Game-A-Palooza: Games, Fun, Learning

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Abstract: There is a long-standing desire to marry games and education. The naturally occurring interest and investment found in games provides much promise to embed games with desired content knowledge and impart it to players. However, the best ways to do so remain non-trivial. Often games are treated as a black box and forced into classrooms. Other times, games are created for the classroom, but do not carry the engaging properties thought to be inherent in them. We at Games+Learning+Society (GLS) believe both the games and curricula around them need to be carefully crafted to complement each other. To this end, we created an informal learning event called Game-A-Palooza in which students participated in 3 curricula designed around 5 educational games. Although each game can be played on its own, we designed the curricula to supplement the materials embedded in them. From these games and curricula, we obtained multiple and diverse data streams – from quantitative click-stream data of each player's in-game actions to audio data of student interaction during each session to physical artifacts created by teams. The result was an event that provided free all-day spring-break activities for local kids while providing our center a large and diverse data set. In this symposium, we detail the design of each game and its attending curriculum, our data collection efforts and plans for analysis, and the challenges we encountered in creating and implementing such an event.

Because of the interest and engagement that they elicit, games have great potential for education. However, it remains non-trivial to find the best ways to harness this power. We at Games+Learning+Society (GLS) believe the best ways to use games for learning is to embed content-rich games into curricula and activities designed to empower the goals of the games. To best leverage this, data is collected from all of our games and activities through click-stream telemetry, and curricula artifacts. These data provide insight into the game mechanics and curriculum design that best promote learning through games and their surrounding curricula. To this end, we at GLS created an event called Game-A-Palooza (GaP). GaP contained 3 curricula wrapping around 5 games previously made by the center and affiliates. The aim of the event was to allow us (a) to provide a free childcare option during spring break with entertaining and educational programming for local middle-school kids, and (b) to collect heterogeneous data sets – click-stream game behavior data, talk audio, group video, physical artifacts, and pre-post measures from the curriculum activities – for cross analysis to look for patterns between in-game behaviors in-group behaviors, whole cohort activities, and individual pre/post assessment. In what follows, we detail the overall structure of the event and its logic, the 3 game-based curricula implemented during GaP.

Overall Structure

Our aim was to create a hybrid space where students could engage in game-based activities related to but not driven by school standards and assessments. A primary concern was to ensure that the event did not seem like "school dressed up as gaming", and thus, we aimed to maintain engagement at a high level across the games, curricula, and event. As such, GaP was structured in a way that gave the players as much flexible time as possible to play and socialize throughout the event with minimal pretests, posttests, and submission of assignments. Because of this, GaP was organized more like a conference or a camp rather than standard school. Participants were separated into three cohorts that rotated between three 90-minute sessions throughout the day. At the beginning of each day, between sessions, during lunch, and during the final 90 minutes of extended day, students were encouraged to play the games informally and socialize within or across cohorts. Participants were also given

individual iPads for the entire 5 days and were allowed to take them home to play informally. An online community environment, closed to non-participants and non-teachers, was also provided for out-of-program communication and posting. In addition, across all three curricula and interstitial programming for GaP, we developed an achievement and point/reward system dubbed “Coin Rewards” in which players were given a list of optional achievements across the entire 5-day program; as they completed achievements, students would earn coins that could then be exchanged for prizes. The achievements ranged from weird-silly (e.g. post a story on the forums that connects all three curricula together in a single storyline) to hard-core difficult (e.g. survive for 2.5 minutes in the “Last Genome Standing” challenge in *Virulent*) and were designed to incentivize participants to go beyond the structure of the curricular goals and engage in broader forms of gameplay.

In order to maximize the potential of the 5 educational games, curricula were designed so in-game play and out-of-game play were components of one another, with the game directly tied to real world activities. Taking the learning goals of the games as the basic anchor point for subsequent design, we created curricular activities including competitions, role-playing activities, and original non-digital games to foster deeper exploration of the in-game content and to encourage players to articulate what they learned to one another and within individual and group projects that doubled as assessment measures.

We anticipated collecting data from multiple sources, including but not limited to: gameplay behaviors through telemetry data, group talk data from audio recorders positioned by each group, video recordings of full cohort meetings, artifacts from curricula activities, gameplay behaviors from informal play outside of the sessions, achievement completion sheets, pre and post surveys, and post-event stimulated recall interviews. Through analysis of these heterogeneous forms of data, we aim to link gameplay behaviors and curriculum activities with learning and engagement. In what follows, we detail the design of each game and its attending curriculum, our data collection efforts and plans for analysis, and the challenges we encountered in creating and implementing such an event.

