10. A Toolkit for Analyzing Teaching and Learning Across Contexts

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Abstract: This session explicates a theoretical perspective that addresses the complexities of moving across teaching and learning contexts in everyday life, both in formal settings such as school but also informal settings, and between physical and virtual spaces. While the education research community has made important progress toward understanding learning in a variety of formal and informal contexts, less emphasis has been placed on understanding how teaching and learning experiences can be connected across these contexts and about the variety of teaching and teachers that are essential to them. We outline an analytic perspective called *distributed teaching and learning systems* (DTALS), which augments other models of learning by stressing the importance of movements across contexts and foregrounds teaching as a key feature alongside learning. We then provide a set of tools for analyzing pedagogical situations through a DTALS perspective and a brief worked example of the tools in action.

Learning is ubiquitous in the world—people learn in schools, but also in workplaces, in the home, on playgrounds, through cultural resources, and increasingly across a range of digital and online spaces beyond any formalized institutional contexts. Furthermore, people move across these contexts in their learning; they are not bounded by one particular site but make connections between them and have their learning shaped by the contacts between them through time (Erstad et al., 2016). While a number of models for addressing informal learning contexts have been developed, including concepts such as "affinity spaces" (Gee, 2003; Hayes & Duncan, 2012) and the connected learning research agenda (Ito et al, 2013), these often miss the importance of a learner's movement across contexts and time. These models often focus on a single site of activity or type of participation as a unit of analysis, whereas a more thorough understanding and examination of how people travel from site to site and participate in different learning activities might provide additional insight into their learning (Erstad et al., 2016; Sefton-Green, 2016). Even less attention has been paid to the critical role of teaching in these nonschool settings. Teaching, broadly understood to include acts of designing and curating learning resources and pathways in addition to more direct "instructional" acts, is just as ubiquitous as learning in the world but is often effaced from analyses or invisible because it may not resemble more common conceptions of classroomlike instruction, and so it is treated as something else entirely.

To address these often overlooked features of learning in the 21st century—the connections and movements across learning contexts through time, and the teaching that plays an essential role regardless of where it happens or by whom—we use a theoretical framework called *distributed teaching and learning systems* (DTALS). A DTALS framework provides a means of addressing the full scope of a learner's pathways and how he or she navigates physical, digital, and socially constructed boundaries. A DTALS perspective also highlights the important ways teaching works within and across these boundaries, and how connections between them can be intentionally designed and curated. Finally, a DTALS approach emphasizes the *designed and emergent systems* in which teaching and learning occur, both proximally (the resources, locations, and people that make up a particular learning pathway) and distally (the larger social and ideological systems that drive the creation and enactment of these encounters).

A DTALS perspective is both a conceptual framework and an analytical tool. Elsewhere (Holmes, 2015, 2017; Holmes, Tran, & Gee, 2017) we have outlined several key features that help us conceptualize teaching and learning as distributed across a variety of resources, designed by "teachers" of all sorts as well as by learners as they move across sites, and primarily centered on deep problems. In this working paper, we wish to turn our attention to how to use the DTALS perspective as an analytical tool in order to carefully and systematically examine the kinds of complex and intricate ways people design, enact, and encounter teaching and learning in their everyday lives. We outline a set of tools that enable

researchers to uncover additional important dimensions that other perspectives may not address; we also provide a brief worked example of the analytical toolkit in action in order to provide a glimpse into the kinds of analysis possible through a DTALS perspective.

Situating DTALS

There are numerous ways in which learning beyond school has been addressed by scholars and educators, including attention to informal STEM learning, literacy learning in and out of school, and digital literacies. The focus often has been on (a) understanding particular sites or contexts of out-of-school learning and (b) identifying differences or disconnects between in- and out-of-school learning. Instead of focusing on these isolated contexts, however, numerous scholars have argued for a holistic approach and outlined how in-school and out-of-school learning are connected (Hull & Schultz, 2001; Sefton-Green, 2004), as well as called for a reassessment of the dichotomy between schools and informal contexts (Vadeboncoeur, Kady-Rachid, & Moghtader, 2014). Frequently, the goal of such research is to encourage educators to make connections between out-of-school and in-school learning, varying from acknowledging kids' cultural "funds of knowledge" to bringing popular digital media into the classroom to using more "authentic" learning activities (Erstad & Sefton-Green, 2013; Jenkins, Ito, & boyd, 2015).

