Empowering Educators

Supporting Student Progress in the Classroom with Digital Games

PART 2:
Case Studies of Game Features Used to Support
Formative Assessment Practices

A REPORT OF THE **A-GAMES PROJECT:** ANALYZING GAMES FOR ASSESSMENT IN MATH, ELA/SOCIAL STUDIES, AND SCIENCE

INSIDE

SCHOOL OF INFORMATION
UNIVERSITY OF MICHIGAN

NYU | STEINHARDT

INTRODUCTION

There is growing interest in the use of digital games as part of K-12 teachers' classroom instruction. For example, in Washington State, legislation[1] is being considered to create a pilot program for integrating games into the school curriculum. And in the fall of 2014, the White House and U.S. Department of Education hosted a game jam[2] to encourage and promote the development of learning games. As with all educational technologies, the most frequently asked question is, "Do they work?" The answer — and the question itself — is complex. Work for what purpose? To help students learn? Learn what? Core content knowledge or 21st century skills? Or is the purpose to engage students? In comparison to what? As with all educational technologies, the real answer to any of these questions is, "It depends." It depends on lots of factors, including the features of the game and, most importantly, what teachers do with those features as part of their instruction.

The A-GAMES project (Analyzing Games for Assessment in Math, ELA/Social Studies, and Science), a collaboration between the **University of Michigan** and **New York University**, studied how teachers actually use digital games in their teaching to support formative assessment. Formative assessment is a set of practices to gauge student progress toward learning goals, and to adjust instruction on the basis of that information to meet students where they are. Formative assessment is arguably one of the most important parts of a teacher's instructional tool kit. When used well, it has been found to be among the most powerful ways to improve student learning outcomes, and it may be particularly important to the success of low-ability students (Black & Wiliam, 1998). But as with any "best practice," in order to be effective, formative assessment approaches must be both useful and used. And that's where games — potentially — come into play.

This study was conducted in two parts: part one was a nationwide survey of K-12 teachers to investigate common formative assessment practices, common game use practices, and the intersection of the two (a report of the survey findings can be downloaded here).[3] Part two, which is detailed in this report, consists of observations and interviews with 30 middle grades (5-8) teachers in the New York City area who volunteered to use one of eleven games as part of their teaching in Spring 2014. These games were designed by a variety of learning games developers, and accessed by teachers in our study through BrainPOP's GameUp portal.[4] The survey offers a "mile high" picture of what teachers are doing with games related to formative assessment. The observations and interviews focused on how teachers used (or did not use) various features within each game that had the potential to be used for formative assessment. Hence, the case studies are organized around these formative assessment features, instead of individual teachers or

The A-GAMES project occupies a special niche among these efforts. Our objective in A-GAMES is to illuminate how teachers understand and make use of game features that support formative assessment. Though prior surveys, including recent work from the Joan Ganz Cooney Center (Takeuchi & Vaala, 2014), have explored how teachers use games for assessment, the A-GAMES study is the first that we are aware of designed specifically to examine game use and formative assessment practices in relation to each other. The A-GAMES case studies look across a variety of educational games that are designed to be modest in scope, for use across one or several class periods, related to topics in various content areas. As noted in a 2013 review of the K-12 games market, "Short-form games provide tools for practice and focused concepts. They fit easily into the classroom time period and are especially attractive to schools as part of collections from which individual games can be selected as curricular needs arise" (Richards, Stebbins,

> The field of games and learning is enjoying rapid growth in both research and development.

games. The study is exploratory in nature, and is not intended to compare or gauge the effectiveness of games, game features, or approaches to formative assessment.

The field of games and learning is enjoying rapid growth in both research and development. Organizations such as the Joan Ganz Cooney Center[5] and Common Sense Media[6] conduct surveys to explore how teachers use and think about digital video games and related media. The Games for Learning Institute[7], the Learning Games Network[8], The Games+Learning+Society Center[9] at the University of Wisconsin, The New Mexico State University Learning Games Lab[10], GameDesk[11], and The Education Arcade[12] at MIT conduct research on games and build games that embody their research. Researchers and developers at UCLA/CRESST[13] and GlassLab[14] (in partnership with SRI[15]) are focused particularly on games and assessment.

& Mollering, 2013, p. 4), whereas longer-form games, such as GlassLab's SimCityEDU, "have a stronger research base than short-form games and are focused on higher order thinking skills that align more naturally with new common core standards. These games do not fit as easily into the existing school day or classroom time period, but are the source of new experimentation in the research community and a variety of school contexts" (Richards, Stebbins, & Mollering, 2013, p. 4).

We hope the information in this study is useful to game designers as they refine and develop future educational games, to researchers as they frame further studies of games and learning, and also to educators and those who support educators as they think about the role of games in everyday classroom practice.

SUMMARY OF KEY CASE STUDY FINDINGS

If digital games are to play a key role in classroom instruction, they must support core instructional activities. Formative assessment — a set of techniques used by teachers to monitor, measure, and support student progress and learning during instruction — is a core practice of successful classrooms. **The A-GAMES project** (Analyzing Games for Assessment in Math, ELA/Social Studies, and Science) studied how teachers actually use digital games in their teaching to support formative assessment.

In Spring 2014, we conducted case studies with 30 teachers in the New York City area. We visited each teacher's classroom to observe them using a digital game with students, and then followed each visit with a phone interview to discuss their experience using the game and how it fit into their formative assessment practices.

We focused on the following features of games that support formative assessment:

- » Points/Scores/Stars
- » Other Forms of Player Feedback
- » Dashboards of Player Progress
- » Screen Capture/Annotations
- » Essential Questions
- » Review Questions
- » Quizzes
- » Less Prominent Formative Assessment Features, including:
  - – Replayability
  - – Ability to Unlock Levels
  - – Graphic Organizers
  - – Game Guides

Our case studies documented that:

1. **A range of features related to digital games provide support for monitoring student progress, including:**

- » *feedback systems*, such as points, scores, or stars;
- » *dashboards* that provide an overview of progress for either individual students or groups of students; and
- » *screen captures* that can be annotated and serve as a point of communication between students and teachers about learning or progress.

2. **The formative assessment utility of the features we examined can be further enhanced by technological and design-related improvements.**

Prominent game-based feedback mechanisms — such as points or stars — are often not clearly linked to desired learning outcomes, making it difficult for teachers to interpret game progress in relation their learning goals for the classroom. Other tools — such as game-specific dashboards — can be difficult for teachers to configure properly to display students' information. While some areas for improvement are technological, others are about how games are designed and how clearly key game play elements are linked to learning goals.

3. **"Wrap around" materials provide valuable formative assessment support for teachers using digital video games.**

Many useful formative assessment features come from outside the game itself: quizzes, guides to curriculum integration, graphic organizers, review questions, screen capture and

annotation tools, and sometimes dashboards. Whether provided by game developers, or accessed via portals or game aggregators, these features can be valuable for supporting teachers' use of games for formative assessment in at least three ways:

» providing support for *teaching with* games;

» providing materials teachers can use for assessment *around* games; and

» providing continuity in assessment experiences *across* games.

ABOUT THESE CASE STUDIES

In order for any particular formative assessment approach to be valuable, it must be both *useful* and *used*. The goal of the A-GAMES study is to explore how teachers employ various features of games to support formative assessment of student learning.

The educational games observed in these case studies all contain features that are intended to support teachers in monitoring and understanding student learning and progress. Sometimes these features are simple, such as an end-of-game score. Sometimes they are complex, such as a dashboard to track student progress towards academic standards across a range of in-game metrics. We examined how teachers interpret and use these features, and what issues and challenges arise that limit

> A unique aspect of our case studies is that they focus on the features within the games—not on individual teachers or games.

their use in hopes of providing valuable information for the future development of games that support learning. A line of inquiry of special interest to this project is concerned with the design of assessment mechanics (Plass et al., 2011; Plass et al., 2012), i.e., patterns of specialized activities that have assessment as the primary objective, to enhance the abilities of games to provide insights on student progress toward learning goals.

In early 2014, we conducted case studies with 30 volunteer teachers in the New York City area. All taught in grades 5-8, in public and private schools. We selected teachers across the subject areas of English/language arts (ELA), social studies/history, math, and science. The teachers were varied in terms of their experiences with games, both personally and as educational tools **(See Appendix A for more information about case study demographics and methodology)**. Each teacher agreed to use one of 11 educational video games accessed via BrainPOP's GameUp portal.[4] We selected GameUp because it provides a single point-of-access for games by a variety of leading game designers spanning a range of content areas, as well as additional curricular and assessment supports for using the games. Some of these supports provide teachers with formative assessment tools that augment features already in the games, and these are also described in this report. **(See Appendix B for a list of the games included in the study)**. Case study teachers participated in a half-day

professional development session on how to use GameUp to access their chosen game prior to entering the study. This professional development included a general introduction to gameplay and features of their chosen game. We then arranged to visit each teacher's classroom to observe them using the game with students, and followed each classroom visit with a phone interview to discuss their experience using the game and how it fit into their formative assessment practices.