Virulent

Game

Virulent is a strategy game through which players learn about viral replication, and how the body’s immune system reacts to fight infection (see Figure 1). Controlling the Raven virus, players move through levels by infecting host cells, stealing precious resources and fighting the immune system with viral proteins. Each level takes players deeper into the microscopic world of virions through a combination of visual and audio directions. *Virulent* meets numerous NextGen Science and Common Core standards and was designed for individuals 9 and up.

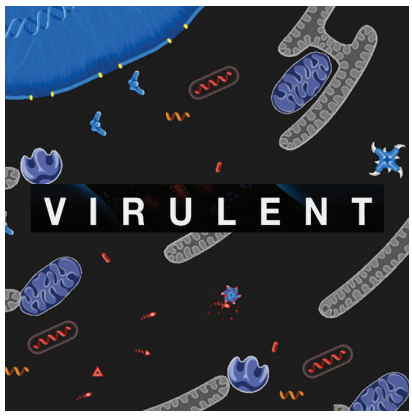

Figure 1: Virulent

Curriculum Design

Participants role-played as scientists recruited by the Center for Disease Control (CDC) to stop an international Raven virus epidemic. Cohorts were divided into “research teams” with tablets referred to as “digiscopes” and game levels as “microscopic slides” (see Figure 2). After viewing each microscopic slide, participants took field notes on virus and immune system behavior. Participants also watched pre-recorded videos from mock CDC scientists before each day’s investigation. Daily videos were used to update participants on the progress of the Raven virus spreading, thus creating a narrative that helped drive participation.

The curriculum was completed over five days. The first day was spent introducing participants to the *Virulent* game. As scientists, participants watched a video from the mock-CDC and wrote preliminary recommendations on how to stop the Raven virus from spreading further. Each participant received a clipboard, labcoat and digiscope to support this roleplaying experience. The second day included gameplay and model making. Participants created models of the virus and its efforts to replicate. Models were updated and shared through self-directed videos on the third day. The fourth day consisted of cohort presentations and ended with an "emergency" call; the CDC was now infected by the Raven virus. Three hypothetical solutions for stopping the Raven virus were presented on the final day. Research teams determined which solution was best based on articles from journals, media, and textbooks that were adapted to the content. Teams presented their findings to the cohort, debated, and voted for which solution to use.

Figure 2: Research groups working together to fight the Raven virus.

Data Streams

Preliminary demographic data was collected from participants, and a pre-assessment on content relating to viruses and cell biology was administered prior to the first session. This same assessment was administered on the final day to measure differences in content learned. USB audio recorders captured conversations between team members during cohort sessions, model making and formal game play. Model creation and group work was photographed each consecutive day. Self-directed videos from participants, along with video recordings of the final cohort debate, were also collected. Click-stream gameplay behavior recorded all game mechanics used. An online portal where participants posed questions, shared pictures and exchanged game strategies was tracked. Recall interviews with students and the curriculum developer provided a reflection of the gaming experience as a whole. Finally, field notes from facilitators on group work and game play were also collected.

Challenges and Future Directions

GaP took place during spring break, which elicited expectations that the event would be decidedly un-school-like and attracted existing friendship and sibling networks. While many enjoyed the planned activities, some participants ignored activities or assessments that seemed too much like the worksheets found in class because it reminded them of schoolwork. Group productivity was also sometimes influenced by relationships in the cohort (e.g. siblings) and participants with prior experience in playing *Virulent* were often less engaged in the curriculum. Another challenge was that, while team-work best suited the pedagogical outcomes of the project, it created complications for the research outcomes by adding within-team and within-facilitator confounding effects. Future analysis of science understanding, model-based reasoning, content acquisition and interest will have to be responsive to this challenge by addressing nesting of individuals within group within cohort within overall intervention.

Anatomy Browser/Oncology

Games

Oncology is a role playing game developed by GLS and available through BrainPop (see Figure 3). As the doctor, players assess a patient's symptoms, order scans, and then use radiation to treat cancerous tumors. On CT scans of the affected area, players highlight cancerous tissue on each layer and use two radiation beams to focus treatment on the tumor. Players earn ratings for the percentage of cancer they highlighted and for the percentage of tumor killed versus the healthy tissue affected by the radiation. Students played through three scenarios of the game during GaP, diagnosing and treating three patients in-game. Session facilitators also created a fourth scenario for the final activity, which included roleplaying and diagnosing with other players, described more in the next section.

Anatomy Browser, also developed by GLS and available as an iOS app, is a simulation of the human body, where users can tap on organs for identification or focus on or fade whole organ systems from view in order to isolate or compare them (see Figure 3). Other components of the application include a GI Tract explorer, where users can try to guide a ship through the digestive tract, and 3D puzzles in which users try to piece together an organ system using sagittal (right and left), axial (top and bottom), and coronal (front and back) views.

