!) introduced conditional statements, loops, and sensors. The challenge involved developing a device that could detect falls and produce an alert. This project helped students understand physics concepts such as acceleration, mass, angles, and axis. As a result, students had to perform measurements to determine which rate of acceleration represented a fall, while ignoring individuals sitting or bending down. Figure 1 presents a graph produced by the gyro sensors used in the project.

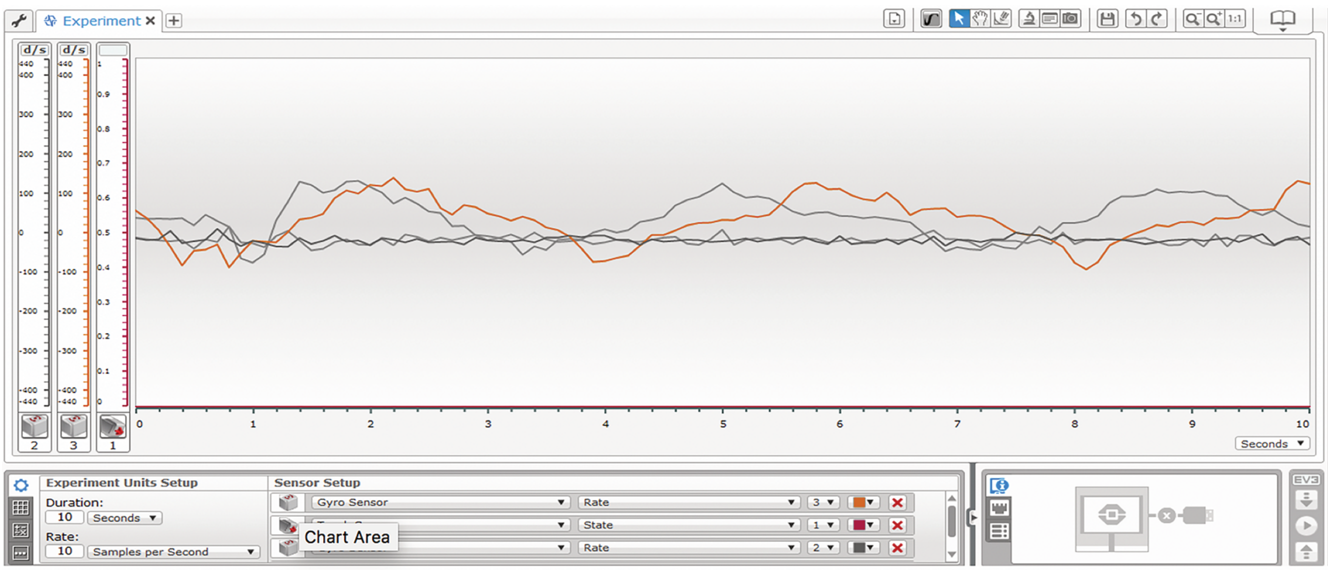


*Figure 1. Graphic represents rate of acceleration for two gyro sensors and one touch sensor state over 10 seconds.*

As a way to provide a real-life connection to the project, the class had a chance to interview an elderly person who recently had had an incident. Although the incident did not have major consequences, the person could have benefited from having a device like the one the students were developing. The interview provided students with an opportunity to refine their devices as well as produce a list of possible future features. At the end of the development stage, students had to present their projects in a "Shark Tank" presentation format, in which each team had a limited amount of time to pitch its product (project) to prospective investors.

Project 3 (Self-Driving Cars!), although similar to Project 1, involved developing autonomous vehicles that were able to safely interact with other objects or vehicles. This project introduced switches, parallel programming, and more complex loops. Because of the limitations of the Lego's sensors, students had to use color sensors to follow lines on the ground, while a second color sensor determined navigation. A third (proximity) sensor was also used, as a way for the vehicle to stop and go when there were objects in front of it. All three projects were accompanied by discussions about the ethics of innovation. Questions included: Are innovations always good? Does developing a device to empower the elderly translate into a more segregated and isolated society? What would happen to truck drivers' jobs if transporting goods became automated? Who is liable when there is an accident involving an autonomous vehicle; is it the driver (or owner), the car manufacturer, or the software developer?

## Methods

We took a case-study approach to this research project. The study was conducted at a private school in New England. The students in the course represent a convenience sample, as one of the authors is an administrator at the school. This sampling is a limitation of the study. The study took place in a course that was offered once a week in a three-hour block as part of the regular day curriculum. Students chose to take the class, and it counted toward one of three graduation requirements: math, science, or elective, depending upon what the student needed. The majority of students at the school are White, middle-class students, many of whose parents graduated from college; 40% of the students self-identify as part of the LGBTQ community, and three of the six research participants were girls.

Data collection included field notes, artifact interviews, and a focus group interview. Students' projects were assessed via an artifact interview, inspired by Brennan and Resnick's (2012) work. Artifact interviews helped us investigate how students thought about their programs, designs, and prototypes. Interviews were audio recorded. Interviews were thematically analyzed and field notes were summarized. Data was then reviewed to develop a characterization of the fidelity of the enactment and the efficacy of the curriculum for motivating interest and knowledge of CS for high school students.

To analyze the qualitative data for this study, we used the grounded theory approach (Charmaz & Belgrave, 2007), which implies initial coding, axial coding, and selective coding to inductively develop categories based on the data. We transcribed all of the interviews. Our unit of analysis was the complete utterance. We independently and iteratively reviewed each interview; after each review, our team met face-to-face to share codes and understanding based on the analysis of the entire research team. To facilitate the presentation of our findings, we provide: (a) a summary of themes related to student engagement; (b) individual student profiles created from the data; and (c) the themes that emerged in the focus group.

## Results

### Student Engagement

Several themes emerged from the data, including the motivation to take the class, prior programming experience (CS skills), communal/agentic goals, and acquisition of new skills. For example, while Susan, Lisa, and Maria (all females) had no prior computer science experience, all the boys (John, Mike, and Phil) had some degree of previous experience before the class. It is also important to emphasize that teenagers have different motivations to learn, or engage, in a specific task. In our study, some of the participants stated that they were motivated by communal goals (Lisa, Susan, John, Mike), while the remaining participants stated that their motivation was agentic (Maria and Phil). We found this breakdown interesting, as it indicates that the majority of students in this study have communal goals regardless of gender. Table 1 presents a summary of our qualitative findings.

| | **Susan** | **Lisa** | **Maria** | **John** | **Mike** | **Phil** |
|---|---|---|---|---|---|---|
| **Gender** | Female | Female | Female | Male | Male | Male |
| **Grade** | 12 | 12 | 12 | 11 | 11 | 12 |
| **Reason to take the class** | Volunteer | Mandatory | Volunteer | Volunteer | Volunteer | Volunteer |
| **Initial CS Skills** | No | No | No | Yes | Yes | Yes |
| **Communal/Agentic Goals** | Communal motivation | Communal motivation | Agentic motivation | Communal motivation | Communal motivation | Agentic motivation |
| **Post CS Skills** | CS skills improved | CS skills improved | CS skills did not improve | CS skills improved | CS skills improved | CS skills improved |

*Table 1. Student engagement with curriculum.*

## Students' Profiles

In this section, we will take a closer look at each of the student participants. Each profile includes information about each student's behaviors and motivations based on the artifact interviews, focus group, and field notes. The pseudonyms of the six students' profiles are Lisa, Susan, Maria, John, Mike, and Phil.

**Lisa.** Lisa is an 18-year-old White female student who has no experience with programming and robotics. At home she has several responsibilities, including doing laundry and cooking. During one of the class meetings, she underlined the fact that money is the main motivator for existing innovations. She stated that people would not invest money if the financial benefits were not apparent, even in those cases where the ideas can potentially be beneficial for society. During Project 2 Lisa was not paired with another student. Lisa was very interested in the design aspect of the device. She was the only participant who decided to make the device arm-wearable, similar to smartphone cases people use when exercising.

Throughout the intervention, field notes indicated that Lisa was more comfortable in the design of the device than the actual programming. During the artifact interview she explained her rationale for her design. She stated that because of the fact that she was working alone, she chose to focus in areas she is proficient with (arts and crafts). We observed that Lisa's head was lowered while the teacher presented information about programming. She sought program-writing help from the researchers observing the class, but she also expressed embarrassment in needing to do so.

Lisa was very interested in the idea of using technology to help senior citizens because of her personal experiences. She stated that her grandmother has been in situations where a life alert–like device would have been very useful.

> And the reason why I chose that is because like it's more like a personal reason because like H told you the story but like my grandma she wears a life alert. … She had the necklace but she never liked wearing it because

> it always got in her way. And so, she took it off but she accidentally sat on it. I think, so, I think it kind of makes it more personal.

Although programming is challenging for Lisa, she seems to realize how programming can be used to develop technologies aimed at helping people.

> I mean I think in the sense of like helping like disabled people. Like it can remind people take medication, or like if like an accident; or like if you were to kind of like the idea of like a smart car, like if you were an accident like me. There would be a device that like tells you that when emergency services like who you are and like that kind of thing.

It is important to highlight that Lisa's Project 2 included a feature that neither of the other two teams' projects did. Her device, after a fall was detected, would beep until a button was pressed. That way it involved a third party to come and check on the elderly people. She also made the device display a heart for a few seconds once the button was pressed,.

**Susan.** Susan is a 20-year-old White female student. She joined the class a couple of weeks later than its start date. At first, her engagement with the class was very limited, as her participation included several off-task behaviors during instruction. Susan noted that her parents would like her to pursue a career that included technology. Although Susan had no previous CS experience, she was able to acquire and demonstrate several basic CS skills as noted above in the description of the curriculum. In addition, Susan seemed to prefer collaborative group work rather than being passive during instructor-led activities. Susan was one of the most active participants, regardless of collaborative group affiliation. Susan became more interested in the class during the second half of the semester, evidenced by an increased level of communication with instructors and higher level of engagement with group partners.

**Maria.** Maria has a different profile from Lisa and Susan. She took the class because she needed a science credit to fulfill graduation requirements. Her participation in class was mixed; at times she would be very engaged while other times she would exhibit off-task behaviors. She stated that her motivation to innovate would be to make money, which we view as an agentic orientation. Like Lisa and Susan, Maria had no prior CS experience. She stated during the artifact interview and focus group how boring the entire class was to her. She also said how much she disliked building things. She explicitly stated that she preferred to play basketball. Maria did not learn much in the class.

**John.** John is a 16-year-old student who defines his race as *human*. He participated in all the sessions and had some CS programming experience. His CS skills became apparent, as described in our field notes: "John was able to begin programming his Lego device directly, rather than using the computer software version (the Lego device screen is about 2 inches by 2 inches)." On one occasion, he talked about how programming languages are the foundation of electronic games. He is interested in computer games and would like to learn how CS programming skills are used in the gaming industry.

Early in the semester, each student was asked to showcase an innovator. John chose Christopher Weaver, a video-game developer and CEO of a computer-game company. John was very passionate about the topic and focused on Mr. Weaver's achievements rather than describing his innovative contributions. The presentation was well researched.

During an innovation discussion, the following question was raised: Are innovations always good or always bad? John stated that innovations can have a negative impact on society. To support his thesis, he brought up the example of the atomic bomb.

**Phil.** Phil seemed to be intent on asking unrelated questions during class time, including talking about music, bitcoin, computer graphic cards, and so forth. He did not have extensive CS programming experience and tended to push school boundaries by introducing inappropriate topics. Phil's participation in class was inconsistent. He would tend to be very engaged during ethical conversations but appeared disengaged during building and coding activities. His team partners praised him for his creativity, specifically in situations where he made design or data-collection suggestions.

During Project 2, a guest speaker was invited to interact with the class. Phil was very engaged during the entire encounter; he asked relevant and thoughtful questions aimed at developing a better understanding of the difficulties of elderly people. Similar to Maria, he stated that his main motivation for developing innovations was to make money. Phil's level of CS skills improvement was marginal. However, he was able to explain CS concepts during the artifact interview and class interactions.

**Mike.** Mike was probably one of the most tech-savvy students in the classroom and was very interested in CS topics. He stated having a communal-goal inclination, specifically helping others. He was always ready to participate in class and was always engaged in discussions and group activities. There were times that he and his group partner would forgo going on class breaks so they could continue working on class assignments. During one of the sessions, when a researcher informed him about an impending break, he replied with: "I'm going to continue working. I hate to stop in the middle of something."

## Focus Group Themes

After the CS course was over, we convened a focus group with five of the students: three boys and two girls. During a 40-minute discussion, students shared their thoughts about the curriculum, specifically the projects they worked on, ideas about innovation, ethics, and most frequently, process. What quickly became obvious was the camaraderie and collaboration the students shared. The students enjoyed working together, even when they were paired with a partner they may not have liked before. When asked about working in pairs, they said they liked their partners:

> John: I quite liked the pairs I was in
>
> Mike: When I worked with Phil it was a bit better because he was better at building than I was, and he was more, you know, large minded. Like he was able to come up with things that I wouldn't have even thought of. Um but when I was working with John, me and him we're pretty close to the same
>
> John: ideas
>
> Mike: ideas and everything. So it wasn't as, it wasn't a breath of fresh air, I guess. Like working with Phil, and I never thought I'd say these words, working with Phil was like a breath of fresh air.

Furthermore, the students found success in using trial and error as a way to problem solve. Perhaps because the ground rules for the class began with "Fail: fail early, fail often," students knew they were not expected to succeed the first time around. They talked about the importance of using trial and error as a tool to create what they wanted, and as a way to test what they built. Additionally, the level of difficulty was important to them. Some students thought some of the projects were too easy and some thought they were too hard. Mike compared the class to being in a robotics club in his previous school. There he worked on only one part of the robotics; he was interested in programming and other students built the actual robot. Here he had to do both: design the robot and program it. In that way it was more challenging than simply programming.

Finally, the students talked about ethics. The discussion revolved around whether technology is good or bad.

> Mike: I have something. Hunting rifles, the original hunting rifles. People needed those to survive. It made hunting a lot easier for everyone. And it made getting food for yourself a lot easier
>
> John: Like whoever invented the cannon invented it for war.
>
> Mike: But the rifle was not made for war. This, yes it was used for war, that's its negative but a hunting rifle in itself was used for hunting, simply. So isn't it the gray line, because it in some cases it was used to keep people alive. But in other cases, to be used to take lives …

The students also discussed smartphones and social media. While they saw these technologies as important for communication, their downside relates to people "not knowing how to talk to each other." Hence these students attempted to understand the negative impact of technology.

## Discussion and Conclusion

Our PBL approach is novel in the sense that we use a communal-goal inclination as a way to attract girls to study computer science. As evidenced by the low number of women in computer science (and/or STEM) careers, there is a general understanding defined by Margolis and Fisher (2002) as: "Boys invent things, and girls use things boys invent." Girls are conditioned from an early age to be subservient to boys' choices. As those choices tend to be marked by societal expectations, men and women tend to choose career paths that align with society's classification of gender-based careers. We acknowledge that increasing the number of women in CS- or STEM-related careers is a multifaceted problem. The problem is rooted in the assumption that CS and STEM careers are not suitable for women (American Association of University Women (AAUW), 2010; Kelley & Bryan, 2018). As educators, we developed a curriculum that attempts to overcome this assumption by providing motivational factors to counter the narrative.

Our curriculum was originally designed to appeal to girls' communal goals (helping people) as a way to raise awareness that CS skills can be employed in a variety of situations. Once students opted into the course, we employed a PBL framework to foster intergender group work. Our intent was to provide an environment where boys and girls can work as equals, regardless of skill set or experience. In addition, we thought that an integrated STEM curriculum gives students affordances to participate, expanding ways for girls and boys to collaborate. Last, we also incorporated an ethics component as part of the innovation process. Incorporating ethics as part of the process seems to have triggered an additional level of passion from the students, while also developing more conscientious citizens. Our results so far are promising; both boys and girls in this study were interested in CS for communal goals, and most of the students gained in CS ability. Students can be motivated to learn computer science when instructional goals are communally inclined and presented in PBL format. Moreover, the students who had an agentic orientation also learned new CS skills. It is likely that both agentic and communal approaches are very worthwhile. Future research should focus on identifying entry points for a variety of students that include and go beyond communal and agentic orientations.

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# Developing a Blended Course for In-Service Science Teachers in India and Its Reception by the Teachers

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**Abstract:** Interactive Science Teaching is a blended practice-based course for in-service high school teachers offered as part of a large-scale field action project called “Connected Learning Initiative” (CLIx: https://clix.tiss.edu). The course is offered to science teachers from government-run schools from 4 states: Chhattisgarh, Mizoram, Rajasthan, and Telangana. A total of 712 teachers registered for the course. Here we are reporting the process of developing the course and its reception by the teachers. Our main observations are: Of the 2 components of the course, the practice component (implementing exemplary blended pedagogic material) was better received by the teachers. The teachers were enthusiastic during the face-to-face workshop of the blended learning component but did not engage with the online material during the distance period. The reasons given by the teachers for this were lack of time and difficulty in accessing online material. Last, we will document some of the revisions we undertook after the experience of the first run of the course.

## Introduction

Continuous professional development is an integral part of any profession. Teachers also need to keep themselves updated throughout their teaching careers in order to perform efficiently. For this purpose, regular teacher-training programs for in-service teachers in the public (government-run) schools are organized by the departments concerned in different countries. These in-service teacher-training programs are expected to respond to the teachers’ needs of adapting to changes in curricula, textbooks, or the introduction of new teaching techniques such as educational technology. The programs also help break the monotony of teaching the same content over the years and expose teachers to new ideas. In India, the most commonly used teacher-training model is called *the cascade model*, in which the master teacher educators train the teacher educators who in turn conduct workshops to train the teachers. Every year, the public school teachers in India are provided 20 days of training, which has implications for their job promotion.

This mode of teacher training is not effective. It consists of workshops with teachers that provide sporadic inputs, usually on random topics as opposed to systematic continual support. The training does not focus on helping teachers incorporate useful teaching practices into their regular teaching; rather the workshops concentrate on the discussion of only the theoretical concepts related to teaching science or emphasize the techniques for teaching some specific topics. A detailed critique can be found in (Batra, 2013). This has led to recommendations that online teacher-training courses be developed to increase the engagement period of the teachers and develop an in-depth understanding of particular topics (NCERT, 2016).

In response to such a situation, Tata Institute of Social Sciences, Mumbai (TISS), is in the process of preparing a blended certificate program for in-service training of teachers called Reflective Teaching With ICT (RTICT). This certificate program aims to provide continual input to teachers in a systematic way over two years. The entire program is worth 16 credits and is broken into several courses. In 2017, four courses (of four credits each) were developed and were offered to the teachers in four states of India (Chhattisgarh, Mizoram, Rajasthan, and Telangana) under the field action project the “Connected Learning Initiative” (https://clix.tiss.edu). As with other blended programs, the RTI has both face-to-face and online elements. The program is introduced to the teachers in a face-to-face workshop after which they are supposed to complete the courses in distance mode by accessing the online content. The online content of the program is hosted on a platform called TISSx (www.tissx.tiss.edu), created using the Open Edx. Open Edx is the open-source software platform of the massive open online course (MOOC) platform Edx. Recognizing that teachers teach in their state languages and are more comfortable in communicating in those languages, the program is offered in two languages, that is, Hindi (for Chhattisgarh and Rajasthan) and English (for Mizoram and Telangana). Out of the four courses, one is a foundational course while the other three are subject-specific courses. The foundational course revisits the learning theories and role of teachers in the context of educational technology. It also includes the basics of digital literacy. Interactive Science Teaching is the subject-specific course for science teachers (the other two are subject-specific courses designed for English and mathematics teachers). In this paper, we will present a description of this course, provide the rationale behind its design, and document the experiences after the first run.

## Interactive Science Teaching Course

Interactive Science Teaching is a blended practice-based course designed for in-service secondary science teachers. Being a blended course, it has both face-to-face and online components. The course starts with the face-to-face workshop and the teachers are supposed to complete the rest of the course in distance mode in four months’ time. The teachers need to register on the TISSx platform (www.tissx.tiss.edu) to do the course. Teachers can access the platform as a website through their browser or as an app from their Android-based smartphones. The course consists of six units. The first of the five units contain videos, readings, and short activities (e.g., interviewing students or fellow teachers, analyzing certain part of the textbook, etc.) that teachers are expected to do in a sequence. The last unit concerns the student module implementation. A student module is a short pedagogic sequence for teaching a particular topic (usually one chapter of a textbook) and serves as exemplary teaching material for teaching science. All the student modules are blended in nature and hence include both classroom activities as well as digital activities for students. Currently, seven such science modules have been designed. These are hosted on a different platform called the CLIx platform (https://staging-clix.tiss.edu/welcome). Teachers were required to implement only one module to complete the course. Studies about the design and implementation of the student modules are not within the scope of this paper and have been documented separately. The time of engagement expected from the teachers and the corresponding credits are given in Table 1. The structure of the course is schematically shown in Figure 1.

| Modality | Unit 1-5 (Blended Learning) | | Unit 6 (Student Module Implementation) | | Total credits |
|---|---|---|---|---|---|
| | # of hours | Credit | # of hours | Credits | |
| Face to face workshop | 21 (3 days) | 1.40 | 0 | 0 | 1.40 |
| Online interaction | 4 | 0.13 | 30 | 1.00 | 2.50 |
| Self study | 5 | 011 | 25 | 0.56 | 0.67 |
| Fieldwork | 16 | 0.36 | 20 | 0.44 | 0.80 |
| Total | 46 | 2.00 | 75 | 2.00 | 4.00 |
| Note: 1 credit corresponds to 15 hours of face to face interaction of 30 hours of self study or 30 hours of online interaction or 45 hours of fieldwork. | | | | | |

*Table 1. Time engagement and corresponding credits for the Interactive Science Teaching course.*

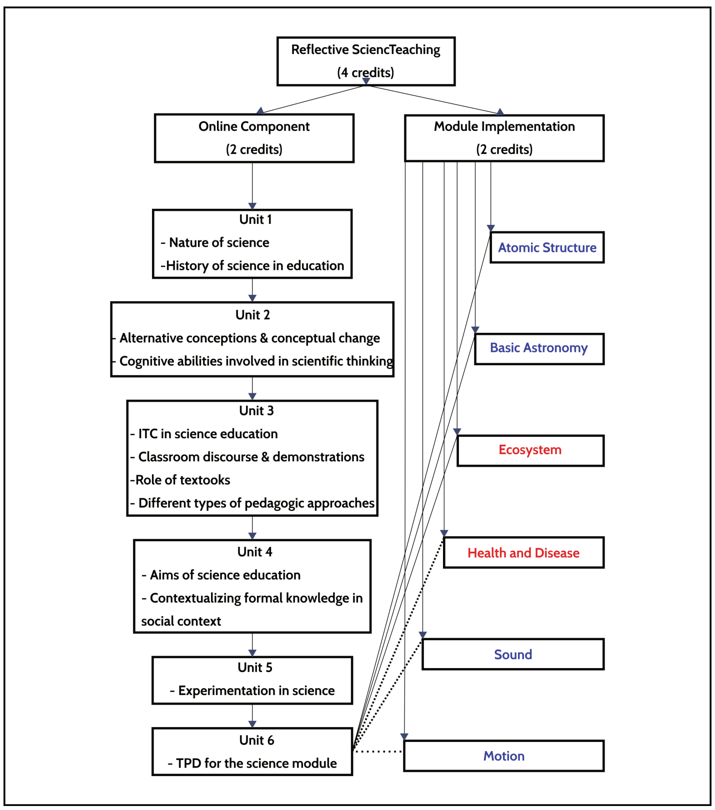


*Figure 1. Structure of the Interactive Science Teaching course.*
**The dotted blue lines indicate that the support material of these modules for teachers was being prepared at the time of first run of the course.*

The teachers were introduced to the TISSx platform and given a brief overview of the online component during the face-to-face workshop but the main purpose of the workshop was to introduce the student modules to the teachers. Teachers went through the classroom activities and the digital activities of multiple student modules. After the face-to-face workshop teachers were expected to spend another 11 weeks on the course in distance mode. Thus they were expected to spend about nine hours every week during the distance period. The entire course is assessed against 100 points. The assessments included peer evaluation, self-evaluation, and multiple-choice questions (MCQs; see Table 2 for breakdown.)

| | |
|---|---|
| Participation in the F2F workshop | 10 points (self-check) |
| Implementation of one student module | 10 points (self-check) |
| Responses to MCQs during the course | 15 points (15 questions worth 1 point each) |
| Responses to post-test (MCQs) | 15 points (15 questions worth 1 point each) |
| Peer-reviewed assignments after each online unit | 50 points (5 assignments worth 10 points each) |

*Table 2. Breakdown of assessment.*

## The Process of Designing the Course

The online component and the student modules were designed in parallel. One of the authors of this paper designed the online component and one of the student modules. The rest of the student modules were designed by experts from different partner organizations. Initially, four units were planned for the online component. The fifth unit was added later by one of the partner organizations to support the student module implementation.

To prepare the online component, we first reviewed some of the science-education courses offered at different institutions. Some of these courses include the course offered to doctoral students at Homi Bhabha Centre for Science Education, Mumbai, and the elective course offered in the MA (Elementary Education) program at TISS (one of the authors of this paper has been teaching the second course). The position paper of the National Focus Group on science education served as a guiding document for designing the course (NCF, 2005). After this review we arrived at the three guiding questions to design this course:

- Why teach science? (aims of science education)
- What do we want to teach when teaching science? (nature of science)
- How to teach science? (pedagogical content knowledge)

The first question was not discussed in the first unit as we reckoned the teachers might not like an abstract topic at the beginning of the course. Rather we decided to start the course with the discussion about the nature of science in the first unit. Teachers' belief about the nature of science influences their teaching practices (Lederman, 1999). It is important to shift teachers' focus from transmitting facts to engaging students in the process of scientific inquiry. This can be achieved by exposing teachers to the history of science (Abd-El-Khalick & Lederman, 2000). Also, the history of science offers stories that help teachers to relate to and look at science as a human endeavor rather than viewing it as a collection of sacred texts. This might help in setting an inclusive tone from the beginning by highlighting the multicultural contributions and contributions from women in science. The unit begins with examples of episodes of development of science. It includes an article about the nature of science. Students' and teachers' beliefs about science are explicitly discussed in this unit.

The second unit is dedicated to the pedagogical content knowledge (Shulman, 1987) of science. It introduces teachers to alternative conceptions, conceptual change, and the importance of different kinds of mental and external representations in science. It also includes an article on some of the key cognitive processes used in science, such as different kinds of reasoning and visuospatial thinking. The third unit is an amalgamation of some of the important pedagogical practices in science education. It includes the use of questioning in an inquiry-based classroom, the role of different tools (e.g., information and communication technologies [ICTs] and textbooks) in science teaching, and introduces project-based learning as an example of innovative pedagogy. In the fourth unit, different aims of science education have been scrutinized. According to the NCF position paper (2005), one of the aims of science education is to relate science to the environment and help students to understand issues in the interface of science, technology, and society. The socioscientific issues are not given much weight in Indian curricula, especially in higher grades (Raveendran & Chunawala, 2013). We discussed the possibility of incorporating socioscientific issues into science lessons through an article. In the fifth unit, the role of experimentation in science has been explored in depth. At the beginning of the course, an introduction has been added that includes a presentation about the course requirements and other course-related details. It also includes the interview of an expert on science education as a keynote. The introduction is not graded. It was covered during the face-to-face workshops.

We invited researchers working in science education to prepare material on the topic of their expertise. Most of them either had a doctoral degree in science education or were in their final stage of doctoral work. Although we had encouraged the experts to use different forms of media, all of them chose to write articles. We printed a handbook consisting of all the articles and gave it to all the teachers, as many of them were unfamiliar with reading from a screen. We mostly relied on the available videos except for one video in the Introduction. Apart from articles and videos, the course consisted of activities such as taking interviews of students or fellow teachers, analyzing students' responses (these were carefully selected or re-created to convey certain points), preparing teaching learning material, and so forth. Teachers were asked to keep a journal to note their observations, opinions, and questions. The breakdown of different kinds of activities is given in Table 3.

| Activity Type | Articles | Videos | Other activities | Telegram Activities |
|---|---|---|---|---|
| Number | 11 | 8 | 32 | 13 |

*Table 3. Breakdown of different kinds of activities in the Reflective Science Teaching course.*

### Role of Community of Practitioners

Communities of practitioners play an important role in professional development (Grossman, 2001). For a large-scale online course, it was essential to create a mechanism through which teachers received support and feedback from their peers. Since the discussion forum on open Edx was not available at the time of course design, and since teachers had better access to smartphones than to computers, we decided to use a cell phone–based app (which also runs on the computer) called Telegram. As Table 3 indicates, many activities in the course required teachers to post on different topics on the Telegram app and they were expected to engage in discussions on those topics. Teachers were encouraged to post messages related to student module implementation as well. Thus the course used connected learning in multiple ways: blended learning, peer assessment, and the community of practice.

## Experiences From the First Round of Implementation

The teachers were introduced to the course at the face-to-face workshops. The workshops were conducted starting in July 2017 in Chhattisgarh, Rajasthan, and Mizoram. These were completed by early August. In Telangana, the workshops were conducted in September and October. The courses were expected to be over by December 2017 in Chhattisgarh, Rajasthan, and Mizoram.

### Initial Conditions

Teachers were enthusiastic about attending the workshop as they hoped to gain some basic abilities in operating the computers. There was a great degree of variation in their familiarity with the computers. This made guiding the teachers through the student modules at a common pace a great challenge for the resource people. However, when hands-on activities were performed, the teachers could work in teams and each one of them could keep up with the pace of the task.

There were some state-level differences in the teachers' response to the course: In Mizoram, the teachers were interested in implementing student modules but did not want to do the courses under the RTICT program. From the post-workshop feedback, we gathered that the teachers were reluctant to take the courses as the program did not offer guaranteed financial gains or promotion. Also, in Mizoram, the entire teacher group refused to use the Telegram app and instead they insisted upon using their Whatsapp as they were already familiar with the app.

In the other three states, we got mixed responses during the workshop. Some of the teachers were keen on using the student modules as well as doing the course. However, it was noticed that most of the teachers were not motivated to do the course even though they said that they would do it. Only a few teachers from Chhattisgarh and Telangana did the Telegram-related activities and posted comments about the video in Unit 1. But most of the teachers were happy to explore the student modules. Some of them even expressed that more time should be allocated for personal engagement with the student modules.

### Changes Made During the Implementation

Initially, we had thought that we would introduce teachers to the TISSx platform and make them take a pretest during the workshop. We expected that they would do the rest of the course on their own. Hence, we kept only one 90-minute session to introduce the TISSx platform while the major chunk of the workshop focused on introducing the student modules. However, as we started interacting with teachers during the workshop, we realized that teachers need more time to understand the navigation on the TISSx platform. Since we introduced both the student and the teacher more or less simultaneously, it was required that the teachers survey both the platforms multiple times to understand the distinctions and connections between them. Thus, after the first four face-to-face workshops (which were held in Raipur, Jaipur, Sirohi, and Aizawl) we significantly increased the time allocated for the introduction of the course during the face-to-face session. We will revise the credit divisions accordingly during the next iteration of the course.

Initially, we had created two different Telegram groups (one for the course-related posts and another for the posts related to the student modules) for Chhattisgarh and Rajasthan. But the introduction of two groups and the two platforms (course and student module) confused the teachers. Hence, the number of posts related to the course was quite low. So we merged the two groups in these two states. We created only one group for Telangana, learning from the mistake in other states.

Teachers did not interact with the course so the time allotted to each unit was increased significantly. As a result the courses did not get completed in the scheduled time.

## Challenges

Teachers did not engage with the articles in the course as they found them difficult. They appreciated videos and might appreciate material in other forms, such as audio files, posters, cartoons, and so forth. However, the people designing the material come from academic backgrounds and do not possess the skills required to create such material. Preparing such material with the help of experts in media is time consuming and energy intensive.

## Conclusion

During the first round of implementation of the Interactive Science Teaching course, the teachers did not engage much with the online component. The reasons reported are lack of time, difficulty in accessing computers and online connections, and lack of motivation. However, teachers did see the utility in such a kind of course and particularly in implementing student modules. From other sources (not reported in this paper) we know that many teachers implemented modules in the classrooms. From informal interactions with teachers, we realized that the course covers more material as compared to the allotted time and contains many abstract concepts that teachers could not engage with. Hence, for the next round of implementation, we plan to simplify the course by reducing the content and including several concrete examples and practice activities.

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# Upload in Your Own Words

## Using Smartphones to Realize a Critical Approach to EFL Pedagogy

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**Abstract:** Currently, 1 in 2 people around the world has Internet access, most of them via smartphone. And 1 in 3 are learning English, with over 80% of these students coming from Asia and the global south. Despite the incredible growth in these 2 trends, few steps have been taken to adapt EFL education methods around access to these devices. This article tests the efficacy of 1 such approach, working with university students in Bogotá, Colombia, to create videos aimed at developing language proficiency and challenging cultural representations. Via a critical-discourse analysis of their responses, the author of the study hopes to highlight potential benefits and downsides offered by smartphones and other devices in developing language and critical-expression skills.

### Introduction

As of 2016, 3.5 billion people have regular Internet access, a figure representing nearly half of the world's current population. Two details stand out in this figure. First, the majority of this access is occurring via mobile devices. Smartphones, viewed as luxury items less than a decade ago, now account for 2.1 billion of this figure and are expected to hit three billion by 2020 (IDC, 2016). Second, the typical smartphone user is now more likely to live outside the "developed" West, specifically Asia, Africa, or South America. In 2016 alone, nearly a million iPhones, Galaxy, and other smartphones were sold in these areas every day (Poushter, 2016).

Concurrent with this smartphone boom is the growth of English as a foreign language (EFL) education. Nearly two billion people engaged in some form of EFL learning in 2016. These learners come primarily from the developing world, representing a wide range of linguistic and cultural backgrounds. Connections between EFL education and Internet access figures are not difficult to find. Globalization, further accelerated by growing Internet access, has, for the moment at least, solidified English as the world's lingua franca. While just 10% of the world's population count as native English speakers, 60% of all content on the Internet is written in English (IALC, 2016). A growing number of economic opportunities, currently the biggest motivator for EFL learners, now require at least some proficiency in English (McClanahan, 2014).

These overlapping trends present an image much different from "disadvantaged" representations commonly associated with developing-world EFL students. The question now, as McLean (2012) articulates, is whether EFL educators will adapt. Can they "abandon outdated fears and assumptions and, instead, embark in a new direction in adult ESL education: one that takes advantage of the technologies many of their students may be familiar with already?" (p. 13). At present, the answer is largely *no*. Despite these connections, EFL education has been slow to embrace technology in classroom practice (Lotherington & Jenson, 2011; McClanahan 2014). A historical reliance upon a skill-and-drill–based pedagogy has continued to center EFL curricula around grammar textbooks and rote learning styles. In following this "banking model" of education (Freire, 1970), teachers are unable to adapt to shifting language usage or to offer cultural context and to relate to students' personal interests (Kazantseva, Valiakhmetova, Minisheva, Anokhina, & Latypova, 2016; Valdés, 2001). Equally powerful is a lingering

Western stereotype of the EFL classroom, one that conjures images of dirt-floor classrooms, old donated books, and poverty-stricken students (McLean, 2012).

In my former position as an English language instructor at Universidad EAN in Bogotá, Colombia, I saw a starkly different picture: students dressed in designer clothes, voice messaging each other on WhatsApp, and studying in order to join a globalized economy increasingly built upon English. Certainly these students, attending a private business school in a posh downtown district, are more privileged than most in Colombia or around the world. Yet statistically speaking, they now present a more accurate vision of today's EFL student: ready to learn with smartphone in hand.

In almost every major field of study, the integration of technology into educational practice is no longer a debatable issue (McClanahan, 2014). As I aim to argue here, the same holds true for contemporary EFL education. This study aims to join a small but growing body of literature in calling for greater integration of technology such as smartphones into EFL classroom practice (Gholami & Azarmi, 2012; Kremer, Brannen, & Glennerster, 2013; Lotherington & Jenson, 2001). Smartphones, of course, should not be implemented as a means unto themselves, as has happened with so much other classroom technology. Instead, this study looks to understand how these tools might point toward a more pedagogically inclusive and engaging classroom space. In this effort, this study frames smartphone integration around several core ideas of critical pedagogy, in particular a "problem-posing" approach to education that relies on student inquiry to drive instruction. Freire (1970) offers the student-driven problem-posing approach as an alternative to the banking model. In the latter, students are regarded as passive recipients of knowledge, a view that disallows them from accessing personal experience and knowledge in order to draw authentic connections with the material. Educators must overcome this banking model by both placing themselves on equal level with students as knowledge creators and by granting students the ability to follow their own course of inquiry. Only by practicing such problem-posing approaches can the classroom become a place for students to engage in authentic inquiry. The goal for EFL educators, then, must be to apply classroom activities that activate inquiry, thus allowing students to connect previous cultural and linguistic knowledge with expression in the target language (Barrot, 2014).