> Our goal is to shed light on the different ways that formative assessment features are implemented in games, and how teachers recognize, interpret, and utilize those features.
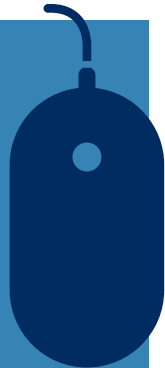
A unique aspect of our case studies is that they focus on the features within the games—not on individual teachers or games. This report should not be viewed as a critique of or commentary on any particular game or instructional practice, or as a comparison of games or features. Our goal is to shed light on the different ways that formative assessment features are implemented in games, and how teachers recognize, interpret, and utilize those features.

We observed the following features of games that support formative assessment practice:

- » **Points/Scores/Stars**
- » **Other Forms of Player Feedback**
- » **Dashboards of Player Progress**
- » **Screen Capture/Annotations**
- » **Essential Questions**
- » **Review Questions**
- » **Quizzes**
- » **Less Prominent Formative Assessment Features**
  - – Replayability
  - – Ability to Unlock Levels
  - – Graphic Organizers
  - – Game Guides

For each feature, we briefly describe its role and use, give examples of how it "played out" in the classrooms we observed, and describe reasons why it might not have realized its potential in the classroom learning environments we observed.

In addition, we offer some general comments on the value of an aggregator or portal for the game-using teacher.

FORMATIVE ASSESSMENT FEATURES IN DIGITAL VIDEO GAMES AND HOW THEY ARE USED

FEATURE	HOW FEATURE "PLAYED OUT"	BARRIERS
POINTS/SCORES/STARS "Quantified" outcome marking overall progress or proficiency within a level	» students monitored own progress or performance » increased motivation or persistence » determined whether or not a level should be re-played for greater proficiency	» lack of clarity about what these indicators mean with respect to student learning » may not be related to content learning objectives » often displayed only at the end of a level (not displayed persistently)
OTHER FORMS OF PLAYER FEEDBACK Game responses to player actions to encourage or discourage future action	» asked students to pay attention to the in-game feedback they were receiving » allowed over-the-shoulder observations » focused each student's attention on areas of weakness before they replayed the game	» students might not perceive or understand the information they were being given » difficult for teachers to assess students' learning and in-game interactions in larger classes
DASHBOARDS Information display that allows one to quickly scan a range of information pertaining to a task	» focused students in their further play and learning » reviewed the report with the student » helped guide post-game discussion with the entire class	» technical complications involving student logins » may be better with longer-form games or when displaying progress across games
SCREEN CAPTURE/ ANNOTATIONS Capture 'snapshots' of the screen at any moment during a game play experience, add text annotation as explanation or reflection	» created a snapshot at the end of every level » got a sense of overall class performance » used the comment function of feature to encourage student reflection and to gain insight into students' thinking during game play » documented that students had completed the assignment » sent feedback to students	» can interrupt the "flow of excitement"
ESSENTIAL QUESTIONS Help teachers focus students' gameplay on key concepts and ideas; could be used at the beginning or end of game play	» used essential questions at various times during a lesson » focused students on what they learned from game play	» teachers often create their own assessment questions

FORMATIVE ASSESSMENT FEATURES IN DIGITAL VIDEO GAMES AND HOW THEY ARE USED

FEATURE	HOW FEATURE "PLAYED OUT"	BARRIERS
REVIEW QUESTIONS Review questions or objectives at the end of a level	» students received feedback about their answer or were shown the correct answer » students were asked to check off a list of objectives met by their writing before moving on to the next task in the game » kept track of what students learned	» no direct way for teachers to see students' progress (without dashboard) » students were sometimes not motivated to spend enough time on them
QUIZZES Quiz features provided by the game designers, including videos with accompanying quizzes and/or a tool for generating quizzes provided by portal	» provided informal checks on learning » set 'cut scores' for whether students should replay a level or move on » offered a "quick read" on how students were doing » offered assessment data that could be used immediately to inform instruction	» not aware of the available quiz features » usefulness of a quiz depended on the purpose of game use » the extent to which quiz content was aligned to the important game content
REPLAYABILITY Game can be played multiple times for practice; new experience each time	» games where there was no "right" answer had higher re-playability	» games with one "right" or "best" answer have no or limited replayability
ABILITY TO UNLOCK LEVELS A code that unlocks all levels of the game at once; allows teacher to tailor difficulty for students	» the majority of a class played and was assessed on content at an entry level, an advanced student could play and be assessed on more advanced content	» generally associated with replayability
GRAPHIC ORGANIZERS Supplemental worksheets and documents that accompany game experiences	» generated traces of student work that the teacher could review » elicited student reflection in advance of the group discussion » reduced cognitive load for students as they played the game	» teachers sometimes preferred their own materials » concerns about printing » students work at different paces
GAME GUIDES Supplements to lesson plans that help teachers integrate games into their curricula; include guidance on how to assess student learning with the game	» provided overviews of game » prompted small-group discussion activities » provided support for peer feedback	» because game designers cannot always anticipate context, the extent of guidance for how to gather and interpret information about student learning is limited

FEATURES

POINTS/SCORES/STARS

Salen & Zimmerman (2003) define games as "a system in which players engage in an artificial conflict, defined by rules, that results *in a quantifiable outcome*" (p. 80, italics added). In many digital video games, the outcome is "quantified" as a score, a report of points, or a display of stars. These displays take a number of forms, but in general they are a report to the player about accomplishment or proficiency. Because stars and points are common elements of video games, students may find such scoring mechanisms to be a natural and expected part of using an educational video game. Many of the games in our study employ one or more of these elements. Points, scores, and stars have the potential to be a key to teachers' formative assessment of student performance and/or learning from game play, serving as an objective indicator of progress and proficiency.

When a game reports points or scores, such as the score reporting in the game *Quandary* by Learning Games Network, the points may represent the player's overall level of accomplishment during a round of play. Points are earned for correct moves, implying both that there is a maximum possible or "most correct" set of responses or moves in a game, as well as a way to improve one's score in future play. Players can com-

> Points, scores, and stars have the potential to be a key to teachers' formative assessment of student performance and/or learning from game play, serving as an objective indicator of progress and proficiency.

pete against other players for the best score or against themselves to improve their score. In other games, as in *Battleship Numberline* by Playpower, the points are reported as a more abstract average accuracy, in which the implied goal is to make progress toward 100% accuracy with each response.

Stars function in a similar fashion to points, by indicating how completely a player has accomplished the goals of a particular level. For instance, in *Monster School Bus* by New Mexico State University Learning Games Lab, players are encouraged to plot a school bus route to pick up combinations of students that result in both a "full bus" and "rock out buildings." It is possible to complete a level without having earned the full "three stars" if both goals are not completely met. Students can continue on through the levels of game, but can also go back and improve their game performance (and demonstrate greater mastery) by earning all three stars. Like points, stars can represent achieve-

Scoring, like that in *Battleship Numberline*, has the potential to be a key to teachers' formative assessment of student performance. Please note: not all games can be used on tablets, please check BrainPop's website to learn more.[4]
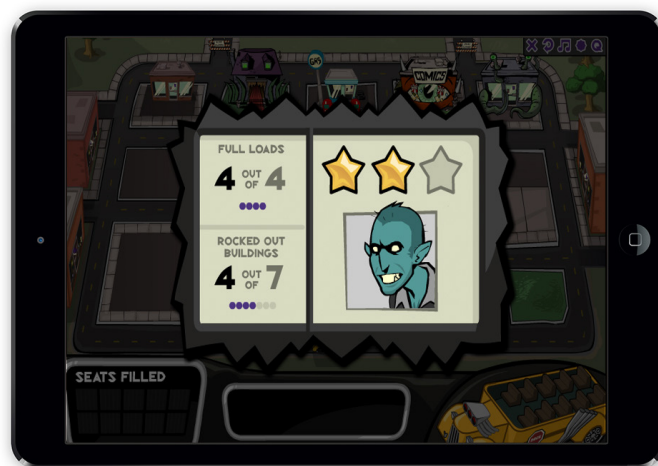
Monster School Bus uses stars in a similar fashion to points, indicating how completely a player has accomplished the goals of a particular level.

ment of multiple types of goals. In the game *Planet Mechanic* by Filament Games, for example, one star is awarded for a correct solution to the overall problem in each level on the first attempt and another star is awarded for correctly answering a "challenge" question about the science content in the level.

How did this feature "play out" as a formative assessment tool?

Points, scores, and stars can play a key role in formative assessment, and in particular in student self-assessment. In our interviews, teachers indicated that they would draw students' attention to these displays in order to:

» **monitor their own progress or performance;**

» **increase their motivation or persistence to complete the task or level; and**

» **determine whether or not a level should be re-played for greater proficiency.**

engaged with each other. There were kids that were not sharing a computer that were actually helping each other out." Another teacher used students' scores to spur in-class competition between the boys and girls.

What can prevent this feature from realizing its potential?