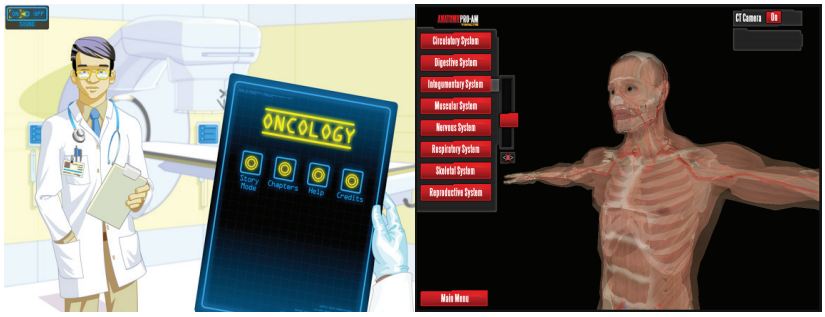

Figure 3: *Oncology* and *Anatomy Browser*.

Curriculum Design & Data Streams

Through the use of *Oncology* and *Anatomy Browser*, students worked together as a large group or broke into groups of 3-4 and explored how a medical team works to diagnose and treat cancer. The pedagogical goals were an introduction to anatomy and physiology, to medical careers, and to medical teamwork. Through Anatomy Browser, students used the GI Tract explorer, and the 3D puzzle components of the simulation and then used what they had learned to draw a life-size model of one organ system, labeling the organs and identifying possible types of associated cancers. The two games provided platforms for exploration and experience, with the final session culminating in a live role-play, requiring use of knowledge gained across the games.

During the live role-play of scenario 4, each group role-played as a team of medical professionals making a diagnosis and proposing a treatment. Each group was comprised of a doctor, who interacted with the patient; a CT technician, who obtained the scans; and a radiologist, who interpreted the scans and collaborated with the doctor. Students had one session to play this out, write a script, and produce a video. The videos produced ware particularly illustrative of student misconceptions of the workflow from diagnosis to recovery and how doctors use evidence from scans to determine treatment. Writing a script required students to delineate roles, furthering the idea that medical work requires cross-functional collaboration. Students volunteered to act out the script for recording while others took on responsibilities of directing, writing, or filming.

Players completed a pre-curriculum assessment, created a paper model of an organ system, and made videos while completing scenario 4, providing data on content knowledge development. At pretest, students were unfamiliar with radiation and the work of oncologists, yet 32 out of 42 students reported that they personally knew someone who had been diagnosed with cancer. Only 5 out of 42 students expressed interest working in the medical field.

Challenges and Future Directions

Before the GaP event, *Oncology* and *Anatomy Browser* were created within the same grant program and by the same design team, but had not been used together within a single activity. As the first trial run of the curriculum, we found promising direction, but there remain some kinks that need to be worked out. Future directions include refining the curriculum and defining and measuring more concrete outcomes. For instance, activities that allowed students to work at their own pace greatly increased engagement. The video activity should be expanded to two sessions so that students could spend the first day playing out “scenario 4” and writing the script, teachers could take time to provide feedback on the scripts, and then the last class period would be spent revising and filming. Integrating feedback into the script writing process would allow time to resolve misconceptions and improve understanding. Finally, a more tightly connected pre- and post-test for familiarity with vocabulary and medical careers would provide feedback as to whether students were connecting with this part of the curriculum.

Econauts & Citizen Science

Games

Econauts is a multiplayer iPad game currently in the alpha stage of development by GLS (see Figure 4). The game

presents players with a choice of career – lumber, mining, or farming – with the overall goal of building a business and making $8,000. Each career makes money in a different way. The lumber career cuts down trees and eventually turns them into houses to rent; the mining career digs up ore and turns it into automobiles; the farming career grows and harvests corn to turn into different types of food to sell at the grocery store. However, because they are in the same game world, players' actions have an effect on their career productivity as well as the productivity of other players. For example, mining ore too close to a lake causes the lake to become polluted, therefore decreasing the property value of houses built on the lake. By providing fast, repeatable game sessions, it is the goal of the developers of *Econauts* to provide players with an educational platform to test their theories on the human impacts on the environment while creating an experience that engages them through conflict, collaboration, and competition.

Citizen Science is an online adventure puzzle game developed by GLS and Filament Games in which a player must go back in time to gather evidence to explain the eutrophication of a local lake (see Figure 4). Using a variety of in-game scientific tools, players create their arguments for how to change the future of the lake, learning the different social factors and variables that contributed to the pollution.