## Study Framework

This study sought to understand how these goals might be actualized in the everyday teaching context of an EFL course. Over the course of a year spent working with Fulbright Colombia as an EFL instructor at Universidad EAN in Bogotá, Colombia, I carried out a smartphone-based activity centered on critical pedagogy with students in a college-level English course. Throughout the semester, I asked them to answer a specific question typically focused on representations of either Colombian- or English-speaking cultures. Students submitted their responses via smartphone videos and uploaded them to a common class Google drive. The classroom activity comprised eight distinct video assignments spaced out across the 18-week semester. As instructor, I would present a prompt ("What is your favorite food?" "How do you travel to school?" "What three words do you associate with the USA?"), and students would record their responses on their personal devices. They would then upload their response to a shared class Google Drive folder. I did not specify the format, length, or content of their responses.

In total, students submitted 250 video responses to the eight total questions posed over the four-month-long project. This article presents a critical-discourse analysis (CDA) of the materials collected for the activity, totaling some 32 video responses. I limited the overall corpus by analyzing only responses to the question "Is Colombia a dangerous place?" Using a critical-discourse analysis of these responses, my analysis targets how dominant social forces are enacted, reproduced, and resisted through text (Van Dijk, 2003). In particular, it targets text representations of Colombia as a place synonymous with violence and drug trafficking. Though instances of violence have subsided greatly since their height in the early 1990s, images of that era continue to dominate Colombia's reputation around the world. English-language media reaching from *Miami Vice* on through the current Netflix hit *Narcos* have ensured that the conversation on Colombia, in the United States at least, fixates on cocaine, violence, and figures such as Pablo Escobar. So to what degree were my Colombian students aware of these Western representations of their country? To what degree might they challenge these forms and assert new ones? And might the personalized format offered through the smartphone video submission allow students to speak more freely on this often-touchy subject? My use of CDA works through the lens of critical pedagogy, focusing on students' perception of hegemonic representations of Colombia in the West. What actions, if any, have they done to disrupt these representations? And to what degree do they see themselves as influencers on this discourse?

## Research Goals

The classroom activity tested for this study was conceived with three goals in mind: to increase English proficiency and expression using the smartphone video format, to access personal and cultural knowledge in the course of expressing themselves in English, and to view English as a means of challenging cultural representations. These aims, along with my aim to use critical pedagogy as a framework through which to tie technology and language development, led me to analyze student video responses around these three research questions:

*RQ1:* How did students use the video response format? Freire (1970) places heavy emphasis on students' ability to express their voice, either in dialogue with their teacher or with each other. Within the context of EFL education, dialogue becomes a trickier proposition, as students are now tasked with conversing in a nonnative language. Aside from lacking linguistic proficiency, many students may resist expression due to the embarrassment of speaking incorrectly in front of an entire class (Yaman, Şenel, & Yeşilel, 2015). My intention with this theme is to see whether the video format, which allows students choice in time, location, and frequency with which they record their message, might encourage more open and fluid expression.

*RQ2:* Did they access personal knowledge in answering these questions? Effective critical pedagogy requires students to access personal knowledge and experience in order to actively engage in their own educational process (Giroux, 1989; hooks, 1994). Within EFL education, with its long history of banking-style education, personal expression has been, if not actively discouraged, deemed less important than grammatical correctness and pronunciation clarity. By eliminating these traditional evaluations of performance, I hope to see whether students will naturally use the activity to express themselves more, in the process concerning themselves not with how to speak in English but with more self-reflexive considerations of what they wish to say in English. I plan to highlight uses of personal experience and other cultural knowledge to track these developments. How do they position themselves as English speakers? Related to the previous goal of self-reflexivity, my concern here is in students' intercultural positionality in their responses. In these English language responses, how are they framing the conversation? To this end, I am interested especially in what identity markers they ascribe to themselves—pronoun use in particular—and what qualities they ascribe to their perceived audience.

*RQ3:* How did students negotiate representations in the target language? English-language media contain no shortage of Colombian caricatures, most of which adhere closely to the *narcotraficante* archetype. So how aware are these Colombian students of these English-language media stereotypes about their country? And if aware, to what degree do they critically engage with these representations, either through negotiation or resistance? Keeping in mind Freire's maxim empowering students to "rewrite the world," will they feel limited by these texts, or take actions to respond to and recast these representations?

## Findings

For the response to "Is Colombia a dangerous place?" a total of 32 videos were analyzed. These responses came toward the latter half of the activity—week 10 of the 16-week term—meaning students were at this point comfortable with the video response format. Transcripts from video responses used here have been reproduced with grammatical errors.

Beginning with RQ1, I noted several interesting aspects of students' use of the video format. Though I did not specify the duration of the responses, videos were generally :30–45 seconds in length, with the longest 2:13 and the shortest 0:08. Five videos featured editing of some sort. The majority of these were simple cuts used to edit together multiple clips, likely as a means of maximizing language clarity. One ambitious submission, however, also included a customized introduction featuring the question prompt and background music. As far as the location, the vast majority of responses seemed to be filmed at students' homes. Their bedrooms seemed to be the most popular filming location, which upholds Yaman et al.'s (2015) finding about students' proclivity to use personal spaces for language learning. Following this trait, all but four responses featured the student on his or her own. Of these remaining four, two were both members of the class using each other as cameramen. Finally, only a handful of responses appeared to be scripted, a promising finding that suggests students felt comfortable expressing their views in a more conversational style.

As the transcripts show, grammar and pronunciation were far from perfect. However, given the particular interest of this study, self-expression is a far more encouraging outcome. This self-expression mostly took the form of extremely formalized messages, ones that often seemed more reflective of media discourse around issues of Colombia's violence than personal views. Almost a third of student responses implemented a similar rhetorical strategy of comparing Colombia's violence to that in other countries, using some version of the phrase "Colombia is not a dangerous place; the world is a dangerous place."

> I think that no, Colombia is not a dangerous place. Like in all the world, in many countries and many cities, there are specific dangerous places. But in general, I think that Colombia is not a dangerous place, Colombia is a wonderful country that has everything which makes it a complete destination. (Dhayana)

The similarity of this response again suggests a repetition of a popular discourse within Colombia on the topic of its violent reputation around the world. Dhayana's interest in selling Colombia as a "complete destination" further suggests an interest in repairing this image for the sake of domestic tourism. It seems interesting (perhaps even distressing) that her concern regarding violence extends not to her own safety or that of her family, but to that of foreign visitors. Still, given the institutional context of the video-response activity in an internationally minded business university, such formalized and financially incentivized responses perhaps should not be all that surprising.

Regarding RQ2, students seemed to access personal knowledge only intermittently in their responses.

Though a handful of students drew upon experience, mostly their answers seemed to be drawn from news reports and other institutional sources. Trust in institutions such as the police was a commonly repeated theme among student responses; they largely viewed the government and supporting security forces as positive agents of change.

> Is Colombia a dangerous place? This is hard to ensure, and can say yes or no. But I can't tell some things of the security of Colombia, first of all the security in the city is very low, and there are many stealings. You have to take care in the street, in the driving, because here are many people walk in the street with the cars and the motorcycles. Colombia is going to create a peace treaty with the FARC and I think this is going to increase the security in Colombia. (Andres)

As Andres illustrates with his focus on peace talks with the FARC taking place during the course of this study, it is reasonable to assume that a sense of progressing toward peace would be on the minds of many students when answering this question. Even then, given the problematic history of these institutions in academic literature and personal conversations with other Colombians I had had in the months before this project, this trust surprised me a great deal. It is possible that these students' ages—born well after the height of Pablo Escobar's power in the early 1990s—and middle-class status affected this more positive view of government security forces, but perhaps there are other factors driving this trust.

While few students explicitly spoke from personal experience, a common tendency was to offer a sort of impersonal advice drawn from a number of knowledge sources.

> I think that Colombia is a dangerous place, as can be in other countries. But depends on the place you visit, like if you visit Avenida Jimenez it would be very dangerous and Las Cruces. I don't know; it depend on the places you visit. And I think that the violence is everywhere, you just must be very careful when walking on the street. (Catalina)

I will further detail the use of pronouns by students to designate in- and out-groups within responses later in this analysis; however, even here in Catalina's response, there is a clear sense of audiencing, in this case to me, their visiting, non-Colombian professor. Indeed, many students framed their responses as street-smart warnings of a local to a visiting tourist.

> If you are in a bigger cities, it's important that you don´t walk in an unfamiliar street at night, or carry cell phone in full view of everyone. For example, you should not take taxi in the street, it's better to use the phone. It's better to visit the smaller towns, because these towns have lower levels of crime and are very beautiful. (Sara)

Again, this framing should not be all too surprising. Though I asked students to consider their responses around a broader English-speaking audience, it is sensible that they would direct their messages at me, the one assigning and assessing the activity. However, this tourist–local framing of the discourse seemed to limit self-reflexivity in their responses. Of the responses, only a small number drew on explicit personal experience to address the question.

> I think it depends on the place you go. For example here in Bogota I think it's a little bit dangerous, and right now you know about the situation with the new mayor. But I think overall in Colombia everything is okay. I used to live down where the violence was quite strong, but now everything is nice. You can travel everywhere here without any problems. (Karen)

Though still working out of the tourist–local frame, Karen's use of personal knowledge mixed with other knowledge sources represents a strong example of the possible dialogue offered through this activity.

As for RQ3, students took a range of tacks in negotiating Colombian representations present in various English-language texts. To begin, students almost uniformly showed awareness of Colombia's reputation in English-dominant media. While some responses mentioned this reputation only in passing, many others directly addressed specific representational elements.

> There is crime, theft, corruption, these things, but what will (be the most) impact is the drug trafficking. Maybe for that reason, a lot of people have the idea that Colombia is only crime and drugs and cocaine, and that Colombians are addicted to these things. (Maria)

With rare exception, students rejected portrayals of Colombia as a dangerous place. As noted earlier, these renunciations often used the tactic of deflecting Colombia's violent reputation back onto the world as a more generally violent place. This was often used in tandem with what I call the *"dar papaya"* explanation, a common Colombian phrase that translates to "don't put yourself at risk."

> I think it's not dangerous because it has an excellent strategic security provided by the government Colombian. It is true that there are some problems. Everyone should care and know which areas to no longer visit because they are dangerous. My advice to you is to not give *papaya* as we say here. (Lina)

Lina's mention of the "excellent strategic security" again shows a tendency among students to place trust in Colombian security institutions. The use of pronouns here further illustrates the demarcation of insider/local *(we)* and outsider/tourist *(you)* groups within the responses. While this frame was by far the most common, the use of the inclusive plural *we/us/our* showcased a more hopeful tendency to change the discourse around violence through social action.

> I think that Colombia is so dangerous place, because we have high levels of poverty and misery. We also have 50 years of conflict with armed groups, and obviously this problems have caused Colombia to become a dangerous place. However we are entering a process to stop violence and to become more safer country. (Diana)

Diana's use of the first-person plural connects her both to Colombia's many social issues along with the process of improving upon these conditions. The "process" in mind here is likely the FARC peace deal mentioned earlier, one which in effect places her hopes on improvement upon the efforts of government peace negotiators. Several students also seemed to be aware not only of the influence of negative cultural representations of Colombia but showed a personal responsibility in disrupting these representations.

> I think we are a stereotyped country, because we are not all like that. We also have good things to be known. For that reason, I think people all around the world should stop thinking about Colombians as drug traffickers because we can do better things. (Michelle)

While few of the collected responses reflected this level of nuance, my overall finding was that students seemed willing to speak candidly about the issue of Colombian representation. Further, the video format seemed to offer a safe platform through which to speak candidly about this issue of representation.

## Discussion

Despite a fair number of shortcomings, overall I believe the smartphone activity was effective in achieving the goals outlined. Most encouraging was students' use of the video format, which showed positive support for RQ1 and upheld earlier research as to the effectiveness of smartphones as a vehicle for expression (Yaman et al., 2015). In spite of a handful of minor video-compatibility issues, students experienced no difficulty in recording or submitting videos for the activity. Their technical proficiency, further demonstrated by their customization of both the form and content of their responses, seems to have emboldened their linguistic expression, particularly in the case of a handful of typically shy students. By being able to record (and re-record) their own speaking, they had access to a useful reference by which to evaluate and improve their own performance as English speakers. Crucially, this evaluation was self-conducted and did not subject them to the possible embarrassment of public performance.

As for the content of the responses themselves, students' frequent use of imperfect English was also highly encouraging. Supporting RQ2, the focus of the activity for most students seemed to be on the message of their response rather than its grammatical correctness. The wide range of views offered across these 32 responses also highlights a distinct advantage of the video-submission format of the activity. It is hard to imagine such a variance of expression through a traditional format such as classroom discussion, where—especially in EFL classrooms—the most confident speakers typically dominate the conversation.

Results related to RQ3, however, were far less unanimous. Much of this, I believe, is related to a number of problematic components to the activity that limited the opportunity for more personal expression. Though a handful of responses offered candid perspectives on representations of violence in Colombia, most seemed to be framed around either state-sanctioned retorts or on tourist advice. These results (the later especially) I see as a failure to account for my own influence on students as the perceived audience for their responses. Despite my instruction to frame their response to a general English-speaking audience, students logically directed their message at me, the one native English speaker directly involved in the activity. A useful revision might be to provide such an English-speaking audience in order to provoke more personally grounded responses. One possibility might be to set up the activity as a sort of video pen-pal project, in which students in the United States and Colombia could coparticipate by posing questions to each other and respond via video responses. Beyond allowing for more direct intercultural communication between students, this approach allows for student-driven inquiry. In setting the questions in the activity myself, I was not able to uphold this key Freirean element. Letting students follow their own curiosity by posing their own questions through the video activity might be an effective means of positioning it closer to critical pedagogy concepts.

The activity did produce some interesting examples of students' negotiating violent representations of Colombia. Overall, most showed a clear ability to identify hegemonic structures that set the discourse of Colombia as a violent place. Beyond media portrayals, many identified political, military, and other social forces at play in this construction, and they often showed a desire to fix the problem rather than just comment upon it. Despite these positive results, I believe the activity could be revised to allow for more self-reflexive considerations of these representations. Mostly because of student embarrassment, I avoided playing any of these responses in class. The issues brought up by these students, however, seem to be a wonderfully organic opportunity through which to ground intercultural discussions in class. A reworked version of this activity should consider ways to apply content from these videos into class activities, allowing students to reflect upon concepts, build upon vocabulary, and develop greater fluency on these issues.

Through this analysis, I sought to better understand the efficacy of this activity in stimulating target-language speech, not just in the sense of practicing words, but in using language as a vehicle for self-expression and self-reflexivity. Though this analysis focused on just this one activity, I hope its findings will provide valuable guidance for EFL educators looking to best integrate technology and language development into classroom practice. Using a common language (English) and tool (smartphones), students now have the opportunity to exchange and access knowledge in newly possible ways. I believe it is now up to educators to open students to these possibilities, using the classroom to bolster language learning and, more broadly, new forms of exchanging knowledge.

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# From Connected Learning to Connected Reading

## Understanding *What*, *Where*, and *How* Teens Read

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**Abstract:** In a digital age texts are available in multiple formats and across various technologies. Readers must make choices about *what*, *where*, and *how* to read. Teens, in particular, have embraced digital tools, yet we do not know much about their reading practices. This study explored the reading lives of adolescents through a survey of 804 students and 23 in-depth interviews. Results indicated that teens are connected readers—using the practices of encountering, engaging, and evaluating the texts they read—yet they varied in their application of critical-reading strategies. This study presents a theory of connected reading that draws upon connected learning principles to understand the practices of adolescent readers.

### Framing the Problem

A recent Pew Internet and American Life Project (Pew Research Center, 2017) study suggested that "Americans today are increasingly connected to the world of digital information while 'on the go' via smartphones and other mobile devices" (para 1). The majority of adults access the Internet through smartphones (77%), computers (80%), tablets (50%), and e-readers (20%). Technology has changed the landscape of reading, and reader habits are mediated by the technologies they use. This context creates challenges for teachers of literacy, who must navigate the demands of both print and digital literacy in the classroom.

Though the field in print literacy is rich in its understanding of the development of critical readers, research in digital literacy is in its infancy. Studies to date in the fields of literacy education and psychology have documented numerous challenges associated with reading on the Internet:

- Verifying website credibility and usefulness through critical searching (Coiro, 2005);
- Managing distractions (Bauerlein, 2008); and
- Overcoming shallow practices and engaging deeply with texts (Carr, 2010; Thompson, 2013).

These kinds of studies have been devoted to the ways in which digital reading affects the comprehension of the reader, yet in most of the work to date, the agency is given to the technology, not the reader. As Rosenblatt (1978/1994) asserted, "The individual reader has seldom been acknowledged as carrying on his [or her] own special and peculiar activities" (p. 4). The present study refocused attention on readers who are able to control both their consumption and their contributions of information within a network of other readers.

The social aspect of reading, while not entirely new, is at least decidedly *different* in an era when opportunities to share and discuss reading have become more widely available with mobile technologies. As readers engage with texts on a daily basis, they are connecting with each other. The connected learning principles proposed by Ito et al. (2013) helped to frame in this study the production and distribution of knowledge and ideas, especially those related to what we (and our students) read.

Rooted in a theory of connected learning, this research presents a framework for how readers engage in the practices of reading as mediated by the technologies to which they have access. Just as Ito et al. (2013) argued for the positive applications of digital media and communications, this research contends that such media can contribute to rich, multifaceted reading lives. Connected reading takes into account that “engaging formats” and “social supports” (Ito et al., 2013) are key elements for digital readers.

## Methodology

This study explored the question “What, where, and how do teens read digitally?” Though not conceptualized as a grounded-theory study, the analysis used tools of grounded theory, which ultimately led to the articulation of the theory of connected reading.

### Participants

Adolescents (ages 13–18) in Grades 7–12 from 12 classrooms in California, Michigan, New Jersey, and New York participated in the study. All students in the classes responded to a survey ($N$ = 804), and 23 of these respondents were selected purposefully to participate in interviews. This interview pool included a variety of readers, including males and females, honor and struggling students, and those who preferred digital reading and those who did not.

### Data Collection and Analysis

In order to explore the digital reading practices of adolescents, the research team collected several types of data and triangulated analysis across these data sources.

First, the team adapted Pew’s “Teen Parent Survey on Writing” (Lenhart, Arafeh, Smith, & Macgill, 2008) to create a “Digital Reading Survey,” which participants completed during their English Language Arts class. The 804 responses to the survey helped to inform the nature of teens’ digital reading, their attitudes toward digital reading, and their access to technology. Data were disaggregated by gender, geography, and grade range (middle and high school), but there were no significant differences among those categories.

Second, a sample of the survey respondents participated in interviews. The interview protocol was inspired by Smith and Wilhelm’s (2002) work and included five fictional profiles of readers to spark conversation about participants’ reading habits and preferences. The profiles were read aloud to participants, who were asked to consider the following questions: (a) What, if anything, do you admire about the character in the profile? (b) What, if anything, do you not admire about the character in the profile? and (c) Where do you see yourself in the characters? Interviews were transcribed for analysis.

Analysis began with coding of the open-ended survey responses and interviews. Though the team intended to apply Smith and Wilhelm’s coding scheme (2002, 2006) from their work on adolescent boys’ out-of-school literacies, additional themes emerged from the data that prompted the development of codes specific to digital-reading practices. Using a grounded-theory approach (Charmaz, 2011), the researchers followed an iterative process of passing through the data multiple times to develop and refine codes and categories. This process was aided by reflective journaling: Members of the research team documented their own reading practices in order to think more deeply about those practices that the teens shared in their interviews. After analyzing the survey and interview data, the team used the findings, as well as the current literature on digital reading and reading comprehension, to develop the connected reading model.

## Findings

The research began by asking *what*, *where*, and *how* adolescents read. The survey of 804 teens provided quantifiable answers to the first two questions.

The results of the survey analysis revealed that teenagers read a variety of texts using a variety of devices. From the sample, 84% said that they read content from the Internet, such as news stories and blogs, 50% read digital books or magazines, and 82% said that they had at least one social network account where they read status updates and followed interesting links. These teens read short-, mid-, and long-form (Thompson, 2009) digital texts. In fact, 45% of the survey respondents said that they like to read "a great deal," and another 32% liked it "some." Finally, 49% of the sample said they read for themselves (mostly outside of school) every day. They read these texts on a variety of devices (see Table 1).

| **Device Owned** | **% of sample** |
|---|---|
| Mobile phone | 84 |
| Laptop or Desktop at Home | 77 |
| Smartphone | 71 |
| Internet Enabled Handheld Device (e.g., iPod touch) | 71 |
| Ereader | 21 (dedicated eReader)<br>45 (Internet enabled) |

*Table 1. Device ownership.*

This snapshot into the teens' reading lives helped elucidate the variety of texts and devices with which they engaged. However, it was the process of reading that formed the basis for the model of connected reading.

### A Model of Connected Reading

To understand *how* teens engaged with texts on their various devices, researchers looked carefully at the interviews of the focal participants. These data revealed several practices in which the adolescents engaged. Through self-study and a process of peer feedback, researchers were able to hone the practices into a model of reading in a digital age. Given the theoretical frame for this study that relied heavily on principles of connected learning, the model of connected reading presented here (see Figure 1) speaks to the variety of texts types, both print and digital, that the teens in the study read.

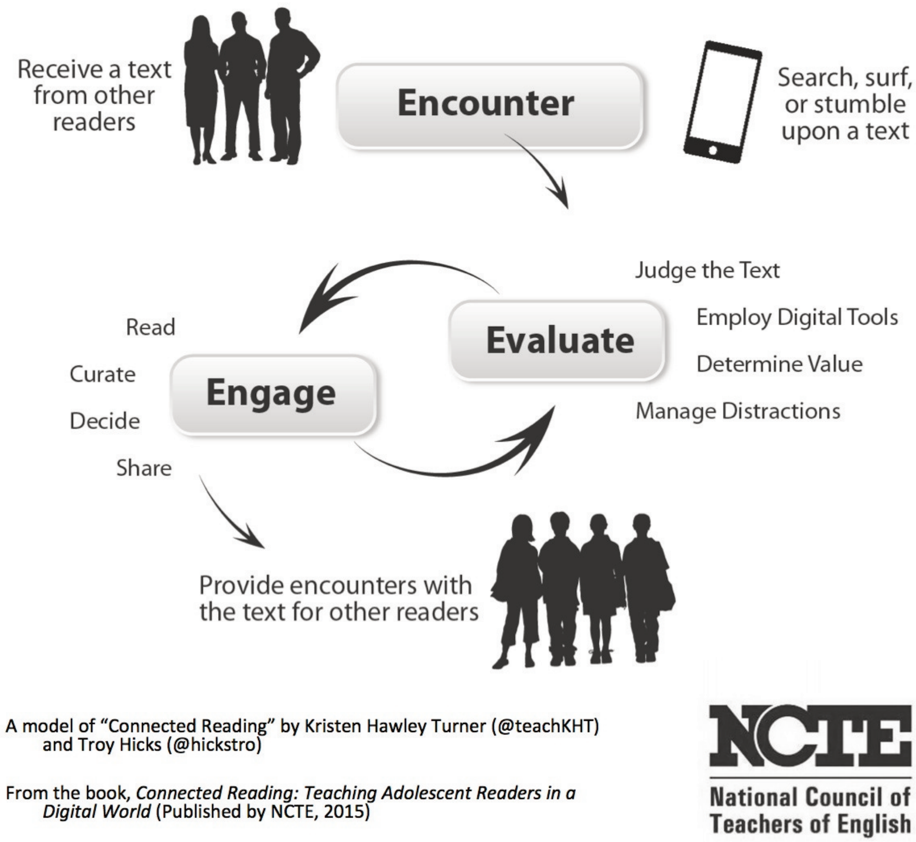


*Figure 1. Model of connected reading (Turner & Hicks, 2015).*

There are several key features to this model.

**Recursiveness.** This model is not linear. Instead, it suggests that readers engage in ongoing evaluation and engagement practices.

**Social connection.** Readers in this model exist within a network of other readers, highlighting the social nature of reading in a digital world.

**Digital and print.** Connected reading involves both print and digital texts. However, particular practices rely on digital tools; these tools and practices mediate the reading experience.

Within this frame, the research team identified key practices described by the participants in the study, each contributing to three main processes: encountering, engaging, and evaluating.

Practices of Connected Reading

The data revealed three primary processes in connected reading:

- Encountering—the manner in which a reader first makes contact with a text;
- Engaging—the activities that happen before, during, and after reading a text;
- Evaluating—the act of finding value in a text.

Each of the three process of connected reading can be broken into several subcategories, presented in Table 2.

| | |
|---|---|
| **Encountering a Text** | |
| Surfing | Moving from text to text with little intent, most often for a purpose of leisure, amusement, distraction, or "killing time" |
| Receiving | Coming across a digital text passively, by means of seeing it upon opening a website, via a link from a friend or colleague, or via a preset RSS feed |
| Stumbling | Following a connected path (both in terms of algorithmic, networked connections provided by websites as well as through cognitive, schematic connections in the reader's mind) of related information from embedded hyperlinks |
| Searching | Actively seeking additional information to confirm (or disconfirm) an existing understanding about a topic, usually with the intent of learning something new |
| **Engaging with a Text** | |
| Deciding | Filtering texts to be read or discarded; deciding when and how to read |
| Curating | Organizing texts for reading and archiving; establishing additional feeds based on current feeds |
| Reading | Skimming, scanning, digging in; using multimedia; annotating; responding; interacting; monitoring; reading beyond a given text |
| Sharing | Offering public response to a text; posting or sending it to others |
| **Evaluating a Text** | |
| Determining value | Considering interest, overarching intentions, and immediate purpose to identify how useful the text might be in the moment and in the future; situating the text in a broader, on-going conversation |
| Judging | Critiquing the quality of a text (both content and form) as it compares to other similar texts (asking, "is it a good or bad example of [this particular genre]?") |
| Employing digital tools | Identifying and utilizing the most appropriate tools to read, annotate, respond to, and share a digital text |
| Managing distraction | Self-regulating one's attention related to the specific reading task and digital tool in use |

*Table 2. Practices of connected readers (first published in Turner & Hicks, 2015).*

The connected reading model suggests that after encountering a text, a reader enters a recursive cycle of engagement and evaluation. Though the data revealed distinct practices within these categories, the teens in the study demonstrated the complicated process of reading, which blurs the lines among these practices.

## Connected Reading as Connected Learning

The connected learning framework suggests that adolescents explore topics of interest in a network of peers and mentors and connect those topics to their personal goals. Not all of the teens in the study demonstrated full facility with the practices of connected reading. Those who did seemed to better achieve connected learning. Two cases, Andrew and Alan, best show the overlap between connected reading and connected learning. Both of these young men were seniors but their reading practices were distinct.

Andrew preferred reading print books at the time of his interview, but he recognized an “innate problem” with his reading life. Despite the fact he would rather read in print, he acknowledged that he searched online almost exclusively for information when he was interested in a topic.

One such topic was art, and Andrew participated in an online community where he could share his artwork, compose journals about it, and give and receive feedback to others. Andrew voraciously read journals of other artists, skimming and scanning until he found something interesting. Then, as he said, “I’ll read the whole thing. If it’s not [interesting], I’ll just kind of like get the gist of it. If it’s a little bit boring in some sections, I’ll move on.” He had honed his reading practices in this digital space, using traditional reading strategies (skimming, scanning, constructing the gist).

However, Andrew also described his use of the technological tools:

> You have the main page and there’s a little thumbnail of every picture that’s been recently posted. There’s like 60 on a page. And you skim through and you’re like, “Hey, I like this picture. I want to see it.” You don’t want to click on the picture, be redirected, look at the picture, like it or don’t like it, then go back to the previous page. Hold down control, click on all the icons you like, and then go through all the pages that you have open. Like this, like this, like this, don’t like this.

His use of scrolling, keyboard functions, and reading laterally helped him to navigate the text—and also to better connect with the other artists in the community. In fact, Andrew ended his interview by stating that “reading is supposed to be … connective.” He had developed his reading practices in order to connect with others as he developed his artistic skills. In this community of artists, he was both a connected reader and a connected learner.

In contrast to Andrew, Alan loved reading digitally. Through his social networks, he felt connected:

> It’s like I’m pretty much connected with everybody. I’m keeping in touch with people, I’m finding out what’s going on. If we need help on a project or help with homework, I’ll just shoot somebody a text or a message on Facebook like, “Yeah I need help with this math homework, this trigonometry. Can you help me out?” And I find that very innovative and very helpful.

In addition to the social connection, he described his practices of searching for information about environmental issues that impacted his neighborhood, reading his schoolbooks on his phone, and searching for articles on popular news sites. In short, he read a lot on his devices for a variety of purposes, and it was clear he had developed some critical searching practices:

> If there's one thing I need to find, I type in that and I go through everything that's on the result list, and I analyze every one. Not click on every one and just go through the story. I like look at the title, look at the source, and if it's good enough to me, then I can use it.

Alan's savvy with digital texts demonstrated several practices of encountering, engaging, and evaluating. However, Alan had not learned how to connect his interests to his reading online. Like Andrew, Alan loved to draw, and in fact, he was interested in becoming an architect. Though he often drew in response to what he read in digital spaces, he did not indicate that he had found a community or that he curated digital texts that could help him achieve his career goals. Though he was a connected reader, he had not developed practices of curating, strategic use of tools, and sharing that could help him to realize the affordances of connected learning, especially as they related to his interest in art and a career in architecture.

The teens in this study demonstrated variable facility with the practices of connected reading. In particular, few of the participants actively curated and shared in a defined network of other readers who shared their interests. Students like Andrew, who had developed these practices, were much more likely to engage as connected learners.

## Implications

Schools and districts are rolling out 1:1 device programs in large numbers. Additionally, an increasing number of students have access to their own smartphones and tablets through personal means. Therefore, the approach of literacy educators to reading instruction must expand to acknowledge the effects of these tools. The results of the present study demonstrated that students developed strategic approaches to reading digital texts, yet those approaches are uneven across students. It is imperative that literacy researchers and teacher educators consider new theoretical models, such as connected reading, to consider the types of literacy instruction offered to preservice and in-service teachers, and subsequently, the kinds of instruction offered to teens. Linking connected reading practices to connected learning may cultivate more critical readers who are college and career ready.

Connected reading, as a theoretical model for understanding who readers are and what they do in an era in which texts are both print and digital, provides researchers with new opportunities to frame both how to define reading as well as how to study reading practices. This study acknowledges and appreciates the work that has been started in digital reading (e.g., Coiro, 2005), yet looking at reading through a purely print/digital dichotomy fails to serve the field well. By simply studying reading practices as if they move from printed text to screen, researchers are not recognizing the complexity of social spaces in which readers participate, nor are they acknowledging the affordances and constraints that digital devices offer. On the flip side, if research simply studies digital texts and how readers move through hypertext, multimedia, and (almost incidentally) words, sentences, and paragraphs, then it will not recognize the actions that lead from decoding to comprehension.

How the field talks about reading in this increasingly hybridized world of print and media, then, matters a great deal. We must consider what readers do, how we study what readers do, and what we teach readers to do. The connected learning framework helps the field of literacy education to think more broadly about a long-standing question: "What do readers do?" By giving agency to the learner, rather than technology, in a connected world, connected learning influenced the interpretation of data in this study. As theory-building research, this work has started us on a path to investigating more fully the processes of readers in a digital age—and ultimately, of creating critical readers who are also connected learners.

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# Connected Learning in Kindergarten

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**Abstract:** The aim of this socioculturally informed study is to explore teachers' insights into connected learning projects in kindergarten. The focus was on the ways in which early childhood teachers and educators ($N$ = 8) supported children in connecting their interest-driven and inquiry-oriented learning to their local surroundings, family, and community. The data consisted of teachers', educators', and researchers' collaborative conversations, supplemented by project portfolios. The preliminary content analysis of the 2 representative projects shows how the children's own discoveries of nature were connected to an extended network of peers, family, and external experts though the use of a trail camera. Conclusions are drawn about activities that afforded the co-creation of a participatory network of people, tools, and resources organized around a shared object of inquiry.

## Introduction

Over the past decade we have witnessed the emergence of extended learning networks and digitally mediated practices. These sociotechnological developments point us toward a more participatory culture, one in which we have relatively low barriers to participation, strong support for creating and sharing one's creations, and some type of mentorship in which what is known by the most experienced is passed along to novices (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2008). Rheingold (2013) argues that these new opportunities challenge educators to advance a participatory pedagogy assisted by digital media and networked publics.

Despite widespread optimism about the potential of digital technologies and social networking, only a small minority of children and youth take advantage of these opportunities (Barron, 2006; Ito et al., 2013). To overcome the risk of an emerging participation gap (Jenkins et al., 2008), Ito and colleagues (2013) argue for the need for *connected learning* that supports children and youth to link their formal learning with society, family, and community in an interest-driven and inquiry-oriented manner. While we have begun to have successful examples and studies of connected learning in schools, we have less of an understanding of what it might mean in the context of early childhood education (ECE).

Mitchel Resnick (2017) argues that a kindergarten approach to learning may offer novel opportunities to develop the mind-sets and skills needed in the rapidly changing 21st century. People of all ages should be focusing more on imagining, creating, playing, sharing, and reflecting, just as children do in traditional kindergartens (Resnick, 2017). Given this insight, we aim to take a kindergarten perspective on connected learning and study the emerging learning networks, activities, and forms of participation that are mediated when teachers and educators describe and reflect on connected learning projects in ECE.

## Sociocultural Framework

The present study draws on sociocultural perspectives of learning and participation that originate from the intellectual work of Lev Vygotsky (1978) and his followers. For Vygotsky, participation in the everyday activities and practices of communities was a crucial feature of learning. Rather than learning's being seen as an individual mental process, he emphasized the essential role played by the experienced others who can support the learning of the child, and who pass on the skills and knowledge from generation to generation through mentorship and collaboration (Kozulin, Gindis, Ageyev, & Miller, 2003). Apprenticeships with community members allow for the development of skills and knowledge that go hand in hand with a growing sense of one's self or identity (Barron, 2006; Wenger, 1998).

Moll, Amanti, Neff, and Gonzalez (1992) argue for the need to develop a positive view of the kinds of expertise and affordance networks that children are already connected to when they enter formal educational institutions. Their *funds of knowledge* approach refers to the knowledge, skills, and social networks that children and their families sustain and develop in their everyday practices (Moll et al., 1992). McTavish, Streelasky, and Coles (2012) note that nowadays, children and their families also use the Internet to connect with various kinds of information networks that stretch beyond the boundaries of their immediate community.

As children's everyday experiences deeply influence their personal interests, goals, and identities, educators have to bridge this range of opportunities in educational activities (Pramling Samuelsson & Asplund Carlsson, 2008). This challenges us to co-design participatory networks that benefit from the existing funds that children are already familiar with and connect them with the resources that their peers and teachers have access to (Vartiainen, 2014). In design-oriented settings, children may learn by co-creating an epistemic environment that affords their interest-driven inquiry activities (Markauskaite & Goodyear, 2016). Given this insight, our research question is: *How do early education teachers support children's interest-driven participation in connected learning projects?*

## Method

### Research Context

This research is part of a long-term, larger design-based project in which the aim is to iteratively develop and study connected learning networks and related design-oriented pedagogical practices and theories (Vartiainen, Nissinen, Pöllänen, & Vanninen, 2018). The context of this design experiment is an educational project for in-service teachers organized in the spring of 2015 at the University of Eastern Finland. The project aimed to support teachers and educators in co-designing forest-related learning projects together with their kindergarten children. The forest served as a joint, multifaceted phenomenon for the project, as it is present in the everyday lives of the children living in the area. In that region, a great deal of forest expertise and resources are also available (e.g., forests, forest museums, forest researchers, and domain expertise).

During the project, five joint network meetings with teacher educators and researchers were organized. In these joint meetings, the teachers were encouraged to reflect on their own project activities and to share the emerging ideas, connections, and challenges. The joint discussions also aimed to support ideating the scaffolds that may subsequently be implemented to facilitate children's activities.

### Participants

Twenty-seven kindergarten teachers and child-care nurses or assistants participated in the project.

However, the analysis of the present study focuses on two representative learning projects of kindergarten teachers ($N$ = 2) and child-care nurses and assistants ($N$ = 6) working in teams of four members. As noted by Heikka, Halttunen, and Waniganayake (2016), Finnish ECE professionals are well-educated, well-trained, multidisciplinary staff who typically work as small teams with qualifications from diverse disciplines.

### Data Collection

The main data reported in this study are the collaborative discussions from the five network meetings between teachers, educators, and researchers. A total of 8 hours and 12 minutes of discussions with kindergarten teachers were recorded. From this data, stories of two representative learning projects were selected for more detailed content analysis. Moreover, project portfolios were used as a secondary data source, for example, when they were relevant to interpreting the object of the collaborative discussions.