More recently, there has been interest in how kids move across spaces out of school as well as the connection between in- and out-of-school learning, so that the classroom and children's out-of-school learning activities do not stand in opposition to each other but rather inform each other, especially as technology changes the social and material nature of children's lives (Leander, Phillips, & Taylor, 2010). Barron's (2006) learning ecologies model investigates how adolescents learn both in and out of school motivated by a personal interest in a topic, and these in- and out-of-school activities are both essential to understanding students' learning. Still, research that focuses primarily on one context predominates, and examinations of the specific nature of these connections are relatively sparse.

Just as there sometimes exists a narrow definition of learning, "teaching" is often narrowly conceived of as a classroom teacher in the professional context of school rather than something that can happen in various contexts. While literature does exist that explicitly examines teaching in informal contexts (Marcus, Stoddard, & Woodward, 2011; Quinn, 2014; Wick, Pollock, & Jefferson, 2010), these focus on more formal and schoollike practices in contexts such as workplace training and museums. In reality, there are myriad spaces for learning such as participation in online spaces and learning in the home, in which teaching takes forms that do not resemble schoollike teaching. We argue that more research is necessary that focuses specifically on teaching in such environments, or that even mentions teaching practices or informal teachers at all.

Finally, in much of the literature around informal learning, a tension exists around idealizing what kids learn out of school versus trying to make up for "deficiencies" in out-of-school learning experiences. This is partly because of narrow conceptions of what "counts" as learning, with value being placed primarily on schoollike learning. Schools do not always value youths' out-of-school learning activities because of the often narrow focus of classroom learning (Erstad & Sefton-Green, 2013). Indeed, school may not value the backgrounds and experiences of nondominant cultural groups and students' own funds of knowledge (Barton & Tan, 2009; Zipin, 2009). As such, out-of-school learning is sometimes conceptualized as a challenge to school learning, and as a way of asserting the value of identities and knowledge that might not be valued in school (Rajala, Kumpulainen, Hilppö, Paananen, & Lipponen, 2016).

A DTALS Toolkit

The DTALS toolkit we present in this working paper is meant to provide a means for looking at a teaching and learning situation, regardless of where it occurs, in order to trace out the important connections, movements, designs, and experiences of teachers and learners. This toolkit is inspired—both philosophically and structurally—by Gee's discourse analysis toolkit (2011), in that the tools are meant to be applied not in isolation from each other but at once to any pedagogical phenomenon under analysis. Some tools may uncover more or less relevant insight depending on the situation at hand, and researchers may emphasize one tool over others, but together the tools provide a more robust understanding. Indeed, as Gee points out, the tools build on each other and, when taken in aggregate, will likely provide more "valid" analysis than any one tool in isolation.

Analytic Framing Tools

These tools provide a high-level way of organizing the contexts, perspectives, and limits of the teaching and learning interactions under consideration in your analysis. They should inform how you proceed in using the subsequent feature-specific tools as well as highlight the necessary limits of any such analysis.

Boundaries Tool. For a pedagogical phenomenon of focus, begin by staking a claim as to what the "bounds" of that situation are. This will likely be modified in the course of your analysis, but an initial claim on this will inform how the analysis begins. Describe where the "cutoffs" for things such as time, resources, or activities are made and why. For example, a study of a middle-school fanfiction writer may not need to trace a learner's pathway back to elementary school to discuss how he or she learned to write per se, so a reasonable starting point of the learner's entry into fanfiction writing spaces may be appropriate and sufficient for analysis.

Perspectives Tool. For a given pedagogical situation, determine whether your analysis will focus primarily on the overall range of sites and resources available to learners and how they are designed (i.e., a "top-down" approach) or about a specific individual (or group) as they design or move across sites (i.e., a "bottom-up" approach). Individual perspectives of analysis can include both those of a "learner" who has a particular objective or outcome and is engaging with one or more "teachers," or from the perspective of a "teacher" or "designer" who has a particular objective or outcome and is engaging with one or more "learners." Analyses may also combine these perspectives by looking at a particular grouping of teachers and learners, such as a classroom, an Internet message board, or a video game affinity space. For example, analysis of a video game DTALS may look at the various types of sites and how designers build and connect them to view them systematically, or it may focus on a specific learner as he or she is introduced to the game and journeys to specific sites in a particular way across the system.

Feature-Specific Tools: Distributed Across Space, Time, and Resources

Participatory Roles Tool. For a given pedagogical situation, ask which participants (human or nonhuman) are involved. Ask what teaching and learning roles they appear to be enacting, and whether these roles seem to change over time, contexts, or interactions. In some situations, the role of teacher and learner are fluid, and participants may exchange roles or act in different roles depending on context. In other cases, one participant may depend on others in the situation, such as with a commercial game that is played in the classroom accompanied by explicit instruction.