Points, scores, and stars are clearly important game-design features, especially for educational games where progress and mastery are important. However, we observed a range of implementation-related issues that inhibited the utility of this game feature. The greatest limiting factor is the clarity with which game designers communicate with teachers what these indicators mean with respect to student learning. This understanding is critical for teachers to assess learning related to game play, and can affect students' views of the game. According to one teacher, *"I did notice [the points], and the kids noticed it. I thought that I didn't understand the relationship between the points earned and the task that the kids*

> "My only surprise is how engaged they were... instead of having a tantrum [when they did not succeed], they went back to try and gain stars.... [Students were] engaged with each other. There were kids that were not sharing a computer that were actually helping each other out." — case study teacher

Teachers used points, scores, and stars as criteria for determining when acceptable performance was achieved by students. They also used them to check that students had complied with a game-related assignment, such as playing a game for homework, or replaying a level for greater mastery. In some cases, teachers could use points or stars to make comparisons of progress or mastery *across* students, to identify which students needed extra support, or to challenge students. Points, scores, and stars provide motivation for students, both for accomplishing the goal and as a way of sharing their progress with others. As one teacher found, *"My only surprise is how engaged they were... instead of having a tantrum [when they did not succeed], they went back to try and gain stars.... [Students were]*

were performing to earn the points.... It seemed like the points were kind of an afterthought.... If there isn't a [clear] rationale behind the points, it can give the impression that the whole enterprise is somehow fraudulent or fake...." Some teachers found "teachable moments" when a game's point display was unclear. In one case, a teacher in our study had students engage in deductive reasoning alongside their game play to try to determine how points translated into bonuses or feature unlocks in the game. In contrast, one teacher expressed a concern that points could potentially distract students from aspects of game play that directly promote learning, for instance, when points are needed to unlock game features that are not in direct line with the learning objectives. Whereas the first issue calls out the challenge

of interpreting points with respect to learning, the second highlights the importance of game mechanics that closely align with learning objectives. We note this as a general drawback to points or scores in game-based learning, where the metaphors and mechanics of the game are intended to serve the overall "cover story" or fantasy of the game, and as such may not align well with the core learning objectives. Later in this report we discuss dashboards, which have the potential to help teachers and students tease apart game feedback associated with specific learning goals from overall game play feedback.

> ⭐ Scores may not provide all of the information teachers desire.
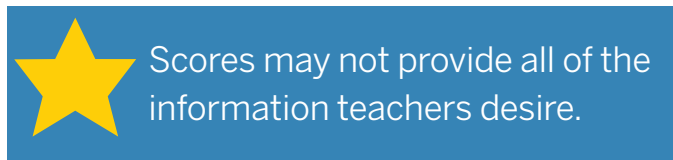
A further challenge to understanding the meaning of points and stars is that in some games, stars indicate mastery of different goals, some of which may not be related to the content learning, or clearly related to particular goals a teacher is focused on. In one math game in our study, students could earn three stars for each level. Mastering the mathematics content earned students two of the three stars, but the final star required students to master a component of game play unrelated to the math. Additionally, scores may not provide all of the information teachers desire. In a game designed to teach argumentative writing, for instance, the score only reported percent completion, without any indication of writing quality.

Another limiting factor in how useful points or stars are in formative assessment practice relates to their display. In some games, points and stars are displayed only at the end of a level, while in others they are displayed all the time, and are continuously updated on the screen. These displays may be useful to the student who is continuously engaged with the game, but not easily accessible by teachers. Teachers in this situation would resort to informal assessment techniques to access students' scores, including "over the shoulder" approaches, or having students "call out" points when

they finish a level. This problem is reduced or eliminated when the points or stars are also communicated via a dashboard or similar feature, where teachers can access information about students' progress over time. As a workaround, many teachers in our study directed students to use GameUp's SnapThought™ feature, which is a way to capture and annotate screen shots, to record points or stars when they are displayed only at the end of a level. We describe SnapThought's role as a formative assessment support on page 15.

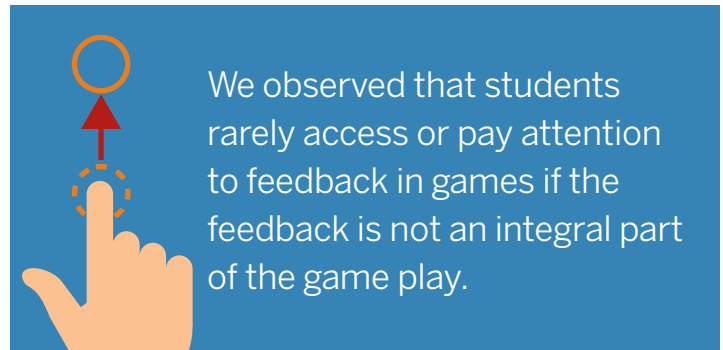## OTHER FORMS OF PLAYER FEEDBACK

Games provide feedback to players through a variety of means beyond points, scores, or stars. For our study, we defined feedback as actions or information that occur in response to the students' actions and decisions in the game. Feedback plays an important role in both learning and game play. In instructional settings, feedback helps students understand what they have done correctly or incorrectly, fosters awareness of their own knowledge and skills, and provides guidance to improve future work. Likewise in games, feedback helps players understand their performance, knowledge, and skills, and improve their future attempts in the game and is a key component of successful formative assessment.

In-game feedback varies greatly in both type and form across games. Some games provide a direct evaluation of a student's actions. For example, in *The Sports Network 2* by Classroom, Inc., when students are asked to categorize interview tips by their main idea, each tip is marked as correct or incorrect. In this way, games provide information intended to help students complete the task on their next attempt. In the game *Planet Mechanic*, when students try to complete a level without meeting the specifications, they are given feedback about what modification will help attain the necessary specifications. While these first two types of feedback are most similar to the kinds of feedback commonly given by teachers, games can also provide feedback in unique ways. For example, if students incorrectly

connect organs in *Guts and Bolts* by BrainPOP, a pipe will burst where the student made the mistake and fluids will run outside of the organ system. This provides visual feedback both that an error was made, and a hint about where the error occurred.

As the *Guts and Bolts* example shows, the timing and explicitness of feedback can be varied in games. The *Lure of the Labyrinth: Employee Cafeteria* game, created by MIT Education Arcade in partnership with Maryland Public Television and Fablevision, uses an abstract representation of accomplishment via a series of small light bulbs that turn off as the player works through a round. An incorrect answer turns off 3 lights, while a correct answer only turns off 1. There is a macro-report of success (if you feed all the monsters correctly before all the lights go out), but there is also a micro-level report of success, in that fewer doused lights at the end of a successful round can be interpreted to mean that the player solved the underlying challenge of the level with fewer errors.

Feedback might be provided after every action, like classifying each attempt at the target as a hit or miss in *Battleship Numberline*. Or it might be given only in response to particular actions, as is the case in *Planet Mechanic* or *Guts and Bolts*. Additionally, students may not be able to immediately make sense of the feedback they are given. In *Lure of the Labyrinth: Employee Lounge*, after putting three coins into the vending

> We observed that students rarely access or pay attention to feedback in games if the feedback is not an integral part of the game play.

machine, an item, whose value matches the total value of the coins, is dispensed and a coin equation appears on the screen for students. It may take several tries for students to understand the connection between the coins they selected and the item dispensed. Discovering how this feedback works is an intentional part of the game design, and part of what makes the game fun; discovering how the feedback works is satisfying to players.

How did this feature "play out" as a formative assessment tool?
Feedback is only helpful if it is used by students, yet we observed that students rarely accessed or paid attention to feedback in games if the feedback was not an integral part of the game play. Many of the teachers in our study had to ask students to pay attention to the in-game feedback they were receiving or demonstrate for students what this feedback looked like.

If students incorrectly connect organs in *Guts and Bolt*, a pipe will burst where the student made the mistake and fluids will run outside of the organ system.
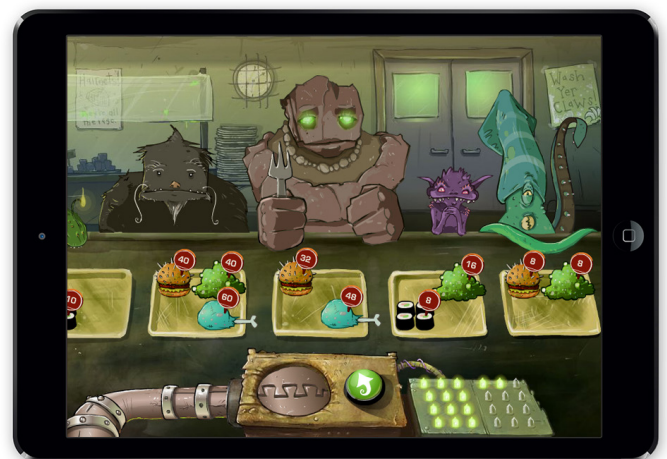
Lure of Labyrinth: Employee Cafeteria uses an abstract representation of accomplishment via a series of small light bulbs that turn off as the player works through a round.