### Preliminary Data Analysis

The data analysis was performed in collaboration with two of the authors. First, the audio data from the collaborative discussions were transcribed in full for analysis purposes, consisting of 230 pages (Arial 12, spacing 1.5). Second, we proceeded to identify the key episodes from each project based on several readings of the transcripts. In this study, an episode was defined as a thematically meaningful unit that consisted of a connecting idea, thought, or suggestion (see Chi, 1997) grounded in group-inquiry activities. An episode was considered to begin when the object of the teachers' discussion shifted and it ended when it shifted again to something else (Kumpulainen & Rajala, 2017). All meaningful episodes related to the research question were coded to develop an initial list of themes.

In the third analysis phase, we compared the episodes to allow for the emergence of key themes that were found in the projects. This stage resulted in the merging and dividing of themes as follows: reflection, observation, discovering, negotiation of meaning, imagination, and the creation of meaning. Finally, we discussed and identified the connections between these key themes in order to further develop our preliminary interpretations about the nature of connected learning in ECE.

## Preliminary Findings

Next, we turn to illuminating our findings through two representative project episodes.

### Preschoolers' Trail Camera Project

Our first example illuminates how the children's ideas and funds of knowledge were connected to a preschooler trail camera project. The group consisted of 20 preschoolers and four adults (in Finland, preschool begins when the child reaches 6 years old).

> So, in a way, our group had started already before Christmas. We saw a weasel while we were looking for the traces of the elves. And we had a project on that. We also evaluated the project with the children. What was fun? And what was interesting? And we studied the weasel as well. The children were trying to figure out where to look for information. From Dad, and Grandpa, and the library, and the Internet, and so on. Then we used the Internet and books for information on the weasel. But we only saw it once. And then in the evaluation, it came out that it was a little bit boring that we didn't see it again. And then this one child, in fact, whose

> grandparents' property we were making the field trip to, said that if only we had a robotic camera, it could be taken to the woods. And this is how this project started.

In the example, the teacher describes the children's reflections on a previous learning project that began with the on-site observation of wildlife while looking for the traces of imaginary creatures. This evaluation mentions the children's funds of knowledge and the Internet as an inquiry resource, but it also indicates the children's desire to extend the existing learning system by connecting novel tools to inquire about wildlife in the forest. The example further illustrates that the children's initiatives were not ignored, but actualized, in terms of installing the "robot camera" on the home turf of the child. This demonstrates how the teacher supported the children in creating a novel bridge across previous activities, their funds of knowledge, and technology in a manner that allowed for their active participation in designing the emerging learning network.

The teachers' written reports evidenced that the project also provided children with the opportunity to connect with the expert tools and community. Here, the father of one child served as an expert on local wildlife. He also installed the camera together with the groups of children, supported by the two domain experts from the university.

### The Animal Trails Project

The second example illustrates how the trail camera project connected another group as well as their parents and grandparents in the collective inquiry of wildlife. This group consisted of 22 children aged 3–5 and four adults. The project began in the local forest and was connected to the preschoolers' project of installing the trail camera alongside external experts.

> Well, the children in our group are 3–5 years old, so we had to wait for the temperatures to get milder. And we went looking for the traces of animals in the woods. Images were taken on the iPad and they, the kids themselves, found the hare's tracks. And then there were traces of other animals, and then they thought of which animals they could be. They strongly felt that there had been a wolf chasing a rabbit. And then one 3-year-old said that no, it was Ms. Dragon. So, the dragon's traces were found there. And now, hopefully, when we go on the field trip and install the trail cameras, something new will emerge. And this information will be incorporated into arts, sports, and drama.

In the example above, the teacher aims to make children interested and engaged in something that exists in their immediate surroundings by taking the children to a forest nearby. The focus is on children's on-site observations, their discoveries, as well as in the different meanings that the children themselves give to them. The example further illustrates that, instead of the children being accountable for providing the correct answer to the teacher with respect to the identification of the tracks, their observations, discoveries, and the imaginary connections between them were going to be harnessed as the basis for designing the various future activities of the project. Furthermore, the meanings that the children built up are connected to the trail camera with the desire of discovering something new.

In the next meeting, she explains how the trail camera that the children installed on the home turf of one child from the preschool group connected new information resources to be appropriated for analyzing the tool-mediated data from the wildlife. This example further illustrates how the teacher supported children in using these information resources to solve problems together with their peers. Furthermore, the teacher also observed that interest evoked from the forest began to emerge in the children's play.

> The kids have learned to use nonfiction books. Every time we visited the trail camera page, the adults did not tell the kids which animals were in the pictures, but the kids themselves figured out that they could look at the book. The boys went to search for some books on animals and the whole group was searching for what animal it could be. And they found it. … Animals have also started to appear in the children's play quite a lot.

Moreover, the teacher described how their funds of knowledge and the tools found from an extended peer network connected their parents and grandparents to the project in an interest-driven manner.

> And families and grandparents have also joined our project. Many grandmothers and grandfathers have asked us for the link to the trail camera page, where you can watch those animals. And the father of one child is also involved. He brought these [shows a hare's paw to the others]. [Everyone says out loud] Oh!

## Discussion

In this paper, we have preliminarily depicted teachers' insights into the ways in which children's participation was supported in the two representative kindergarten learning projects. The results of the study indicated that the teachers encouraged children to observe and discover their surroundings as well as to engage in collaborative meaning making with their peers. The teachers purposely left room for the children's imagination and playful initiatives. Rather than presenting a fixed solution to the children's own discoveries, such as the traces of animals, the teachers cultivated a generative mind-set in which the object under investigation was approached and negotiated from many perspectives. Such acts of imagination transformed the real-life environment into a space of play and experimentation (Thomas & Brown, 2011) in which experiences of interest stemming from multiple settings could be re-created (Hedges & Cooper, 2016).

As stated by Hedges, Cullen, and Jordan (2011), understanding and engaging with children's interests also requires the acknowledgment of the richness of children's lives and positive collaboration with their parents. Here, the expertise and affordance networks that children were already connected to in their everyday practices were harnessed in educational settings by observing, discovering, imagining, creating, playing, sharing, and reflecting together with the children (Resnick, 2017). The learning community that emerged included peers, peers in other groups, experts, parents, and grandparents, and it was organized around a shared object of inquiry.

Overall, the extended learning network, as reflected in these project examples, involves an orientation similar to what Henry Jenkins et al. (2008) define as the emergence of a participatory culture. Instead of merely socializing within existing practices, the children were positioned as a contributing member of a larger community of people interested in what they were learning about (Engle, 2006). Building meaningful connections with tailored-to-the-need networks promotes children's epistemic authority (Barton & Tan, 2009) and supports the children in seeing themselves as knowledge creators whose contribution is relevant to the community.

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# The Connected Learning Framework

## Exemplified by a Saudi Arabian Educator via Twitter

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**Abstract:** The connected learning framework was used to analyze Twitter posts of Saudi Arabian educators for the duration of 1 year while the educators were involved in a training program in the United States. This framework has typically been applied to youth and not to adult learners; however, learning does not stop at any particular age. Through an analysis of the technological trail of posts on Twitter, this paper demonstrates how each part of the connected learning framework, adapted for adult learners, manifested therein. This includes contexts for learning (colleague-supported, inquiry-driven, and improvement-oriented proposed by Eidman-Aadahl [2012]), core properties, guiding design principles, and the role of new media. The ability to expand the connected learning framework to apply to a specific set of adult learners is a step toward applying the connected learning framework to learners of all ages.

### Introduction

Education in the United States, as it is in the rest of the world, is changing. As described by Kumpulainen and Sefton-Green (2014), the classroom of the past, which was largely "based on a reproduction model wherein one teacher in one classroom teaches one subject at a time to one class, is increasingly being questioned (e.g., Dumont, Istance, and Benavides, 2010; Facer, 2011; Salj, 2012)" (p. 9). In its place is a focus on students who are actively involved in their learning and developing critical-thinking skills. Learning is no longer done in isolation. It is connected between subjects and student interests, as well as between both formal and informal learning environments. Today, learning can happen at any time, anywhere, and at any age, with the goal of developing the skills needed for career and personal success in the 21st century.

The connected learning framework can be used to observe and analyze participants' learning over time and in a variety of spaces. According to Ito et al. (2013), the focus of the connected learning framework is on spheres of learning, core properties, guiding design principles, and the role of new media. "Connected learning is socially embedded, interest-driven, and oriented toward expanding educational, economic or political opportunity" (Ito et al., 2013, p. 42). This framework has typically been applied to youth but not to adult learners, even though it can be applied to any age group (Ito et al., 2013, p. 8). Broader application to adult learners is needed. As Eidman-Aadahl (2012) stated, "[We] can't expect young people to be powerful learners if not surrounded by adults who are supported in being powerful learners themselves." Around the globe, this is particularly useful when considering educators who are interacting with each other as connected learners in inquiry-driven ways through reading, posting, commenting, and video chatting.

Educators from Saudi Arabia are driven by a goal set forth by their government to expand educational opportunities for students within their country and to help their country become an educational leader. To do this, groups of educators chosen by the Ministry of Education (MoE) in Saudi Arabia are being sent to various educational systems around the world, including the United States, United Kingdom, and Finland, to explore that country's educational system and begin to develop plans to change the educational system in Saudi Arabia. The overarching goals for these educators are outlined in the government's plan, Vision 2030. According to Saudi Vision 2030, "We want Saudi children, wherever they live, to enjoy higher quality, multi-faceted education. We will invest particularly in developing early childhood education, refining our national curriculum and training our teachers and educational leaders" (para. 2). Without exposure and connections to other educational systems, the Saudi educators have been stuck in a repetitive cycle of teachers' using directed learning to foster memorization. They are committed to making change to the educational system in Saudi Arabia, and in the pursuit of doing so, have the opportunity to be connected learners. These educators are witnessing, documenting, and sharing their experiences in the United States via Twitter.

This paper documents how each of the areas of the connected learning framework were evident in tweets posted over a period of one year to a Twitter account that was used to share a variety of experiences of Saudi Arabian educators before, during, and after their time in the United States. Upon examination, the data that emerged from the adult Saudi educators' tweets demonstrated the key areas of connected learning: spheres of learning, core properties, guiding design principles, and the role of new media. These data also support the notion that the connected learning framework can be applied to learners of all ages.

## Saudi Arabia Education System

Formal education in Saudi became established in the 1930s when the Kingdom of Saudi Arabia was established (Elyas & Picard, 2010). At that time, there were three separate systems of education: general education for boys, traditional Islamic education for boys, and education for girls. In 2000, all were combined and fell under the purview of the Ministry of Education (MoE), which oversees a standard curriculum for all teachers and students so that boys and girls are exposed to the similar learning goals, objectives, and materials, even though they are taught in separate schools (Rugh, 2002). As the MoE controls the curriculum and content in textbooks, there is little latitude as to the topics, content, or materials used in the classroom, and Saudi Arabian teaching methods tend to rely on rote memorization focusing on knowledge gained from textbooks. Critics of the educational system contend that the skills needed for the 21st century, including critical-thinking and technological skills, must be emphasized to a greater extent than they currently are (Rugh, 2002). As reported in Courington and Zuabi (2011), "[in] Saudi Arabia, you have to memorize things very well and put it down on paper … it's the same in [Saudi] medical school, we get the theoretical base but have to go abroad to get the technical expertise" (p. 142).

The Saudi Arabia educational system has deep roots in teacher-directed learning in which the teacher is the knowledge transmitter and learning centers on memorizing facts (Alyamani, 2016). This way of teaching is due to teachers' lacking skills in the use of appropriate teaching methods, classroom-management techniques, language-proficiency skills, and assessment strategies (Al-Seghayer, 2014). This cycle is perpetuated by teachers who teach as they were taught and who are not supported with teacher in-service training programs. Teacher training is oftentimes left up to the individual to pursue on his or her own, and resources to do so are limited (Al-Seghayer, 2014).

With the implementation of Vision 2030, education for both students and teachers in Saudi Arabia is undergoing a transformation. Through changes in professional development for educators, a more student-centered learning model is emerging. In so doing, the Saudis hope to promote the development of core life skills and the creation of a school-family partnership. The ultimate goals of Vision 2030 are to "create a vibrant society" with "a thriving economy" for an "ambitious nation" (Saudi Vision 2030).

To support this initiative, six-month programs for educators from Saudi Arabia began in early 2017 at sites around the world, including two sites in the United States. There, the programs were designed so that the Saudi educators learned more about the American educational system and also improved their skills in English. The program that the participant Twitter user attended was at a midsize Midwestern university. This program specifically addressed teacher leadership and student learning, with substantive contributions in the areas of best practices for curriculum, instruction, and assessment; professional learning; technology mobilization; leadership and supervision; equity and cultural awareness; management; English language improvement; and organizational development and growth. Excitement for the program led to a connection being made organically through the use of Twitter between the Saudi Arabian participants in the program and the American educators planning and developing the program. These technological connections were sustained throughout the program and subsequently as the participants returned to Saudi Arabia.

## Twitter

The use of Twitter to increase professional connections in the field of education and learning has been well documented. Since 2006, Twitter has created a public way to share and interact with people from around the globe. During the time of this research study, tweets were limited to 140 characters and publicly available unless the account was created as a protected account; then the tweets are available only to approved followers. Public tweets, however, can be found via a Twitter search or through data mining. Users can choose specific people to follow and topics to discuss. It has been demonstrated that Twitter is used to make connections between people, blogs, organizations, and groups related to education. Carpenter and Krutka (2014) found upon surveying 755 K–16 educators who used Twitter that “96% reported they shared and acquired educational resources via Twitter” (p. 428). Additionally, these educators acknowledged that when using Twitter they were learning with other educators while combating feelings of isolationism. Twitter has also been found to help teachers personalize their professional-development needs (Visser, Evering, & Barrett, 2014). Preservice teachers were found to benefit from using Twitter to share resources, communicate, and connect with others inside and outside of the classroom (Carpenter, 2015). As for the content of the tweets, 9,000 tweets of graduate education majors were examined and it was found that learning and transmission of knowledge was supported in formal and informal learning environments (Greenhalgh, Rosenberg, & Wolf, 2012).

## Twitter Use by Saudi Educators

This drive for change in Saudi Arabia created an opportunity for connections. These connections emerged between colleagues in the United States and in Saudi Arabia and took place in an informal learning space. They were enhanced and facilitated by technology, specifically the microblogging platform Twitter, and through which the publicly available data were analyzed. This journey was one that was documented for one year: before coming to the United States, while living in the United States, and upon returning to Saudi Arabia via one participant’s Twitter account that others followed, commented on, and retweeted. The program ran from February 2017 through August 2017; tweets were mined from October 2016, when the student Twitter account was activated, through October 2017. The educators who participated in the program and maintained the account on Twitter did so without help or encouragement from the American educators involved with the planning and delivery of the United States–based program. Posts were made to Twitter relating information about program experiences in the United States through text, photos, videos, and links to educational information. During this one-year period, there were 291 tweets with 168 tweets favorited 1,376 times, and 57.39% of tweets posted being retweeted. To someone scrolling through the technological trail of tweets of the participant Twitter account, the themes and characteristics of the connected learning framework were evident.

Of the 291 posts shared from October 2016 through October 2017, all posts contained text. Two original posts did not contain a photo or video while an additional 41 of the account's retweets contained only text. Using a word cloud to begin to examine the data provided by the participant Twitter account, one can see specific words that were used with more frequency in the posts. The most predominant words when examined in this way were *school*, *learning*, *educators*, *leadership*, *project*, *plan*, *immersion*, *development*, *support*, *experiences*, and *ESL*. A more detailed coding of the specific content of the text of the tweets found that the content of the posts focused on leadership, school immersion visits, specific culminating learning activities, and plans for change.


*Figure 1. Most common words.*

## Connected Learning Framework

According to the Connected Learning Research Network (n.d.), "connected learning is about examining learning that cuts across the contexts of home, school, and peer culture, looking at the links and disjuncture between them" ("Dedicated," para. 1). Specifically, according to Ito et al. (2013), research "stressed the importance of civic engagement, connecting schools with the wider world, and the value of hands-on and social learning" (p. 33). The bulk of the research, including information shared in *Connected Learning: An Agenda for Research and Design* (Ito et al., 2013), has focused on young adult learners because it is a critical time for them to develop their social identities and interests as well as to begin thinking about working toward career goals. Nonetheless, as the report stated, connected learning can apply to any age group, including adults. For example, Mirra (2015) focused on teachers who needed to incorporate digital literacy into their classrooms but may

> be unable or unwilling to do so if they do not have the opportunity to develop their own skill sets, find connections between digital tools and the kinds of meaningful learning opportunities they desire for their students, and wrestle with issues of equity and access. (para. 5)

To do this, however, some modifications to the spheres of learning must be made so that connected learning can apply to a wider range than just adolescents. The educators who are connected are more easily able to lead by example. That is,

> to meet the needs of the learners of today and tomorrow, [educators] need to recreate ourselves. We need to rethink how we do our job. We need to redefine our actions as educators so that we are teaching students how to learn, in part by modeling the role of lead learner. We need to stop thinking of a teacher as the giver of all knowledge and students as passive receivers of all knowledge and adopt a learner-first attitude. (Nussbaum-Beach & Hall, 2012, p. 46)

### Spheres of Learning

According to Ito et al. (2013), the three spheres of learning of the connected learning framework for youth are: peer-supported, interest-powered, and academically oriented (see Table 1). Eidman-Aadahl (2012) adapted these for adult learners, suggesting that the equivalent spheres of learning for adults in professional environments as a subsection of the connected learning framework are: colleague-supported, inquiry-driven, and improvement-oriented (see Table 1). Viewed through the theory of *andragogy* (Knowles, Holton III, & Swanson, 2012), the needs of adult learners are different from the needs of children; therefore, the spheres of learning need some slight adaptations to account for these differences. Andragogy describes the characteristics of adult learners and discusses the belief that as adults manage aspects of their lives they are more capable of directing or assisting in their own learning (Merriam, 2001), as in being colleague-supported. The adult learner wants to be treated with respect. Adults are ready to learn, and time is valuable to them, so they want to learn what they can use. In addition, they are motivated to learn through problem solving as they are capable and independent learners. Both characteristics point to adults' being inquiry-driven. Last, they view mistakes as opportunities to learn, as it is part of life experiences (Weingand, 1996), which points to adults' being improvement-oriented. Andragogy is not without its critics. First, instead of being a theory, to some it seems as more of a set of best practices for learners who are no longer considered to be youth. Second, it seems as if the theory in question is better to be viewed as a model of assumptions about adult learners. Regardless, andragogy does address the fact that adults' cognitive abilities are different from children's and should be taken into consideration when adapting the three spheres of learning according to the connected learning framework for adults.

| Spheres of Learning | | |
|---|---|---|
| Youth | Peer-supported | In their everyday exchanges with peers and friends, people are contributing, sharing and giving feedback in inclusive social experiences that are fluid and highly engaging. |
| Adult | Colleague-supported | |
| Youth | Interest-powered | When a subject is personally interesting and relevant, learners achieve much higher-order learning outcomes. |
| Adult | Inquiry-driven | |
| Youth | Academically oriented | Learners flourish and realize their potential when they can connect their interests and social engagement to academic studies/skills, civic engagement, and career opportunity. |
| Adult | Improvement-oriented | |
| (Adapted from Ito et al., 2013, p. 12, and Eidman Aadahl, 2012) | | |

*Table 1. The connected learning framework.*

**Colleague-Supported.** The educators from Saudi Arabia were very adept at using technology to make connections with other educators. They used technology to connect with peers in Saudi Arabia, American educators involved in the program, and colleagues within their country concerning topics and ideas learned while in the United States. Followers of the account reported that they were from such countries as the United States, Saudi Arabia, England, Libya, Canada, South Africa, Finland, Yemen, New Zealand, Scotland, Egypt, Australia, France, and India. Posts included program information concerning the phase of the program the user was involved in, topics observed and discussed, or celebrations of accomplishments related to the program. For example, the Saudi Arabian educators were colleague-supported, as they were chosen by the Saudi Arabian MoE, their colleagues, for this experience. In addition, based on the 662 followers and 1,376 favorited posts they received during a one-year period, others were reading and following them during their time in the United States. Posts were retweeted to be shared with others and comments were written such as "طريقة ناجحة جربتها طيلة تدريسي ولها نتائج إيجابية جدا" ("A successful method I tried throughout my teaching and it has very positive results," posted by Norah) in reply to a tweet with photos of books and text concerning reading. It is important to note, however, that there was no communication in reply to any of the comments posted to the original tweet. The tweets were used as a one-way mode of communication to deliver information. There was no evidence of chats between individuals or sustained discussions. A greater sense of support from colleagues may emerge when such dialogue is evident.

**Inquiry-Driven.** The Twitter posts also demonstrated that the participants were inquiry-driven. Posts contained artifacts related to a variety of educational themes. For instance, photos of classroom libraries and literacy events were taken and shared via Twitter because reading and the abundance of public libraries in Saudi Arabia are not as prevalent as they are in the United States. This led to one participant's creating a video upon returning to Saudi Arabia that emphasized the need for reading and an initiative for parents to read to their children. The ideas they had begun to delve into and use to create a plan of change were being shared with other teachers in Saudi Arabia, and in turn, shared with all Twitter followers.

**Improvement-Oriented.** As for being improvement-oriented, the entire experience of observing the American educational process and developing personal plans of action for improving the education in Saudi Arabia was just that—improvement-oriented. By coming to the United States, they demonstrated their desire to work toward improving their educational system not only for themselves and their students, but for their country. Upon their return to Saudi Arabia, they shared events and programs via Twitter to showcase the educational ideas that were being used to improve the schools and train additional teachers. These ideas included the use of technology (using games such as *Kahoot!* with students), using thinking routines, collaborating in small groups, and using Post-it notes to share information. It also included activities that the participants had been a part of in the United States, such as a Gallery Walk to share ideas in a poster presentation–type setting. Ideas that had begun to germinate while participants were in the United States were seen to come to fruition upon their return to Saudi Arabia.

One particular case of an adult learner's exhibiting the three spheres of learning was also evidenced. Student success and leadership were two themes of the program that were topics of book discussions, observations, and school personnel interviews. Upon returning to Saudi Arabia, one participant developed a program he titled مبادرة(فريق دعم المعلم, which translates into "Teacher Support Team Initiative." In short, this program was geared toward bringing all support personnel together in the school to assess students and provide interventions for students when needed so that students were successful. This post was liked 24 times and retweeted 17 times. Not only was this participant bringing educators together within the school, he was sharing his idea with other educators; ideas that began through the experiences in the United States and were interest-driven. He was driven by the desire to help students learn and while in the United States explored how support services are used here. He took this idea and sought the help of colleagues to implement his idea for student success in Saudi Arabia.

## Core Properties

The core properties of the connected learning framework were also evident in the tweets of the Saudi educators: production-centered, shared purpose, and openly networked (Ito et al., 2013, p. 12). The tweets gave the participants the ability to share photos, texts, and videos of their experiences. Specifically, videos were created to illustrate the activities the participants had been involved in for that month. Explanations of the photos were included in some of the videos while in other videos recordings of presentations by each participant were shared. The purpose of the tweets was to record and document the activities of the group. Posts were liked and comments were made by others from around the globe. However, no in-depth discussions were evident. The tweets were publicly available and can still be viewed by others. Because of this, not all of the Saudi Arabian women in the group were visually shown in photos or videos. They were recorded and audio of their voices were shared.

## Guiding Design Principles

The guiding design principles of the connected learning framework focus on everyone participating, learning happening by doing, challenge being constant, and everything being interconnected (Ito et al., 2013, p. 12). For the Saudi Arabian educators, participants were involved in several different activities in which they were asked to explore areas of interest and then to share this information with others. One activity that was documented through a photo montage shared online via Twitter was that of a conference in which all participated. For the conference, the participants had to create a lesson incorporating active learning. Lesson topics were based on concepts taught in Saudi Arabia coupled with ideas observed and discussed while in the United States. The focus of the presentations was on applying and synthesizing ideas. There were a variety of topics presented with various types of technology used as the focus of the presentation or as support. One participant shared an app for English vocabulary development in the classroom while another showed a video and discussed the importance of eating healthy food. Some asked their audience to use smartphones during their presentations while others asked them to use paper and pencil. All left the conference with the knowledge gained from presenting something they were interested in while being given feedback on their presentation by the audience as well as more formal feedback from the American instructors.

During the program, however, the conference was not the only time participants demonstrated their ability to analyze, synthesize, and evaluate information. When one reviews the time line of activities as shared by the participants on Twitter, it is evident that they were exploring a variety of new concepts while being encouraged to explore areas of personal interest and to think of ways to incorporate and use this information once they returned to Saudi Arabia. New concepts included focusing on student learning, importance of literacy, using technology as a tool, and more. From responding to daily writing prompts, to self-selected book-discussion groups focusing on books such as *Write Like This* by Gallagher, *When Kids Can't Read* by Beers, *Making Thinking Visible* by Morrison, Church, and Ritchhart, and *The Truth about Leadership* by Kouzes and Posner, the participants were challenged to think of how they could use the information in their classroom.

The participants were challenged not only by the use of English, but by the activities they completed. From diving into personal topics of interest to creating and collaborating on a group project that required them to write feature articles, create puzzles, critique movies, take photos, or interview people for a program newspaper, the desire to explore areas of interest was created along with the need to share information that they had learned. The Twitter posts documented the ideas that caught the participants' eye at moments in time along with documenting the staying power some ideas had while others did not. Examining these themes that created a thread throughout the Twitter posts, one sees that literacy was clearly important to the participants. Photos of books, classroom libraries, school libraries, and literacy topics ran throughout the program. At other times, one can see when a topic was introduced to the participants and a new thread was created and ideas related to the first post began to appear in subsequent Twitter posts. For instance, at the midpoint in the program, a book study of the book *Making Thinking Visible* by Morrison, Church, and Ritchhart took place. After a picture of the book was shared documenting the beginning of the book study, photos were shared from classroom activities and school visits that illustrated the routines in action that had been discussed in class, such as Claim, Support, Question, and Circle of Viewpoints. The issues discussed in class were documented and shared in the real world.

### New Media Role

The fourth area of the connected learning framework is the role of new media. Within this area, media foster engagement in self-expression, increase accessibility to knowledge and learning experiences, expand social support for interests, and expand diversity and build capacity (Ito et al., 2013, p. 12). The Saudi Arabian educators immersed themselves in the United States to learn about the educational system, the culture, and the language. They interacted with people in person and online to share what they were doing and learning, all through a single Twitter account. In fact, the most popular tweet that was posted by this participant was a thank-you video, which the cohort had created, dedicated, and directed to the university hosting the group. The video was shared with 671 followers and retweeted by four others who had a total number of followers of 16,858. The reach of this one video was extensive.

Scrolling through posts shows that the participant Twitter account contained a variety of educational topics related to personal interests. Others who read the posts commented or provided feedback about the posts, which created an interactive environment. Relationships went well beyond the circle of university educators involved in the program, as the Saudi participants interacted with superintendents, counselors, teachers, paraprofessionals, and other individuals at schools. However, what was not maintained was a back-and-forth discussion of specific topics. In person, a discussion in which one comments, and another responds in real time, may allow for a deeper and more rich examination of a topic. However, at no time did the participant who created the Twitter account respond to a comment.

Not only has Twitter provided American and Saudi educators a platform for communication, it is also helping male and female Saudi Arabian educators discuss their separate systems of education within Saudi Arabia. This discussion began inside of the classrooms in the United States. To continue this discussion in an open public format such as Twitter is necessary if the country is truly going to change the educational system. Through the use of Twitter, educators can share ideas, network with other educators who have the same educational interests, participate in chats to debate educational policies, and begin to work together with an eye toward fulfilling the goals of Vision 2030.

## Conclusion

The opportunity to travel to another country to explore its educational system in detail from a myriad of angles, and then to share that experience with others across the globe through posts on Twitter, is a unique situation. Aside from the benefits to the participants, it also serves as a case study for how expanding the connected learning framework to adult learners, with slight modifications, may provide a lens through which to better plan and evaluate similar environments. These modifications do not change the essence of the subcategories of the spheres of learning in the connected learning framework, but they do make each one more pertinent to the characteristics of adults, as adult learners are colleague-supported, inquiry-driven, and improvement-oriented learners and leaders who continue to learn, grow, and connect—all of which appear well facilitated by using Twitter.

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# Part Two: Abstracts

# Hall of Failure

## Implementation Fail: A Postmortem of the Elusive but Highly Desired Educational Digital Badge System

Theresa Horstman (University of Washington), Gavin Tierney (University of Washington), & Carrie Tzou (University of Washington)

The work presented is part of a Badges for College Credit project that partners a four-year university with three informal science-learning organizations to design badge systems connected to informal programs that ultimately lead to college credit. This work has generated a better understanding of how digital badges can successfully serve as a conceptual framework and design tool for organizing informal educational programs and elevating youth voice. Described are failures we typically do not get to share but have informed this and other work. The implementation of digital badges proved to be one of our biggest challenges. Tension between outdoor programs and online activity, differences in understanding exactly what a badge is, differences in platform features and functionality (and how those features and functionality get baked into program design), and which activities are “badgeable” are a few of the factors that impacted implementation.

## The Rise and Fall of Digital Corps

Ani Martinez (Remake Learning) & Thomas Akiva (University of Pittsburgh)

The Digital Corps (DC) was a countywide initiative in 2014–2015 to equip digital-savvy adults to conduct technology-based workshops with youth ages 9–12 in existing Out of School Time (OST) programs. The program boasted numerous successes: DC trained and deployed 82 adult corps members to 53 locations, engaging more than 500 young people, and provided outreach to another 1,000 children and families through events. Moreover, a majority of participating organizations reported an increase in youth participation; these were very cool workshops in robotics, programming, and web development! However, the program was discontinued after a very short time and we seek to understand why. Possible reasons include the cost (e.g., paying educators a livable wage) and the nature and infrastructure of OST (e.g., irregular attendance). Perhaps we failed to communicate the successes well. We hope that understanding what happened will help us and others learn from this initiative.

## Learning on the Move: Lessons From a Research-Practice Partnership Focused on Evaluating, Assessing, and Reflecting on Connected Learning

Nathan Phillips (University of Illinois Chicago), Virginia Killian Lund (University of Illinois Chicago), Wendy Gonzales (University of Illinois Chicago), Emma Martell (Lincoln Park Zoo), David Bild (Chicago Academy of Sciences / Peggy Notebaert Nature Museum), Ilana Bruton (Chicago History Museum), Ani Schmidt (Chicago History Museum), Jaclyn Carmichael (Project Exploration), & Shawndra Allen (University of Illinois Chicago)

In this Hall of Failure presentation our team of practitioners and researchers will discuss lessons learned from four years of design and iteration of a set of tools, methods, and activities for evaluating, assessing, and reflecting on connected learning "on the move." Our development and implementation team consists of educators from a zoo, a nature museum, an after-school STEM initiative for middle school and high school girls of color, a history museum, and university-based learning scientists and researchers. Recently, we have completed a macrocycle of iteration by producing and distributing a published facilitator guide so that teachers and mentors can use these tools and activities in their own work with youth and adult learners. The completion of this four-year cycle of iteration and design affords us an ideal opportunity to share what worked and did not work across our collaboration.

## The School of Hard Rocks: Lessons Learned From Our Youth Digital Music Program

Tom Swanson (foundry10)

When students told us they wanted to learn about digital music production we were excited to explore how advanced technology could be used to empower creativity. We believed this class would be a huge hit, but we were wrong. It turned out to be far more difficult to engage students than we anticipated given the popularity of the subject among youth. We tried many different class formats and tools yet still failed to get consistent attendance and follow-through. When things worked, the outcomes were fantastic, so we kept at it and iterated on our approach. Today, we have used those hard lessons to build a program that is finally growing. As audio technology becomes more available, our goal is to share our mistakes to ensure that other educators can leverage what we learned and build programs that give students the power and access to be composers.

# Ignite Talks

## Sparking a Revolution in Teacher Education: The Birth of the CLinTE (Connected Learning in Teacher Education) Network

Kira Baker-Doyle (Arcadia University)

This Ignite Talk tells the story of how the Connected Learning in Teacher Education network grew from small side conversations in 2015 to a network of scholars across the country working to revolutionize teacher education to align with the connected learning principles in order to build greater equity and social justice in education. From joining together for virtual writing retreats, to designing collaborative course work that connects across multiple institutions, to curating scholarly work, the CLinTE network is on a mission to redefine and reenvision teacher education.

## A Rising Tide Lifts All Boats: What I Learned From Developers at 12 Design Studios

Barbara Chamberlin (New Mexico State University Learning Games Lab)

I investigated the models other studios use in developing educational games. I visited six studios and interviewed an additional six developers. It gave me perspective in comparing the different groups, and—more important—seeing the areas in which we are the same. *We say the same thing and mean different things:* Each studio uses similar terminology but uses different meanings, such as “beta,” “preproduction,” and “Agile.” It would help all of us if we could arrive at more similarities within. That means more discussion about our processes. *We think we each do it differently, but we do not:* Every studio I visited had the fear I would give away its secret sauce—because every studio believes it has the perfect process for moving from education goal to final developed product. However, the processes each studio went through were all very similar. That process can be learned, and taught. *We compete, but we are not each other’s competition:* We do not compete with each other for work that often: Our work often comes from established relationships or well-articulated grant proposals. Our competition is the idea that educational games should not be made. We can all work together to provide evidence to the contrary. *One thing makes us each better than the others:* So, what does make one project exceptionally good? It is that one thing. And the one thing was different for each studio. When we build this intuition, and share it with others, we improve our field.

https://youtu.be/47bFtw4-hew?t=1650

## Queering Up Games Through an Inclusive Game-Design Workshop

Jeremy Dietmeier (University of Iowa)

We are developing a curricular model for game-design workshops that help participants explore issues in the LGBT+ community around identity, inclusion, and artistic expression. We are going to queer up the gaming space with games that represent who we are and create the materials and resources necessary so other groups can do so as well. Attendees will walk away from this talk knowing more about the importance of representation and have ideas on how to start and run their own game-design workshop. From developers, to researchers, to consumers, we could all do a better job with representation in the games community and this talk will help highlight the issue and suggest one possible way to combat it.

## Data Science Education: A Gateway to Connected Learning

Chad Dorsey

Data science education is a gateway to connected learning as a production-centered and interest-driven approach to meaning making. With more and more people joining the movement every day, the Concord Consortium is fostering a unified community of researchers, practitioners, and developers interested in data science education so today's youth become tomorrow's data-savvy citizens.

## GGJ Next: A Global Game Jam for Children

Matthew Farber (University of Northern Colorado)

While the Global Game Jam has been successful in providing many benefits to its participants, it has been generally targeted toward the adult audience. With increased attention to both computer literacy and game-based learning, and initiatives such as Code.org that aim at computer literacy for children (and adults), the Global Game Jam launched Global Game Jam Next (GGJ NEXT)—game-creation challenges for young creators worldwide, ages 12–17, held July 2018. Approximately 800 youth from 20 countries participated throughout, learning technical skills and game design through making games. We mapped the learning outcomes to the curriculum and the expected learning outcomes that were the foundations of our curriculum development, including: (a) cognitive outcomes (such as logical thinking, problem solving, creativity, and vocabulary); (b) skill-based outcomes (STEAM skills including programming, math, physics, art, and design, and other skills such as research, planning, communication, and organization); and (c) affective outcomes (motivation, exploration, confidence, friendship, fun, etc.). This was embedded in GGJ NEXT's newly created curriculum allowing non-game developers to deliver workshops and educational material to be used by instructors before the event to prepare the youth participants for success in their own jam. Our hope was that this model of curriculum delivery could allow students anywhere to learn basic game-development skills (programming, art and design, storytelling, in combination with communication, collaboration, and planning), all infused with STEAM skills. Like the Global Game Jam, jammers shared a common theme. This year's theme was fractals, made in conjunction with the Fractal Foundation.

https://ggjnext.org

## The Hero of Your Own Story: A Crash Course in Live Action Role-Playing Games for Educators

Caitlin Feeley (MIT Education Arcade)

We talk a lot about the benefits of augmented or virtual reality—why not create an immersive game in actual reality? Live action role-playing games (LARPs) are role-playing games (RPGs) in which players physically act out their characters' actions. Instead of watching a protagonist on-screen, LARP players actually physically embody that character and make their own narrative choices. As a result, LARP is a highly motivating context for skill development. LARPers often find that they are more willing to pursue new knowledge in order to better portray their character—whether learning to play an instrument, running a small business, reading challenging books, or taking up running or martial arts. LARPers eagerly take on challenging tasks from decryption challenges and political negotiations to public speaking and project management. Combine opportunities for growth and engagement with a low-tech, adaptable nature, and LARPs are an ideal playground for creative educators.

https://www.youtube.com/watch?v=0xqDqZ2vVvc

## The Future of Immersive Storytelling: The Birth of a New Medium

Maya Georgieva (The New School)

As we move into a world of immersive technologies, how will virtual and augmented reality transform storytelling? In the traditional storytelling format, there is a narrative (linear) structure. However, in virtual reality, you are no longer the passive witness. As Chris Milk has said, "In the future, you will be the character. The story will happen to you." We are in the earliest stages of virtual reality as an art form. The exploration and experimentation with immersive environments is so new that new terms have been proposed for immersive storytelling. Abigail Posner, the head of strategic planning at Google Zoo, says that it totally "shatters" the storytelling experience and refers to it as "storyliving." At the Tribeca Film Festival, immersive stories are termed "Storyscapes." Immersive storytelling will be as Shakespeare once said: "All the world's a stage, and all the men and women merely players."