Places and Spaces Tool. For a given pedagogical situation, ask what places and spaces, physical or virtual, the situation seems to encompass. A student who may be searching for online resources to support his or her understanding of a concept that was lectured on in chemistry class may involve both physical and virtual spaces. The Boundaries Tool may be used to "bound" the spatial context as fits the focus of the research.

Movement and Connections Tool. For a given pedagogical situation, ask how learners move from site to site and what kinds of connections are made by (and for) them. In conjunction with the Pathways Tool, consider how people move across resources and what are the relationships that form and are fostered by them.

Feature-Specific Tools: Teaching and Learning

Teaching Acts Tool. For a given pedagogical situation, ask how teaching is being enacted by a human or nonhuman agent. Such acts can include the design of resources, the curation and connections between resources, and direct engagement in instruction. Note that just as humans cannot *not* communicate, even if their communicational "objective" has not been achieved, so too can teaching be enacted without evidence that a pedagogical objective has been achieved. Complement this with the What, Why, and How? Tool to better understand intended teaching outcomes and realized learning outcomes.

What, Why, and How? Tool. For a given pedagogical situation, identify intended pedagogical outcomes, reasoned logic behind those objectives, and the process through which those outcomes appear to have been realized (or not). Do this also for unintended outcomes.

Evidence of Learning Tool. For a given pedagogical situation, identify empirical evidence of learning outcomes, intended or unintended. Depending on the focus of the research, these can be observationally determined or analyzed through an "artifice"—for example, a test, survey, or interview.

Feature-Specific Tools: Designed and Emergent Systems

Gateways Tool. For a given pedagogical situation, identify potential "gateways" through which participants can move into and out of the situation. Ask what gateways are "officially sanctioned" by teachers or designers, and which gateways emerge from outside of these official sources and which may run counter to the overt learning goals. For example, a formal science classroom might serve as a gateway into domain-specific learning, but so might a video game or a book.

Designed Elements Tool. For any given pedagogical situation, ask about the role that design plays and identify evidence for the degree of its impact on the situation. Ask about what kinds of choices designers make about what to include or exclude, what kinds of resources they make or curate and how they connect them for learners, and what kinds of assumptions they make about what learners need and where they should go next within the system.

Emergent Elements Tool. For any given pedagogical situation, ask about the role that emergent actions and connections that are due to a learner's specific movements play and identify evidence for the degree of its impact on the situation. For example, what kinds of connections do they make that are not explicitly due to designed pathways, and what kinds of resources do they connect?

Worked Example: Code Club Through a DTALS Perspective

To illustrate an application of this toolkit, we turn to data collected as part of a study conducted on a library-based computer programming club for middle school–aged youth known as the Code Club (Aguilera, 2017a; Holmes, Aguilera, & Tran, 2018). This project collected observational, artifactual, and interview data over the course of a nine-month observational study of the experiences of 33 participants, 8–14 years of age, as they took part in 45-minute weekly sessions to engage in activities related to the Code Club. Data sources for the study included digital artifacts produced by students, archival user interface data of virtual spaces, publicly available participant profile information, observational field jottings, interview and survey data, postsession field notes, and analytic memos. These sessions were co-facilitated by library staff, along with one member of our research team, between the period of September 2016 and August 2017.

Applying the Boundaries Tool to our analysis, this analysis focuses on the meeting spaces in which student participants gathered each week along with library facilitators. The virtual contexts for teaching and learning we chose to analyze were the online sites visited by students during the Code Club's weekly meeting times. These included Code.org, Khan Academy, and MIT's Scratch platform. While some students accessed Code Club resources and engaged in related activities outside of the program's meeting times, our initial analysis did not encompass these connections. However, future work might consider how expanding the boundaries of focus might inform other interpretations of distributed teaching and learning in this context. Using the Perspectives Tool, we focus on the pathways of individual learners as they traveled across the designed artifacts (such as the online platform that acted as a "gateway" to distributed teaching and learning resources) and made connections with peers and tools for teaching and learning. We chose such a perspective because while the librarians in the space helped coordinate student efforts as "facilitators," they did not have particular domain-specific or pedagogical goals themselves. An alternative approach could consider the stated goals in a given online tutorial, for example, in Khan Academy, and examine how a collection of users in that system might take up, navigate, or transform designed learning pathways within the system.