The in-game feedback was helpful for teachers who were assessing students during gameplay using over-the-shoulder observations, providing a specific piece of information on student progress and effort. One teacher using **Drafting Board** by iCivics commented, *"I noticed the game giving feedback about incorrect choices. It was useful because it just indicated to me whether or not the children were picking the appropriate source materials for their support."*

One game in the study, **Do I Have a Right** by iCivics, produced a final game play report. One case study teacher used the information in the report to focus each student's attention on areas of weakness before they replayed the game. *"You did pretty good. You got 5. What I want you to do, [is] go back and hire lawyers to get these other amendments."*

### What can prevent this feature from realizing its potential?

Feedback is only useful if it can be used to improve future performance and understanding. As a core part of the learning process, in-game feedback must therefore provide meaningful information in a way that students or their teachers can interpret and translate into improved performance. In some cases, in-game feedback was not taken up by students because they did not pick up on the information they were being given. In other cases, the feedback did not seem tailored enough to the particular student. *"One of the biggest problems was that the feedback was one size fits all, it did not have intelligent feedback."*

Many teachers in the study employed over-the-shoulder observations of students to assess students using the in-game feedback they were provided. However, this method has drawbacks. *"In-game assessment features were less useful for gathering information on student understanding because I can't be everywhere at every time."* This made it difficult for teachers to assess students' learning and in-game interactions in a large class. According to one case study teacher, *"I realized halfway through that there is no way for me to see*

students' progress [...] I still haven't figured out what ways to see wrong attempts, what reasons the students had, or any progress. There was no info provided by [the] game to me" One solution might be greater integration of student feedback with a dashboard system that tracks student progress over time, or some other kind of system that can alert teachers to students who are showing early signs of needing extra support.

DASHBOARDS

A "dashboard" is an information display that allows one to quickly scan a range of information pertaining to a task, such as the teacher dashboard in **The Sports Network 2** by Classroom, Inc. Dashboards that display student progress or learning progress are potentially important tools for formative assessment. Teachers have long used grade books, which could be considered a form of dashboard. By scanning entries in a grade book, an experienced teacher can learn to recognize patterns that might indicate some students are struggling and require remediation or enrichment while others have mastered a topic and are ready to more on. Digital environments, including games, offer the possibility to automatically generate data based on student actions and present that data to students and teachers in real time. Well-designed games are good at adjusting the level of difficulty to match learner competence, and
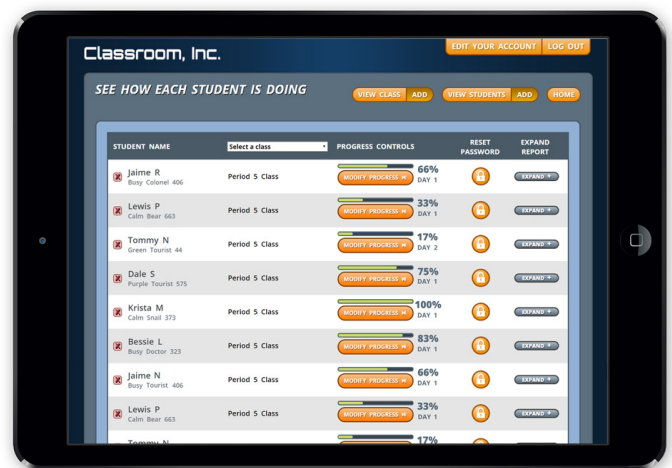
The dashboard in *The Sports Network 2* displays student progress or learning progress.

Digital environments, including games, offer the possibility to automatically generate data based on student actions and present that data to students and teachers in real time.

for some learning games, it has been proposed that effective game design matched to learning objectives can result in an environment where students' learning can be accurately assessed without the need to take tests external to the learning experience. This has been called "stealth assessment" (Shute, 2011), and is the goal of new game development efforts such as *Mars Generation One* and *SimCityEDU* from GlassLab[14] (Mislevy et al., 2014; Butrymowicz, 2013).

Whether or not dashboards make use of "stealth" assessment, they should enable teachers to quickly scan and interpret the learning progress of individuals and groups of students. Furthermore, it is crucial that this information be actionable, enabling a teacher to make instructional decisions regarding next steps for their class or for any individual student. Designing a dashboard that supports such decision-making is not an easy task. In part, this is because teachers are not trained to interpret data (Means, Chen, DeBarger, & Padilla, 2011) and may need guidance to do so.

Opportunities to observe teachers' use of dashboards were extremely limited during this study due to the nature of the games observed, which were designed to cover relatively small or discrete amounts of content, over relatively short periods of time. Ideally, a dashboard is holistic with respect to a student's ongoing or overall learning progress. This requires dashboard systems that are knowledgeable about learning interactions across

a range of activities, something that is still beyond the reach of many current educational game contexts (see page 26 on "The Value of an Aggregator or Portal" for more on this topic), but which is starting to gain traction in the world of learning analytics (Siemens, 2013). The teachers in our study also encountered some technical challenges, which we describe below.

How did this feature "play out" as a formative assessment tool?

In our conversations with teachers, almost all were familiar with the concept of a dashboard, and were positive about the role such a tool could play in their formative assessment practice. As noted above, dashboards were not found in many of the games included in our study. However, some games had summary displays of information about progress at the level of individual student players. For instance, *Do I Have A Right* produces a report at the end of game play. One teacher found this useful for focusing students in their further play and learning. The teacher reviewed the report with the student: *"Let's take a look. Not bad. You lost one case. So I want you to play again, hire people with expertise with those amendments. Start with 'Sally Forth' [a character in the game] so you have experience with other amendments."* A teacher using *The Mission US* games by THIRTEEN and Electric Funstuff noted to her students that students could work at their on pace, and that she would be "tracking their progress."

Some teachers noted that they would value a dashboard to help guide post-game discussion with the entire class, by helping them see what the class accomplished and did not accomplish. The teachers we spoke with also had ideas about how to make dashboards more convenient, such as having game software automatically send reports to teachers via email so they could be reviewed outside of class.

Dashboards should enable teachers to quickly scan and interpret the learning progress of individuals and groups of students. Furthermore, it is crucial that this information be actionable.

What can prevent this feature from realizing its potential?

As researchers and educational designers, we remain extremely positive about the potential of dashboards to support productive formative assessment practice. However, we had little opportunity to observe the successful use of dashboards in this study. In our interviews, one teacher summed up the critical need for displays such as dashboards: *"A game [where] the teacher can't track what the kids are doing does not help us teach."*

In the games that did have some kind of dashboard, teachers found they were not able to access it due to technical complications involving student logins, and in some cases they had trouble locating the dashboard. These types of barriers represent socio-technical hurdles that might be overcome with revised interactive designs, coupled with greater familiarity and experience.

protects student data and provides teachers with the information they need to support learning.

SCREEN CAPTURE/ANNOTATIONS

A key aspect of formative assessment is the eliciting of evidence about student achievement (Black & Wiliam, 2009). While games provide ongoing and rich feedback to students, oftentimes that feedback is ephemeral, leaving no trace for students or teachers to leverage at a later point in time. Moreover, while games track student behaviors and make them visible in the form of points, stars, or progress panels, they do not typically provide opportunities to elicit and capture evidence of students' underlying thought processes.

"A game [where] the teacher can't track what the kids are doing does not help us teach." — case study teacher

The issue of grain size for tracking student learning progress is also important to keep in mind. The learning that might accrue from students playing a single game, especially a game with relatively modest curricular goals, as was true for many of those included in our study, may form a single component of a learning progression or standard. But to really visualize student progress, a dashboard would ideally be able to coordinate data-based insights across multiple games over longer spans of time. This was beyond the scope of the individual games in our study. Furthermore, federal laws such as COPPA or FERPA (designed to protect student privacy online and educational data) are most easily followed by not collecting any identifiable student information. These policies may deter developers from developing or sharing data that could be beneficial to teachers and learners. We hope that some reasonable path or common ground can be found in the near future that both

Screen capture tools offer a potential solution to this challenge. In BrainPOP's GameUp platform, a screen capture tool called SnapThought™ creates opportunities in the classroom for students to reflect on their game play experience. Using the SnapThought tool, students can capture up to five 'snapshots' of the screen at any moment during a game play experience. Students can also write annotations or short written reflections to accompany each image. As students play, they can access the snapshots they have already captured, and edit their annotations. Once they are done, they submit their collection of annotated snapshots to their teacher. Teachers can then view the SnapThoughts, write a response and send it back for students to see. Teachers' prompts for students' use of SnapThought, such as an instruction to capture an end-of-level score, are not directly integrated with the tool itself or the games and must be provided during instruction. Teachers are

therefore able to use the tool in a variety of ways and can make decisions about which events to capture, and what (if any) comments students should include. Teachers often referred to this feature simply as the "snapshot" tool.

A screen capture tool called SnapThought creates opportunities in the classroom for students to reflect on their game play experience.

How did this feature "play out" as a formative assessment tool?

This was a popular feature for the teachers in our study, who used the tool in a variety of ways. Unlike other features we describe, because this feature was part of the platform rather than a specific game, it was used by teachers across nearly all games. We therefore had more opportunities to see it in action and to gather teacher feedback on its usefulness and potential.