## Kaanbal Foundation: Enablement of Community WiFi Hotspots for Digital Education and Connectivity in Rural Areas Without Internet Access in the Mayan Region of Quintana Roo

Pedro Antonio González Martínez (Kaanbal Innovación Social A.C.)

In Mexico and all over the world there are thousands of rural communities where neither phone signal nor Internet access is an option. This is what millions of people face every day in places where they have to walk several miles or spend a lot of money just to move to the nearest Internet cafe. We decided to face this problem at Quintana Roo and the Yucatán Peninsula by creating Kaanbal Foundation. At Kaanbal, which means "to learn" in Mayan, we promote universal access to information for educational or productive purposes through the use of technology in places where the Internet is very limited or nonexistent.

## The Rise of Monitorial Citizenship

Erhardt Graeff (Franklin W. Olin College of Engineering)

Monitorial forms of civic engagement are on the rise, sparked by high levels of mistrust in governments and politicians around the world and access to technology that makes recording, organizing, and sharing information easier. We need to ask what this means for how we conceive of citizenship, the design of our civic tools, and the future of civic learning. This presentation introduces a new definition for monitorial citizenship, surveys exemplar technologies and practices, and calls us to action to design new technology and pedagogy. “Monitorial citizenship is a form of civic engagement in which people collect information about their surroundings or track issues of local or personal interest in order to improve their communities and pursue justice. Common activities of the monitorial citizen include collecting information, sharing stories and insights, coordinating with networks of other civic actors, and pursuing accountability for institutions and elite individuals and their perceived responsibilities” (Graeff 2018). Technologies that support monitorial citizenship have been used for a range of civic and political work from activism to participatory governance to disaster response. Educators and youth organizers play an important role in encouraging young people to develop monitorial skills, use these tools, and launch new projects.

https://erhardtgraeff.com/2018/08/01/the-rise-of-monitorial-citizenship/

## Affinitive PIES in *Overwatch:* Collaborative Knowledge Building in Beyond-Game Culture

Yu Jung Han (Warner School of Education, University of Rochester)

Beyond-game culture (Ryu, 2013), also known as game-related practices, has just begun to attract researchers’ attention. Beyond-game culture is defined as activities that gamers do in online communities to “enrich their game experiences, discuss game-related issues, and create fan-fictions, screenshots, or scenarios” (Ryu, 2013, p. 286). Many researchers, especially those in the education field, have focused on the learning potential of the beyond-game culture. In this Ignite session, I first present collaborative knowledge-building activities in the beyond-game culture around a team-based multiplayer online game, *Overwatch,* developed by the game company Blizzard Entertainment (2016). *Overwatch* has constantly added new characters and its online communities have been predicting new possible characters based on the fragmented information and clues that are hidden in the various artifacts (e.g., short animations). I have observed the communities’ reactions to the latest character, Moira, which was released in November 2017. The close analysis revealed that the communities accumulate knowledge on the new character through a knowledge-building cycle that requires a high level of critical and multiliteracy practices, collaboration, and cooperation. In addition, I found that the overall practices can be better identified when I combine the theory of affinity space (Gee, 2005) and principles of cooperative activities, also known as PIES: positive interdependence, individual accountability, equal participation, and simultaneous interaction (Kagan & Kagan, 2009). I conclude the session by discussing how these practices align with the principles of connected learning and how education can benefit from them.

## Connected Learning Environments: Coding and Making With *Minecraft*

Mirek Hancl (University Osnabrück)

Connected Learning Environments is an Ignite Talk on the project Coding and Making With *Minecraft* in the “Digitalwerkstatt,” an after-school club held by Mirek Hancl at Lessing-Gymnasium Uelzen, Germany. When Hancl’s students introduced him to the game back in 2012, he intuitively reframed *Minecraft* as a virtual learning environment to teach the whole class computer science and chemistry in multiplayer mode. To extend the possibilities of the virtual world and to foster the digital competences of his students and himself, Hancl implemented the mod RealRobots for *Minecraft* to create an interface between the game and real hardware such as Lego WeDo, Arduino Leonardo and RaspberryPi, and in particular Scratch from inside the sandbox game. His students use RealRobots to create innovative ideas for house automation, intruder alerts, traffic lights, and a lot more. Bringing the virtual and real worlds together does not only extend the possibilities in teaching. It prevents students from getting too heavily immersed in the game and motivates them to focus on the right balance between creating things in the virtual and real worlds simultaneously. Two vital characteristics of Coding and Making With *Minecraft* as a connected learning environment are a shared purpose in the after-school club and the shared practice through collaborative coding and making. The academic-oriented contents of the project, namely the field of computer science, are taught via stealth learning: Formal learning is achieved by a student-centered, action-oriented approach, in which the relationship between teacher and students is fundamentally different compared with teacher-centered methods.

http://www.hancl.de

## Make, Design, Compose: A Cautionary Tale

Kim Jaxon (California State University Chico)

This Ignite Talk offers provocations for make and design movements in education, asking “What counts as making? And whose making counts?” The talk begins with a cautionary tale from the field of composition studies, exploring comparisons between the writing across the curriculum movement in higher education and (troubling) connections to proposed courses in design thinking. Can we teach a course, in general, about design thinking apart from the disciplinary design problems we are trying to solve? Who teaches such a course? What would we imagine transfers? What will other faculty expect students to learn in these intro courses that will be useful in their disciplines? In my more cynical moments, I fear that we will create an introductory course—the equivalent of first-year composition—that quizzes students on the order of design thinking, as in: “Please place these phrases in the correct order: empathize, design, ideate, prototype, test.” We already do this with writing—brainstorm, outline, draft, revise, edit—and in doing so, we create an imaginary and unrealistic world in which writing becomes tidy, removed from the challenging, recursive process we know writing to be. We should pay attention to the ways in which design and making are woven throughout the disciplines, considering how making and design emerge from disciplinary problems. As we take this step toward design and making in schools, my hope is to call attention to the messy, recursive, and disciplinary ways we make and design.

https://youtu.be/47bFtw4-hew?t=4244

## Hacking Our Perception: MERGE-ing the Physical and Digital

Jeremy Kenisky (MERGE)

We are quickly moving into a world where digital and physical blur, and ultimately we will interact with both of these worlds simultaneously and seamlessly. What does that mean for interaction, learning, gaming, and how we live our lives in general? We will discuss how these lines blur and how different people are looking at solving these unique challenges, both technically and philosophically.

## City as Platform: Connecting Culture, Creativity, and Computing

Elizabeth Lawley (Rochester Institute of Technology)

In this talk, I will discuss the planning and delivery of a study abroad program for game design and development students. The full-semester program, held at a university in a historic European town that is also a major tourist destination, immersed students in a culturally rich environment and challenged them to put their game design and development skills to work in addressing challenges faced by the city. I will discuss the learning strategies I employed to engage students with the course materials, as well as with the city and its residents. I will also share stories about the students as they learned and grew throughout the semester, and I will demo the games that they developed as part of their studies.

## 42 Flavors Is the Answer

Danielle Martin (Foothill College)

How might I straddle informal and formal worlds of maker education? Is there a secret formula or equation or time cycle to devise a strategy for positioning this work … to define maker education in the educational environment in 2018? This Ignite Talk will swing through my monkey mind and land on the first six of 42 strategies!

## Learning-Record Store on Blockchain: A Glimpse Into the Future

Alexander Pfeiffer (Donau Universitaet Krems), Nikolaus Koenig (Donau Universitaet Krems), Thomas Wernbacher (Donau Universitaet Krems), & Lior Yaffe (Jelurida)

Academic credentials are difficult to validate. Especially when information is shared across different institutions or even countries, the academic community (and most other professional communities) relies more on trust than on strict and verifiable background checks: Usually, we submit copies of our diplomas, and the receiving institution will accept their validity without knowing for sure whether they have been tampered with or even forged altogether. Still, certain situations (such as high-level job applications) call for our academic achievements to not only be plausible and convincing, but objectively verifiable. Especially in light of digital reproduction possibilities, letterheads, signatures, or stamps have little evidentiary value, and even digital signatures (as they rely on governmental trust centers) cannot provide cross-border acceptance and verification of “digital originals.” Blockchain-based technologies—while still in their infancy—can provide a comprehensive solution by verifying both the institution and the learner globally and in a reliable and tamper-proof way. This, however, requires that the increasing number of (often private permissioned, centralized) blockchains is complemented by a decentralized intermediate, a modern mainchain-verification/childchain-storage system that gives learners/institutions control over their data, while at the same time providing secure storage and verification of credentials. A next step might be the reduction of human error, as digital interfaces reduce errors/interferences by tying test evaluations and data entry closer together—maybe reaching a point where serious games are used as assessment tools that immediately transform learning progress into meaningful blockchain entries, thereby constituting “digital game-based learning and assessment (‘DGBL/A’).”

## BLOCKCHAIN U.

David Preston (Santa Maria Joint Union High School District)

Over the past few years blockchain technology and cryptocurrency have commanded an increasing amount of speculative attention and investment that got us thinking about banking, money, and record keeping in general. Where does the blockchain provide value in educational records? Imagine the job interview candidate in 2027: Thanks for seeing me today. Everything I've ever done is in the ledger: See for yourself. It's been verified. Those institutions and mentors are rock solid. But those aren't badges. That's not Sony's platform. I own my data. It's my learning record. I may be a recent graduate, and you may not trust me any further than you can throw my résumé, but I don't take offense. People stopped trusting a long time ago. But I can do this job. Look at my grades trapped in digital amber. You don't have to trust me. But you will have to pay me.

## Teach Like a Game Master, Design Like a Teacher

Scott Price (BrainPOP)

The best teachers and the best tabletop role-playing game (RPG) "game masters" do many of the same things. Looking at education, or at game design for learning, in this way makes clear many good ideas and bad ideas for game-based learning. With a light heart, I will draw the parallel, and then I will challenge those in the audience to prepare their projects like they would prepare a good *D&D* campaign. After relating a personal anecdote that led me to realize that lesson planning and RPG design were similar, I will juxtapose points about good lesson planning with notes about how to be a good dungeon master, and vice versa. I conclude with the point that designing our games for learning in this way recognizes the parallel truth of good pedagogy and of fun game design.

## The Books We Need: The Learning in Large-Scale Environments Series From MIT Press

Justin Reich (Massachusetts Institute of Technology), Nichole Pinkard (Northwestern University), & Susan Buckley (Massachusetts Institute of Technology)

Learning across the lifespan is more important than ever, and increasingly learners of all ages—in formal and informal settings—are turning to online tools to help them develop new skills and knowledge. While some new online environments focus on expanding our understanding of how to integrate online tutorials, coaches, small seminars, and recommendations within traditional-size classrooms (e.g., 1:35), many new opportunities for learning attempt to examine these and other issues at very large scales. The field of large-scale learning refers to the study of networked environments with many learners and few experts to guide them.The editors of the new Learning in Large-Scale Environments series are soliciting proposals for books that investigate, critique, and explain these large-scale environments. In this presentation we will invite Connected Learning Summit participants to submit their very best ideas as manuscripts for the Learning in Large-Scale Environment Series from MIT Press.

## Where's the After-School Club for Teachers?

Maggie Ricci (Indiana University)

The literature is full of studies on after-school programs. Well-designed programs with effective mentors and well-thought-out goals can have positive effects on kids. We use phrases such as *building identities* as designers, as programmers, as peer mentors, and these experiences can be life changing for the students. They can be life changing for the teachers and mentors, too, but that is only a by-product of the programs. Why do the kids get all the fun? How come they get to build new identities as designers and programmers and all that stuff, but the teachers are still just teachers? I want to talk about a space, both physical and mental, where the teachers get to experiment, play, learn something new, and do stuff for the sake of learning, whether it is strictly applicable to what they are teaching or not. Is this professional development? Of course, but please do not call it that. Maybe they will actually come.

## Don't Change the Player. Change the Game!

Doris Rusch (DePaul University)

Lessons learned from clinical mental health counseling for the design of mental health games.

## Using Citizen Science to Connect Learners Across the Globe

Leonora Shell (North Carolina Museum of Natural Sciences)

As an undergraduate in California I was afraid of being weeded out of my pre-med classes to an unknown place. But then I stumbled upon a class that changed everything: Introduction to Entomology. Suddenly these animals that everyone seemed to fear were the source of great inspiration to me. I started to appreciate (and obsess over) their beauty and I wanted to tell everyone. I help to take science out of the lab and ignite the potential of citizen scientists working together to contribute to the body of knowledge that is science. For the past five years I have been the curator of digital media to help educators bring citizen science into their classrooms so scientists can reach the people who need it most: bored middle school students. Through citizen science we can put into practice ways to combat fear with curiosity by connecting educators, scientists, and the public.

## Wrestling With Manga as Literacy: Youth Conversations on Fighting Games and Reading

M. Kristana Textor (University of Rochester) & Lynn Gatto (University of Rochester)

Professional wrestling and manga comics might not be what first come to mind when considering how students approach literacy. However, for one group of urban youth, connections to the drama, backstory, and alignment of characters from these forms of popular culture seem to be leading to deeper engagement with reading. This Ignite presentation will share findings from a qualitative research project intended to investigate youth interactions with an educational video game. The tangential conversations sparked by a fighting game mechanic reveal that these fifth- and sixth-grade children hold a detailed subject knowledge of manga comics and professional wrestling and are deeply engaged with narrative in play. How the peer-supported, interest-powered content of these conversations might be leveraged to make learning and literacy more relevant to youth will be a question for the audience to ponder.

## Can We DISGUISE Learning to Create a SPECIAL FX for Our Students?

Rich Thompson (The Dome)

At YOUmedia Springfield, we operate with the process of HOMAGO (hang out, mess around, and geek out). We serve approximately 13,000 high school students annually, and it is our goal to move them from coming to hang out to higher levels of engagement. We saw a gap in engagement with different groups within our space, particularly our female demographic. Through conversation and conferencing, we developed a successful Special FX Makeup and Cosplay workshop to engage a wide range of students within our space. We look to bring these skills and curriculum to the Summit for a hands-on exploration of how this program can work in a learning space.

## I'm a Recycled Teenager. Challenging Assumptions About Who Lives in Virtual Worlds and What They Do

Yen Verhoeven (University of Rochester)

This Ignite Talk explores and challenges the generational assumptions about users in virtual worlds and what they do. For this presentation, I share vignettes from a community of youth-ful people from Second Life who consider themselves "recycled teenagers" in a digital place where, obviously, age does not matter.

# Spotlights

## Designing Biomimetic Robots in Middle School

Debra Bernstein (TERC), Gillian Puttick (TERC), Kristen Wendell (Tufts University), Fayette Shaw (Tufts University), Ethan Danahy (Tufts University), & Michael Cassidy (TERC)

The goal of Designing Biomimetic Robots is to develop and study an education program that integrates science, engineering, and computing by engaging students in biomimicry design challenges. Middle school students study how animals and plants accomplish different tasks and engineer a robot inspired by what they learned. Our design goal is to create an interdisciplinary learning environment for students. This submission describes the project's design conjectures (Sandoval, 2014), including the embodiments and mediating processes that guide our design work. We also describe some persistent design challenges we are confronting, including: (a) How can we maximize possibilities for student agency and creativity while providing sufficient constraints and support materials? (b) How can we maximize biomimetic elements in the engineering solution? (c) How can student documentation support engineering practice and interdisciplinary thinking? This material is based upon work supported by the National Science Foundation (NSF) under Grant 1742127. Any opinions or findings expressed are those of the authors and do not reflect the views of the NSF.

## Choose Your Own Adventure: Virtual Exchange and Connecting Youth Across Borders

Sarah Bever (IREX)

In this hands-on, collaborative workshop, the Stevens Initiative and IREX will lead a discussion on the building blocks of virtual exchange. Our workshop will use interactive learning to explore the problem of increasing access to global communication and technology literacy for youth from underresourced backgrounds. Virtual exchange—defined as online, international, collaborative learning—can extend access to opportunities for young people to develop essential skills for the global economy when factors such as time, money, and location were once prohibitive.Inclusion in the global economy is essential for stable societies, and increasingly the global job market requires workers to be culturally competent, which includes skills in cross-cultural collaboration, technology, and creativity and problem solving.

## The Aquarius Project: Using Narrative and Hands-On Science to Drive Youth Innovation

Chris Bresky (Adler Planetarium)

February 6, 2017, 1:26 a.m., a meteor traveling at 38,000 miles an hour entered the atmosphere above Wisconsin. Weather radar spotted the end of its journey as it splashed into Lake Michigan. Little is known about the lake bottom in this region. It is this combination of knowns and unknowns that inspired high school students and science professionals from across Chicago to mount The Aquarius Project. This multidisciplinary endeavor is the first student-driven attempt at underwater meteorite retrieval. The project's main goal is to provide students a chance to work hand in hand with scientists across disciplines in authentic research. Teens from Chicago Public Schools have the opportunity to collaborate with scientists from NASA, cosmochemists and meteoritics experts from The Field Museum, marine biologists from the Shedd Aquarium and NOAA, and engineers and astronomers from the Adler Planetarium. The project has inspired more than 600 students across Chicago to participate in the hunt for submerged meteorites. Last fall, 50 Chicago students engineered environmental sensors, a magnetic bilge pump retrieval sled mount, and an outfitted meteorite retrieval ROV. In the spring, Adler Planetarium's Far Horizons spring interns worked with NOAA researchers as the scientists mapped the lake bed of the strewn field with sonar and magnetometers. This past summer, Aquarius Project student participants traveled to Wisconsin to deploy their equipment in Lake Michigan. The sled was successful in retrieving ferromagnetic content from the lake bed. The content is being analyzed by students and scientists to identify possible meteorites.

https://docs.google.com/presentation/d/1nuDnY5zrTEo6eJlsQ50FQ3O4mWFKZF8X-kfkPlSGg7Q/edit?usp=sharing

## OpenLearning '17 and '18: Connected Learning as Faculty Development

Gardner Campbell (Virginia Commonwealth University) & Sue Erickson (Virginia Wesleyan University)

This presentation discussed the origin, development, and implementation of the Open Learning connectivist massive open online courses (MOOCs) offered in Virginia in 2017 and 2018. The project began as a Faculty Collaboratives initiative, sponsored by the Association of American Colleges and Universities (AAC&U), with project administration supplied by the State Council of Higher Education for Virginia (SCHEV). The project sought to create sustainable networks for professional development related to the AAC&U's "Liberal Education and America's Promise" (LEAP) signature program. This presentation highlighted lessons learned and encouraged discussion of how national organizations, state government, and both private and public institutions of higher learning might collaborate to create connected learning platforms for professional development. The pedagogical design principles for this learning experience were discussed in detail, particularly the principle that to understand connected learning, one must practice connected learning. The presentation discussed the strategically chosen technologies used during the cMOOC and emphasized the importance of the openly networked aspects of the course. The site architecture was explained, including page layouts, blog syndication (via RSS and the FeedWordPress plugin), hypothes.is pages, and a Twitter syndication widget. Twitter TagsExplorer, a free, open-source affordance for visualizing Twitter activity for each learner as well as the entire network, was demonstrated. A personal story of a learner's journey from "novice to node" was shared. Audience members responded to open-ended questions about what OpenLearning '19 could look like and how professional development in a connected learning environment could be sustainable, especially after initial grant money runs out.

http://openlearninghub.net

## Making in Schools: Envisioning and Sustaining Making in Learning

Stephanie Chang (Maker Ed), Lisa Brahms (Children's Museum of Pittsburgh), & Lauren Penney (Maker Ed)

In 2016, the Children's Museum of Pittsburgh and Maker Ed joined to create Making Spaces: Expanding Making in Schools Across the Nation, which aims to develop a national strategy to sustainably integrate making into schools across the country. The Making Spaces program employs an innovative model in which a regional hub (such as a school district, library, museum, or community organization) works closely with 5–10 local schools to help jump-start and sustain maker education in classrooms through fund-raising, professional development, and community engagement. An accompanying tool kit of resources supports hubs and schools during their two years of planning and implementation. Through three-plus years of effort, we have seen hubs increase their capacity to serve as regional leaders, thought-partner on challenges that influence the state of maker education, and develop programs in their communities that are unique, sustainable, impactful, and equitable. In the Connected Learning Summit's facilitated hands-on workshop, participants leveraged two of the tools—focused on visioning and evaluating the "parts and pieces" of a makerspace or maker program—to create concise, vibrant, and compelling visions for their maker-centered learning efforts, spaces, and culture. The resources and tools are intended to support sites to reflect upon the "why" and "how" of maker-centered learning and think critically about their intentions and practices in order to plan and implement approaches that are authentic and accessible to their audiences.

http://makered.org/making-spaces

## "Help Us Get Rid of Surveys": Emerging Findings From Capturing Connected Learning in Libraries

Josephina Chang-Order (University of Colorado Boulder), Bill Penuel (University of Colorado Boulder), Katie Van Horne (University of Colorado Boulder), & Timothy Podkul (SRI Education)

The Capturing Connected Learning in Libraries project addresses the urgent national need for evaluation approaches that reflect new emphases on digital, networked, and production-centered content, spaces, and programming. Libraries need evaluation resources that help develop their connected learning programming and document critical outcomes for youth participants. We have developed and tested instruments that can be used for improving services and demonstrating their value. In this session, we will share findings from two library evaluations and discuss how "talk-back boards" have been embraced and adapted to assess connected learning principles, outcomes, and data collected vis-à-vis these tools. For example, preliminary data from one library indicate many of its patrons are brokered into the makerspace by others, and that they come to "hang out" and "mess around." We will also discuss how this library developed staff capacity for supporting production-centered principles.

## A New Approach to Family Engagement

Courtney Dastis-Galvin (PowerMyLearning) & Elisabeth Stock (PowerMyLearning)

Research shows that students with engaged families are more likely to do better in school, especially when families are engaging in learning activities at home. A variety of approaches seek to improve learning interactions at home, yet many are based on teacher reminders to families or giving families access to grade books, putting parents in the role of a “compliance officer” with their children. National nonprofit PowerMyLearning recently piloted a new approach called Family Playlists that involves families in what their children are learning in school (not as “naggers” but as partners). Family Playlists are interactive homework assignments built on the evidence base from the Johns Hopkins Teachers Involving Parents in Schoolwork program. They are designed to break down technology and language barriers. The pilot transformed family engagement at a high-poverty school in New York. Given these promising results, PowerMyLearning has begun to make Family Playlists more widely available.

## How Principles of Play Can Transform Your Research Practice

Mindy Faber (Columbia College Chicago) & Matt Mateus (Spy Hop)

Play is a powerful means for youth to engage in problem solving, sense making, and learning. But can researchers and practitioners also apply principles of playfulness to the process of evaluation and assessment? This Spotlight features five gamelike ways that Convergence Design Lab/Columbia College (Chicago) and Spy Hop (Salt Lake City), a digital media education organization, are conducting participatory action research for assessment, evaluation, and audience-impact storytelling. Civic Imagination Bingo, Re-capture the Flag, Mentor Identity Hats, Data Therapy, and Map Your Journey are fun, dynamic, and tested strategies that empower youth media organizations to conduct rigorous evaluation and capture and share their impact story with multiple communities. Presenters will invite participants to join in the play and participate in all the activities.

## Stitching the Loop Curriculum: Making Electronic Textiles in Exploring Computer Science Classrooms

Deborah Fields (Utah State University), Yasmin Kafai (University of Pennsylvania), Debora Lui (University of Pennsylvania), Tomoko Nakajima (University of California Los Angeles), Joanna Goode (University of Oregon), & Jane Margolis (University of California Los Angeles)

In order to broaden access to both making and coding, deepen learning in those fields, and promote better diversity in what is being made, we created and implemented an eight-week-long formal curricular unit, Stitching the Loop, which facilitated students’ interest-driven projects, supported peer collaboration, and provided equity-minded teaching. Our electronic textiles (e-textiles) curriculum was situated within Exploring Computer Science (ECS), an equity-focused and inquiry-based yearlong introductory computer science course taught in public high school classrooms all over the country. We concentrated on bringing creative making in the form of electronic textiles into computer science classrooms. Consciously combining traditionally masculine activities such as engineering and computing with traditionally feminine activities such as crafting and sewing disrupts preconceptions about who can do computing, engineering, and crafting. With this background, we brought together experts in e-textiles educational activities and the ECS development and implementation team. The curriculum was codeveloped to combine best practices of teaching and crafting e-textiles based on a constructionist philosophy alongside ECS principles (inquiry, equity, and computing) and style. It was piloted for three years with a total of 15 public school teachers. The Stitching the Loop curriculum contains big ideas and recommended lesson plans, with room for teachers to interpret and bring in their own style. It is accompanied by a 60-plus–page technical guide that includes fine-grained details about crafting, circuit design, and coding, and it also includes a number of pictures of students' actual designs for each project.

http://www.exploringcs.org/e-textiles

## Ready to Learn With Twin Cities PBS: Science and Literacy Digital Playlists for K–2 Learners

Joan Freese (Twin Cities PBS), Momoko Hayakawa (Twin Cities PBS), & Dennis Ramirez (Twin Cities PBS)

The Twin Cities PBS Ready to Learn project is a broad and engaging educational media initiative focused on early learning for elementary school children and their families. Funded by a cooperative agreement with the United States Department of Education, the program aims to improve the school readiness and academic achievement in science and literacy of children in grades K–2 nationwide. Project content centers on an innovative learning platform featuring thematic playlists comprising animated segments from *Hero Elementary,* a new PBS Kids television series (available in English and Spanish); complementary live-action videos; digital games, hands-on activities; nonfiction e-books; a digital science notebook for student writing and drawing; and embedded learning analytics and assessment dashboards (and hero-themed badging system) that provide feedback to learners, educators, and parents. This approach integrates science and literacy to ignite children's natural curiosity, engage them as scientists and communicators, and broaden their understanding of how the world works—specifically in life, earth, and physical science. Our extensive outreach effort supports program dissemination nationally, engaging children in tech-integrated informal science learning at libraries, Hispanic-serving organizations, after-school providers, and community-based organizations. Blended professional-development workshops prepare educators for effective implementation in their communities. Parent engagement centers on a Family Science App, which encourages collaborative play between children and their parents. Developed using co-design methods, the Family Science App enhances science and literacy learning for children by involving the whole family. Two playlists (including digital games), the learning platform, and the Family Science App were shared.

## SciGirls Code: Connected Learning for Middle School Girls in Out of School Time

Joan Freese (Twin Cities PBS), Cassandra Scharber (Learning Technologies Media Lab, University of Minnesota), & Karen Peterson (National Girls Collaborative Project)

Funded by the National Science Foundation Grant No. #1543209, SciGirls Code is a pilot program that uses the principles of connected learning with 16 STEM national outreach partners to provide 160 girls and their 32 leaders with computational thinking and coding skills. Women remain significantly underrepresented in the STEM workforce within the United States, particularly computer science. Women constitute only 25% of the computing workforce despite its being the STEM area with the most demand (Pew Research Center, 2018). Starting early with interventions that introduce girls to computer science in elementary and middle school can help increase interest in computer science; cultivating early interest is paramount because interest in STEM fields in high school, rather than achievement in these areas, is more closely associated with pursuit of careers in computer science (Corbett & Hill, 2015). Project implementation occurred between September 2017 and May 2018 and included a nine-month curriculum with three strands (Mobile Apps, Robotics, E-Textiles); role-model training for female technology professionals; professional development for STEM educators; and a research component that investigated the ways computational learning experiences impact the development of computational thinking, computational participation, as well as interest and attitudes toward computer science. SciGirls Code will serve as a model for supporting girls' pursuit of computer science in Out of School Time and is collaboration between Twin Cities PBS (TPT), the National Girls Collaborative Project (NGCP), and the University of Minnesota.

http://stemforall2018.videohall.com/presentations/1105

## Learning Creative Learning: How We Keep Tinkering With MOOCs

Lily Gabaree (MIT Media Lab), Yumiko Murai (MIT Media Lab), Carmelo Presicce (MIT Media Lab), & Moran Tsur (MIT Media Lab)

Learning Creative Learning (LCL) is a free online course designed to share principles and strategies on how to engage people in creative learning experiences, that is, working on projects that they are passionate about, in collaboration with peers, within a playful environment that encourages experimentation. The latest edition of the course started in October 2018 and attracted overall 15,000 participants from around the world (as of November 2018). Although LCL is organized and presented as a six-week online course, its ultimate goal is to cultivate an ongoing learning community in support of creative learning around the world. Having a structure while letting participants explore on their own pace is not easy. Through our two past editions of the course in 2013 and 2014, we identified three design tensions to achieve this goal. The first tension was to offer a structured course while allowing a community to develop. The second tension was to support multiple pathways but at the same time provide a shared experience among the course community. The final tension was to support the global community to grow while encouraging participants to engage in the local communities. This Spotlight presentation described the design choices that we made in the latest edition as a way to negotiate those tensions. In addition, we share some ideas for future directions.

http://lcl.media.mit.edu

## *Factitious:* Iterative Design, Fake News, and Games as Polling Systems

Lindsay Grace (University of Miami), Bob Hone (American University), & Maggie Farley (American University)

*Factitious* is a game designed as both a polling system and playful education tool. In the game, simply described as Tinder for news, players must swipe a news article left or right if they think the article is real news or fake news. In the original 2016 version of the game, only 162 players engaged in the game. In its redesign for 2017, more than 1.6 million plays were recorded in the first three days it was released. While most players simply engage in the front-end play experience, this open-source platform works to do basic A/B testing and polling. The back end of *Factitious* records each session's answers, time for engagement, and other attributes that prove useful for assessing how people understood the content. The *Factitious* team can not only report how many of the 50,000 players in a given week thought the article about a weasel shutting down the world's largest particle collider is real or not (it is), the team can also tell you how many milliseconds the average person took to make his or her judgement, how often he or she needed a hint to determine so, and fundamental demographics about respondents. This Spotlight illuminates the design process, design goals, and heuristics for launching the relatively successful, low-budget project as part of the Knight-funded Jolt initiative. The game can be played at http://factitious.augamestudio.com/

http://factitious.augamestudio.com/

## A-Pops: Transforming Urban Spaces Into Learner-Directed Playful Learning Environments

Jennifer Groff (MIT Media Lab), Thomas Sanchez (MIT Media Lab), Leticia Lozano (Laboratorio para la Ciudad), Guillermo Bernal (MIT Media Lab), & Mina Soltangheis (MIT Media Lab)

A-pops is a networked learning experience that transforms urban spaces into playful and collaborative learning environments that give learners agency of their learning experience and the space itself. A collaboration between the MIT Media Lab and Laboratorio para la Cuidad, the first installation was piloted in Mexico City in December 2017. A-pops supports young learners in engaging in emergent and playful opportunities in and beyond their local communities. Popular and underused city spaces are embedded with technologies that allow learners to take agency over the space and collaboratively explore the space's potential while building their understanding in key domains, such as computational thinking. In a central square in the city, the circular fountain is a delightful feature of the space and very popular with local young people. With existing embedded colorful LEDs, the fountain activates intermittently throughout the day and plays in a random pattern. We installed pads with pressure sensors in blocks of the outer ring, each of which corresponds to basic programming commands, and then programmed the fountain to respond to these pressure pads, allowing users to program a sequence by jumping on the pads and then "playing" the sequence back. Individuals can play with the command blocks to program the fountain to play back simple patterns, or groups of players can explore how to work together to create patterns collaboratively. Their natural play in the space can be transformed into active agency over the experience; this installation promotes discovery through play, collaboration, design, logic skills, and communication.

https://www.media.mit.edu/posts/update-Dec2017/

## Using NGSS to Design Educational Games for Multiple Grade Levels

Momoko Hayakawa (Twin Cities PBS), Dennis Ramirez (Twin Cities PBS), Joan Freese (Twin Cities PBS), Laura Beukema (Twin Cities PBS), & Beth Daniels (Twin Cities PBS)

While kindergarten and first-grade children may be able to identify a location on a map (DeLoache, 1991), they may not understand abstract symbols, large numbers of symbols, or complexity of symbols (Mohan & Mohan, 2013). This becomes a problem when designing an educational game that targets multiple grades. In our study, we describe the development of an educational game aligned to second-grade Next Generation Science Standard (NGSS) content that is developmentally appropriate, and engaging, for multiple grades. To identify problematic aspects of our design that may result from designing for multiple grades, we conducted user tests with paper and digital prototypes during preproduction. Simultaneously, cognitive task analysis provided an approximation of the developmental appropriateness for young learners. The result of these tests was a NGSS-aligned cooperative game, in which players take turns identifying the location of an elephant on a map, using symbolic representations of items as clues. Pairs of kindergarten–second graders (*N* = 34) played through the game until they failed a level objective. Data were collected through researcher observation and telemetry data. Although the content is second grade, kindergartners were able to complete most of the game. Since first and second graders easily finished all available levels, there is concern that the game is not sufficiently challenging. However, levels in development will also introduce concepts of relative location and relative size—concepts expected to be challenging for younger learners. Future telemetry testing will inform the effectiveness of these additions.

## FemTechSonic: Playlists of Global Collaboration and Connected Learning

George Hoagland (Minneapolis College of Art & Design), Alexandrina Agloro (Arizona State University), Anne Cong-Huyen (University of Michigan), Kristy H. A. Kang (Nanyang Technological University), Veronica Paredes (University of California Los Angeles), & Hong-an Wu (University of Texas Dallas)

FemTechSonic is an online multimodal plug-and-play pedagogical platform with iterative playlists for collaborative critical making and mapping of media. Our vision for this developing work represents our own system of global collaboration and connected learning that serves lineages of intersectional feminists, technologists, teachers, and learners in a variety of learning environments that include universities, community organizations, youth centers, adult education, and others. The first set of playlist themes addresses concerns surrounding “Games,” “Sound,” and “Location.” Each playlist contains a media piece (podcast, digital game, or other media), links to readings, discussion questions, and an activity, such as cooking recipes and dance videos. These playlists act as invitations for learners to create and share their own critical making responses to curated materials on our platform.

http://mediamaplab.com

## Let Me Help You Learn From My Meal: User-Generated Meal Photos as a Benchmark for Nutritional Estimation

Maria Hwang (Columbia University Medical Center) & Lena Mamykina (Columbia University)

Healthy eating often depends on individuals’ nutritional knowledge and their ability to quickly gauge the nutritional composition of meals. However, both of these tasks present considerable challenges, and computing tools meant to assist in these tasks continue to be cumbersome and labor intensive. In a pilot study, we investigated the potential of promoting nutritional literacy with social computing platforms by helping individuals compare their own meals with meals captured by others. We compared this holistic comparison approach with a more traditional method that requires mental decomposition of a meal into ingredients and estimating their portion sizes in a controlled experiment with crowd workers on Amazon Mechanical Turk. Based on the results of this study, we have identified new approaches for incorporating socially generated data, crowdsourced evaluations, and gameful components into smartphone apps to increase engagement and fun.

## Look at the Stars: Integrating a User-Centered Design Process Into a Natural History Museum

Barry Joseph (American Museum of Natural History)

How do you take a 19th-century institution—such as, say, a natural history museum—into the 21st century? At the American Museum of Natural History, one approach was to develop an internal skunk works to tackle how to bring the digital specimens produced and studied by museum scientists to the public through new digital interactives. Using virtual reality (VR), augmented reality (AR), and more, we developed prototypes and tested them with more than 1,000 visitors to identify challenges and opportunities for the museum visit of the future. Virtual weevils and sharks cavorted with augmented constellations and moonscapes. Come learn how we developed the process and what we learned along the way.