Figure 4: *Econauts* and *Citizen Science*.

Curriculum Design

This session of GaP was centered on teaching/promoting environmental science concepts such as the complex interactions of different variables in the environment as well as human impacts on the environment as specified in the NextGen Standards. *Econauts* was used as the centerpiece for this session, driving student interest with a competitive multiplayer experience. *Citizen Science* was used in tandem with *Econauts* as a way for students to experiment with their theories on what impacts the environment in *Econauts* so they might gain a competitive edge in subsequent playthroughs.

Also, in line with *constructionist* learning theory (Papert & Harel, 1991), students participated in an activity for creating their own custom *Econauts* maps that would later be imported into the game. Given the alpha state of the game, there were some difficulties importing all of these maps into *Econauts*. However, students found this activity to be particularly engaging. The maps also gave insight into student thinking processes. For instance, one group of students produced a map that contained an area specifically for farming (see Figure 5). When asked about this space, the group indicated that, by and large, farmers did not pollute lakes; neglecting the effects of fertilizer and pesticide runoff. Such misconceptions suggest that further work could be done on highlighting the human impacts that farmers can have on groundwater and lakes.

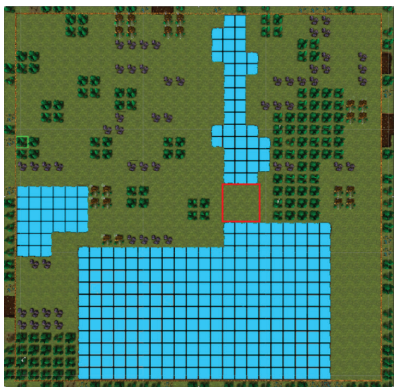

Figure 5: Player created map for *Econauts*.

Challenges and Future Directions

Generally, the curriculum was very well-received by the players, and provided data that generated unexpected insights. These data only serve to encourage further curriculum development. For instance, creating more targeted and specific tasks that highlight what has been suggested in these data will help validate this *Econauts* pilot and help to link participant understanding of the game to participant understanding of the real world. For instance, the current version of the game only has one win condition: Make $8,000. However, the system is designed to have different situations that players would have to navigate. For instance, how would a win condition of "Make $8,000 AND Keep Global Pollution Under X Amount" change player thought processes? Furthermore, creating maps to help players achieve the aforementioned condition or, better still, a condition that simulates current events may prove insightful.

Discussion

As a community service, GaP was considered an overwhelming success by both the participants and their parents. In each of the three sessions, curricula and games complimented each other in ways we did not expect, resulting in high levels of satisfaction and observable changes in content competency. One observation was that the games and the curricula were not the mere sum of their parts; together they created something more powerful for learning the embedded material. For instance, at the beginning of the week, some players were more engaged in the game than the curriculum around it, but as the game and curriculum entwined, they became more interested in the content. In just 5 days, players who seemed to be uninterested in learning had developed a passion for the content and were showing high levels of competency; an end state neither the game nor the curriculum alone could produce. As a data collection effort, our internal teams were equally satisfied. Across all five games, data collection included not only telemetry data but talk and interaction data as well as individual and group assessment artifacts that were crucially all connected across modality and context by individual participant number. Our hope is that, through the resulting corpus, we can examine individual and group learning progressions across time (by game login, by session, by day) and across context (by game, by facilitator, by teacher). Thus, GLS plans to make this event a yearly event provided as a service to community parents looking for an enrichment activity suitable for kids during spring break holiday when many parents simply do not have ready access to high quality childcare.

The event was not without its difficulties, however. First, regular and stable attendance was difficult to achieve. For the analyses planned, we needed a minimum of 60 participants attending all 5 days of the event. Although the number of participants who registered met our targets, many participants signed up but did not attend or did not attend regularly. Second, accommodation for attendees with special needs. Our event was intended to be inclusive and to accommodate a somewhat generous age range (middle school and early high school) but we were under-prepared for the number of participants with learning difficulties that attended. In at least one case, in order to prevent disruption of the other players in the program, we had to request parent pickup before activities were completed. In future iterations, we will need to explicitly ask about special accommodations needed and make every attempt to accommodate for them. Third, the Coin Rewards achievement system proved to be a highly motivating tool for engagement and informal play, shaping in some ways how and why different students differentially engaged in the three designed curricula. Analyses of our data will have to somehow account for its unanticipated yet, in places, rather keen impact. Fourth and finally, our online community tool was reasonably leveraged during the five-day program but largely under-utilized by students. Our general impression was that spring break may well not be the time to ask kids to do additional educational screen-time at home.

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