Students across-the-board used the SnapThought feature according to their teachers' prompts. We saw a range of prompt styles, from very specific to very broad. Several teachers used this feature to know how far, and with what success, students had progressed in the game. This use of the tool typically did not draw on the written reflection feature. For instance, some teachers asked students to create a snapshot at the end of every level, and in other cases they only asked for students to capture their highest level achieved. In games that included a reporting screen, teachers utilized the feature to capture that as well. *"[SnapThoughts are] what I was using to follow the students' comprehension because I'd be able to see which cases they won and which ones specifically they lost."* Teachers also utilized SnapThoughts directly as assessment data, using game progress to assign a grade. *"Proceed to **Guts and Bolts**, I want you to spend the remainder of the period in it and take a snapshot of your group. Write your group members on a sheet of paper. You are being graded. Take a snapshot of the highest level."*

SnapThoughts offer a helpful alternative to other assessment strategies to get a sense of overall class performance. As one teacher explained, *"I can just go on the computer and take about 20 minutes. Look at everyone's snapshots and I can tell more or less if they understand it or not."* Teachers who assigned game play for homework made use of this feature to document that students had completed the assignment, as well as to see how far they had progressed. *"I want to make sure the kids are doing it, they're not just telling me yeah, yeah I did it. The snapshots they can send to me, so even over the weekend, before I come into class, let's say Monday morning, check my e-mail, check that*

everyone did it. For those who didn't do it, I can just tell right away and can use as formative assessment as well." The focus of this feature on tracking progress could be considered a work-around for the lack of dashboard tools that would automate the capture and display of students' game play and learning outcomes.

Teachers also used the comment function of this feature to encourage student reflection, and to gain insight into students' thinking during their game play experience. Teachers' prompts to students asked them to show the strategy they were using, to describe what they had learned about the activity, what they found interesting, and what was confusing. Also important from a formative assessment perspective is that, in addition to documenting progress, this feature was utilized to identify moments where students encountered difficulties, particularly in conjunction with the annotation function. As a teacher using **Citizen Science** by Games+Learning+Society instructed her students,

"As you are going throughout the game, you can take up to five snapshots during the game, if you get stuck, or if you made a really good argument, or something you think is interesting, you will submit the snapshot. So space them out. I want you to take at least three. Maybe it was something interesting. Write a comment and submit it." When teachers later reviewed these comments, they were looking to understand what students had learned and to *"see their reasoning."*

While the majority of teacher comments were focused on the ability to gain information about students' gameplay, there was some evidence to suggest that teachers referred to the SnapThoughts to make instructional changes. For instance, one teacher described using the comments feature to send feedback to students. Among the other ways that teachers leveraged this feature were to gauge student engagement, identify what students liked or disliked about the game, and as a source of notes for students to refer to later for review and test preparation.

What can prevent this feature from realizing its potential?

Overall the SnapThought feature was viewed positively by teachers in our study. Their comments suggest several functions that would enhance the impact of annotated screen capture as a tool for formative assessment. These include the ability for teachers to specify prompts within the tool, the ability for students to submit their snapshots and comments throughout game play so that during class teachers could see, comment, and direct instruction in response; an unlimited, or perhaps teacher-determined, number of snapshots; and the ability for teachers to set specific places within the game where students are prompted to create a snapshot and comment before continuing. The latter functionality would admittedly be more challenging to implement from a game development perspective as it would require deeper integration with each specific game.

Though most teachers in our study made use of this tool, we heard from several participants that they were not aware of the feature. During the period of data collection, the SnapThoughts tool was still relatively new and some teachers who hoped to use it encountered technical difficulties that have since been resolved. Some expressed interest in the tool, but had concerns about the five-capture limit. One teacher observed that she didn't want to interrupt the "flow of excitement" by having students pause to create snapshots. Still others were not clear how they would make use of the feature for instruction, for instance, in determining which points in the game would offer meaningful screen capture opportunities. This might be related to teachers' familiarity with the game and its connection to their instructional goals. Also, the nature of some games might lend itself more to a snapshot tool, for example having clear levels or key feedback moments. Finally, increased familiarity with new tools like SnapThought is likely to lead to more innovative applications over time. For instance, the teacher who asked groups of students to document their highest level attained with a SnapThought had them write the group member names on a piece of paper, rather than typing them into the annotation area.


Essential questions, like those in *Do I Have a Right,* are designed to help teachers focus students' game play on key concepts and ideas.

ESSENTIAL QUESTIONS

Many of the games in our study came with essential questions provided either by the game designers, by BrainPOP as a "wrap-around" feature of their Game-Up portal, and sometimes developed by the teachers themselves to match their curricular goals. These essential questions are designed to help teachers focus students' game play on key concepts and ideas, and can be used at the beginning or end of game play. Students might also be asked to think about a question while playing the game. Some essential questions are related to game play strategy, while others focus on specific content in the game or broader questions that students might answer based on their learning from the game. For example, an essential question for **Do I Have a Right** asks, what are some of the individual rights protected by the Constitution? One of the questions for the science game **Guts and Bolts** asks students what it means to test a hypothesis.

How did this feature "play out" as a formative assessment tool?

Teachers used essential questions at various times during a lesson. Several teachers who used the game **Quandary** began class by asking students about the meaning of the word "quandary." A teacher who used **Lure of the Labyrinth: Employee Cafeteria** had students

> Essential questions are designed to help teachers focus students' game play on key concepts and ideas.
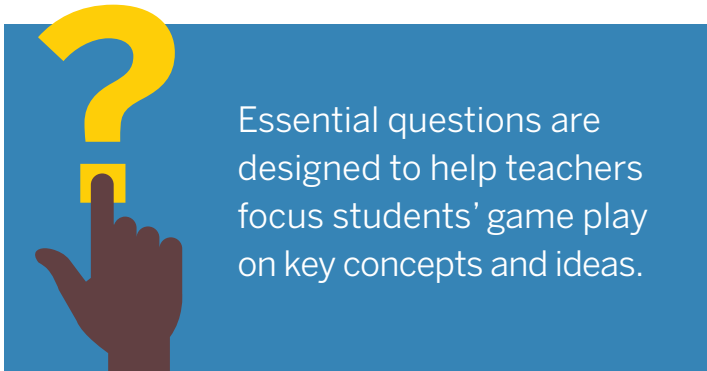
discuss their game play strategies. At the end of game play, another teacher used an essential question to focus students on what they learned from the game play. *"Next period, I want you to do a summary, a synopsis. What did they teach you? I'm going to give you an index card. I want to know what did you learn? Did you learn anything? You still are responsible for a synopsis. What did you learn?"*

The essential questions provided insights into students' understanding before, during, and after playing the game. Our case study findings are consistent with results from our survey, which found that among teachers who assess student learning with digital games, the majority (75%) use whole class discussions to assess what students have learned through game play.

What can prevent this feature from realizing its potential?
As skilled professionals in unique contexts, teachers often create their own assessment questions to match their specific goals and their students' unique needs. For this reason, some of the teachers we observed only glanced at the essential questions or did not look at them at all. One teacher who did not realize the questions were there felt confident in her own ability to create questions for her students. According to another teacher, who opted not to use the questions provided, *"I kind of like to adapt and change things for me, I don't take anything verbatim from that. I need to make it reachable for my kids. I do want them to gather and understand domain-specific vocabulary but I have to build into it."* As with the provided essential questions, teachers who used their own questions asked students about both content and game play strategies. Although

many teachers prefer to come up with their own questions, the essential questions provided can support teachers who are less familiar with the games and the key lessons students can take away from them. They can also provide a starting point for teachers who prefer to create their own questions.

REVIEW QUESTIONS

Although many educational games rely on information obtained directly within game play to gain insights into students' learning, others contain more overt assessments, such as review questions or objectives at the end of a level. In addition to their purpose of assessing student learning, these questions can also have a metacognitive function by making students more aware of what they have learned or accomplished in a particular level. These review questions and objectives can vary in their form, in their importance in the game, and in what they require of students before they are allowed to continue in the game.

How did this feature "play out" as a formative assessment tool?
Review questions and objectives were a part of a few of the games in our study. In *Planet Mechanic*, for example, at the end of each level, students were presented with a multiple-choice question about the science content
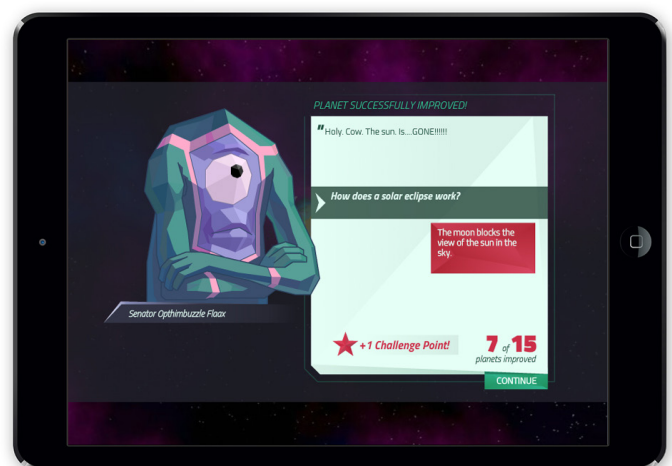
Review questions, like those in *Planet Mechanic*, can have a metacognitive function by making students more aware of what they have learned.

related to the level they had just completed. After answering, students received feedback about their answer, and those answering incorrectly were shown the correct answer. In addition to assessing students' learning, the questions also provided a chance for students to earn stars in the game by selecting the correct answer on the first try. In *Drafting Board*, which was focused on essay writing, at the end of each task, students were asked to check off a list of writing objectives, such as using transitions, they had met. Only after completing the checklist could they move on to the next task in the game.