## Educator Connected Learning via Collaborative Web Annotation

Jeremiah Kalir (University of Colorado Denver), Christina Cantrill (National Writing Project), Francisco Perez (University of Colorado Denver), Jeremy Dean (Hypothesis), & Joe Dillon (Aurora Public Schools)

This Spotlight describes a multi-stakeholder partnership that supports educator connected learning via open and collaborative web annotation. The Marginal Syllabus convenes and sustains conversations with K–12 classroom teachers, higher education faculty, and other educators about equity in education using the open and collaborative web annotation technology Hypothesis. The project's name, design, and learning opportunities are intentional references to multiple interpretations of the word *marginal*. First, the Marginal Syllabus partners with authors whose writing is contrary to dominant education norms. In other words, participating educators engage with authors' original and marginal perspectives on schooling and learning. Second, the project hosts and curates publicly accessible conversations among educators that occur in the margins of online texts using open and collaborative web annotation. The Marginal Syllabus creates marginal online spaces for discussion. And third, the effort supports educator collaboration using Hypothesis, an open-source web annotation technology developed by the eponymous nonprofit organization. This tool is marginal to commercial educational technology. The Marginal Syllabus understands that open and collaborative web annotation is an everyday media practice. Since 2016, the initiative has created a geeky book club for educators eager to discuss educational equity. The texts educators read are equity-oriented counternarratives to the educational status quo. And the tools educators use for collaboration open up marginal discursive spaces for professionally relevant conversations that are more substantive and participatory than those typically found on social media. The Spotlight featured stakeholders discussing the project's development, design principles, and plans for Marginal Syllabus conversations during the 2018–2019 academic year.

http://marginalsyllab.us/

## Digital Fabrication in Elementary Schools

Todd Keruskin (Elizabeth Forward School District) & Mary Carole Perry (Elizabeth Forward School District)

In this session, the audience will learn about Elizabeth Forward School District's (K–12 public school district in Elizabeth, PA) K–12 digital fabrication curriculum, K–5 design challenges, and what software and hardware are appropriate for K–5 students in an elementary FABLab. This session will also explore professional-development approaches for elementary teachers and principals on how to implement digital fabrication in an elementary school, how to teach design thinking to K–5 students, and how to teach growth mind-set to K–5 students to help create a FABLab in an elementary school.

## Empowering Girls: The Intersection of Design Thinking and STEAM Activities

Rie Kijima (Stanford University) & Marcos Sadao Maekawa (Keio Graduate School of Media Design)

Empowering girls in Japan is not an easy task. While other countries have implemented various efforts to promote girls' education, Japan has made little progress in improving the status of women. According to the World Economic Forum, Japan ranks 114th out of 144 countries in gender equality. To address this issue, we devised an educational intervention to empower the next generation of girls by employing design thinking to ignite their interests in science, technology, engineering, arts, and mathematics (STEAM) fields. In this session, we share preliminary results from our study. Our study reveals that the girl participants showed a greater sense of interest in STEAM fields, increased levels of creative confidence, exhibited greater empathy, and had greater appreciation for collaboration. This study has strong implications on future educational interventions by highlighting the opportunities for using design thinking to encourage girls to become more interested in STEAM fields.

## GeoConvos: Exploring Embodiment in Connected Learning

Virginia Killian Lund (University of Illinois Chicago), Nathan Phillips (University of Illinois Chicago), David Bild (Chicago Academy of Sciences / Peggy Notebaert Nature Museum), Ilana Bruton (Chicago History Museum), Ani Schmidt (Chicago History Museum), Jaclyn Carmichael (Project Exploration), & Emma Martell (Lincoln Park Zoo)

In this session, we propose to engage session participants in exploring the interrelationships between connected learning and embodied learning through interactive engagements in GeoConvos—place-based activities we have developed over the last four years. During and after engaging in these activities, session attendees will critically reflect on their own participation and on ways they can implement these activities in teaching and learning in their own connected learning contexts. End-of-session reflection will focus on better understanding embodied learning in the design, implementation, and assessment of connected learning environments.

## Music "Making" to Advance STEAM Learning

Youngmoo Kim (Drexel University ExCITe Center) & Brandon Morton (Drexel University ExCITe Center)

At the Expressive & Creative Interaction Technologies (ExCITe) Center at Drexel University, we have developed a portfolio of STEAM (STEM and Arts and Design) research and education projects at the forefront of music technology, particularly involving novel actuated and robotic instruments. Celebrating its 12th year in 2018, the Summer Music Technology Program (SMT) is a one-week experience for rising high school freshmen and sophomores. SMT participants pursue individual projects, including a "maker" option to create an autonomous musical instrument controlled with Arduino microcontrollers (e.g., robot drumsticks, self-playing guitars, and autonomous xylophones). These instruments are used in a music performance at week's end. After the success of these projects, we incorporated similar concepts into a nine-week course for students of the Science Leadership Academy Middle School (SLA-MS), an inquiry-driven learning school serving residents of the West Philadelphia Promise Zone (a federal initiative to help support neighborhoods facing persistent challenges involving poverty). The course, though more structured than the high school version, still emphasizes learning through making and creating. Initially, students use K'nex pieces to develop simple structures to strike percussion instruments, with the ultimate goal being a freestanding instrument with mechanically sound support structures. Each session, they explore how to incorporate different electronic controls, sensors, and actuators using littleBits, allowing for rapid prototyping. In developing their creations, students are encouraged to generate their own ideas, and some students advance to more sophisticated control using the Arduino platform. We presented our data on learning outcomes at the end of the course.

https://drexel.edu/excite/

## When Inquiry Meets Making: Demystifying Inquiry-Based Making Using Guided Inquiry Design

Kyungwon Koh (The University of Illinois School of Information Sciences), Xun Ge (University of Oklahoma College of Education), Kathryn Lewis (Norman Public Schools), Shirley Simmons (Norman Public Schools), Lee Nelson (Norman Public Schools), & Janessa Doucette-Frederickson (Norman Public Schools)

Learning in Libraries: Guided Inquiry Making and Learning in School Libraries is a three-year design-based research project in collaboration between K–12 school administrators, school librarians, classroom teachers, and university researchers from library and information sciences and learning science, funded by the Institute of Museum and Library Services. The project aims to develop a replicable model of inquiry-based making in K–12 standard-based curricula and assess the learning outcomes. Inquiry and maker learning are two powerful approaches to connected learning, in which students actively engage, create, and solve problems around personal interests with the support of peers and adults. Our hypothesis is that guided-inquiry instructions coupled with maker learning may have the capacity to increase student interest, learning, self-regulation, and engagement. This project focuses on specific types of inquiry and making—Guided Inquiry Design (GID) and inquiry-based making, because we identify they are among the most suitable approaches to enabling interest-based learning while still meeting the need of standard-based curricula in public schools. Efforts have been made to integrate the strengths of GID and making into curriculum units. We find that GID's scaffolding tools and facilitation techniques have a potential to inform educators who wish to better guide students' making processes, beyond providing technology tools and spaces. Also, maker mind-sets and approaches, such as hands-on activities, use of technology for a deeper inquiry, iterative and flexible processes, and student-driven initiatives and community engagement, can augment the full potential of inquiry.

https://sites.google.com/norman.k12.ok.us/learninginlibraries/home?authuser=0

## Voyage: A Collaborative Classroom-Scale Virtual Reality Experience

Julian Korzeniowsky (Carnegie Mellon University), Jessica Hammer (Carnegie Mellon University), Sharan Shodhan (Carnegie Mellon University), Sijia He (Carnegie Mellon University), Rajeev Mukundan (Carnegie Mellon University), Na-yeon Kim (Carnegie Mellon University), Heather Kelley (Carnegie Mellon University), & Scott Stevens (Carnegie Mellon University)

Voyage is about using collaborative mobile virtual reality (VR) to bring a virtual field trip to the classroom. We talk about our process in designing a multiplayer, educational, VR experience, the questions we were trying to solve, and lessons that we learned from building it.

## Educative Maker Activity Materials for Small-Town Librarians to Support Connected Learning

Victor Lee (Utah State University), Mimi Recker (Utah State University), Abigail Phillips (Utah State University), & Aubrey Rogowski (Utah State University)

Education settings are increasingly aware of the importance of integrating *making* and *connected learning* activities. Yet images of how these terms would translate for practice in small and rural library settings has been lacking. In response, we have been working for the past two years with public and school libraries to codevelop maker-oriented programs for small town and rural youth. This Spotlight shares findings obtained from observations and interviews across four middle school libraries and two public community libraries in a largely rural region and presents a set of educative program materials we have developed and iteratively refined in those library settings. This involves the creation of visual guide materials that could convey what kinds of creative maker activities were possible, what were essential steps for getting started, and how such an activity could be organized and structured for different library settings.

## Using Tablet Apps and Hands-On Activities to Explore Preschoolers' Computational Thinking

Mollie Levin (WGBH Educational Foundation), Heather Lavigne (Education Development Center), Jillian Orr (WGBH Educational Foundation), & Marisa Wolsky (WGBH Educational Foundation)

Developing computational thinking (CT) skills from a young age is critical for improved achievements in STEM, literacy, and other disciplines. Despite increasing calls to integrate CT into early childhood education, very little is known about children's CT learning and how best to integrate CT activities into a preschool classroom. Research, however, does suggest that embedding CT in basic math instruction could create powerful learning experiences. Public media producers from WGBH and Kentucky Educational Television and researchers from the Education Development Center (EDC) have teamed up to explore young children's CT learning and preschool teachers' CT understanding as they engage with playful prototype hands-on activities and digital tablet apps. The prototypes were developed in stages, with iterations tested and discussed with teachers during monthly visits to rural and urban preschools. After each visit, researchers analyzed classroom observation notes and identified promising practices and areas for improvement for each of the prototypes tested. At the conclusion of the project, the team will have developed 12 hands-on activities and three digital app prototypes, all of which leverage a charming group of monkey characters from WGBH's new media property *Monkeying Around* (working title). These prototypes focus on supporting children's CT skills in sequencing, debugging, and modularity. This Spotlight will walk attendees through the exploratory research and development process: what was learned during prototyping and how these research findings informed the continual development of prototypes that promote the underinvestigated area of preschoolers' CT.

## Breaking Barriers at the Adler Planetarium: Bridging Museums and Working-Class Neighborhoods of Color

Rosalía Lugo (Adler Planetarium)

The Adler Planetarium in Chicago works with high school youth out to one of the neighborhoods in Little Village, known as the "Mexico of the Midwest." A STEM civic action program was created to empower high school youth to advocate within their community about an environmental issue, light pollution.

https://www.adlerplanetarium.org/teen-opportunities/

## *Mission Admission:* The Evolution of a Digital College Access Initiative at the School Level

Tattiya Maruco (University of Southern California) & Zoe Corwin (University of Southern California)

Over the past two decades, the Pullias Center for Higher Education at the University of Southern California has conducted research on college access and success. In response to a desire to scale up our outreach efforts and create a dynamic, interactive space for engaging in college preparation, in 2009 our team of researchers partnered with designers from USC's Game Innovation Lab to create a series of games. For the past three years, we have been engaged in research to bring one particular game, *Mission: Admission,* to scale in California. Following up on our 2016 and 2017 Digital Media and Learning Conference presentations, presenters will highlight the evolution of the *Mission: Admission Challenge*, illustrating the tension that exists between (a) standardization and customization, (b) scalability and sustainability, and (c) assumptions and the reality of implementing a schoolwide digital intervention.

## Designing a Better World: Engaging Youth in STEM for Good

Maggie Muldoon (Mouse)

Mouse Design League is a diverse team of high school tinkerers and innovators from across New York City public schools who come together weekly over the course of a full school year to design, prototype, and build a new technology product that addresses a social need using the Human Centered Design process. This year, Design League students have been working closely with volunteers with disabilities from Adapt Community Network (formerly United Cerebral Palsy of New York) to prototype new assistive and adaptive technology solutions with the aim of improving the lives of their users. We would like to present select student assistive-technology inventions (ideally, though not necessarily, with young people as the presenters) and showcase our Design League program, the student-led design process, and our digital badging platform along the way.

## Large-Scale EdTech Interventions in Resource-Constrained Contexts

Sadaqat Faqih Mulla (Tata Institute of Social Sciences), Omkar Balli (Tata Institute of Social Sciences), & Bindu Thirumalai (Tata Institute of Social Sciences)

Efforts to harness technology for improving school education have gained traction internationally. However, these efforts have been reported to encounter multifarious challenges varying from poor information and communications technology (ICT) infrastructure to wicked problems of technology design, implementation models, and inadequate teacher capacity building. In resource-constrained contexts, these challenges get exacerbated by various other systemic and nonsystemic factors. In this symposium, drawing upon our experiences from a large-scale EdTech intervention in India, we deliberate and demonstrate aspects of design, development, and implementation of scaled-up EdTech experiments. The focus of discussion would revolve around three aspects: program design, technology leveraging, and teacher capacity building.

## Unhangout for Educators: Best Practices for Participant-Driven Online Workshops

Yumiko Murai (MIT Media Lab), Elizabeth Choe (Massachusetts Institute of Technology), Neil Patch (Harvard Business School), Katherine McConachie (MIT Media Lab), & Philipp Schmidt (MIT Media Lab)

Unhangout for Educators (U4E) is an online professional-development program for K–12 educators who are interested in maker education practices. U4E was born out of a need for teacher professional-development opportunities that build a sense of community among colleagues, support teacher agency, and allow teachers to share and learn from one another. Hosted on an online video conference platform called Unhangout, U4E has been iteratively designed and conducted as online unconference sessions, in which participants actively propose and organize small-group discussions based on their own interests in the topic. Each session started with a short video clip that introduces the theme of the unconference, followed by a breakout session, and a whole-group wrap-up at the end. Each breakout room had a shared notepad where participants in the same breakout room can coauthor. We also used this space to provide additional information and facilitative prompts to the participants. These prompt texts were iteratively updated over time to explore the best way to support participant-driven conversation in the breakout rooms. This presentation reports on the findings based on the feedback and observations from two lab tests and five workshop iterations. We have found that successful participant-driven workshops finely balance intervention and guidance for participants, but also grant them enough autonomy to freely explore their own interests. A few successful facilitation strategies of participant-driven learning, as well as respective uses of different breakout styles, were assembled as a set of support materials and shared to help teachers and teacher educators create similar types of learning opportunities.

http://unhangout.media.mit.edu

## Board Game for Peace: Integrated Game-Based Learning and Activation Program to Counter Violent Extremism

Eko Nugroho (Kummara Creative Studio)

Board Game for Peace is an integrated game-based learning and activation program targeted at youth to strengthen the inclusivity of Indonesian society by promoting tolerant, open, and peaceful religious values through interactive media (board games). The program, which runs in five cities in Indonesia—Bandung, Solo, Surabaya, Padang, and Makassar—is also designed to enhance public awareness and motivate active participation in order to counter volent extremism (CVE) throughout Indonesia. The whole program is also supported by a simple gamification process using a social media platform. The pre- and postanalysis has shown a significant increment in terms of awareness regarding peace values and the counter violent extremism movement. As of December 2017 the Board Game for Peace program had reached more than 1,700 youth in five cities in Indonesia and we expected to reach more than 3,000 by March 2018.

## Localized! Leveraging Global and Local Data Sets to Build a Statewide System for Connected Climate Learning

Leigh Peake (Gulf of Maine Research Institute)

This session will report on a work-in-process to create a system of technology-enabled, data-rich, localized climate-learning experiences. Since 2005, the Gulf of Maine Research Institute has brought ~70% of Maine's fifth-/sixth-grade cohort annually to our marine research lab for a 2.5-hour exploration of ecosystem complexity. We are now renovating the program's technology and learning experiences to combine global data sets (sea surface temperature), local data sets (lobster landings), and MultiTaction technology to enable students to investigate the impacts of climate change in the Gulf of Maine. By completion of the project, we will have extended this informal learning experience through connected learning experiences in the classroom, in regional science centers, in public libraries, and through teacher professional development. A digital Field Notebook enables assembly of student-created assets from across these environments, as well as from experiences chosen by students themselves.

## That's Horse S#!T: Connected Learning Through Compost, Weather Balloons, and Other Projects

David Quinn (Mendon-Upton Regional School District) & Atakan Kadi (Adobe)

This Spotlight session featured an overview of the Mendon-Upton Regional School District's work to increase opportunities for students to participate in connected learning experiences. The presentation showcased four projects that connect students, technology, and community members to make learning engaging, relevant, and meaningful. Examples include: a revenue-generating equine composting system; a student-designed high-altitude balloon launch with video recording; a Grade 3 public-service announcement (PSA) that raised awareness and took action to reduce plastic marker landfill waste; and the Nipmuc 21C biannual event in which students, teachers, and community members collaborate to host interest-driven learning seminars. Presenters outlined how connected learning shaped these and future projects. In closing, the session highlighted the Inspired Learning Project, an open web platform that connects educators via monthly Zoom sessions and a blog to share practices that have led to inspiring learning moments for students.

http://theinspiredlearningproject.weebly.com/

## DiscoverDesign: Digital Artifacts and the Nature of Learning

Edgar "Edge" Quintanilla (Chicago Architecture Center)

Design process allows for transparency in assessing student work and understanding. Chicago Architecture Foundation's (CAF) DiscoverDesign.org is a connected learning tool for structuring design process and supporting connected learning. At CAF, design process is used as a means of moving youth from consumers to producers of digital media learning with the help of a structured design process. Real-world design challenges are framed through a web interface enabling students to engage in a design process that is production-centered and interest-driven. The platform is openly networked and academically oriented by enabling teachers to remix existing content for their own classrooms. This has enabled a new wave of community-driven design challenges with an array of digital artifacts that represent student process and 21st-century skills development. This Spotlight explores the production of digital artifacts and implications for the nature of student work in connected learning contexts.

## Ball State Achievements App

Scott Reinke (Ball State University)

Ball State Achievements is a mobile app for iOS and Android devices that uses gamification to increase engagement and retention of low-income, freshman students at Ball State University. In the app, students are given hundreds of tasks and goals called *achievements.* Completing achievements awards students an in-app currency called Bennies—named after Ball State's beloved institutional icon, Beneficence. Students can then use their Bennies to purchase real items from the Ball State Bookstore, Tech Store, and Rec Center from a curated in-app store.

## Let's Challenge the Design of Educational 360 VR Videos

Jeanine Reutemann (Leiden University, Centre for Innovation) & Monique Snijder (Leiden University, Centre for Innovation)

360 videos for virtual reality (VR) are considered promising for education. While 360 videos resemble traditional videography in some of their affordances, they are genuinely different when it comes to innovative storytelling, playful learning elements, and strategies for directing the gaze-attention of the recipient. Therefore, there are still lots of possibilities to be explored regarding the use of 360 VR videos in (higher) education. At the New Media Lab (Centre for Innovation, Leiden University, the Netherlands), we are currently developing six innovative educational 360 VR videos. We follow a process of co-designing for these projects, developing them in a collaborative multidisciplinary team of university teachers, learning experience designers, media designers, and researchers. The projects cover a variety of educational fields such as remote sensing, recognizing first signs of dementia patients, lab security simulations, archaeological digging processes, classroom conflict management, and a critical metamedia inquiry with scholars from visual anthropology. All these products have different learning goals, such as promoting problem-solving skills, identifying important signals, finding cues in a new environment, and experiencing consequences of actions and wrong choices (feel free to fail). In our Spotlight presentation, we will explain our design decision–making processes, incorporating both the media and the educational perspective. We will discuss our successes and failures in the development

of the 360 VR pilots and touch upon different aspects such as kinesthetic movements, interactivity, affordances, framing, and guidance.

https://newmedialab.centre4innovation.org/

## Making and Using Games for Teen Thriving: A Multidisciplinary, Participatory Approach

Susan Rivers (iThrive Games)

This Spotlight will feature iThrive Games's unique multidisciplinary approach to designing and using games in the best interest of teens. Games are an engaging and safe space in which teens can explore and experiment, practice skills, and make the most of their innate curiosity and drive to understand themselves and the world they will one day run. Too few games currently exist specifically to support teens' unique social and emotional needs; reflect their varied experiences and interests; and empower them to build the strengths they need to thrive. Our nonprofit organization addresses that gap by collaborating across disciplines to intentionally design and use games to support teens' healthy development. Our approach involves designing directly with teens and collaborating with scientists in learning and teen development and game developers across several key initiatives. This method has resulted in a growing portfolio of games, products, and programs to support teen thriving.

## Coding for All: Connecting With Diverse Youth Interests

Natalie Rusk (MIT Media Lab), Andres Lombana-Bermudez (Berkman Center for Internet and Society), Mizuko Ito (University of California Irvine), & Moran Tsur (MIT Media Lab)

This Spotlight session will focus on Coding for All, an initiative to develop interest-based entry points into coding, particularly for girls and youth of color. The collaboration was initiated by the MIT Media Lab, the Digital Media and Learning Hub at the University of California Irvine, and Harvard University's Berkman Klein Center for Internet & Society. The project builds on the Scratch coding language and online community, where young people create interactive stories, games, and animations based on their interests. Coding for All offers new tools and activities designed to connect with the diverse interests of youth who otherwise may not become engaged in coding. Workshops engage librarians and community center staff in learning to offer these experiences for youth in their communities. Researchers have examined youth participation in Scratch and other youth-driven learning communities. The presenters will discuss what they have learned from the perspective of designing for equity.

## A Space to Grow In and a Space to Own: An Online Game-Based Resource for Teachers and by Teachers

Mamta Shah (Drexel University) & Aroutis Foster (Drexel University)

In this Spotlight, we described "Learning in Game-Based Environments Web-Resource," an online resource developed for teachers and populated by teachers learning about game-based learning (GBL) in a master's program in Learning Technologies at Drexel University from September 2010 to currently. It was intended to serve as an informal hub for current and past students enrolled in the GBL concentration and for teachers to participate in a community where knowledge about games and game-based learning could be found, shared, and discussed, particularly in relation to issues such as curricular alignment, fitting within school contexts, and any insights obtained from personal and professional experiences. We explained the impetus and described the design of a collaborative space for teachers as they developed a foundation in GBL, explored the role of motivation in engaging learners, grappled with issues of play in the context of participatory cultures and affinity spaces, and became knowledgeable about integrating GBL through a variety of analytical and pedagogical approaches through their experiences in the GBL concentration. We showcased the kinds of games and game-related resources teachers posted about and the information they shared in their posts. We also illustrated the discussions that ensued around the posts. In doing so, we shared our reflection on what we learned about how teachers think about teaching with games and the significance for providing a resource that teachers could grow in, own, and come back to even after they graduated from their master's program.

## Tools for Computational Action: New Features in MIT App Inventor

Mark Sherman (Massachusetts Institute of Technology), Mike Tissenbaum (Massachusetts Institute of Technology), Josh Sheldon (Massachusetts Institute of Technology), & Hal Abelson (Massachusetts Institute of Technology)

MIT App Inventor has begun to frame its work in a theory of computational action: the idea that students should learn about, and create with, computing in ways that provide them the opportunity to have direct impact in their lives and their communities. We suggest that there are two key dimensions that contribute to computational action. They are (a) computational identity and (b) digital empowerment. Computational identity is a person's recognition that he or she can solve problems using computing and may have a place in the larger community of computational problem solvers. This dimension emphasizes authentic experiences in two ways: authenticity of the problem to the individual, and authenticity of the problem-solving experience to the greater engineering and computer science community, including professionals. Digital empowerment is the belief that a person can put that identity into action in meaningful and impactful ways. The App Inventor team is developing new features that allow students to more easily engage with authentic problems in their own lives with computational solutions. These features—maps, real-time collaboration, and support for Internet of Things applications—are powerful tools that students can bring to bear with minimal computing background to solve specific, local problems.

http://appinventor.mit.edu/explore/team-blog.html

## Why Do Educational Games Matter? Lessons Learned at the Cornell Lab of Ornithology

Mya Thompson (Cornell Lab of Ornithology), Jeff Szuc (Cornell Lab of Ornithology), & Noah Warnke (Cornell Lab of Ornithology)

Starting in 2014 the Cornell Lab of Ornithology started developing educational games and digital interactives with the goal of engaging public audiences in new ways. Three games and five interactives on, we are now in a position to evaluate the impact of these digital experiences collectively and share our findings with the digital learning community. This Spotlight presentation will briefly introduce the games, describe the communities in which they are used and shared, and explore the ways in which these free digital experiences have changed how we, as a nonprofit educational institution, think about public engagement and strategically reach new audiences.

https://academy.allaboutbirds.org/

## Participating in Literacies and Computer Science: An Approach to Computing Ed With Emergent Bilinguals

Sara Vogel (The Graduate Center City University of New York), Christopher Hoadley (New York University), Ana Rebeca Castillo (New York City Department of Education), Laura Ascenzi-Moreno (Brooklyn College City University of New York), & Kate Menken (Queens College City University of New York)

Just as learning to use a new language is more than memorizing verb conjugations and vocabulary, being computationally literate is more than ordering the keywords of a programming language with the correct syntax. It is about participating in communities that create, read, and use code and computing for particular purposes and in different contexts. In this Spotlight, practitioners and researchers who are integrating computer science (CS) into K–12 bilingual classrooms describe an approach to teaching and learning computational literacies that considers how language learning and in particular, learning literacies with and through language, may provide clues for supporting students' participation in computing education. Our approach is rooted in the philosophy of literate programming (Knuth, 1984)—that code is meant to be understood by machines and people—and a lens from bilingual education called "translanguaging"—that bilinguals select linguistic, semiotic, and social features from unique language repertoires as they communicate and learn (García & Li Wei, 2014). These theories guide us to view code as a resource people use in constellation with other languaging practices to communicate with and for computers and other humans. Presenters describe examples from classroom practice, including an activity that guided students to compare projects created with the Scratch software to telenovelas, a genre most had more familiarity with, and one in which students predicted what would happen upon running given codes. Both activities drew on a range of students' meaning-making practices, guiding them to put code in their own words and voices to participate in broader conversations.

## iCivics and Filament Games: A Game-Based Learning Partnership Committed to Innovative Instruction for All Learners

Kelly Whitney (iCivics) & Dan White (Filament Games)

iCivics has had unparalleled success in the American game-based learning space, with over 54 million plays of 18 games in under seven years. Today, iCivics is the most widely adopted game-based learning solution in the United States, teaching critically important concepts related to democracy, government, and civic engagement. iCivics materials are available for free online, are used in all 50 states, and are in 50% of middle schools nationwide. iCivics had an unlikely beginning. Upon her retirement, Supreme Court Justice Sandra Day O'Connor made it her mission to improve civics education. Justice O'Connor knew that the success of any democratic system depends on the active participation of its citizens. But the justice wanted to engage students specifically—and this is where educational researcher James Paul Gee guided the justice to game-based learning. A critical partner in iCivics' success is Filament Games, an award-winning studio that focuses exclusively on game-based learning. iCivics has embedded its director of digital learning on-site at Filament Games to allow the teams to accelerate production, creating efficiencies and synergies that would not be possible otherwise. iCivics's content experts work side by side with Filament Games to create innovative yet highly playable ideas for student learning and engagement. In this session, Dr. Kelly Whitney, EdD, iCivics's chief product and partnerships officer, and Dan White, Filament Games CEO, discussed how their focus on purpose, process, practicality, and playability have contributed to the rapid adoption of iCivics's civic learning games in classrooms, community centers, and homes across the country.

## Being a Connected Parent: Learning and Living With Digital Media

June Ahn (University of California Irvine), Alicia Blum-Ross (London School of Economics), Carmen Gonzalez (University of Washington), Vikki Katz (Rutgers University), Sonia Livingstone (London School of Economics), Meghan Moran (Johns Hopkins University), Jennifer Pavlick (London School of Economics), Lori Takeuchi (Joan Ganz Cooney Center), & Sarah Vaala (Vanderbilt University)

Millions of parents struggle with how to support their children's learning with digital media. Emerging research has documented how parents think about, monitor, restrict, or encourage their children's technology use (Clark, 2011; Livingstone & Helsper, 2008; Nathanson, 1999; Valkenburg, Piotrowski, Hermanns, & de Leeuw, 2013). Yet other studies illuminate how parents and children can learn together through co-viewing and co-learning activities (Roque, Lin, & Liuzzi, 2016; Sobel et al., 2017; Takeuchi & Stevens, 2011). Finally, there are open questions about what other roles parents can play to support their children's learning as they develop over time and across multiple settings (Barron, Martin, Takeuchi, & Fithian, 2009; Bricker & Bell, 2014). In this symposium, we bring together researchers to share cutting-edge research about parental practices, perceptions, and roles as they integrate technology and learning into their family practices. The three presentations in this symposium use nationally representative surveys of parents to explore issues of parental roles, perceptions, and obstacles as they work to support their children's connected learning with technology. Two studies examine national surveys of U.S. parents, and one study uses a national survey of U.K. parents. Taken together, these studies contribute substantially to the field by drawing more representative portraits of parents, digital media, and learning across two countries.

## Changing Who Is Making: Broadening Participation in Maker Activities

Kinnari Atit (University of California Riverside), Kay Ramey (Northwestern University), David Bar-El (Northwestern University), Kemi Jona (Northwestern University), Marcelo Worsley (Northwestern University), Reed Stevens (Northwestern University), Grace Hall (Northwestern University), Jue Wu (Northwestern University), Mark Vondracek (Northwestern University), & David Uttal (Northwestern University)

One of the critiques of traditional learning in schools is that it is relatively disconnected from both the rest of students' lives and the authentic practices of disciplinary professionals. In contrast, "makerspaces" and "making" activities have been touted by many as contexts that allow youth to bring in outside interests and construct their own learning in ways that empower them to cultivate STEAM interests and identities. However, with all the excitement around making for learning, we actually know relatively little about how or whether these activities promote interest development and learning, and perhaps more important, for whom they do so. In particular, there is a growing body of literature suggesting that conventional, out-of-school makerspaces present barriers to entry to females, underrepresented minorities, and students not already interested in making or STEM. In this symposium, we present three projects examining how to design making activities that support interest development and learning, particularly for students who have been left behind, both by traditional STEM education and by the maker movement. The first project examines how to cultivate interest development and learning through making and tinkering activities around one specific interest, music. The second project explores how choice-based STEAM making and design challenges integrated into the school day facilitate STEAM interest development and learning. The third project examines ways to increase access to making and engagement in science learning by involving teachers and students as co-designers of science labs to be incorporated into a traditional high school physics classroom.

## VoiceUp: Civic Media Connects Marginalized Youth to Their Communities Through Development of Agency

Yonty Friesem (Columbia College Chicago), Mindy Faber (Columbia College Chicago), Virginia Killian Lund (University of Illinois Chicago), Renee Hobbs (University of Rhode Island), & Susan X Jane (SXJ/Media Education Lab)

For marginalized groups that traditionally have been silenced, the opportunity to connect their personal interests with their home, school, and community provides a path to voice their career aspirations and enhance civic engagement. In this symposium, we will share four examples of how youth media activists apply the connected learning framework to explore participatory, playful, and creative development of agency. Mindy Faber and Virginia Lund will introduce Spy Hop, a youth-development program in Salt Lake City, Utah, and Free Spirit Media in Chicago. Susan X Jane will describe her work with juveniles in Boston. Yonty Friesem will share a youth media initiative to connect students from Rhode Island School for the Deaf with other youth. All four case studies will showcase videos produced by young people. This interactive session will include backchanneling using #VoiceUp as participants provide feedback and contribute their comments on VideoAnt.

## Authentic Esports, Enriched Curriculum

Matthew Gaydos (Massachusetts Institute of Technology), Alexander Cho (University of California Irvine), Mark Deppe (University of California Irvine Esports), Mizuko Ito (University of California Irvine), Gerald Solomon (Samueli Foundation), Kurt Squire (University of California Irvine), Constance Steinkuehler (University of California Irvine), & Tom Turner (Orange County Department of Education)

Esports, or professional competitive video games, are an already popular and rapidly growing medium with strong appeal to many students, especially young males. At present, these games are underused in academic contexts, disconnected from schooling or seen as a distraction to learning. In this project, we leverage student interest in esports by creating a new, authentic competitive high school esports league and matching this league development with rigorous academic content. By wedding student interest and participation in the robust esports community, our work will improve our understanding of competitive gaming, develop connections between game practices and school content (especially STEM), and improve esports communities through positive leadership and mentoring. In this symposium, we present our ongoing progress after six months of development, detailing key elements of the program including curriculum, coaching, league structure, and research.

## Constructionism in Context: Connected Learning Across Technologies and Spaces

Nathan Holbert (Teachers College Columbia University), Yasmin Kafai (University of Pennsylvania), Matthew Berland (University of Wisconsin Madison), Kylie Peppler (University of California Irvine), Deborah Fields (Utah State University), Sara Grimes (University of Toronto), Ricarose Roque (University of Colorado Boulder), & Amon Millner (Olin College)

Constructionist designers have used new technologies to engage learners in rich opportunities to build personally meaningful artifacts for decades. In this symposium we bring together expert designers and scholars who have successfully developed constructionist innovations using emerging technologies in a range of domains, including gaming, making, and coding, and in a variety of contexts, including schools, the home, and in the virtual world. In a panel discussion, format participants will identify key constructionist principles effective at enabling connected learning approaches.

## The Connected Learning Research Network: Reflections on a Decade of Engaged Scholarship

Mizuko Ito (University of California Irvine), Vera Michalchik (Moore Foundation), Craig Watkins (University of Texas Austin), Sonia Livingstone (London School of Economics), & Josephina Chang-Order (University of Colorado Boulder)

From 2011 through 2017, the MacArthur Connected Learning Research Network (CLRN) collaboratively investigated the changing landscape of digital media and learning and helped develop the connected learning model. The CLRN follows in the footsteps of other interdisciplinary MacArthur networks that aim to develop new paradigms and approaches to social change, tied to changing social, cultural, and technological conditions. Among these networks, the CLRN has been unique, however, in being part of a larger foundation initiative that has included major efforts at developing new educational innovations and organizations such as schools, educator networks, and youth-development programs. In a nutshell, connected learning is learning that connects personal interests, supportive relationships, and academic, civic, and career opportunity. Although connected learning does not require technology, the emerging landscape of social and digital media can potentially make connected learning more accessible to young people with diverse interests and backgrounds. This symposium commemorated this decade of interdisciplinary scholarship since the publication of *Connected Learning: An Agenda for Research and Design.* It kicked off with a recap of major findings and how the connected learning model has evolved. Then members of the research network reflected on the biggest challenges and successes they encountered, and what it has meant for them to participate in this extended and ambitious collaborative effort.

https://clalliance.org/about-connected-learning/

## Chocolate-Covered Broccoli or Superfood Smoothie? How to Make Learning With *Minecraft* Both Nutritious and Delicious

Mizuko Ito (University of California Irvine), Deirdre Quarnstrom (Minecraft Education), Meenoo Rami (Minecraft Education), Seann Dikkers (Bethel University), Michael Dezuanni (Queensland University of Technology), & Paul Darvasi (Royal St. George’s College)

James Paul Gee has quipped that we should not approach games and learning as covering broccoli with chocolate—using games to engage kids in unappetizing topics and activities. *Minecraft* is a rare case of a wildly successful commercial game loved by kids and embraced by many educators and parents. At its best, *Minecraft* creates more superfood smoothies than chocolate-covered broccoli, a blender of entertainment and education into a tasty experience both nutritious and delicious. Still, *Minecraft* is not immune to the challenges of connecting and blending education and entertainment. Parents complain about "minecrack" and the hours that kids spend watching silly *Minecraft* videos. *Minecraft* probably does not connect to academic growth for most players. Conversely, even *Minecraft* becomes chocolate-covered broccoli when placed within a more traditional classroom culture and process. This symposium featured dialogue and debate between leading *Minecraft* and learning educators, technologists, and researchers. The focus was on tough problems in practice in using *Minecraft* to connect in- and out-of-school learning, and stories from the trenches in the classroom and at the front lines of innovation in technology and program development. Moderated by Mizuko Ito, director of the Connected Learning Lab, the symposium featured Deirdre Quarnstrom and Meenoo Rami from the Minecraft Education team and researchers and *Minecraft* educators Michael Dezuanni, Paul Davarsi, and Seann Dikkers.

## Learning From Failure: Debugging in Coding, Gaming, and Making Activities

Yasmin Kafai (University of Pennsylvania), Debora Lui (University of Pennsylvania), Karen Brennan (Harvard University), Paulina Haduong (Harvard University), Deborah Fields (Utah State University), Gayithri Jayathirtha (University of Pennsylvania), Breanna Litts (Utah State University), Michael Eisenberg (University of Colorado Boulder), Chase Mortensen (Utah State University), & Whitney Lewis (Utah State University)

Most attention in learning research has focused on how to provide instruction that supports or scaffolds students' learning and solving problems with success, ignoring that helping students' understanding mistakes or overcoming failures can provide equally rich learning opportunities. In this symposium, we want to examine how failure is situated and perceived in different contexts, especially those in which learners design complex artifacts such as software, games, or electronic textiles. Our presentations and discussions will focus on how learners and teachers talk about failure, how they overcome challenges, and what they can learn from their failures. We want to examine differences and similarities in approaches and mind-sets that can help us include failure as a productive dimension in future learning designs.

## Beyond the Screen: Engaging Learners and Transforming Communities Through Augmented Reality Technologies

Laini Kavaloski (State University of New York Canton), Breanne Litts (Utah State University), & David Gagnon (University of Wisconsin Madison)

In "Beyond the Screen," we contribute AR design cases from diverse contexts as examples of implementations that connect learners beyond the screen through location- or place-based activities. The symposium icomprises an interdisciplinary group of educators, researchers, and developers who are experimenting with the ways that AR technologies shift classrooms and communal knowledge through playful learning. The projects in this symposium vary from teacher-created to learner-created experiences and from large-scale (e.g., a major history museum project) to smaller-scale class projects (e.g., augmenting a campus with cultural theory). By presenting a range of implementations, we hope that our interactive symposium structure will engage participants in a rich discussion around how to leverage AR to design location-based learning experiences that move beyond traditional barriers of walls and screens into local spaces such as nature preserves, museums, campuses, and neighborhoods.