Having established this framing of the analysis, we can turn to a feature-specific analysis of distributed teaching and learning across time, space, and resources. For example, several of the Code Club's participants engaged in activities hosted on the website Khan Academy. Our artifactual analysis of the Khan Academy computer science curriculum "Simple Snowman" Challenge suggests that the tutorial is designed to involve a user, such as a novice Code Club participant, and a set of digital resources, including tutorial text, a responsive programming environment designed to present "novice-friendly" feedback, and a "hint" area representing a possible solution to the puzzle presented. However, we noticed in our observations that while some students mainly used the Khan Academy's designed resources, others navigated across the Internet to "off-site" resources, such as discussion boards, to address a challenge that arose. In the latter case, applying the Places and Spaces Tool suggests that beyond the "sanctioned" virtual space of Khan Academy, some students added alternative virtual spaces to their individual DTALS. In addition, if contributors of "solutions" on a discussion board are previous users, then the roles of "teacher" and "learner" appear more fluid and interchangeable in this situation. Finally, tracing how users move between virtual spaces that present a "problem" or puzzle to be solved (such as Khan Academy), and virtual spaces that offer a "solution," such as a particular posting on a discussion board, may be highlighted using the Movement and Connections Tool to provide a kind of "model" for how new members of the Code Club might overcome challenges they encounter.

Turning our attention to interactions between the library facilitators and the youth participants in Code Club, we can apply the Teaching and Learning Tools to examine how teaching is enacted and learning is experienced. A common site for more experienced members of the Code Club to visit is a website called Bitsbox. While the site offers free programming challenges for children, Code Club participants have expressed challenges in reading the small font size of digitized versions of the "cards" that the challenges are displayed on. In such cases, we have observed the librarian facilitator downloading "zooming into," and printing these resource cards for students to apply to the development of

simple online apps. Examining such an interaction using the Teaching Acts Tool, we can see that while content creators on the Bitsbox site are enacting teaching through the design and curation of interactive digital artifacts for students, the library facilitator is also enacting a kind of teaching by resourcing students and helping them overcome some limitations of a purely digital experience. While in interviews, librarian facilitators have appeared quick to distance themselves from the notion of formal instruction, they have also explained why it is important for students to learn to problem solve "independently." Applying the Why, What, How Tool to the Bitsbox example, librarians appear to realize this pedagogical objective by "stepping back" while students learn by trial and error, all the while informally observing to gather evidence of success or frustration on the part of students. At the end of the most recent iteration of the Code Club, in the summer of 2017, the main library facilitator organized a "showcase" of students to present projects they had created during the sessions. Applying the Evidence of Learning Tool, we might consider a multidimensional evaluation of (a) the on-the-screen "look and feel" of student-designed artifacts, (b) the code students have written "behind the screen," and (c) the ways they have integrated their awareness of social context into the projects (Aguilera, 2017b).

Having examined situated examples of such pedagogical interactions, we might then "zoom out" to consider the broader Designed and Emergent Systems that connect these distributed teaching and learning experiences into a more cohesive whole. Through the Gateways Tool, we can interpret the offering of the Code Club program itself, an effort of the public library accompanied by a dedicated space, adult facilitator, and Internet-connected computers as one kind of physical "gateway" into the world of computer programming, along with the Designed Elements of the various websites and online resources used by students. However, once students have "entered" the creative and collaborative practices promoted by the Code Club, we have observed events such as students sliding their chairs next to one another or pushing together computer monitors to enact a more "communal" experience than working or playing individually. Library facilitators have shown enthusiasm for these Emergent Elements, which had not initially been enacted in the more "individualized" design of the computer stations. Indeed, subsequent observations suggested that these interactions became more regular through time.

Implications

The Code Club worked example highlights several important insights made possible by using a DTALS perspective. First, it shows how learners move from site to site—some in person, such as with the facilitator and their own peers; some online, such as StackOverflow and YouTube—and how those movements demonstrate varying learning pathways that they take around learning to code. Second, it shows how some of these pathways are actively designed and curated for learners, such as the tutorials on the "formal" Khan Academy platform and hyperlinks to additional resources, but that many of these connections emerge from a learner's interest or specific learning need. Last, it shows that many different objects and people act as teachers throughout the learners' journey, and that learning does not just "magically" happen in nonschool contexts; learning is the result of designed and carefully connected learning opportunities that then intersect with the learners' own agency. DTALS addresses the complexities of moving across teaching and learning contexts regardless of where they occur.

More broadly, we take inspiration from the Working Paper session format by noting that the DTALS framework and this particular toolkit are very much a work in progress. While we have multiple publications around the conceptual features of DTALS, we are now actively developing and using this toolkit across a variety of settings, from video games (including *Dota 2*, *Pokémon GO*, and the Twine development community) to museum and library contexts and more. Future research using this toolkit will highlight the importance of thinking about movements across contexts by both intentional design and emergent practices. We expect that this toolkit will demonstrate these crucial, but as yet undertheorized, acts and help situate the DTALS framework as a useful complement to existing models of formal and especially informal learning and teaching wherever they occur.

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