Teachers in our study varied in how much they paid attention to and highlighted the review questions and objectives for students. One teacher commented that the questions were a resource for students to keep track of what they learned. *"I like the self-check, it's a nice assessment. Some students used these questions as their notes."*

What can prevent this feature from realizing its potential?
Review questions are useful as a formative assessment tool if teachers are able to review students' answers after game play. When students know that their teachers will not have access to review their responses, they may not take the questions seriously. Our observations found that some students paused and read the review objectives at the end of each section, while others just clicked to continue in the game. One teacher reported, *"I would love for them to spend more time, but they just wanted to move on."*

QUIZZES

Quizzes are among the most familiar means of conducting formative assessment that we examined in the study. Some games included their own quizzes, and for many, multiple-choice quizzes had been created by BrainPOP. These quizzes typically address content covered in each game and can be accessed via a link

on the main game screen in the GameUp platform. The design of these quizzes allows students either to use them in a traditional quiz format or to review each answer as they work through the quiz. At the end of the quiz, students can submit their results to their teacher through the GameUp platform. Teachers are then able to see which questions the student answered correctly and incorrectly. Some games also included quiz features provided by the game designers, and the BrainPOP GameUp platform included videos with accompanying quizzes and a tool for generating quizzes called Quiz Mixer.
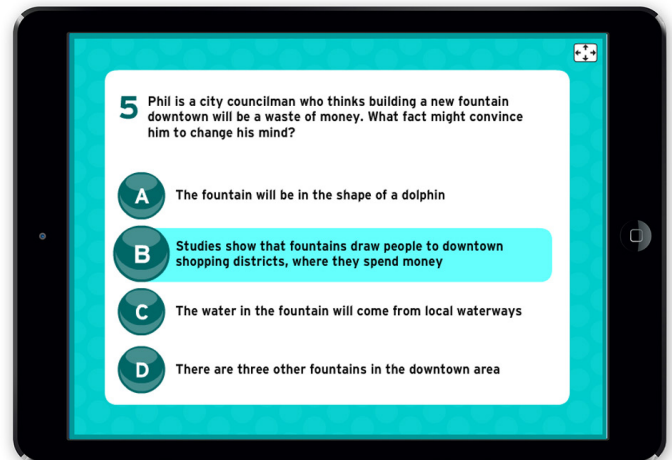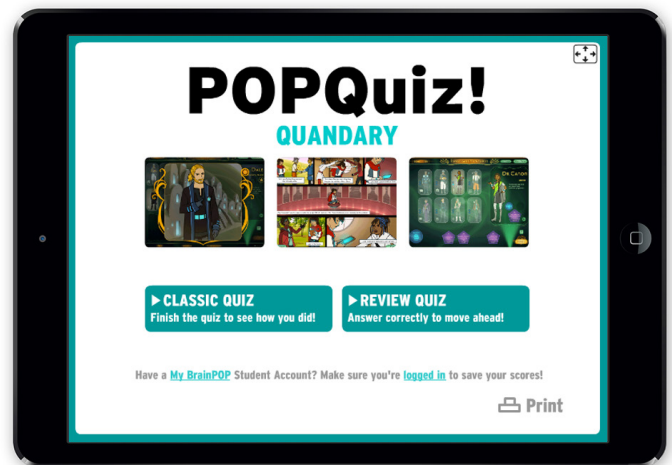
Teachers in the study occasionally used the quiz feature, such as the one shown above from *Quandary*, for informal checks on learning.

Quizzes provide teachers with a "quick read" on how students are doing and offer assessment data that can be used immediately to inform instruction.

How did this feature "play out" as a formative assessment tool?

Teachers in our study occasionally used the quiz feature, most often as informal checks on learning. This comes through in one teacher's instructions to her students as they played *Quandary*: *"When you finish with the first chapter of the game, take the quiz and then we will see where everyone is (...) Don't worry if you don't get to the quiz part, it's not a big deal. It's just something to let me know how you are doing. I don't want you to be rushed. .... It's not something you are graded on, I just want to know how you do."*

Among the benefits of quizzes are that they support self-paced learning by providing a checkpoint for understanding. Teachers can set threshold criteria for whether students should replay a level or move on. Another benefit is that they provide teachers with a "quick read" on how students are doing and offer assessment data that can be used immediately to inform instruction. *"It gives me a general understanding of how well students grasp the concept. A student got six, so she did it again. It told me to reteach."*

What can prevent this feature from realizing its potential?

Many teachers in our study were not aware of the available quiz features, which speaks to the importance of documentation or interface cues to the quiz options.

In addition, teachers noted that the usefulness of a quiz depended on the purpose of game use. For instance, if students were assigned the game for review, then quizzes were less relevant as a feature. The other issue that emerged in our conversations with teachers was the extent to which quiz content was aligned to the important game content.

LESS PROMINENT ASSESSMENT FEATURES

REPLAYABILITY

Mastery requires practice (Bransford, Brown, & Cocking, 2000), so it is helpful when a game can be used (and enjoyed) more than once in order to let students practice their skills and develop automaticity. In our survey, 90% of responding teachers thought games were either effective or very effective for reinforcing or mastering previously taught content. Some of the games in our study are meant to be played once, but others, such as *The Lure of the Labryinth*, are designed so that the answers to the problem change with each play through. This means that students focus on trying to understand the algorithm behind the puzzle in this math game, which is more important than the ability to solve any single problem in the game. In other games, such as *Do I Have a Right?*, replayability comes from choosing different pathways through the game. In almost all games, students can play again in pursuit of a higher score.

How did this feature "play out" in its role in formative assessment?

Both students and teachers were aware of their game's replayability. In one of our interviews, a teacher noted that students playing *The Lure of the Labryinth "noticed that every time they would go back it would have different numbers, so it's not like they can just do process*

It is helpful when a game can be used (and enjoyed) more than once in order to let students practice their skills and develop automaticity.

of elimination, they actually have to do the mental math in order to get the three stars." Another teacher, commenting on **Do I Have A Right?**, made a similar comment to the effect that, *"I love the fact that the kids never knew what was coming next because all of the cases came in different orders."*

When a game was designed to support replayability, the options available for teachers in assigning the game increased.

What can prevent this feature from realizing its potential?

Games where there is no "right" answer have higher re-playability. Games with one "right" or "best" answer are a special kind of game—a puzzle—which is fun, but is generally not fun to continue to play after the best answer has been found (Salen & Zimmerman, 2005).

judgments about the appropriate level of challenge for their students. If the game has embedded assessment features, this differentiation can provide more detailed knowledge to teachers about each student's level of performance. For example, while the majority of a class is playing and being assessed on content at an entry level, an advanced student can play and be assessed on more advanced content.

How did this feature "play out" in its role in formative assessment?

Unlocking levels might provide an additional challenge for students, and provide an extra level of control to teachers. One teacher indicated to us during the follow-up interview that one student suggested that the game they played should have a feature similar to that of **Monster School Bus.** *"One student wanted to be able to choose different levels of trickiness."*

> The ability to unlock levels can allow teachers to differentiate students' game play based on content covered in class or by individual students' progress.

ABILITY TO UNLOCK LEVELS

Many games get progressively more challenging as players move from one level to the next. In educational games, this may mean that the game becomes more complex, but more often it is the academic content that increases in complexity. In such a game, the ability to unlock levels can allow teachers to differentiate students' game play based on content covered in class or by individual students' progress. In one of the games we observed, there was a keyboard shortcut that unlocked all levels of the game at once, allowing students to skip ahead to levels covering more advanced mathematics concepts.

Many games require students to play through all levels in order, regardless of how easy or challenging the content in a particular level is for each student. The ability to unlock levels allows teachers to make professional

What can prevent this feature from realizing its potential?

While unlocking all of the levels provides flexibility for teachers to tailor the game to their students, it can also prevent the game from being replayed. If students are able to jump to the final levels of a game and complete them, they may not be interested in going back to earlier levels, rendering them less useful. This feature might be made more valuable by allowing teachers to unlock specific levels of a game at particular points in time. In doing so, they can select particular levels to unlock based on content covered in a particular lesson. One teacher in our study mentioned the ability to unlock the game level-by-level would be preferable, since units can take many days to complete. The teacher wanted the option to unlock certain levels and keep others locked to help pace the content being covered: *"I would unlock the three levels on level one and they can get practice on*

it. Then the next day, I can unlock level two and they can do it for homework. If I can unlock it by section, it's easier for them to play the game multiple times. If students can unlock themselves, they will go home, play it once, then come here and they're already experts on it, not knowing that it's not the learning process, it's more like memorization."

> Graphic organizers can be used to scaffold or provide structure for student thinking in the game.