## The Design-ification of Learning

Lesley Liu (University of British Columbia), Kesiena Chris-Iwuru, & Namae Stella Maris (University of British Columbia)

This symposium explores the design-ification of learning to generate discussion on digital learning, curriculum, and design. Three empirical reports offer depth and scope on what it means to design-ify learning: (a) 25 eighth graders designing affinity spaces to understand cyberbullying; (b) nine high school students design-ifying the self through a variety of social networking platforms; (c) 250 teachers in 14 secondary schools design-ifying information and communication technologies (ICT) practices in their classrooms.

## The Connected Learning Initiative in India

Brandon Muramatsu (Massachusetts Institute of Technology), Kirky DeLong (Massachusetts Institute of Technology), Eric Klopfer (Massachusetts Institute of Technology), M. S. Vijay Kumar (Massachusetts Institute of Technology), & Judith Perry (Massachusetts Institute of Technology)

The Connected Learning Initiative (CLIx) is an innovative collaboration led by the Tata Trusts, the Tata Institute of Social Sciences (TISS), and the Massachusetts Institute of Technology (MIT) that is built upon the theme of connection—connecting students and teachers to authentic learning experiences and contemporary teaching and learning practices, connecting teachers with teachers in learning communities, and connecting technology-enabled curriculum with the infrastructure in schools and states. CLIx's goal is to provide high-quality learning experiences at scale that focus on authentic, hands-on learning of concepts, as well as development of values, citizenship, professional skills, and competencies to widen opportunities for Indian youth, thereby enabling them be successful in further academic studies or in the workforce. Through 2018, CLIx is estimated to reach 460 schools, 30,000 students in grades 8 and 9, and 3,300 teachers in four states in India (Rajasthan, Telangana, Chhattisgarh, and Mizoram). CLIx is driven by the concepts of "quality at scale" along with "connections." CLIx is modeling the transformation of the entire secondary education experience. CLIx connects experiences that deeply integrate technology with real-world and relevant examples in hands-on and active learning experiences that connect learners and teachers. The uniqueness of the CLIx approach is through addressing the following three intersecting lenses simultaneously: (a) the design, development, and delivery of quality learning experiences using open educational resources (OER) and open-source tools and platforms; (b) a systematic process of implementing a large-scale educational innovation across states and schools; and (c) professional development to transform teacher practice.

http://clix.tiss.edu/

## Partnerships for Digital Futures: Community-Based Collaborations to Support Youth Pathways With Technology

Rafi Santo, June Ahn (University of California Irvine), Jerelyn Rodriguez (The Knowledge House), Jeff McCarter (Free Spirit Media), & Jeremy Dunn (YOUmedia Chicago Public Library)

How can partnerships be developed that support youth pathways into digital futures? Informal learning organizations use partnerships to “punch above their weight” in various ways—to design and spread new learning innovations and programs (Santo, 2017), to spread their pedagogical practices into formal settings (Bevan et al., 2010), and to coordinate learning across settings (Pinkard, Barron, & Martin, 2008). Within the connected learning community, a persistent focus has been on the question of “youth pathways” (Ching et al., 2016)—how youth can “geek out” (Ito et al., 2010) and pursue interest-driven learning with digital media in ways that span longer timescales and multiple settings. In this session, we looked at how informal learning organizations build and implement different types of “pathway partnerships”—interorganizational collaborations that support youth to deepen engagements with digital learning in ways that span institutions and create the possibility of extended engagement over long periods. The session featured representatives from three leading informal digital-learning organizations—Free Spirit Media, The Knowledge House, and YOUmedia at the Chicago Public Library—each of whom shared a distinct partnership model that highlighted a particular way to use interorganizational collaboration to support youth pathways. After this, a research team from New York University that has been studying these organizations within the context of a larger research-practice partnership shared a framework for thinking about and understanding “pathway partnerships” in informal digital learning organizations.

http://bit.ly/digitalfuturesCLS2018

## Designing the Wisconsin Teacher Studio: Informal Maker-Based Professional Learning

Emily Schindler, University of Wisconsin Madison

This presentation detailed the design and implementation of a maker-based professional learning network called the Wisconsin Teacher Studio. Data presented centered around design aspirations from design teams, including university researchers, university professional developers, and maker educators based at each site (a public library and a children’s museum). The presentation traced the implementation of three specific design aspirations: (a) Create interest-driven learning for educators interested in making, (b) Connect educators from diverse educational contexts, and (c) Make a stable, generative partnership between university and nonuniversity entities. Design features led to nuanced outcomes. First, attendance numbers varied by site: At one site, the meetings were attended consistently by five to seven educators, whereas at the other site, attendance numbers were higher (ranging up to 30 participants), with a small group of repeat attendees. Perhaps because of these attendance patterns, site 1 was able to engage the participants in co-designing future maker-based learning sessions, whereas site 2 was left to design learning for participants. The “who” of attendees also varied by site. At one site, attendees were tied, in some way, to a local school district. At the other, attendance was split between formal and informal educators. In all, site 2 is still offering maker-based professional learning in the exact way it was designed during the study, whereas site 1 has incorporated the design features from the Teacher Studio into a separate maker-based professional learning opportunity for area teachers. Overall, this study highlights the needs for wide participation by multiple stakeholders in designing maker-based professional learning.

## Connecting Learning Across Generations and Contexts: Designing for Family Learning

Kristin A. Searle (Utah State University), Breanne K. Litts (Utah State University), Jasmine Ma (New York University), Ricarose Roque (University of Colorado Boulder), Carrie Tzou (University of Washington), Megan Bang (University of Washington), Philip Bell (University of Washington), Keisha Varma (University of Minnesota), June Ahn (University of California Irvine), Tamara Clegg (University of Maryland), Jason Yip (University of Washington), Teresa Casort (Utah State University), Sequoia Dance (Arizona State University), Bryan McKinley Jones Brayboy (Arizona State University), Annie McNamara (University of Pittsburgh), Thomas Akiva (University of Pittsburgh), Lisa Brahms (Children's Museum of Pittsburgh), & Peter Samuelson Wardrip (University of Wisconsin Madison)

Connected learning emphasizes the significance of youth learning through engagement with personally meaningful content and digital technologies while supported by a network of peers, teachers, and families across settings (Ito et al., 2013). Western schooling often limits opportunities for learning across generations, yet it was the primary way through which learning occurred before the introduction of formal schooling. We are just beginning to understand the role of digital media in family learning (Gee, Takeuchi, & Wartella, 2017). We are especially interested in family learning for nondominant families. This session brings together scholars studying intergenerational learning across school and out-of-school contexts. It is broadly guided by the following research questions: (a) How can we engage families in learning together? (b) What activities, strategies, and tools are promising for engaging families in intergenerational learning? Participants will not only share their research through a structured poster session format, but they will also demonstrate a tool or activity from their research during the session.

## Ghost Stories From Learning-Game Design: Surprises! A Lively Storytelling Session

Bert Snow (Snow & Co, KidCitizen), Barbara Chamberlin (New Mexico State University Learning Games Lab), Caitlin Feeley (MIT Education Arcade), David Gagnon (University of Wisconsin Madison), & Dan Roy (MIT Teaching Systems Lab)

This symposium aimed to spark a lively discussion among some of the wizened designers of learning games who attended the summit. It was an interactive discussion—not a panel talk. Ghost stories involve surprise, and that will be our theme. We will focus on discoveries that occur in the design process: both serendipitous and things that the designers wish they had foreseen and possibly avoided. For example, one question we will look at is where learnings from data and feedback have differed from what we expected or what our design instincts told us. The goal was to talk about the experience and the lessons of the work itself, the surprises and what we have learned from them. The author-facilitators are designers who between them have many years and many games on their résumés, in particular a lot of work and thinking about learning games. While we generally share an interest in working forward from core learning or practice objectives, our work and approaches have tended to vary quite widely. We started by telling some of our own stories, prompted by questions that we prepared for the session. For each question, we then asked members of the audience for their own stories—with the goal of sharing and discussing wisdom from the "trenches" in the form of entertaining "ghost stories." We are in the process of transcribing the discussion and will share it at www.bertsnowandco.com.

https://www.bertsnowandco.com

## Making Computing Meaningful: Computational Action for Formal and Informal Computing Education

Mike Tissenbaum (Massachusetts Institute of Technology), Josh Sheldon (Massachusetts Institute of Technology), Mark Sherman (Massachusetts Institute of Technology), Hal Abelson (Massachusetts Institute of Technology), Betsy DiSalvo (Georgia Tech), Kayla DesPortes (Georgia Tech), Allison Colyer (Iridescent), Rusty Nye (Iridescent), Rachel Nicoll (MassTLC Education Foundation), Lissa Soep (Youth Radio), Asha Richardson (Youth Radio), & Clifford Lee (Saint Mary's College of California)

Many current approaches to computing education focus primarily on students learning the fundamentals of programming. This decouples how people learn to program from why people should learn to program and runs the risk of making learners feel that computing and computer programming are not things that they will need in the future. As computing education grows in importance, there is a need to provide learners with opportunities to connect what they learn to their everyday lives. By allowing computing education to connect with young learners' lives we can provide them opportunities to not only learn computing, but also to design solutions that can have a real impact—we call this refocusing *computational action.* Through computational action, we can empower students to develop a critical awareness of the role they can play in their communities and develop their own computational identities, which is particularly important for underrepresented youth and young women, who often struggle to find belonging in computing and engineering. This symposium brought together four groups using computational action to support young learners as they learned computing by developing digital solutions to self-identified problems in their lives and communities. Each looked at a different cross-section of the computing education world: a formal computing classroom; community and classroom makerspaces; a worldwide app competition for young women; and a youth-driven media enterprise. By providing this rich variety of educational settings, learning goals, and curriculum designs, this symposium aimed to inspire and inform others who wished to develop their own computational action-focused designs.

## Integrating Computational Modeling Into K-12 Science Classrooms

Daniel Wendel (MIT Scheller Teacher Education Program), Emma Anderson (MIT Scheller Teacher Education Program), Ling Hsiao (MIT Scheller Teacher Education Program), Hyeonsu Kang (MIT Scheller Teacher Education Program), Irene Lee (MIT Scheller Teacher Education Program), Eric Klopfer (Massachusetts Institute of Technology), Meredith Thompson (Massachusetts Institute of Technology), Bob Coulter (Missouri Botanical Garden), Stacey Carman (Missouri Botanical Garden), Susan Yoon (University of Pennsylvania), Jooeun Shim (University of Pennsylvania), Okhee Lee (New York University), Alison Haas (New York University), Lorena Llosa (New York University), Ashlyn Pierson (Vanderbilt University), Corey Brady (Vanderbilt University), & Douglas Clark (University of Calgary)

Most scientists today create models or simulations in order to understand phenomena, explore questions, and increase the rate of innovation and discovery. The Next Generation Science Standards (NGSS) have recognized this and placed an increased emphasis on modeling (National Research Council, 2012).

Students must learn not only to use prebuilt models, but also to modify and create their own (Krajcik & Merrit, 2012). Computational modeling provides a platform for students to develop and experiment with models (Lee, Martin, & Apone, 2014). However, incorporating computational modeling into classrooms is challenging, in part because integrated curricula are rare (Sengupta, Kinnerbrew, Basu, Biswas, & Clark, 2013), and because there is a dearth of high-quality teacher professional-development programs supporting school adoption (Blandford, 2012). Tools designed especially for students are needed to enable their engagement in higher-level scientific modeling practices (Willingham, 2009). In this symposium, we present four projects that make inroads into solving some of these issues through StarLogo Nova, an agent-based computational modeling platform designed specifically for learners. These projects focus on a range of contexts: elementary science, middle school science, high school biology, and teacher professional development. Our studies explore how teachers and students learn using cutting-edge curricula and tools. In this symposium, we address the following research questions: How is StarLogo Nova used in the various contexts to develop computational modeling skills for the project's target learners? How have the curricula evolved to address the challenges inherent to their specific contexts? What are the remaining challenges that need to be addressed?

https://docs.google.com/document/d/1qok9QuretCuNVwEdpdyfM1-0Vc-e4ZfEXUvlAR049aA/edit#

## A Collaborative Digital Game for Learning Introductory Quantum Mechanics

Aditya Anupam (Georgia Institute of Technology), Azad Naeemi (Georgia Institute of Technology), & Nassim Parvin (Georgia Institute of Technology)

How can we engage students with abstract subjects such as quantum mechanics (QM) that are beyond our direct experience? Textbooks and videos are useful for visualizing QM concepts but are inherently limited as students cannot experiment with them. Digital games and simulations, on the other hand, can allow students to experience and interact with digital renditions of quantum phenomena such as probability. We posit that two key factors for the success of educational games in the classroom are: (a) structured collaboration that engages all players in the process of hypothesis making and testing, and (b) gameplay that integrates scientific accuracy and playful mechanics. Based on this hypothesis, we present *Psi and Delta*—a collaborative digital game for learning introductory QM. The game is a platformer (like *Mario*) where players control nanobots in their journey through a quantum world. The goal of each game level is to use the probabilistic nature of the electron to overcome obstacles such as an opposing nanobot. To be successful in the game, players need to observe the probability distribution of an electron, formulate a strategy to approach the obstacle, and coordinate their actions to execute those strategies. In this way, the game builds QM concepts and collaboration into the game mechanics and environment. *Psi and Delta* is designed for undergraduate (or advanced high school) students enrolled in courses involving introductory quantum mechanics. This demo showcases four game levels involving the concepts of probability and measurement.

http://learnqm.gatech.edu

## *Illustrating Group Theory:* A Coloring Workshop

Alexandra Berke (Massachusetts Institute of Technology)

*Illustrating Group Theory* is an interactive, free learning resource, designed to educate a mass audience about the beauty of mathematics through playful art. It is a “coloring book” both on the web and on paper, leveraging its variety of mediums to engage learners varying from children to college math professors to adult coloring enthusiasts: http://coloring-book.co. The “book” introduces group theory, which is the mathematical study of symmetry, through a visual language that requires no prior knowledge. Why? Because math is about more than just numbers. Some of the most beautiful mathematical concepts are considered “higher-level math” but can be discussed with simple visual mechanisms, and the world is missing out without them. All concepts presented in the “book” are complemented by illustrations that come to life in interactive animations on the web or that can be colored on paper, sometimes with “coloring challenges,” guiding the reader in active learning.

http://coloring-book.co

## What Can Liberal Arts Students Learn to Program in One Semester?

Angela Chang (MIT / Emerson College / TinkerStories.com)

Students in the arts and humanities are highly motivated to address current social and cultural issues, such as racism, gender inequality, and spin journalism. Although programming classes are not part of a traditional liberal arts curriculum, we show how coding literacy is useful to these students. We gave liberal arts students coding instruction using an open-ended approach called exploratory programming. This approach prompted student creativity by using connected learning. In one semester, students mastered basic programming concepts and became proficient at using professional coding tools. Some used semantic analysis to collect a corpus of sexual harassment postings from the #MeToo movement. Others researched the pervasiveness of native ads, news bias, racism, sexism, and mental health stigmas. Students initiated explorations by posting to online forums, contributing to open-source projects, and sharing code online. They created works of personal interest, investigated social issues, and expressed themselves creatively. Come to see creative computational works made by students at Emerson College, a small liberal arts school. Take part in reading a dynamically generated play with *The Hero's Journey* (http://benergize.com/herosjourney), use Twitter to create a crowdsourced meme with MemeCaptionBot (https://twitter.com/memecaptionbot), or use Connoixer's machine learning to rate photo aesthetics (https://goo.gl/s24UPX). We share how we overcame challenges unique to nonprogramming majors and our insights for future teachers. Come for the show and walk away with a new approach to teaching programming based on connected learning and exploratory programming for humanistic inquiry.

http://bit.ly/2SaP7vt

## Virtual Mentors in the (S)Partners for Health Website

Leticia Cherchiglia (Michigan State University), Will Renius (Michigan State University), Rabindra Ratan (Michigan State University), Joseph Carlson (Michigan State University), Breanne Carlson (Michigan State University Extension), Karin Pfeiffer (Michigan State University), & Erich Petushek (Michigan State University)

(S)Partners for Health is a school web-based six-week program designed by researchers at Michigan State University to promote healthful nutrition and physical activity behaviors in fifth-grade students. Drawing from research on the positive use of avatars (i.e., representation of the self in mediated environments) in educational settings, virtual mentors were developed and implemented for the (S)Partners website, to be soon evaluated for effectiveness in selected schools. Virtual mentors are responsible for providing automated feedback and encouragement to participants after they track their nutrition and physical activity behaviors on the (S)Partners website. Messages and images portraying emotions of the virtual mentors are tailored to match how well participants are doing in terms of meeting their nutritional and physical activity goals. This is similar to what college student mentors were doing in previous implementations of the program. Virtual mentors were visually designed to be as diverse as possible in terms of gender and ethnicity while still resembling college students. Each virtual mentor features a short bio that was created based on data from previous college student mentors in the SPartners program. This research has three main goals: (a) to improve behaviors related to nutrition and physical health by facilitating a psychological connection between participants and their chosen virtual mentors; (b) to identify the most effective art and behavioral design elements of the virtual mentors; and (c) to determine if using the virtual mentors in the (S)Partners website is equally (or more) effective compared with the human college student–mentor version.

http://spartnersvm.msu.edu/

## City Data Dashboards: Paper Circuit Pop-Ups to Engage Youth in Creative Exploration With Open Civic Data

David Cole (Nexmap) & Elisabeth Sylvan (Nexmap)

The City Data Dashboard project is a platform for supporting youth to design paper-circuit crafts that portray the story of their localities using pop-up illustrations and open data. The first prototype data dashboard is the Austin Data Dashboard, which portrays public information about Austin in a playful, ambient display. The proposed Tech Demo will include technical demonstrations of the original Austin Data Dashboard and the newer City Data Dashboards platform, as well as templates and tutorials designed for youth dashboard creation.

http://www.nexmap.org/open-data-open-minds/

## *Ramp It Up:* Gamifying College Financial Readiness

Commonwealth

Access to a college education is one of the key drivers of financial security, and financial aid can make college a viable opportunity for many students. However, understanding how to access such aid requires financial capability and specific knowledge that can be lacking. Deficits in financial capability for engaging with higher education can lead students to forgo further schooling, pay too much, take on crippling debt, and/or choose an ill-matched school. Commonwealth received financial support from the U.S. Treasury Financial Empowerment Innovation Fund to test and refine *Ramp It Up*, a gamified app providing high school students with information about financial choices related to college and to study its effects on students who use it. Commonwealth tested *Ramp It Up* with almost 1,000 students to learn about its effectiveness in engaging students, changing mind-sets, building knowledge, and prompting action. The research found that *Ramp It Up*: was overwhelmingly endorsed by students as something they would recommend to a friend; significantly increased confidence in paying for college; had a positive impact on perceived self-knowledge about college finance topics; led to statistically significant improvements in actual knowledge among players; encouraged action taking outside of the game. *Ramp It Up* achieved take-up among its target audience, stimulated their engagement, and attained its outcome goals despite being a relatively modest intervention—just 28 minutes of gameplay, on average. Commonwealth designed the app to have even effectiveness across race and gender and achieved this outcome.

https://buildcommonwealth.org/work/ramp-it-up

## Unplatform and Open Embedded Assessments for Rural India

Kirky DeLong (Massachusetts Institute of Technology)

The Connected Learning Initiative (CLIx) is a collaboration between Tata Trusts (India), Massachusetts Institute of Technology (MIT), and Tata Institute of Social Sciences (TISS, India). CLIx has been created to provide young people from underserved communities in India opportunities for participation in quality education offerings through the meaningful integration of technology. This Tech Demo will showcase two platforms: the Unplatform and Open Embedded Assessment (OEA) player. Unplatform is a lightweight, stand-alone content-delivery environment developed to be used in rural schools with limited or no Internet connectivity. The Open Embedded Assessment (OEA) player is an open-source platform and widget that presents the student with one or more questions, tracks his or her responses, offers feedback if needed, and saves student data.

## *Gem Spinner:* Teaching Probability With an Idle Game

Ira Fay (Fay Games, Hampshire College)

*Gem Spinner* is a game designed to help students learn probability, with a particular focus on expected value, independent events, and dependent events. The core of the gameplay involves placing items on spinning wheels to earn mana, then reinvesting that mana to earn better items and bigger wheels. *Gem Spinner* also includes other features, such as: a minigame that uses a deck of cards with a suit- and number-matching mechanic; a prediction mechanic where players predict their earnings from 100 bonus spins; and a quest mode with achievement quests, puzzle quests, and long-term quests to discover and construct GemBots (creatures in the game world). Very early in the game, players will grapple with questions such as “Where should I put my items to maximize my mana payout?” or “How long will it take to earn 100 more mana?” These questions naturally follow from playing the game, but to answer them accurately, players must understand probability. To facilitate and assess that understanding, the game offers a series of progressively more difficult puzzle quests, which scaffold learning and are supported by context-sensitive hints. As players solve easy puzzles and earn rewards, they unlock more puzzles. Conveniently, the puzzles also provide assessment opportunities for teachers to review, if desired. *Gem Spinner* is nearing completion and has undergone significant playtesting via several public school math classroom collaborations. We welcome further collaboration by anyone interested—please feel free to get in touch!

http://irafay.com

## The *Lost & Found* Game Series: Teaching Medieval Religious Law in Context

Owen Gottlieb (Rochester Institute of Technology) & Ian Schreiber (Rochester Institute of Technology)

*Lost & Found* is a strategy card-to-mobile game series that teaches medieval religious legal systems with attention to period accuracy and cultural and historical context. The *Lost & Found* project seeks to expand the discourse around religious legal systems, to enrich public conversations in a variety of communities, and to promote greater understanding of the religious traditions that build the fabric of the United States. Comparative religious literacy can build bridges between and within communities and prepare learners to be responsible citizens in our pluralist democracy. The first game in the series is a strategy game called *Lost & Found* (high school and up). In *Lost & Found*, players take on the role of villagers who must balance family needs with communal needs. Play is at times cooperative, at times competitive. The game emphasizes the prosocial aspects of religious legal systems, including collaboration and cooperation through trade-off decisions. The second game in the series, *Lost & Found: Order in the Court—The Party Game* (junior high school and up) is a fast-paced storytelling and judging game. Players compete to tell the best story about how a medieval legal ruling may have gotten to court in the first place. The game emphasizes legal reasoning. Both games are set in Fustat (Old Cairo) in the 12th century, a crossroads of religions. *Lost & Found* and *Order in the Court* both teach elements of the Mishneh Torah, the Jewish legal code written by Moses Maimonides. An Islamic law expansion module is currently in development.

http://www.lostandfoundthegame.com

## *Hurl the Harasser:* Making Games at the Pace of News

Lindsay Grace (University of Miami), Maggie Farley (American University), & Joyce Rice (Teeny Robots)

*Hurl the Harraser* is an experiential metaphor for the situation of women who have been subjected to sexual harassment. The metaphor is that it takes lots of people speaking up to tip the scales of justice against the harasser—particularly when the harasser is a high-profile professional like the cases we have seen of late in popular media. The game was created at the first “Newsjam,” a game-building experience that links journalism and games. The “Newsjam” is a Knight Foundation–funded effort between the public, the University of Miami, and American University Game Lab, http://newsjam.persuasiveplay.org/. The goal was to demonstrate that games can be made on current news topics at the pace of news. The game concept was created on October 20, 2017, completed by October 22, 2017. It was picked up by several news organizations within seven days. By November 2, the game was featured in news outlets in the Philippines and Indonesia. Players are tasked with breaking women out of bubbles to tip the scales. But much like in real life, the harasser makes winning the game anything but easy. With victims of sexual harassment often shamed into silence or blamed for their harassment, the game gets people to think more critically about the undue power harassers tend to have and the hurdles victims have to jump to get justice. *Hurl the Harasser* was created by University of Miami Knight Chair Lindsay Grace, adjunct professor Maggie Farley, and American University Game Lab alumna Joyce Rice. It features three levels, depicting the environment and likeness of prominent sexual harassment cases. It is playable on mobile devices and the web.

http://hurl.persuasiveplay.org/

## Getting Started With Teaching E-Textiles

Caroline Hardin (University of Wisconsin Madison)

E-textiles are fun, creative, and a great way to engage underrepresented groups in tech (Buechley, 2013). Many excellent resources exist to help beginners get started as individuals; this work will share years of experience in translating these resources into workshops that fit a variety of price points, workshop time lengths, participant backgrounds, and instructional settings (from guided to drop-in). This Tech Demo will feature the resources, materials, and finished demonstration projects created by the author to make it easier for nonexperts to run e-textile workshops on their own. Included will be first e-textile project variations, a first programming project workshop, and a showcase of inspirational projects. These are interactive, complex, and award-winning examples of what can be created with e-textiles. Having been featured in a science museum exhibit, they also are lessons in the wear and tear of e-textiles under heavy handling.

http://ictwiki.org/carolinecastle/digi-design

## SynthSync—Decoding Music Together

Anna Jordan-Douglass (University of Wisconsin Madison), Vishesh Kumar (University of Wisconsin Madison), & Peter J. Woods (University of Wisconsin Madison)

It is widely recognized that to be ready for the future, today's students need to develop the ability to think critically, identify and solve complex problems, communicate clearly about their thinking, and work collaboratively with a team. Computational thinking (CT) is the core of science, technology, engineering, and mathematics (STEM) disciplines, and it is about developing a set of problem-solving heuristics, approaches, and habits of mind. Collaboration and creativity, now seen as cross-cutting 21st-century skills, are also viewed as CT practices. Not all learners are motivated to learn CT through traditional programming contexts, even those designed for young learners. Moreover, there are a lack of learning environments to engage children in tinkering—trying things out and debugging—finding out why things did not happen as expected. And the vast majority of existing CT learning environments for young children do not explicitly support the development of positive attitudes toward problem solving, confidence in dealing with complexity, and communicating and collaborating with others to achieve a goal. SynthSync aims to enhance students' grasp of collaborative problem solving and ultimately computational thinking by engaging them in fundamental concepts that unite computing and music.

## *NEWSCAN*

Srujani Kamineni (Carnegie Mellon University)

*NEWSCAN* is an educational mobile game that deals with the consumption and spreading of fake news and is designed for real-time play by up to 100 participants. The game is being developed by a six-member team from Carnegie Mellon University's Entertainment Technology Center as a 12-week-long project, and it will be presented at the Games for Change Festival in June 2018. *NEWSCAN* is currently in the production phase and will be iterated on and refined via playtest and observation. During our presentation at the Games for Change Festival, we intend to divide our audience into different groups in order to simulate the real-world state of affairs surrounding news creation and distribution. The news pieces and strategies are based on analytical research of the attributes that encourage fake news to be believed, and in turn, spread. The core objective of *NEWSCAN* is to educate players about identifying with (as well as sharing) fake news. In the end, CMU and Games for Change hope to make a mobile game that successfully encourages players to check articles' sources and think before they share.

## DIALOGOS—Fishbowl Conversation Online: Video-Conference Classroom for Fishbowl Conversations

Teemu Leinonen (Aalto University) & Marjo Virnes (Aalto University)

Online learning platforms, from learning-management systems (LMS) and massive open online course (MOOC) platforms to video-conference services, do not provide affordances to build highly engaging learning communities when compared to a well-designed face-to-face classroom or studio learning. To overcome the low course participation and to build engaging dialogue among students, we wanted to implement a real-time discussion tool in an online environment. For that purpose, we designed and developed the DIALOGOS tool, a video-conferencing method for a fishbowl conversation. DIALOGOS makes it possible to have a discussion with a large group of participants (up to 40) sitting in a circle. In the center, there is a fishbowl: four chairs with four people having a discussion. Anyone in the audience may at any time go to the fishbowl and join the discussion. When someone joins the discussion, one of the people in the fishbowl must move to the audience. With DIALOGOS the teachers can engage students in active learning online with dialogue (e.g., flipped classroom). It enables student-driven activities, such as collaborative inquiry and co-design and helps to bring studio studies (common in art and design) and project-based learning (common in engineering) online. The first functional prototype of the DIALOGOS was implemented and tested in one university course in Spring 2018 in Helsinki, Finland. With the new version of the prototype, we are experimenting with various kinds of analytics, including sentiment analytics, which will be used for students' reflection and self-regulation.

https://youtu.be/D6WyE6ndW3U

## Tiles for Tales: Exploring the Links Between Storytelling and Technology

Margaret Low (University of Warwick), James Johnston (AHDB), & Robert Low (Coventry University)

Tiles for Tales explores links between the craft of storytelling and technology. The project shows how physical computing activities can be combined with creative and collaborative activities to support storytelling by young people. It is a framework that supports creative physical computing activities at very low cost. A tile represents a character or scene, partly animated through the use of LEDs controlled by ScratchX scripts running on a single computer or multiple computers. Tiles can be used in a similar way to story stones (or dice) to prompt storytelling. The project encourages small-group collaborative working to create tiles that can contribute to a larger project. An important aspect is that it uses affordable components to create the tiles, ensuring cost is not a barrier to participation. It is also particularly suitable for mixed age groups. The project involves construction of a cardboard tile, which can be decorated using paper, felt, colored pencils, and pens. LEDs are added and connected to an inexpensive microcontroller. Finally, participants control these LEDs using ScratchX. It is then possible to have a gallery of these tiles controlled by scripts written by their creators. A strength of this project is its flexibility and that it is not based on success or failure at a task. It is flexible: Tiles could be built by older children and younger children can then explore activating the tile and narrating a story. Having a common theme to the tiles enables collaboration across teams, meaning tiles can be used in various different ways.

http://www.warwick.ac.uk/TilesForTales

## BBC Academy Studio Directing Experience

Charles Miller (BBC)

The Studio Directing Experience I developed for the BBC Academy uses virtual reality (VR) with Oculus Rift technology to allow users to experience studio directing with voice commands in a game format. It combines 360 video and CGI, and it gives scores for accuracy and timing of shot changes at the end of the game. The project is a pilot for the BBC Academy, which is the training department of the BBC. The VR project will not replace physical training but should allow students to arrive for it with some feel for directing. It can also give potential students a flavor of the experience of the role before deciding whether to pursue that direction in their careers. The project offers two levels of difficulty. It is also offered in an online version so that casual users can try it without having to access a VR headset. Both the online and VR versions can be accessed from this page:

http://www.bbc.co.uk/academy/en/articles/art20170925155112061

## Chibitronics *Love to Code:* Paper Craft Meets Programming

Jie Qi (Massachusetts Institute of Technology), K-Fai Steele (Chibitronics), Natalie Freed (Chibitronics), & Andrew “bunnie” Huang (Chibitronics)

*Love to Code* is an electronics and programming tool kit that comes in the form of an interactive storybook. With this book, *Love to Code*, Volume 1, we aim to create a gentle introduction to circuit building and programming by using hands-on craft activities and friendly characters. Our story is about a frog named Fern and her journey to learn electronics with the help of her friends. As Fern learns to build circuits and write code, so do our readers. What is unique about this book is that readers build functioning circuitry right onto its pages and program them to light up to tell their own stories. Imagine a coloring book for circuits that blends the expressiveness of paper with the interactivity of programming. With the book is a kit of electronic craft materials such as LED stickers, conductive copper tape, and a programmable clip. Together it is a basic electronics workbench contained in friendly, portable storybook.

## Learning Analytics in a Teacher Dashboard to Facilitate Inquiry-Based Instruction

Joseph Reilly (Harvard Graduate School of Education), Vishesh Kumar (University of Wisconsin Madison), Shari Metcalf (Harvard Graduate School of Education), Matthew Berland (University of Wisconsin Madison), Tina Grotzer (Harvard Graduate School of Education), & Chris Dede (Harvard Graduate School of Education)

This product is based on research on EcoXPT, a multiuser virtual environment (MUVE)–based ecosystems science curriculum. In EcoXPT, students observe a virtual pond and authentically test their own hypotheses regarding the underlying causal relationships in ecosystems through experimentation and investigation. In terms of metacognition, model-based feedback, and guidance for unproductive floundering, EcoXPT thus far has not taken full advantage of the rich data that virtual worlds generate. Time-stamped log files of activities in the virtual world can be used to guide teachers as facilitators of open-ended activities without imposing rigid structures that would negate some of the benefits of authentic scientific inquiry. The described teacher dashboard is a part of the EcoLENS project (Learning with Embedded Nuanced Support) that will explore adding near-real-time, automated guidance for students and teachers via learning analytics around learners’ actions in the virtual world. These supports will help teachers effectively implement and assess open-ended inquiry-based immersive simulations.

On different days of the curriculum, different actions are typically more prevalent. While there is no one "right" way to tackle the ill-structured problem, outliers on the graph may warrant teacher intervention to check for unproductive struggle or roadblocks. Seeing these patterns gives instructors a snapshot of how classes are progressing through the activity and can direct their guidance to groups that may need it most.

http://ecolearn.gse.harvard.edu/

## Watch Your Tendons Stretch as You Kick—A Foot-Controlled MR Experience

Jeanine Reutemann (Leiden University Centre for Innovation)

*Foot-eye coordination in mixed reality (MR):* At the Leiden University's Centre for Innovation, we codeveloped a playful, foot-eye coordination DynamicAnatomy application for the Microsoft Hololens. Medical students connect their own foot movements with the visualized and accurate detailed anatomic 3D model of the lower leg. The dynamic movement of the foot ankle with its resulting involvement of various different muscles, bones, and tendons are known to be a difficult challenge for medical students with traditional learning media. In the light of embodiment studies, this playful approach allows students to control the anatomical model with their feet and therefore recognize the activation and deactivation of the elements not only visually but also kinesthetically. *A novel approach toward anatomy learning:* Whereas other MR productions for anatomy focus on 3D visualization only, we assume that the involvement of the whole body of the user in the experience leads to more playful learning, and that it can be particularly helpful for concepts difficult to understand such as the movement dynamics of the lower feet (research study ongoing at this very moment). Moreover, the pure representation of a 3D model in MR is considered an instance of a classical media fallacy of the affordances. While such pure visualizations add a spatial factor to the experience of traditional moving images, they do not play toward the strengths of MR, as they only marginally interact with the body of the learners.

https://newmedialab.centre4innovation.org/augmented-reality-ar.html

## Learning Through Movement and Play: Creative Gamification in *Energetic Alpha*, an iPad App for Preschoolers

Gretchen Rinnert (Kent State University School of Visual Communication Design) & Marianne Martens (Kent State University School of Information)

Children are fascinated by digital devices. While there are thousands of apps in Apple's App Store claiming to have "educational" value, many fail to deliver. Some apps on the market generate income through invasive in-app purchases and advertising. Others rely on animation, motion, interaction, or activity that is contextually void of meaning. Our team of researchers created an iPad app called *Energetic Alpha* that presents letterforms through interaction and motion design. We incorporated meaningful gamification (Nicholson, 2012) via integrated video and participatory elements that require preliterate children to practice letter writing in order to unlock animated rewards. Our methods were inspired by Sanders and Stappers' co-design (2008) and Druin's (2005) cooperative design. We involved children and caregivers as co-designers in a series of focus-group interviews that provided insight and feedback on our prototypes. Our team had three initial goals: to create an app that meets the needs of young learners, is engaging, and is inclusive and incorporates diversity. In this Tech Demo we presented our finished app, which is now available for download.

https://www.energeticalpha.com

## Trash Traders: Synchronized Sustainability for Students

Jacob Rosenbloom (Carnegie Mellon Entertainment Technology Center), Longyi Cheng (Carnegie Mellon Entertainment Technology Center), Kacey Eichen (Carnegie Mellon Entertainment Technology Center), Jibran Khan (Carnegie Mellon Entertainment Technology Center), Zhenhao Xiong (Carnegie Mellon Entertainment Technology Center), & Michael Christel (Carnegie Mellon Entertainment Technology Center),

*Trash Traders* is an iPad game made through, designed for, and with the after-school environmental club of Steenrod Elementary School in Wheeling, West Virginia, and a team of students studying at the Carnegie Mellon University Entertainment Technology Center. The game's goal is to teach students about sorting, recycling, and how recycling positively impacts the environment. This resulted in the development of a 4-16–player collaborative iPad game played across four iPads, complete with teacher-facilitation pamphlet.

https://www.etc.cmu.edu/projects/flower-power/

## F**k #EdTech: Nonprofit Innovators Must Make Things

Kate Rosenbloom (Mouse) & Marc Lesser (Mouse)

Mouse believes that learning technology is no longer about basic engineering, computation, or information alone, but building students' skills and senses to apply technology creatively to make a positive impact in the world around them. Central to that mission is designing learning platforms that not only allow youth to traverse the wide landscape of skills and competencies that interest them in the digital age, but that also scaffold their practices to document, curate, and share their work through portfolios. Launched 15 months ago, now with over 18,000 accounts registered, Create is tool with which the Mouse organization offers especially underresourced public schools the opportunity to engage STEM and creative computing content, along with learning-management features, without the financially cumbersome burden of most "ed tech."

## MiTi Robot: A Chat Bot for Teacher PD in India

Louisa Rosenheck (MIT Education Arcade) & Brandon Hanks (Massachusetts Institute of Technology)

The Connected Learning Initiative (CLIx) is a collaborative project designing technology-supported, student-centered modules for Indian students in underserved communities. Professional-development courses, workshops, and communities of practice are also central to the program. However, Internet access for both students and teachers can be quite limited. To lower the barrier for teachers to access PD course materials on their phones, we created a chat bot to help teachers find materials when needed. In this Tech Demo we will display both the final version of the bot, as well as the content-management system used to create the content and its structure. We will discuss the design and development and share some results from the implementation with hundreds of CLIx teachers in India. We believe MiTi could be of particular interest to others designing for areas with limited connectivity, or creating other unique types of online learning experiences.

## Measuring Implicit Learning Through Analysis of Eye Movements

Elizabeth Rowe (TERC), Jodi Asbell-Clarke (TERC), Ibrahim Dahlstrom-Hakki (Landmark College Institute for Research and Training), & Eric Anderson (Landmark College)

The measurement of implicit learning requires tools that can analyze learners' behaviors in natural settings rather than relying on the learners' articulation of their knowledge. Revealing the Invisible (RtI) is augmenting game-based learning data with eye-tracking data to explore multimodal models of implicit learning. Many learners, particularly neurodiverse learners, are unable to demonstrate their knowledge on traditional paper-and-pencil assessments because of language- and attention-related barriers (Haladyna & Downing, 2004). We will present new tools for the analysis of eye-movement data gathered during gameplay in real-world learning contexts. We invite conference participants to test out the multimodal game data visualizations and discuss how they can help the research and teaching community identify and understand diverse learning and performance strategies.

## Analytics in App Inventor—Teacher Dashboard

Lisa Ruan (Massachusetts Institute of Technology) & Mike Tissenbaum (MIT Center for Mobile Learning)

App Inventor is a block-based programming language that allows young learners to quickly design and build fully functional mobile applications while developing their computational skills. Since its inception, App Inventor has grown to over six million users worldwide. This large user base has also produced a huge amount of data, which can provide important retrospective insight into a range of learners' computational activities such as understanding programming complexity and usage of specific programming concepts. One understudied facet to note is how this data could be used to provide teachers insight into the state of the students in their class during live coding sessions. In response, this Tech Demo showcases a real-time dashboard for App Inventor that uses analytics to reveal specific student behaviors so teachers can know when and where they are needed.

## Playing the Procedural Sonnet

Corey Sparks (California State University Chico)

This Tech Demo presents the Procedural Sonnet, a project that links electronic literature, gaming, and poetics. This project uses *Twine*—a narrative hyperlink game platform—to "play" a 17th-century sonnet. Each game screen presents players with a line of the sonnet that includes multiple bolded words. Players navigate by clicking on the bolded words. Players might proceed through the sonnet line by line. One might also skip lines or loop back. The game's conclusion displays a player's "edition" of the sonnet. (A beta version of the project can be reached via the link below.) The Procedural Sonnet provides multiple pedagogical possibilities. First, it enacts the idea that reading a poem is an active process and requires noting details and making choices. Presenting students with multiple ways to navigate the poem invites them to reflect on readerly choices. Second, the game can become a template; students then use *Twine* to produce their own sonnet games, making developer choices to craft player experience. Named in reference to Ian Bogost's concept of "procedural rhetoric," the project complicates a highly recognizable poetic form to argue for the intersection of game studies and poetics via concepts of procedure and form. Furthermore, the project enacts what Lisa Samuels and Jerome McGann call "deformance"—a deforming, performative procedure "for reconstituting [a] work's aesthetic form" (1999, p. 28). The project demonstrates how the digital deforms the poetic, and it also considers how the poetic itself provides deformative possibility in its encounter with the digital.

http://philome.la/CoreySparks/the-procedural-sonnet-beta-12/play

## Circulating Voices: A Hybrid System for Listening

Benjamin Stokes (American University) & Samantha Dols (American University)

In a digital age, communities need new ways to listen, including to marginalized voices. Local stories matter—especially on issues of diversity, racial bias and inclusion. Yet there is often a gap between the stories that circulate in private spaces and in more formal environments. Too often the same members are called to repeatedly testify in person about the community's past and current issues. Can we shift how stories circulate and bring audio stories into new spaces? Our design investigates a hybrid model for circulating local voices in a residential community, connecting physical space to digital flows of media. Specifically, we combine a physical object (a rebuilt pay phone) with digital distribution and short message service (SMS) interactivity. This hybrid object has a physical footprint, yet it can also gather stories from cell phones and publish to the Internet. Over the past year, our team has tested a prototype on a university campus. We find that the technology is the easy part; the harder challenge is to position the stories, including through participatory governance, student journalism, oral history, live events, and conversation guides. The physical installation is the most visible aspect of the design. It resembles a pay phone on wheels, positioned in public spaces where foot traffic is high. Positioning such objects matters, and echoes how architecture can facilitate conversations, and how traditional cafés can foster dialogue as third spaces. Yet the digital shifts the geography for conversations too, and hybrid models are increasingly needed to affect local storytelling networks.

https://auvoices.net/

## A Collaborative Emotion Recognition Game Designed With and for Autistic Individuals: *Connecting Through Kinect*

Deborah Sturm (Department of Computer Science College of Staten Island CUNY), Michael Kholodovsky (Department of Computer Science College of Staten Island CUNY), David Shane Smith (College of Staten Island), Pavel Asanov (PlayFitness), Rayan Arab (Psychology Department College of Staten Island CUNY), Joseph Hayes (Psychology Department College of Staten Island CUNY), & Kristen Gillespie-Lynch (Psychology Department College of Staten Island CUNY)

Despite excitement about computer-mediated supports to help autistic people develop social skills, evidence-based benefits remain limited. Participatory research in which autistic people collaborate in game design and evaluation can help address the disconnect between the potential of computerized autism interventions and the limited benefits documented thus far. Autistic people face challenges collaborating with others, including difficulties responding adaptively to others' emotions. By involving autistic college students in game design, we aimed to develop a game-based intervention to help autistic people understand complex emotions and collaborate, *Connecting through Kinect*, which is engaging and has social validity. Our game is designed to promote generalizable social-communicative skills by providing players with immersive opportunities to simultaneously engage digitally and in person. Standing next to each other, players complete collaborative emotion-matching puzzles using gestures to move puzzle pieces. Each puzzle depicts the outline of a figure in an emotional context. After players construct the body, they agree on the correct emotion by selecting from three faces. Our autistic collaborators have provided useful suggestions that have led to extensive improvements in game design. They reminded us to incorporate key design principles (a story line and an interpretable reward system) that are believed to promote generalization but are often lacking in games designed for autistic people.

http://www.cs.csi.cuny.edu/~sturm/ConnectedLearningSummitMIT/ConnectingThroughKinect.pdf

## Moving Beyond the Novelty Effect: VR in K12 Education

Meredith Thompson (Massachusetts Institute of Technology), Judith Perry (MIT Education Arcade), Dan Roy (Massachusetts Institute of Technology), Rik Eberhart (MIT Media Lab), Philip Tan (MIT Media Lab), & Eric Klopfer (Massachusetts Institute of Technology)

*Cellverse* is an educational game designed to help students in high school biology learn about cells. In *Cellverse*, an explorer using a head-mounted display and a navigator using a tablet work together to diagnose and treat the cell. *Cellverse* is created by the Collaborative Learning Environments in Virtual Reality (CLEVR) group, a partnership between MIT's Education Arcade and the MIT Game Lab. Using a design-based research approach (DBRC, 2003), we evaluate the game both from a "top-down" (expert) and "bottom-up" (user) approach to ensure quality (Kurilovas, 2016). Subject-matter experts provide ideas about scientific tools and a current understanding of cystic fibrosis. User feedback enabled us to develop effective locomotion and interaction with the organelles. User testing has also provided insight into how to create effective rules, roles, and resources in the game. The top-down and bottom-up approach to creating *Cellverse* has enabled us to create an interactive and engaging experience in the unfamiliar environment of the cell. Many of the experts and users had never experienced VR before, yet were able to give critical feedback that has helped us design and refine the game. Our next round of user testing will focus on how to create the curriculum and resources needed to support educators in using *Cellverse* in their classrooms. Although the design and development process and user testing process has been time intensive, we believe that this approach has helped us create VR games that move beyond the novelty effect.

https://education.mit.edu/portfolio_page/clevr/

## Improving Spatial Reasoning Through a Mobile Game: *Optica*

Nicolaas Vanm (University of Minnesota Twin Cities)

Embracing simplicity with a geometric design, *Optica* reveals puzzles in complex and mind-bending ways. From curious shapes and optical illusions to unexpected perspectives, *Optica* puts spatial thinking to the test through 70-plus challenging levels.

https://opticagame.com/

## Reflections on Workforce and Career Exposure Through Youth-Led Immersive Storytelling

Aparna Wilder (IRL Labs) & Ali Momeni (Carnegie Mellon University)

Preparing today's youth to actively explore and understand a range of career options requires teachers, students, and industry professionals to engage in collaborative learning, advising, and exposure programs. In an effort to create transformational high school experiences, several high school institutions are integrating workforce-development programs into their curricula. Nazareth College and Career Prep (an independent Catholic school that serves all faiths) partnered with IRL Labs (an education-technology startup) to work with a small group of students to design and iterate a series of 360 immersive virtual reality (VR) stories in collaboration with students in the Corporate Internship Program. During the Tech Demo, participants can view the student-built immersive stories, discuss lessons learned, and discuss potential curriculum-integration opportunities in schools that may not have advanced internship programs but might still be interested in digital storytelling platforms for career exploration.

## The Architecture of *Assassin's Creed II*'s Florence: An Analysis With the History-Game Relations (HGR) Framework

Gabriele Aroni (Ryerson University)

This presentation explores how the city of Florence during the Renaissance is represented in the game *Assassin's Creed II*. The city of Florence stands in a particular position as concerns its historical representation, as it has been preserved largely intact from the time of the game's setting in the 15th century. Moreover, it is this very characteristic of being mostly unchanged that shaped its look in the collective imaginary, not to mention the millions of tourists who visit the city every year. In order to analyze how the city of Florence has been re-created in *Assassin's Creed II*, and how it has been adapted to satisfy both the needs of a functional and entertaining game, and what people would expect from the "Cradle of the Renaissance," we will use the history-game relations framework (HGR) during the first phase of the game set in Florence.

## The Logical Journey of Reimagining *"Zoombinis"*: Adventure, Research, and Computational Thinking

Jodi Asbell-Clarke (TERC), David Libby (TERC), Peter Stidwell (FableVision), & Scot Osterweil (MIT Education Arcade)

*The Logical Journey of the Zoombinis* was created by Scot Osterweil and Chris Hancock while they were working at TERC in the 1990s and it became an instant sensational "edutainment" game. Zoombinis, TERC, FableVision Studios, and the Learning Games Network redeveloped and re-released *Zoombinis* for today's audience and modern devices. Many of the skills applied in *Zoombinis* gameplay fall under the category of computational thinking (CT), which includes practices such as problem decomposition, pattern recognition, abstraction, and algorithm design. To study the development of CT in *Zoombinis*, EdGE at TERC is currently conducting a nationwide implementation study with over 30 classes of upper elementary and middle school students. The *Zoombinis* research uses educational data mining to design and validate automated assessments of CT that players demonstrate implicitly within their gameplay. These formative assessments will enable educators and designers to provide adaptive and customizable CT learning experiences, aiming to differentiate learning for a diverse audience of young learners. Thus far the research study has found that (a) teachers highly value activities that help them connect CT in the game to their math, science, and other class content, (b) teachers are finding that students with individualized educational plans (IEPs) are becoming class leaders in *Zoombinis* activities, and (c) we have identified patterns in the players' game-log data that we can reliably say are consistent with CT. Future work will include releasing results from a study of over 50 classes that compares CT assessments within the game with external ratings of students' CT.

http://zoombinis.com

## *Hearthstone:* Managing Randomness and Collectible Card Gameplaying as Collective Cognitive Achievement

Nicholas Persa (University of California Irvine), Kurt Squire (University of California Irvine), & Mike Tissenbaum (MIT Center for Mobile Learning)

*Hearthstone* is a mobile and PC collectible card game sporting an estimated 70 million player base. The gameplay experience and mechanics emphasize making predictions and systematically constructing and referencing probabilities ("What is my opponent trying to do; what is my most likely next card?"). Each game relies on a random ordering of cards, which requires players to think through complex scenarios and potential configurations of plays and counterplays. When a plan goes awry, flexible players adapt and reconfigure their resources to accomplish a different plan. A sizable community supports the recruitment of this expertise through novices, experts, teachers, mentors, and guides. The player Jeffrey "Trump" Shih alone has garnered hundreds of thousands of followers on his instructional-content channels and reached millions of views. Other noncelebrity players contribute information and drive collaboration, such as the large-scale data-analysis project HSReplay.net. Streams, videos, tools, and other resources visualize the nature of *Hearthstone* expertise and provide vicarious demonstration of that skill in practice. Cognitive achievement within this system of production and consumption is meaningful for personal development and further study of its affordances can advance the design of future and current expertise-recruitment systems. Games, and particularly titles similar to *Hearthstone*, support the development of probabilistic and strategy-driven mind-sets while illustrating a decentralized self-organizing community model of expertise development.

## Players as Transitional Characters: How Youth Can "Breakaway" from Gender-Based Violence

Hua Wang (University at Buffalo, The State University of New York), Yishin Wu (University at Buffalo, The State University of New York), (University at Buffalo, The State University of New York), & Ann DeMarle (Emergent Media Center Champlain College)

*Breakaway* is a football-themed digital game that uses the mechanics of interactive storytelling from a first-person perspective to help youth worldwide learn about gender-based violence. We highlight narrative elements built into the game design to facilitate social learning and behavior change, enabling players to become "transitional characters" and break away from negative gender norms. We also feature the user experience captured through various research methods and summarize how young players in different parts of the world have responded to the *Breakaway* initiative.

https://breakawaygame.champlain.edu

### *Zoombinis:* Bridging Implicit to Explicit Computational Thinking

Jodi Asbell-Clarke (TERC), Elizabeth Rowe (TERC), Erin Bardar (TERC), & Santiago Gasca (TERC)

*Zoombinis* is a popular learning game that engages young learners in computational thinking. Research on *Zoombinis* is revealing how educational data mining can be used for formative assessment of computational thinking within *Zoombinis* gameplay, and how teachers can leverage this implicit game-based learning for improved computational thinking in the classroom.

### Improving Peer-to-Peer Interactions and User Experiences Within a CSCL Environment Through Gamification

Susan Bitetti (Tufts CEEO) & Ethan Danahy (Tufts University)

InterLACE (interactive learning and collaboration environment) is a computer-supported collaborative learning (CSCL) tool developed at Tufts University supporting active learning in high school physics education. Initial usability testing yielded positive results. In classroom testing, peer-to-peer interactions were below expectations. Gamification was employed to motivate use, and its influence on InterLACE user interactions and participation was studied during a physics learning activity. University students ($N$ = 48) aged 18–31 were assigned in groups of four to six to either gamified or control conditions. Rules for points, a leaderboard, badges, and time constraints were introduced. The leaderboard provided immediate score and rank feedback. Results were studied using social network analysis. Sociograms revealed stronger ties in gamified participants and there was increased idea uptake indicated by greater in-degree centrality or prominence.

### Define Privacy: Teaching Kids About Privacy and Social Media Using an Educational Game and Interactive Documentary

Giuliana Cucinelli (Concordia University)

K–12 schools across Canada face long-standing problems with digital devices in schools, such as bullying, theft, bystander apathy, student performance, cheating, and short attention spans, to name a few. These issues stem from years of schools not being equipped with the proper educational support to adapt to the technological changes in the lives of their students. Financial support has trickled down from Ministries of Education and established expensive state-of-the-art technological classrooms of the future with SmartBoards, clicker systems, and tablets; however, minimal to no financial support is provided to help teachers and schools build curriculum for these electronic tools. Furthermore, there is very little infrastructure at the Ministry of Education level available in regards to policy for digital devices for teachers to establish guidelines in their classrooms and reach out for support. To ensure that Canadian K–12 students, teachers, administrators, and parents are prepared to participate in healthy, balanced, and informed digital-device practices within the context of supportive and insightful digital-device policies, this research project wishes to develop insight into the existing practices and policies shaping the learning environment in school settings and informing policy makers such as Ministries of Education and Conference Board of Canada of the changes. This presentation will showcase the outcome of a two-year research project available on the research project website www.YouthMediaPractices.ca that responds to our need to better understand how young people engage in digital media practices to live, learn, and play. It will offer insight on how young people understand and define privacy in the context of their digital devices, both online and offline. The project is fundamentally grounded in theoretical tenets of media literacy, media education, social-emotional intelligence, and social construction of technology.

http://youthmediapractices.ca

## Exploring Learning and Community Engagement Using Virtual Reality in Washington State Libraries

Negin Dahya (University of Washington), Jin Ha Lee (University of Washington), & Kung Jin Lee (Information School)

This study explores the public library as a location to engage patrons in otherwise unattainable experiences such as exploring the solar system, the White House, and venturing into history, using the virtual reality (VR) technology Oculus Rift. The six libraries included in this pilot project represent the socioeconomic and racial diversity of western Washington State. In this session, we will discuss our partnership with the local library sites and focus on our collaborative process of constructing programs that enrich local learning ecologies in meaningful ways, using VR and other available library resources. We will also discuss the research study with a focus on the process of collecting and analyzing data across these sites. Our project aims to serve library patrons in nondominant communities, and especially young people. This project began in January 2018 and VR programs will be deployed from March to June 2018, with intensive data collection throughout these months.

## EcoMOD: Blending Immersive Technologies and Programming to Support Scientific Inquiry in the Elementary Grades

Amanda Dickes (Harvard Graduate School of Education), Shari Metcalf (Harvard Graduate School of Education), Amy Kamarainen (Harvard Graduate School of Education), Joseph Reilly (Harvard Graduate School of Education), Karen Brennan (Harvard Graduate School of Education), Tina Grotzer (Harvard Graduate School of Education), & Chris Dede (Harvard Graduate School of Education)

In the modern world, it can be argued that computing structures much of our daily lives and impacts how we interact and relate to the world around us. Given the primacy of technology in modern society it is unsurprising that computational thinking, an analytic problem-solving and design approach fundamental to computing, has now been incorporated as an essential focus of science, technology, engineering, and math education. However, recent research has shown that curricular integration of computational thinking is a complex and challenging endeavor that involves the introduction and adoption of new literacies to both teachers and students, alongside disciplinary ideas and practices that students already find challenging to understand. The EcoMOD project addresses this challenge by meaningfully blending

immersive virtual environments and computational modeling and programming tools to reinforce the fundamental role of models and modeling in elementary science. In particular, we extend the argument that framing the design of the EcoMOD learning environment around Pickering's notion of the "mangle of practice" meaningfully integrates both computational mediums such that the epistemic goals of science become explicit to young learners, which, in turn, supports elementary students' learning of computation and scientific modeling in a reflexive manner.

https://ecolearn.gse.harvard.edu/ecoMOD/overview.php

## Make It Playful 2018: A First Step Toward Playful Design

Laure Dousset (Plush & Nuggets)

Play has been studied as a very powerful and engaging experience. However, it is difficult to currently find research or use cases associating play with mediums other than games. Games are a structured form of play and we should explore other types of mediums that are more open ended. To explore this idea, we organized a hackathon called Make it Playful. What is happening when we design an object with the idea of making it playful? Is there *a way* to do it? How does it affect the designers? What is playful design? For one week, 14 multidisciplinary and multicultural participants hacked seven objects to make them more playful. We chose the objects that we tend to interact regularly with. We were surprised by the diversity in the results of their production but they all had in common to try to promote deeper interactivity (physical, emotional, social, and cognitive). We would advise designers who want to make playful design to focus on the invitation to play—instead of the process. We also thought that the classical problem-solving approach tends to limit playful ideas and that the use of creative material (and not just technological ones) was very inspiring. We also realized that participants had a lot of fun when designing, that they liked the idea of it, and they reported themselves enriched from the experience of trying to make playful design. This first hackathon was a real learning experience and we are aiming at building more Make it Playful events.

https://www.plushnuggets.com/make-it-playful/

## Connected Learning From Assessment to Treatment: How Clinical Decision Making and Practices in Speech Therapy Can Inform Game Design

Yao Du (University of California Irvine)

Speech language pathologists (SLPs) use both educational and medical models during assessment and treatment, and their clinical knowledge about working with children across different contexts can inform the design of digital media and technology for children with communication impairments. SLPs are not only investigators for children's impairments but also designers of children's learning experiences during therapy using a variety of nondigital and digital activities, including games. This paper first reviews two guiding frameworks—international classification of functioning, disability, and health (ICF) framework, and response to intervention (RTI) framework—and then explains how working with SLPs may address existing limitations in participatory design (PD) with children when designing digital media and technology for speech therapy. Last, after summarizing design challenges for children with communication impairments, the paper synthesizes the value of involving SLPs for research and offers a future research agenda.

http://sites.uci.edu/yaodu/

## Journey of the Esports Digital Warriors

Jason A. Engerman (East Stroudsburg University) & Richard Otto (East Stroudsburg University)

With close to one billion dollars in revenue, esports has seen international growth unlike any other traditional sport in human existence. This fast-paced industry is expected to reach 1.5 billion dollars in revenue by 2020. In fact, esports leagues such as Overwatch seek to become the next NFL. The Digital Media Technologies Department at East Stroudsburg University decided to digitally document and explore meaning-making processes by leveraging the new and captivating communities that form around esports clubs. As the student body took on a quest for esports club status, the two faculty advisors within the department saw an opportunity to build a project around the authentic digital media–technology competencies that formed. Specifically, this project sought to unearth the digitally creative competencies that formed toward establishing a sustainable student-organized esports community, developing a universitywide esports tournament, and links between interest-driven digital development and career readiness. This study showed how students organically engaged in STEM activities around digital media technologies as they developed graphic materials, used multicamera 4K Livestream Switcher as well as 4K cameras, Glide camera mounts, tracked dolly systems, and Twitch streaming software toward a full live-production esports event.

https://clalliance.org/blog/the-emergence-of-the-esu-digital-warriors/

## Understanding Hip-Hop Music as Collaborative Media Making in the Formal Classroom: The Case Study of Chicago's Foundations of Music

Jabari Evans (Northwestern University)

Hip-hop culture has long been argued to be very beneficial to understanding the learning strategies of youth in marginalized urban communities. Many researchers have historically depicted hip-hop–based education programs and pedagogy as having significant value for students disengaged from traditional approaches to learning. However, scholars have almost exclusively looked at these experiences in a high school or postsecondary setting, particularly how this pedagogy engages those youth from a music education context. This paper is an ethnographic study of the Foundations of Music Songwriting and Music Production program as an exemplar of hip-hop as a pedagogy of artistic practice for younger students within the music classroom. Through the personal narratives of teaching artists and observed classroom discourse in two middle schools, I describe how class activities encouraged the civic imagination of students and invoked essential critical reflection about their personal lives and communities. This case study replicates and extends previous work by suggesting that understanding hip-hop's presence in the lives of youth in early and middle childhood not only offers cultural relevance to K–8 classrooms but can bolster problem-solving skills and critical media literacy within a student-led community of practice. In promoting hip-hop pedagogy in music education, this study suggests that

placing hip-hop as artistic practice in the academic spaces helps students to use critical media skills to advocate positions, contest claims, and organize action around issues that they truly care about.

http://www.foundationsofmusic.org/

## Make/Share/Keep: Cultivating, Promoting, and Documenting a Making Community at the Library

Jason Evans Groth (North Carolina State University Libraries) & David Woodbury (North Carolina State University Libraries)

*Making* has taken on a specific meaning in the world of education and instruction. How can educational institutions promote the making, in several forms, of new knowledge, use what is made to inspire others to make more creations that demonstrate new knowledge, and keep those creations to document the changing landscape of knowledge and knowledge making? In addition to a firm dedication to providing access to previously made knowledge, North Carolina State University librarians have democratized technologies and making methodologies to assist in all forms of making new knowledge and have created several channels to “capture and promote” this kind of making. These channels celebrate the diverse voices that make up a community of knowledge and, in a sense, create an inspiring “menu” of opportunities for other students, faculty, staff, and any patron interested in making new work and sharing it locally and with the world, in various formats. The libraries strive to both incorporate making as it is currently interpreted and broaden it to include all forms, from traditional to the cutting edge, to inspire our patrons. Our presentation shows how the library, by amplifying the results of the instruction, consultation, and democratization of technology to which it has always been dedicated, can be instrumental in promoting making, sharing what is made to exemplify to others what is possible and promising, and keeping what is made as part of its collection to provide community context and inspire others—both in and out of the campus and academia—for years to come.

https://docs.google.com/presentation/d/1m7RAxRInQvfF91Icac6OCKXCjsL4-RMyJfl3JKSrGlU/edit?usp=sharing

## The Exam Is a Lie: Using *Her Story* to Teach Close Reading

John Fallon (Fairfield Country Day School)

*Literacy* and *media literacy* have both long been identified as essential, but separate, areas of study. Marshall McLuhan and, more recently, danah boyd have argued that the multimedia landscape requires citizens to be acutely aware of not only the message they are receiving but how it is being presented. Fortunately, unreliable narrators have been paving the way to build the intellectual immunity to survive a messy media landscape. Literary unreliable narrators from Edgar Allan Poe to Shirley Jackson have challenged readers to untangle vague, distorted narratives that even the narrators themselves may not fully understand. However, in the YouTube era, we need to challenge our students with the visual, too. As such, Sam Barlow’s video game *Her Story* may be an exemplary text for this. Its combination of close reading and multimedia interactivity is an engaging way to prepare students for the unreliable narrators they find around them.

## Designing for Multiple Pathways in Online Learning Experiences

Lily Gabaree (MIT Media Lab), Carmelo Presicce (MIT Media Lab), Yumiko Murai (MIT Media Lab), & Moran Tsur (MIT Media Lab)

Massive open online courses (MOOCs) have the potential to reach a large number of people, and they typically do so by providing a standardized, homogenous experience for all the participants. Designing an online learning experience that is relevant and personally meaningful for a group of diverse learners is an enormous challenge. As we designed an online course and community around the idea of creative learning for 15,000 participants from around the world (as of November 2018), we experimented with offering a learning experience that would support many personal learning paths accommodating those participants' diverse roles, motivations, interests, and preferred styles of engagement, while providing shared learning experiences where they can find a point of connection with one another. The analysis of observational notes on the interactions in the discussion forum as well as the pre-, mid-, and postsurveys revealed that the course accommodated various styles of participation, while participants connected with one another sharing resources and learning from one another. In this presentation, we introduced some of our design choices and how we addressed the tension of supporting diverse personal learning paths while building community through shared course experiences. In addition, we shared some early observations about the participants' engagement and discuss directions for further investigation.

http://lcl.media.mit.edu

## The Family That Codes Together: Creative Engagement With English Language Learner Families and Public Media

Mary Haggerty (WGBH Educational Foundation), Mollie Levin (WGBH Educational Foundation), Devon Steven (Corporation for Public Broadcasting), & Daniel Noyes (Tech Goes Home)

Immigrants make up more than a quarter of Boston's population; many are families with young children. As parents work hard to acclimate to a new culture and a new language, they often sacrifice time spent with their children. Tech Goes Home (TGH), English for New Bostonians (ENB), Boston Public Schools' Adult Learning Center (ALC), and WGBH, Boston's public media station, saw an opportunity to bring these families together to learn *and* have fun around coding. In 2017, they collaborated under the CPB–PBS Ready to Learn Initiative, funded by the U.S. Department of Education, to implement a workshop series—PBS KIDS Family & Community Learning: PBS KIDS ScratchJr—to teach storytelling through coding.

https://mass.pbslearningmedia.org/collection/pbs-kids-family-community-learning/

## Creating Digital, Interactive Professional Learning Experience for Educators

Leigh Hall (University of Wyoming) & Lori Bruner (Michigan State University)

The purpose of this project is to document how short, online courses (called microcourses) can help middle and high school teachers develop and implement instruction that supports students' abilities to read and write within their academic disciplines. Additionally, we examined how the creation of an interactive online community could provide ongoing support for teachers as they engaged with the ideas they learned about in the microcourses. Going forward, we are interested in seeing how the instruction provided in these courses helps students grow as readers and writers when it is applied by their teachers. In our presentation we will share: (a) what we have learned about how to implement effective online professional learning, (b) how teachers participate in the interactive, online community, and (c) what teachers have learned through participating in the microcourses

## Symbiotic Learning Partnerships: Toward Action Sports–Inspired Learning Environment Design

Ty Hollett (Pennsylvania State University)

Reporting on an ethnographic study of youth digital media production in action sports, this paper describes the symbiotic learning partnerships formed between teen skateboarders and teen videographers necessary to collaboratively demonstrate mastery of both tricks and video capture/editing. Symbiotic learning partnerships emerge when partners are, as one participant says, vibing with one another: when they are deeply invested in the production of a collaborative media artifact that they will jointly distribute across social media. When vibing with one another, skaters and videographers fall into collaborative, rhythmic cycles. This working paper advances perspectives on symbiotic learning to further consider the design of digital media learning environments that attend to the nuances of specific interest-driven cultures in order to open up learning opportunities to youth who share related interests (e.g., skateboarding, videography) within an overarching community (e.g., action sports).

## Involving Youth as Educational Program Co-designers: Disrupting Hierarchy and Empowering Youth

Theresa Horstman (University of Washington), Gavin Tierney (University of Washington), & Carrie Tzou (University of Washington)

Youth co-design can strengthen the impact of educational programs and learning environments by empowering youth, incorporating diverse perspectives, and attending to ideas that might otherwise go uncaptured. However, there are also challenges that prevent youth co-design from becoming standard practice. This paper repositions co-design to focus on: (a) supporting learning processes, (b) the sustainability of learning programs, (c) broadening participation in STEM, and (d) positioning youth to have ownership in the program through the design process. Using qualitative research methods, we analyze interview transcripts, video, and documents from co-design design sessions with Aquarium program coordinators and high school youth volunteers who co-designed a digital badge system to correspond with the Aquarium's youth volunteer program. We found that co-design is not a uniform process, but one that requires intentional design of specific tasks and how those tasks position youth.

## Participatory Place-Based Augmented Reality Co-Design for Scientists and Girls

Amy Kamarainen (Harvard Graduate School of Education), Catlyn Stylinski (University of Maryland Center for Environmental Science), Ruth Kermish-Allen (Maine Mathematics and Science Alliance), David Gagnon (University of Wisconsin Madison), & Martin Storksdieck (Oregon State University Center for Research on Lifelong STEM Learning)

To support young women in adopting identities as competent in science and technology, our NSF-funded AR Girls project partners 12–16-year-old girls in rural Maine with local science professionals and art educators to create location-based augmented reality (AR) tours that communicate science issues related to their communities. Prior powerful “proof-of-concept” projects provide insight into how to engage youth in AR design. Yet we need to better understand how these experiences impact learning, engagement, and affective outcomes, and how to best create instructional contexts to support these outcomes. The AR Girls approach rests on four foundational principles: stealth science, nonhierarchical co-design, place-based education, and learning through design. Girls are recruited through their interest in art and attend activities at a local art organization led by an art educator. They gain AR design and programming skills and work collaboratively with local science professionals to produce an AR experience to communicate about an important community issue. They share their design experience and AR tours during a communitywide event and gather feedback on impacts of their messaging on users. Throughout they gain exposure to career opportunities at the intersection of art, communication, technology, and science, and they explore how their own interests relate to using digital interactive art (e.g., AR) to communicate about important issues. Our AR Girls team is iteratively testing the design of the project, and we hypothesize that collaboratively producing AR to communicate about science-related issues can improve girls’ self-efficacy, attitudes, awareness, and intention with regard to science communication and digital design.

## Transformative Teacher Inquiry Group: Connect, Make, Hack

Julia Kantor (University of Colorado Denver), Jennifer Garst (Manual High School), Branta Lockett (Ashley Elementary School), & Julia Nucci (Green Valley Elementary School)

The following working paper proposal describes the process, emerging questions, tensions, and design work by four public school teachers in their quest to learn more about connected learning (Garcia, 2014; Ito et al., 2013). As part of a larger study around connected learning in teacher education, this collective work uses the principles of connecting, making, and hacking (Baker-Doyle, 2017) to enable the teachers to pursue interest-driven projects that ultimately work toward equity and justice for their students. This collaboration between university instructor and the teachers represents one way to use connected learning to help teachers develop a powerful pedagogical framework within which to develop agency in their teaching.

## Bringing Joy and Rigor to Elementary and Middle School Computer Science Education With Coaching

Diane Levitt (Cornell Tech)

To address the challenge of teaching computer science to all students in New York City, Cornell Tech has piloted a content-coaching strategy called the Teacher-in-Residence. The coach is a member of the school’s teaching community, meeting regularly with teachers to plan, observe, and review. Through content coaching, we build both content and pedagogical mastery, helping teachers present highly engaging project-based learning experiences.

## Global Workshop: When Global Education Meets 21st-Century Learning in an Internet-Based

## Society

Marcos Sadao Maekawa (Keio Graduate School of Media Design) & Keiko Okawa (Keio University)

Global education was conceived in postwar Europe to widen students' eyes and minds to universal values required for citizens of a global society. Over the years, social phenomena and processes such as mass migration movements or globalization have influenced and shaped the global community and consequently global education. However, in the last two decades, the Internet came, became a unique global infrastructure, and has been making profound impacts, rapidly transforming what global society used to be. This research has been designing practices to foster a generation of young global citizens for the digital era. First, the authors summarized the current status of global education, identified the needs of global citizenship in an Internet-based society, and then proposed programs inspired by 21st-century learning, design thinking, and information and communications technologies (ICT).

## Engaging Students to Engage Students for Connected Learning

Trish McCluskey (Victoria University), Katie Elizabeth (Victoria University), & Miriam Bennett (Victoria University)

VU Scout is a mobile app designed by students for students to promote social connection and engagement with peers, teachers, and the university community and ultimately ensure student success. This presentation will outline the challenges and opportunities of partnering with students to co-create an innovative product that meets the expectations of all stakeholders. The app enables students to activate learning spaces both online and around campus, including virtual learning spaces. The app encourages activities known to improve student engagement: making friends at university, attending class, spending time on campus, and engaging in extracurricular activities. The app is designed to incentivise these activities using fundamental gaming principles such as leader boards, prizes, and rewards while drawing inspiration from popular apps such as Snapchat and *Pokémon GO*.

## Building on the Strengths of Technology-Timid Teachers and Diverse Digital Writers

Katie McKay (University of Texas Austin)

In this session, the context of an Educator Innovator LRNG Challenge Grant–funded project jump-starts conversation about how writing for local and digital audiences can support connected learning and also motivate technology-timid teachers to integrate digital tools in authentic and innovative ways, despite challenging contexts. As we play with edu.buncee.com and view and comment on teachers' and students' buncee creations, we consider: How can we flip the digital conversation from deficit to additive? How can we talk not about all that our culturally and linguistically diverse students lack in access to digital tools and connectivity, but instead recognize their strengths and use those strengths to build connections?

## Self-Directed Student Learning Pathways Before and After Games

Kevin Miklasz (BrainPOP)

Prior research has shown that the context around a game often matters as much as the game itself when considering if the game is a good learning tool. This can mean considering what educationally relevant activities occur before and after playing a game, or what we term here as *student learning pathways.* We examined common student learning pathways that occurred between GameUp (containing over 150 vetted educational games) and BrainPOP (containing over 800 learning topics across subjects). Using sequential pattern-mining techniques, we are able to mine the common student pathways and investigate how learning occurs across those pathways. This is a work in progress, but results so far show asymmetric patterns between games and other learning content—students tend to move from learning content to games more often than the opposite. These patterns are relatively consistent across games, with some differences between different game publishers.