GRAPHIC ORGANIZERS

"Graphic organizers" is an umbrella term we use to refer to supplemental worksheets and documents that sometimes accompany game experiences, provided either by the game developers, BrainPOP, or other "lesson plan" sites. Graphic organizers take a variety of forms. In some cases they are purely informational, other times they include explicit prompts to students but are not intended to capture responses to the prompts, and others are designed to elicit and capture student responses. Graphic organizers can be used to scaffold or provide structure for student thinking in the game. The **Mission US** games, for example, come with extensive curriculum guidance for teachers. Echoing a theme from other features, graphic organizers offer opportunities for students to reflect on their game play, and also generate a persistent trace of student thinking or strategy use. As documents that can be completed and turned in to the teacher, graphic organizers have the potential to serve as a rich source of insight into student progress, stumbling blocks, and understandings.

The kinds of graphic organizers that accompanied games in our study varied, as did teachers' use of them.

How did this feature "play out" in its role in formative assessment?

There was clear evidence that some teachers used graphic organizers as formative assessment tools to reveal students' progress, strategy use, and reasoning, and to check for understanding. For instance, a teacher using **Drafting Board** described what she looked for in students' work on the graphic organizer in assessing their understanding, *"The first sheet from the student activity packet asks them to write out their claim. To help me understand whether or not the students understood their task, I would need them to come up with a reasonable claim for or against the ban on T-shirts."* For **Guts & Bolts**, one teacher gave students a packet to draw and sketch their systems diagrams in the box, and to draw and label their solutions to each level. One teacher using **Lure of the Labyrinth** explained to her students, *"The goal is to fill the trays, you need to*
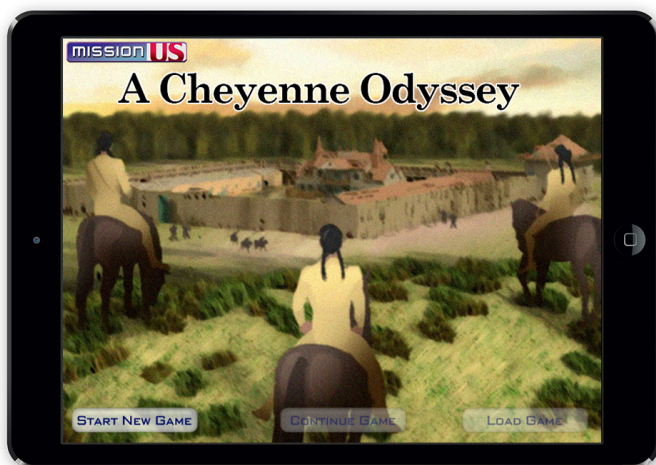
Some games, like *Mission US,* come with extensive curriculum guidance for teachers.
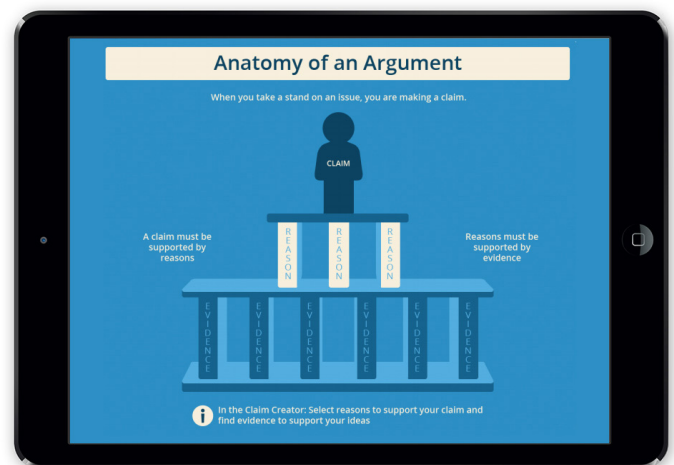
There was evidence that some teachers used graphic organizers, like those in *Drafting Board*, as formative assessment tools.

> Graphic organizers generate traces of student work that the teacher can review, and which can also serve as the basis for group discussions. In this sense, graphic organizers play a similar role in formative assessment to tools like screen capture and quizzes.

be aware of the proportion and the number. I am giving you the graphic organizer, I want you to tell me the strategy to use for the game. You will see the lights, this is an indication of how you are doing. The button dispenses the food. Be sure at the end, you can tell us the strategy you used." Some teachers used the simplest form of graphic organizer—blank index cards—to encourage and capture student reflections as well as key terminology. *"When you get to a specific word, write it down on this card. If you see something interesting, write it down so we can share."* This feature was also used to assign homework, to provide continuity across multiple class periods of game use, and to bridge game activities to more familiar classroom activities such as peer editing.

Importantly, what these applications of the graphic organizer feature have in common is that they generate traces of student work that the teacher can review, and which can also serve as the basis for group discussions. In this sense, graphic organizers play a similar role in formative assessment to tools like screen capture and quizzes. We observed one teacher begin a lesson with a discussion of the worksheet used during game play in a previous lesson. This application offered the teachers insight into student thinking, and also provided opportunities to ask probing questions and engage multiple students in reflection. They also elicited student reflection in advance of the group discussion.

We saw two ways that graphic organizers were used to reduce cognitive load for students as they played the game. The first was to provide game-related information to support students in understanding the game challenges and key characters, or to provide background information especially for games that draw heavily on students' content knowledge. The second form was to have students jot down notes, which

reduced the need to hold large amounts of information in their working memory. As one teacher instructed her students, *"The game asks for information, if you have the piece of paper, you can write down the opinions of people in the game."*

What can prevent this feature from realizing its potential?

We heard a few comments from teachers related to the shortcomings of graphic organizers as a formative assessment feature. In some cases, they simply were not deemed necessary, particularly when the purpose of game use was to review existing knowledge or skills. We also heard teachers express concern about printing a lot of materials and having a preference for online versions of these supports. Another issue that surfaced was that in classrooms where students worked at their own pace, it was not always clear to teachers how to make use of the graphic organizers. Finally, there were some instances in which teachers gave students the option of using the graphic organizer, with mixed results. In this case, the potential of the feature depended on students' willingness to make use of them.

Citizen Science offers a curriculum guide that provides a context for the game.

The Sports Network 2 provides a navigation guide, summaries of each quest, preparation tips, student handouts, and more.

GAME GUIDES

Game guides are documents intended to support teachers in using games in their classroom. They are generally supplements to lesson plans, and include helpful tips and strategies for teachers to use to support instruction. One way that game guides have the potential to support formative assessment is by including specific suggestions on the ways that the information from game play could be used to inform instructional decisions. *Citizen Science* offers a curriculum guide that provides a context for the game, primary documents including photographs that can be used in class discussions, and a map to accompany the game. The Teacher's Guide that accompanies *The Sports Network 2* provides a navigation guide, summaries of each quest, preparation tips, student handouts, and more.

How did this feature "play out" as a formative assessment tool?

We saw several teachers apply strategies in their instruction based on suggestions from game guides. These included prompts for terms, such as "What do you think a quandary is?", as well as prompts for small-group discussion ("If you and your neighbor are done, ...talk about what you've done [together]"). We also found that some teachers used the game guide suggestions specifically for assessment purposes, for instance to

support peer editing, or as assessments of prior knowledge. Game guides that included overviews of the game trajectory also enabled teachers to keep track of where students were in the overall experience. In some cases, we observed teachers reading directly from the game guide to introduce students to the game.

What can prevent this feature from realizing its potential?

A number of factors seemed to determine whether this feature was useful to teachers. One was the context of the game use, including whether students were working at their own pace. Among the reasons teachers shared for not using the game guides was that the suggestions were not compelling or helpful. In some cases it wasn't clear to teachers how to implement the suggestions or associated materials with students. Perhaps most importantly, the potential of this feature to support formative assessment hinged on the extent to which the guide offered specific support for this activity—by supporting the gathering of assessment-related information from students, and by providing direction on how to interpret student responses to improve instruction.

THE VALUE OF AN AGGREGATOR OR PORTAL

When we began this study, our goal was to investigate various features of games intended to support teachers' formative assessment practices. Along the way, we realized that a good deal of the support that teachers value comes not from the features of any particular game, but from the surrounding resources and context for the game. We were fortunate to have BrainPOP as an implementation partner for this study. We used their game-aggregation portal GameUp[4] as the means for teachers to access the games used in the study. But GameUp was more than merely an access point—it provided additional value and enhancements around the games in the study, including supports for formative assessment. GameUp also helped to lower some of the barriers to the use of games in the classroom, as we explore below. The observations we provide about the

value of a game aggregation site or portal are not intended to be particular to GameUp; they could describe many current educational game aggregation sites, such as GameDesk's Educade,[16] the Learning Games Network's Playful Learning,[17] and Common Sense Media's Graphite.[18]

In the survey portion of this study, nearly half of teachers indicated either that they weren't sure where to find "quality games" or games that "fit our school's curriculum." A portal like GameUp alleviates these issues by providing teachers with a curated set of games that are aligned to content standards and curriculum areas in ways that map well to school-based instruction. In our surveys, 32% of teachers indicated that not having access to formative assessment materials or resources *as part of* their curriculum materials was a barrier to their formative assessment practice. Here again, a portal can provide "wrap-around" resources including quizzes or tools like SnapThought that add formative assessment support where it did not previously exist.