## Where the Wired Things Are: A Study of Current Technology Use in Public Library Programming for Young Children

J. Elizabeth Mills (University of Washington), Kathleen Campana (Kent State University), Marianne Martens (Kent State University), & Claudia Haines (Homer Public Library)

Children today are growing up in a technology-filled world, in which they use technology in some form at school, at home, and in other informal learning environments, even as the access gap persists. Libraries, valued as important sites of informal learning for children, have the opportunity to fill this gap by providing technology and media mentorship through the programs and services they offer to families and children. A 2014 survey provided crucial insight into how libraries throughout the nation are using different technological devices in their programming with children, with more than 70% of libraries surveyed reporting some kind of technology use in their programming with young children. The current study looks to build on those initial findings by more deeply exploring cultural inclusivity in this tech use as well as types of mentorship and types of adult–child interactions involving technology in libraries through a subsequent survey. This intentional study of the landscape of technology use in library story times will help to establish current practices, making it possible to carve out an area of study that will best inform and advise librarians in this new age of programming for young children and families. The more that librarians know about how children and families are using media and the more that they understand effective ways to incorporate media into the services and programs they offer to all families, the better their work will be to provide families with the information they need to plan for healthy, interactive, cooperative media sharing.

https://sites.google.com/view/ycnml18/home

## The Evolving Design of a Blended Course for In-Service Teachers: The Communicative English Language Teaching Course Story

Surbhi Nagpal (CLIx / CEIAR / TISS, Mumbai) & Anusha Ramanathan (CLIx / CEIAR / TISS, Mumbai)

This working paper discusses the process of designing a practice-based blended course for in-service professional development of middle and higher secondary school English language teachers in India. The Communicative English Language Teaching course encourages teachers to reflect on their classroom practices and equips teachers with methods and principles to teach English as a second language in their classrooms. This is in tandem with the information and communication technologies (ICT)–enabled Connected Learning Initiative (CLIx) student modules developed to enable learners to acquire “communicative competence.” This disquisition outlines the need and relevance of such a course for English teachers in the Indian context and discusses the considerations kept in mind and the steps involved in designing this reflective language teaching course for teachers. It also highlights the key findings, reflections, and suggests recommendations from a yearlong process of development and implementation of the course.

https://clix.tiss.edu

## Availability of AP Computer Science Among Magnet High School Students: A Question of Accessibility

Fay Cobb Payton (North Carolina State University), Jenna McChesney (North Carolina State University), & Alexa Busch (North Carolina State University)

The pathway(s) to Advanced Placement Computer Science (CS) has been met with well-documented barriers for Black, Latinx, Native American, and female high school students. We report on an initial examination of public instruction data with a focus on two magnet schools in North Carolina. Because of their magnet status, the high schools are often considered to be well resourced, and students are depicted as high achievers. The data provide insights on the availability of and accessibility to CS curricula among high school students. The schools have significant representation of students of color, but their enrollments in the CS courses is not representative of the populations enrolled. This study explores the factors that affect equitable student engagement in CS in schools that do not have the challenge of course availability. We address what is the meaning of CSForAll, and who has availability and access to CS curricula.

http://changecomputerscience.org

## Augmented Reality in Informal Learning Environments: Research Trends 2010–2017

Mark Petrovich Jr. (Drexel University), Mamta Shah (Drexel University), & Aroutis Foster (Drexel University)

The evolution of digital media technologies has afforded educators the ability to approach learning from an interactive and personalized perspective. Augmented reality (AR) provides several opportunities for these developing forms of learning. Despite abundant research within formal learning environments, research surrounding AR and informal learning environments is lacking. This study provides a review of empirical investigations involving AR applications within informal learning settings to address the current gap in literature. Eighteen articles were examined between 2010 and 2017 to gain insights about educational outcomes, claims, methodologies used, and demographics that were involved in studies involving AR implementation. Initial analysis has demonstrated both similarities and unique challenges between formal and informal learning environments concerning AR. This review looks to expand on existing trends to evaluate the ways AR uses vary across formal and informal settings.

http://glide.soe.drexel.edu

## Gameful Mind-Set and Play

A Nicole Pfannenstiel (Millersville University)

As a teacher of freshman composition, I often encounter students who “can’t write” or “don’t like writing.” In exploring pedagogical approaches to support transfer of writing practices to various school and nonschool–based writing contexts, I found that supporting metacognitive reflection through gameful Twitter posts supports student engagement with writing. Drawing on game-based learning, and the idea that “there are no games; only players” (Benson, 2014, p. 224), I propose gameful mind-set as a frame for student-centered pedagogical design that incorporates habits of mind and positive reflection to support writing-practices development and encourages positive transfer of practices (framework for success). Gameful mind-set draws on the habits of mind (curiosity, openness, engagement, creativity, persistence, responsibility, flexibility, metacognition) as a way of approaching learning design to create prompts/quests for students to develop their own writing knowledge through the personal creation of learning artifacts and experiences through volunteer gameplay. This study found that, when prompted to write additional Twitter posts engaging with playful, creative posts, 50% of students (in junior-level and graduate courses) created more content than the minimum required. Based on this data, educators and instructor-designers can approach curriculum design drawing on habits of mind to develop pedagogical games that support student learning and student awareness of their learning.

## Learning English Through a Transmedia Storyworld

Patrícia Rodrigues (Universidade Aberta) & José Bidarra (Universidade Aberta)

Transmedia storyworlds present the potential to be used as multimodal sandboxes within which learners can gain a higher agency to produce language. We describe in this paper, part of an ongoing research project, the design and implementation of a transmedia learning storyworld. Through the discussion of a learning experience based on the storyworld, we explore challenges and issues related to the development of transmedia learning practices in English as a second language context.

http://ccat.site

## My Learning, My Story: Supporting Youth Agency With Digital Learning Portfolios

Kate Rosenbloom (Mouse)

A learner’s accomplishments go beyond what you see on a transcript, which is why DreamYard and Mouse have partnered to bring digital learning portfolios to organizations across New York City. Digital portfolios represent a holistic demonstration of achievement and, importantly, enable youth to narrate their own success stories. Unlike traditional portfolios, these multimedia collections of work emphasize reflection, documentation, and technology skills. Digital portfolios represent a turning tide in assessment and introduce digital-age skills into college/career readiness programming. With participating youth on our panel, our workshop will discuss the movement toward digital learning portfolios, letting youth tell their own success stories and the experiences of youth and educators participating in our pilot program. Students will walk through the digital portfolios they have built and we will demonstrate activities from the course, which are available online as open educational resources.

## "You Know That Feeling When the Light Bulb Goes Off in Your Head?" Connected Learning With SciGirls Code Programs

Cassandra Scharber (Learning Technologies Media Lab University of Minnesota), Lana Peterson (University of Minnesota), Sarah Barksdale (University of Minnesota), Yu-Hui Chang (University of Minnesota), Angelina Constantine (University of Minnesota), Ramya Sivaraj (University of Minnesota), & Joan Freese (Twin Cities PBS)

Funded by the National Science Foundation Grant No. #1543209, SciGirls Code is a two-year project (2016–2018) that integrates computational participation and connected learning frameworks to support 16 STEM outreach partners in providing 160-plus middle school girls and educators with computational thinking and coding skills in outside-/after-school programming. The project includes a nine-month curriculum, role-model training, professional development, and a research component. The research study investigates the ways in which learning experiences impact girls' development of computational thinking; interests and attitudes toward computer science; and their understanding of how participation in creation with technology impacts themselves and the world around them. Case study analyses of two programs (Team Draco and Team Lynx) are featured in this paper. Girls in both programs demonstrated increased knowledge of computational thinking concepts, practices, and perspectives as well as increased confidence and interest in future computer science activities. Team Draco girls (11 total) expressed feelings of frustration, confusion, and annoyance as they persevered through the curriculum. Girls cited patience and attention to detail as keys to working through these feelings; they also felt rewarded when success occurred after facing significant levels of frustration. Team Lynx girls (12 total) noted that they learned patience and the importance of communication, using pair programming, and following instructions. Team Lynx video shorts illustrated their excitement, collaboration, and creativity as they worked through SciGirls Code activities.

http://stemforall2018.videohall.com/presentations/1105

## Using Case-Based Learning to Fuel Digital Innovation

Mary Welsh Schlueter (Ohio Department of Education)

Partnership for Innovation in Education (PIE; www.piemedia.org) is the leading nonprofit provider of K–12 curriculum and experiential programming featuring case-based learning. Using cases in emerging career pathways with leading business partners, students experience the relevancy of classroom learning by "cracking" cases in subjects such as drone aviation, health-care analytics, and artificial intelligence. PIE program data show elevated academic achievement, college/career readiness, entrepreneurship, social– emotional skill sets, and high school graduation rates. Our presentation will feature the use of drones, drone technology, and the development of drone racing clubs to jump-start interest in engineering, aviation, physics, data analytics, and entrepreneurship. This program expedites high school graduation because of Ohio Career Tech credits and FAA Part 107 Commercial Drone Pilot's License, with elevated program interest among girls and minorities.

## Developing Virtual Equipment to Enhance Learning of Structures and Material Science in an Aeronautics and Astronautics Engineering Program

Genisson Silva Coutinho (Purdue University), Alberto Da Silva Mello (Embry-Riddle Aeronautical University), Alejandra Magana (Purdue University), Vinicius do Rego Dias (Algetec Corporation), & Vinicius Côrtes (Algetec Corporation)

This working paper presents the process of revamping a traditional hands-on laboratory course in an Aeronautics and Astronautics engineering program using a virtual-equipment approach. Six traditional hands-on experiments will be used in a pilot program that aims to create virtual counterparts for each real experiment in the Aeromechanics course. The authors present one of these six experiments and also discuss the main concerns and difficulties in developing the virtual-equipment platform.

## Playing With Words: Supporting Early Vocabulary Learning Using a Digital Game

Tamara Spiewak Toub (Temple University), Rebecca Dore (University of Delaware), Marcia Shirilla (University of Delaware), Tara Saunders (University of Delaware), Lindsey Foster (University of Delaware), Emily Hopkins (Temple University), Molly Collins (Vanderbilt University), Jacob Schatz (Temple University), Molly Scott (University of Delaware), Jessica Lawson (Vanderbilt University), Elizabeth Hadley (Vanderbilt University), Roberta Golinkoff (University of Delaware), Kathy Hirsh-Pasek (Temple University), & David Dickinson (Vanderbilt University)

Despite the prevalence of educational apps for children, little research has investigated their effectiveness. We designed and tested a narrative-based digital game to support vocabulary learning. Preliminary findings ($N$ = 18) show that children who played the game answered more vocabulary questions correctly ($M$ = 6.3 out of 10, $SD$ = 2.3) than control group children who did not play the game ($M$ = 2.8, $SD$ = .84), $t(15) = 4.5$, $p < .001$, $d = 2.2$. These findings tell us that the words selected were not generally known by children in this age bracket and that the training had an effect on vocabulary knowledge. In Study 2, low-socioeconomic status (SES) 3- and 4-year-olds played the game four times over four weeks as part of a larger classroom intervention. Although there was not a significant gain on the receptive test, children's expressive knowledge showed significant gains from pretest ($M$ = .11, $SD$ = .35) to posttest ($M$ = .94, $SD$ = 1.8), paired $t(31) = 2.68$, $p = .01$, $d = .65$. The difference between pre- and posttest scores was significantly larger for target words than for the control words that children were not exposed to, paired $t(31) = 2.63$, $p = .01$, $d = .65$. These studies show that both middle-SES children in the lab and low-SES children in the classroom learned new vocabulary from an interactive tablet game, suggesting that developmentally appropriate digital games show promise for vocabulary learning during early childhood, especially when parents and teachers are not available.

## Challenges in Adopting ICT-Enabled Interventions: The Mizoram Teachers' Perspectives

Sahana VP (TATA Institute of Social Sciences) & Anusha Ramanathan (TATA Institute of Social Sciences)

This working paper gives a preview into the challenges involved in adopting information and communication technologies (ICT)–enabled interventions from the perspective of the teachers of Mizoram, India, where the Connected Learning Initiative-X (CLIx) works to develop an ecosystem of

learning that is constructionist. In this regard, the CLIx team developed modules for high school students in the domains of English, mathematics, and science. The emerging data from the 2016–2018 cycle of implementation suggests that teachers have reservations about the module implementation. This paper attempts to throw light on the perceptions teachers have of an ICT–based intervention and the impact of this on implementation. Another concern is the lack of confidence in digital literacy among the teachers. This paper attempts to focus on such issues in the context of CLIx and posits suggestions as to how some of these can be addressed.

## 360 Walkthroughs: Documentation and Collaboration of Teaching and Learning Practices

Aparna Wilder (IRL Labs) & Jeffrey Evancho (Quaker Valley School District)

Educators at Quaker Valley School District (QVSD) outside of Pittsburgh, Pennsylvania, have been engaged in innovative professional learning through a variety of research-informed practices. One of Quaker Valley's recent partnerships with education-technology start-up IRL Labs is focused on attempting to innovate practices related to teacher growth in and through classroom walkthroughs using the immersive storytelling platform SocialVR. Teachers have helped inform new platform features that would allow them to add multiple forms of media to one hot spot as well as integrate video into their story lines.

## Marginalized Youth Learning Through Film: The Case of a Small Island Developing State (SIDS)

Hadeikaye Williams (University of the West Indies Mona) & Ian Boxill (University of the West Indies Mona)

Many inner-city communities tend to be characterized by high crime and low levels of social and economic development. Youth in these communities are often trapped in a cycle of poverty and are alienated from the wider society. This paper discusses how a project, an "experiment" called UWICFP, has been creating social change in marginalized urban communities in a small island developing state (SIDS). The project trains "at-risk" youth in the techniques of filmmaking. It provides a platform for the graduates to showcase short films to the public via a specially created film festival—GATFFEST Film Festival. This paper examines the impact of the project. Drawing on recognition theory, it argues that the film project has been able to plant seeds for positive change in those communities that are its main beneficiaries. The paper highlights how this groundwork with marginalized youth serendipitously embodies the principles of PV and connected learning.

# Workshops

## A Proof of Concept: Engaging Informal Learning Practitioners and Researchers Through a Connected Learning and Computational Thinking Framework

Linda Braun (LEO), Marijke Visser (American Library Association Washington Office), Paula Langsam (Washington DC Public Library), & Juan Rubio (Seattle Public Library)

While libraries focus more and more on providing youth STEM learning opportunities, STEM activities that do not put youth at the center of learning do not adequately support young people in developing the critical skills needed to succeed in education, careers, and life. For library staff to engage youth successfully, they must themselves have opportunity and resources to critically examine their own skills and mind-sets. Developing computational thinking (CT) activities through a connected learning–based framework is a promising model that supports such reenvisioning for library staff and other educators in informal learning spaces. Out of School Tme programs are also testing strategies to ensure their staffs are prepared. Research conducted by the National Afterschool Association, with support from Google, found that "Afterschool professionals will need more tools and training to become effective facilitators of digital learning." The research also notes that "For afterschool educators, training resources must articulate the distinction between facilitating the 'consumption' of technology through passive activities and the 'creation' of digital content through activities that help students build critical 21st century skills." As a way to better understand what is required to bring these mind-sets to successful informal learning experiences, the Ready to Code initiative funded 25 libraries to implement CT activities. These libraries span all types of communities—urban, rural, suburban—and include youth from diverse backgrounds. The institutional learning generated by these projects led to the development of the Ready to Code Collection, online resources that will be available in late Fall 2018.

http://www.ala.org/tools/readytocode

## The Secret Process for Creating Games That Matter

Barbara Chamberlin (New Mexico State University Learning Games Lab) & Jesse Schell (Schell Games)

Great transformational games succeed by focusing on three key questions. First, what problem are we solving: What changes do we want to see in the player, or in the world? Second, what player activities are likely to result in the change? Third, what game structures are best suited to motivate those key activities? In this workshop, Schell and Chamberlin described how to use these questions to create engaging and effective transformational games. Participants engaged in mini-design jams, working on one of three sample design challenges. Each group then worked through the three-part design process together. *Identifying the change in the player:* You want a change to happen in the player—what is it that is keeping this change from happening? We described a taxonomy of ways individuals can change and guided participants through thinking through each kind for their game. *A taxonomy of activities:* There are many activities that can change players, and successful games often include more than one transformational activity. It helps to think through all the different kinds of things a person has to do before choosing which of those activities should be translated to gameplay. *How to wrap your activity in gameplay:* Designing effective games begins with clear understanding of how different game structures (including game characters, worlds, and rules) motivate the player. The most effective games give players the opportunity to go through the types of activities that lead to meaningful change.

http://goo.gl/sDkmPW

### Embedded Assessment for Maker-Centered Classrooms

Stephanie Chang (Maker Ed), Yoon Jeon Kim (MIT Teaching Systems Lab), Peter Kirschmann (MIT Teaching Systems Lab), & Yumiko Murai (MIT Media Lab)

For maker education to take root in sustainable and meaningful ways within school classrooms, assessments of maker activities need to clarify what cognitive and noncognitive skills are being learned and practiced while connecting them to existing competency frameworks and capitalizing on current assessments. In addition, these assessments must be accessible for teachers to adopt and in particular, adapt. Traditional assessment methods tend to fail to maintain these qualities as they are often designed to measure learning practices that have one definite answer or set path. Clear evidence of learning and skill development in making enhances the impact of maker education in schools while also reinforcing and supporting open-ended, process-oriented, student-centered learning. Building on the idea of embedded assessment in game-based learning environments, MIT Teaching Systems Lab and Maker Ed have been collaborating on an NSF project to co-design assessment tools with schoolteachers to address the question of how assessment could look in the contexts of maker classrooms and how to support educators to become co-designers and assessment-savvy maker educators. These assessment tools are designed to allow students and teachers to engage in evidence-based, construct-driven, and just-in-time assessment processes. This workshop engages participants in hands-on maker activities while playing, testing, and iterating on these assessment tools. We will discuss the implications of embedded assessment tools and how participants may take these tools back to their maker-centered environments to assess the skills and competencies developed.

https://tsl.mit.edu/projects/beyond-rubrics/

### A Framework for Maker Education: Framing, Doing, and Reflecting on the Maker Experiences

Jackie Gerstein (Boise State University)

Providing a framework for maker education activities helps ensure that their use is intentional, that meaningful learning is extracted from these experiences. The educator, using such a framework, becomes proactive in framing or frontloading maker experiences and in debriefing or processing them to increase the chances that learning occurs. Framing or frontloading is making clear the purpose of an activity before actually doing it; it helps to set purpose and intention for the activity. Reflecting on the maker activities after their completion can done through a variety of methods: talking, writing, sketchnoting, and using technology such as Web 2.0 tools and social media.

### Creating in, With, and for Community: Computational and Civic Participation in the Cambridge

## Creative Citizens Project and RAW Art Works

Paulina Haduong (Harvard Graduate School of Education) & Raquel Jimenez (Harvard Graduate School of Education)

Developments in today's technology-driven culture have transformed opportunities for cultural participation. While mainstream discourses generally frame the value of computational fluency in terms of workforce preparation, there is enormous untapped potential for engaging historically marginalized youth in computing education by reframing the goals of computing toward developing student voice and civic agency (Kuttner, 2015; Soep, 2006). Nevertheless, for many nondominant youth, evidence persists of both a civic empowerment gap (Levinson, 2012) and a digital divide (Ito et al., 2013). In this workshop, we shared learnings and experiences from the Cambridge Creative Citizens Project (C3P), a summer enrichment project that engaged historically marginalized youth in action-civics projects using the Scratch programming language as a tool for exploration, expression, and connection making, as well as Raw Art Works, a teen arts center that engages young people in public art–making experiences connected to contemporary civic issues. Drawing from social learning theories and studio practices, we engaged participants in a process of critique through the creation of hand-drawn and digitally animated GIFs. The practice of critique commonly embedded in art-making experiences encourages creative idea development and iteration and offers opportunities for being in community with one another.

## Pedagogy and Practical Tools for Computational Poetry

Elliott Hauser (University of North Carolina at Chapel Hill) & Angela Chang (MIT / Emerson College / TinkerStories.com)

During this one-hour workshop, participants will learn about tools and pedagogical techniques to help them successfully bring computational poetry into their classrooms. By the end of the session, participants will have customized at least three computational poems and, optionally, shared them on the Web. The pedagogical strategies and tools we will use will model how participants can adapt the workshop's content to their own teaching needs. The workshop instructors will touch on pedagogical issues and approaches throughout, and participants will likewise be encouraged to contribute their own experiences and observations. Participants should leave the workshop with new ideas about how to approach teaching computational poetry in addition to seeing their own personalized programs up on the Web.

## Tangible and Playful Connected Learning

Sherry Hsi (Concord Consortium), Colin Dixon (Concord Consortium), Karen Wilkinson (Exploratorium), Mike Petrich (Exploratorium), R. Benjamin Shapiro (University of Colorado Boulder), Lila Finch (University of Colorado Boulder), & Annie Kelley (University of Colorado Boulder)

When design tools are computationally enabled, interactions can be more participatory, accessible, and engaging of learners' creativity and agency. Playful and asset-oriented making and tinkering activities foster collaboration, encourage inclusion of learner interests, and can destabilize relational inequities that position young people as passive learners. Computationally enabled technologies expand the potential of connected learning in a few key ways: (a) low-cost and/or readily available materials combine with new computational media to disentangle powerful learning from black-boxed devices; (b) tools are flexible, straddling art studio and science lab and able to scale from playful experimentation to in-depth disciplinary endeavor; (c) creative artifacts are easily sharable across settings and backgrounds, giving learners a chance to see their products in use and display their growing expertise among parents, mentors, and peers. This workshop brought together three perspectives on making, tinkering, and computationally enabled design to showcase novel ways in which youth and educators are engaging in meaningful production-centered activities. In the workshop, facilitated by CU Boulder's Laboratory for Playful Computation, the Concord Consortium, CU Boulder Craft Technology Lab's Paper Mechatronics team, and the Exploratorium's Tinkering Studio, participants had a chance to visualize sensor data with dynamic sculptures, construct interactive paper machines and low-cost electronics, and explore light, sound, color, and motion. After "messing around" and talking with project designers, the group held a reflective discussion that challenged all participants to think about connections between play, equity, and their experiences in the workshop.

https://concord.org/conferences/connected-learning-summit/

## Game Design and Coding in *Minecraft*

Steve Isaacs (Bernards Township Board of Education) & Cathy Cheo-Isaacs (Trevor Day School)

Creating opportunities for students to develop their own games provides an entry point to computer science that is relevant to the children we serve. Code Builder for Minecraft Education Edition brings block-based coding to *Minecraft*. Programming environments including code.org, Microsoft MakeCode, Tynker, and Scratch connect to *Minecraft*, allowing students to execute code they write directly in *Minecraft*. In addition, redstone and command blocks allow students to implement engineering and computational thinking concepts in their *Minecraft* worlds. During this session, participants will see how two educators have brought computer science and game development to their students in grades 2 through 8. Participants will be guided through hands-on activities related to game development and computational thinking. Ideas will be explored for how educators can incorporate these tools to create exciting learning experiences with and for their students.

## Exploring Openness in Learning Environments With HIPC

Karen Jeffrey (Forall Systems), Ashlyn Sparrow (University of Chicago), & Eve Tulbert (Mumkin Studio)

The Hive Interoperability & Portability Coalition (HIPC) has established a community of practice (CoP) to advance openness and related concepts (such as transparency, agency, and portability) in the design of learning environments and technology solutions. This workshop will emulate the CoP with hands-on games, conversations, and collaborative discovery. We will explore openness in the contexts of learning design, gameplay, and the design of technology. HIPC is a partnership between the Adler Planetarium, Forall Systems, and Ci3's GameChanger Chicago together with Mumkin Studio and other members of the Hive Chicago Learning Network. Over the course of the past funding cycle, the HIPC partners organized six workshops for learning-program providers in Chicago that explored openness as an approach to creating learning opportunities for teens. The workshops emphasized fun, game-based activities that straddle digital and analog frameworks for shared understanding and co-design.

## Playful STEM Teacher Preparation: Designing the Woodrow Wilson Academy of Teaching & Learning

Yoon Jeon Kim (MIT Teaching Systems Lab), Peter Kirschmann (MIT Teaching Systems Lab), Raha Moussavi (Massachusetts Institute of Technology), Katarina Rolf (Woodrow Wilson Academy of Teaching & Learning), & Breauna Campbell (Woodrow Wilson Academy of Teaching & Learning)

Historically, teacher-education programs have used fieldwork as the primary means for preservice teachers to practice teaching. However, this leap from classwork to fieldwork skips practice in a low-stakes environment before stepping in front of actual students. These practice spaces allow preservice teachers to hone their skills and also allow in-service teachers to try new techniques without the risks involved in trying a new strategy with students. In response to this gap, many different models of teacher education have emerged to incorporate learning experiences that simulate situations that reflect the real complexity of classrooms (Forzani, 2014). Building upon practice-based teacher education, the MIT Teaching Systems Lab and the Woodrow Wilson Academy of Teaching and Learning (the Academy) is creating a new STEM teacher-preparation program by incorporating the rich knowledge of game-based learning (Gee, 2007). The curriculum is a time-variable challenge-based curriculum, grounded in essential competencies. One core element of the Academy's curriculum is the playful practice space. A practice space refers to learning experiences that target specific skills and dispositions of teaching. In the design of practice spaces, the curriculum team often borrows mechanics of well-designed games to make them playful. The design team embodies playfulness because playfulness combined with seriousness, as Dewey (1916) identified long ago, represents the ideal mental attitude of teachers, and playfulness is closely associated with creativity and innovation. If teachers can learn new pedagogies and techniques in a playful manner, they are more likely to continue to practice and hone these skills.

## *Resonant Games:* Design Principles to Connect Hearts, Minds, and the Everyday

Eric Klopfer (MIT Education Arcade), Louisa Rosenheck (MIT Education Arcade), Jason Haas (MIT Education Arcade), & Scot Osterweil (MIT Education Arcade)

In the MIT Education Arcade, we design learning games that have deep connections with players' lives—artifacts that could be a part of their lives in school and at home, that could rouse their curiosity and determination, that might even seep into their dreams and imaginations. Our games are designed to resonate with your life, with your passions, and with all the systems in which they are embedded. Our recent book, *Resonant Games*, is a compendium of principles we have used to design our learning games, illustrated by projects we have created with these principles in mind. In this workshop we presented the concept of resonant games and a selection of the principles to help participants apply them to their own work. Together educators and designers engaged in design exercises that explored the idea of resonant design.

https://www.resonant.games/

## Scaling Connected Learning: Community-Based Solutions for Open Education Design

Patricia Monticello Kievla (The Sprout Fund) & Aria Chernik (Open Source Pedagogy, Research + Innovation [OSPRI], Duke University)

Open educational resources (OER) have not yet delivered on their potential to democratize and transform learning. Indeed, a central challenge with OER is access: Often, widely available resources are not easily adaptable and community-developed resources are not widely accessible. We believe that this disconnect is a fundamental threat to developing high-quality connected learning programs. To address this challenge, we think it is critical to harness the power of community-based design to remix national open curricula to meet the needs of local learning communities. In this highly interactive 60-minute workshop, the presenters engaged participants in human-centered design activities to imagine how diverse stakeholders might collaborate to address this challenge to open education design in their local contexts. The session opened with two brief presentations about connected learning lesson plans shared from Pittsburgh's Remake Learning Network (remakelearning.org) and the work of the CSbyUs initiative (http://csbyus.org) from OSPRI (Open Source Pedagogy, Research + Innovation; https://ospri.ssri.duke.edu) at Duke University. Then, this session asked its participants to grapple with the following question: How might we work together to find a truly community-based approach to open education design?

https://remakelearning.org/

## Designing Mobile Stories: An Introduction to the Augmented Reality and Interactive Storytelling Development Platform

Chase K. Mortensen (Utah State University), Breanne K. Litts (Utah State University), & David J. Gagnon (University of Wisconsin Madison)

The connected learning community is generally concerned with questions around how digital media support meaning making that spans across a range of settings and disciplines (Ito et al., 2013). Thus, in this session, we will investigate how we can leverage mobile technologies to connect learning across space, time, and context. Specifically, we will explore how storytelling, as a cultural, historical, and social practice, intersects with the affordances of mobile technologies. In the workshop, we will focus our design efforts on how augmented reality (AR) technologies can generate connections across personal interest, peer relationships, and academic achievement to engage key civic issues. To complete this work, we will use the Augmented Reality and Interactive Storytelling (ARIS) platform as a design case for how to design digital media experiences at the intersection of AR and storytelling practices. ARIS offers nonprogrammers a sandbox-like platform on which to build these connected experiences, which makes it accessible across audiences and disciplines. The ARIS platform supports connected design trajectories through which learners work together to make their own interdisciplinary, multimodal design projects. Moreover, ARIS is rooted in place-based learning and its design highlights the importance of "building long-term relationships with familiar, everyday places" (Gruenewald, 2003). Hence, at the project level the games and narratives that users design connect with the community and across life spheres in unique ways to promote critical engagement with connected meaning making. Workshop participants will gain the necessary experience in this development platform to implement it into their fields of interest.

https://learnexploredesign.org/

## Read the Comments! Fostering Constructive Dialogues in Online Spaces

Sarah Otts (Massachusetts Institute of Technology), Matt Taylor, & Kasia Chmielinski (Massachusetts Institute of Technology)

Everyone knows you should not read the comments. Or should you? This session explores how we can create constructive and caring online spaces. Drawing from our experience with Scratch, the largest online creative community for youth, we will discuss how design and moderation can nurture dialogue across experience and identity. We will start with an analysis of dialogues around the 2016 U.S. presidential election on Scratch, and then encourage participants to share strategies for supporting the exchange of ideas across difference.

## Game Design Studio: Designing With and for Teens

Susan Rivers (iThrive Games) & Gabrielle Rappolt-Schlichtmann (EdTogether)

In Game Design Studio teens play, analyze, and design games as a way to deeply engage in social and emotional learning in personal and meaningful ways. We use game-design techniques to engage teens in thinking critically about—and experimenting with—the systems that impact their lives. Game Design Studio provides teens with the tools and support they need to be the drivers in their own learning. In this way, we recognize that teens are experts of their own experience. Workshop participants will join Game Design Studio and engage in the design experience we create with teens. Participants will collaborate to create some core elements of a game using inspiration drawn from real-world data from teens who have participated previously in Game Design Studio sessions. Participants will learn how to engage teens in design practices as a method for deep, authentic engagement between and among teens and adults.

## Designing Creative Learning Workshops That Put the Learner in Charge

Ricarose Roque (University of Colorado Boulder) & Saskia Leggett (Family Creative Learning)

Well-designed workshops can provide inviting entry points for people who might otherwise not become engaged in creative learning experiences with technology. Informal learning spaces such as libraries, after-school programs, or makerspaces often use workshops as a common form of engagement to introduce newcomers or allow others to dive deeper into an interest area. In this workshop, we will explore how we can design equitable, inclusive, and creative learning experiences. Participants will engage in the purpose and practice of workshops, examine workshop design principles, and spend time brainstorming ideas for workshops in their settings. We will share our experiences designing workshops for youth and families across many settings, backgrounds, and cultures. Participants will engage in small-group work to develop their own workshop design for their settings. We will conclude by reflecting on how workshop facilitation can help to develop interests, build relationships, and connect to new opportunities.

## Playful Assessment Roundtable: Current Practices and Future Directions

Louisa Rosenheck (MIT Education Arcade) & Yoon Jeon Kim (MIT Teaching Systems Lab)

We believe that assessments should be playful, engaging, and authentic. If learning is fun, as it can and should be, then there is no reason the fun should stop for assessment. In many cases these should be ongoing and authentic performance assessments that are seamlessly woven throughout learning experiences rather than interrupting the flow of an activity (DiCerbo, Shute, & Kim, 2017). They should be authentic in that the interactions feel relevant and students view them as a tool to help them learn and progress. Designing these tools as performance assessments is key as they should put learners in situations where they must use their skills and demonstrate their abilities, rather than simply answer questions about them. In this way, the assessments can track a variety of skills beyond traditional content knowledge. And most important, students will remain engaged throughout the iterative cycle of learning and assessment. The high-level goal of this session was to bring educators, researchers, and learning designers together to share their visions for playful assessment. We started the session by sharing examples of playful assessment, both digital and nondigital, to frame what we mean by playful assessment. Then we had participants share their current playful practices, tools, and designs that relate to assessment. Through a roundtable discussion format, we aimed to garner interest in this emerging field and build the playful assessment community.

https://tsl.mit.edu/playfulassessment/

## Making, Playing, and Coding With Sound and Music

Natalie Rusk

You can get started with coding by playing with sound! This workshop lets you experience an engaging introduction to coding. We will start with a group warm-up activity that sparks initial ideas and then dive into tinkering with interactive sound and music. In the process you will learn about the new sound features you can use in the latest version of the Scratch creative coding environment. The new version of Scratch has new features for playing and creating with sound—including a simple sound-recording tool, an expanded library of sounds, and new coding blocks for sound effects. These features make it easier than ever to make interactive sound projects and expand the possibilities for creative expression.

## Tell Data Stories Using Paper Circuit Visualizations With the Open Data/Open Minds Project

Elisabeth Sylvan (Nexmap) & David Cole (Nexmap)

The Open Data/Open Minds (ODOM) project supports learners to convey stories of their local concerns using science journaling, crafted visualization, and data investigation. While we focus on the 10–14 age group and their educators, the approach and materials support learners and learning spaces of all kinds. Through a series of activities scaffolded by their educators, learners develop their own research questions, explore existing data sets, collect new data based on their research questions, analyze that data, and present them through stories and electronic visualizations. They tell their stories through paper circuitry projects using notebooks, batteries, copper tape, paper project templates, LEDs, and circuit stickers. Overall the ODOM program covers creating and illustrating illuminated paper circuits; telling personal nonfiction stories with paper circuits; completing surveys and then creating individual and communitywide visualizations of the data; developing research questions, based on issues important to members and their community; learning how to gather, interpret, and present data based on their research questions; visualization of data in graphs and illustrations, with or without illumination. This Connected Learning Summit workshop introduced the content and ideas of the Open Data/Open Minds program and presented short versions of two of the program's activities. Participants got a taste of how to support learners in developing compelling scientific stories with open data and illuminating their infographics or maps using paper circuitry. Participants learned about developing paper-based data group datagraphing activities (using bar charts, scatterplots, and maps) and integrating circuitry and light to illuminate information and data in the design and presentation. We used Nexmap's free paper circuitry templates and Chibitronic's circuit stickers. Participants left the workshop with completed illuminated infographics and links to online resources, including the templates and guides necessary for these activities.

http://www.lisard.com/open-dataopen-minds/

## Design Thinking for Teachers: Using Design Thinking and Participatory Design to Experiment a Bottom-Up Approach to Media Education

Gabriella Taddeo (National Institute for Documentation Innovation and Research in Education)

*Design thinking in a nutshell:* The paper proposes a methodology for teachers to co-create the educational dimension of the media together with their students. Here are the four steps. *Empathize: Learn about your students.* Teachers are asked to enter the media practices of youngsters. The empathize phase is based on two activities: the media selfie (students present a photo representing a meaningful media moment) and the media classroom portrait (photos are visually organized and pinned in the classroom). *Define: Focus on skills to improve.*The teacher identifies the desired training aspect to work on through the media activity. The revised Bloom's taxonomy of educational objectives (Krathwohl, 2002; remember, understand, apply, analyze, evaluate, create) can be used as a theoretical framework to define what type of skills to develop. *Ideate: Find out skills from students' media practices.* Starting with the skill chosen by the teacher previously, students are invited to collect media activities regarding such competence. If, for example, the teacher chose the "evaluation" skill, the students collect examples of all the times that they undertake activities related to evaluation through the media, for example, using YouTube reviews or Instagram polls. *Prototype: Intertwine informal and formal skills.* Starting from the media activities gathered by the students, it is now necessary to transform them into educational tools. If, for example, the media practices were the use of YouTube reviews or Instagram polls, the teacher may suggest to students to create YouTube reviews of books or Instagram polls to perform visual evaluations.

https://indire1.academia.edu/gabriellataddeo

# About the ETC Press

The ETC Press was founded in 2005 under the direction of Dr. Drew Davidson, the Director of Carnegie Mellon University's Entertainment Technology Center (ETC), as an open access, digital-first publishing house.

What does all that mean?

The ETC Press publishes three types of work: peer-reviewed work (research-based books, textbooks, academic journals, conference proceedings), general audience work (trade nonfiction, singles, Well Played singles), and research and white papers.

The common tie for all of these is a focus on issues related to entertainment technologies as they are applied across a variety of fields.

Our authors come from a range of backgrounds. Some are traditional academics. Some are practitioners. And some work in between. What ties them all together is their ability to write about the impact of emerging technologies and its significance in society.

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In keeping with that mission, the ETC Press uses emerging technologies to design all of our books and Lulu, an on-demand publisher, to distribute our e-books and print books through all the major retail chains, such as Amazon, Barnes & Noble, Kobo, and Apple, and we work with The Game Crafter to produce tabletop games.

We don't carry an inventory ourselves. Instead, each print book is created when somebody buys a copy.

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This is definitely an experiment in the notion of publishing, and we invite people to participate. We are exploring what it means to “publish” across multiple media and multiple versions. We believe this is the future of publication, bridging virtual and physical media with fluid versions of publications as well as enabling the creative blurring of what constitutes reading and writing.