A good deal of the support that teachers value comes not from the features of any particular game, but from the surrounding resources and context for the game.
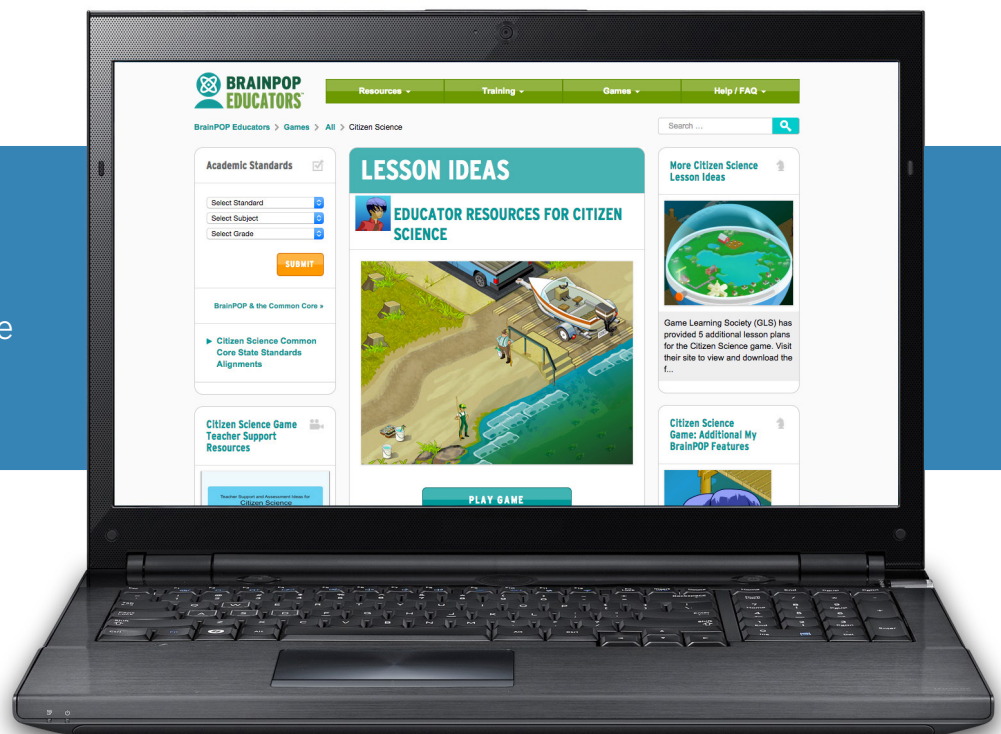
BrainPOP's GameUp aggregation portal

One concern we have about the future of games in the classroom is the potentially piecemeal nature of games within the curriculum. If a teacher uses a different game for each of several different topics across the curriculum, he or she would be faced with different interfaces and different "cover stories" for each of those topics. Time that could be invested in focusing on content is instead focused on learning how to use/play each of the different games. This is reminiscent of a challenge faced by teachers in the CD-ROM era of the 1990s, when each disc had unique/artistic interface features that had to be learned, but rarely transferred across discs. Addressing this was one of the challenges of "learner-centered design," which argued that we need to recognize that learners are both learning how to use tools while they are also learning the content, and anything we can do to reduce the time spent learning to use the tools increases the time spent learning with them (Soloway, Guzdial, & Hay, 1994). Longer-form games, such as GlassLab's[14] *Mars Generation One*, are less likely to suffer from this limitation as students are meant to engage with the game over extended periods of time. But the smaller "bite-sized" games that are most common may be more susceptible to these challenges, as they are designed to be played over one or two class periods. Even here, a portal can also provide tools to help overcome these limitations, such as a unified dashboard where teachers can track progress across different games (such a dashboard was not part of our study), or a tool like SnapThought that works the same way across many different games, allowing students and teachers to utilize the tool as part of a regular classroom formative assessment routine.

Though all of the games in GameUp are free to play, advanced features such as the SnapThought tool are only available to schools that pay a subscription fee. Without a platform like GameUp, schools would have to navigate payments to a range of individual vendors, not all of whom are skilled in working with schools. With a paid subscription, schools also gain access to support that might not otherwise be available. Reports on the use of "off-the-shelf" games in school have indicated that installation can be problematic for schools, partic-

> Our focus on features specifically tuned to formative assessment in this study indicates that a purposeful approach to the topic can result in designs that are better attuned to the needs of teachers.

ularly with myriad copy protection schemes and other limitations that game developers frequently employ to block piracy (Sandford, Ulicsak, Facer, & Rudd, 2007). These installation issues would pose a problem for the 26% of the teachers in our survey who indicated "unfamiliarity with technology" as a barrier to using games in the classroom. A web-based portal like GameUp can remove that barrier, by restricting teachers' searches to games that can be played in a web browser. Though we would argue that all games used in education have some potential for formative assessment use, our focus on features specifically tuned to formative assessment in this study indicates that a purposeful approach to the topic can result in designs that are better attuned to the needs of teachers. As our study was getting underway, some new efforts were being launched that focus specifically on assessment design and reporting to teachers, such as the GlassLab Games[14] platform. These games employ dashboards and other feedback mechanisms designed to present key assessment information to teachers in order to support instructional decision making (Mislevy et al., 2014).

We want to stress that our intention is not to provide an endorsement or evaluation for either GameUp or BrainPOP. In our study, we used only the GameUp portal, which means that we are not able to comment on the features/performance of GameUp compared to any other portal service. We suspect that GameUp and similar portals will continue to provide essential support for teachers' formative assessment practices with a range of useful resources and integrations that go beyond the features of individual games.

CONCLUSION

The goal of the A-GAMES project was to gain insight into the features of educational games that have the most promise for supporting formative assessment. As a backdrop to the case studies described in this report, we conducted a national survey of teachers' formative assessment practices and instructional game use. The survey results revealed that many teachers—over half of those surveyed—are using games on a regular basis in their instruction, and that a substantial number of these teachers use games for formative assessment

purposes. It also identified key barriers faced by teachers to using games in the classroom, which included the challenge of finding games aligned to specific curricular content (the survey findings can be downloaded from gamesandlearning.umich.edu/a-games/downloads)[3].

In addition to confirming that some teachers are already using games for formative assessment purposes in the classroom, survey results found that teachers who use games for formative assessment engage more often in formative assessment practices, and are more likely than other teachers to report "no barriers" to conducting formative assessment. This suggests that games can play a key role in supporting classroom formative assessment practices. The case studies enabled us to look more closely at how specific game features support teachers in their formative assessment practices. Not all features were equally useful, and often, utility was related to how the feature was implemented. Our observations and conversations with teachers revealed both promise and pitfalls, but in general the shortcomings faced by teachers in our study can be repaired through either improvements in game design, improvements in support around the game, or both.

Among the most common game-related, assessment-related features we observed were feedback systems such as points, stars and scores. These features served both teachers and students in providing indications of progress in the game, and in encouraging practice and improvement. Teachers used this feature to encourage students to monitor their performance, to increase their motivation, and as criteria for whether to repeat a level. But teachers were sometimes unsure of how to use these features for formative assessment purposes, because points and stars were not always clearly related to progress on desired learning outcomes. In order to be useful for formative assessment, a game element must not only be easy to interpret, but the information it yields should be related to the learning goals or objectives the teacher has for their students. This issue – alignment with the curriculum – is key for the successful use of games in classrooms, as indicated both in our case studies and in our survey results.

Another issue related to points, stars, and other in-game feedback is that it is often not displayed on the screen persistently by games, making it hard for teachers to monitor student progress, especially in

in classrooms is a key way to improve teachers' use of games for formative assessment. Dashboards that can display progress toward learning goals across multiple games would be especially valuable, but will require new kinds of coordination across game developers.

The ability to capture specific moments of game play in the form of screen captures – a feature called "SnapThoughts" on the GameUp platform – was extremely valuable as a formative assessment tool for teachers in our study, particularly in the absence of dashboards or other methods for teachers to access student game progress. Annotations of the screen captures was found to be an effective way to elicit student thinking, as well as to promote student reflection. It was also important that use of the screen capture tool was under the control of teachers. They could determine when and how to use the SnapThought tool, tailoring it to their needs.

Finally, we identified a variety of "wrap-around" features and tools for supporting formative assessment, such as essential questions, quizzes, game guides, graphic organizers, and review questions. Resources like these,

> In order to be useful for formative assessment, a game element must not only be easy to interpret, but the information it yields should be related to the learning goals or objectives the teacher has for their students.
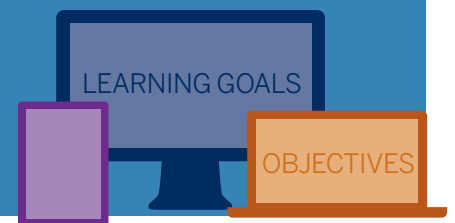
larger classes. Dashboards are a potential solution to this challenge. Dashboards can provide a coherent overview of progress, both for individual students and across a classroom of students. However, they are also technically complex, both to design and to use. Teachers in our study, even when they did not have access to or use the provided dashboards, seemed to recognize the potential utility of this feature. We argue that future development of dashboards with a focus on usability

which are external to game play, offer teachers ideas for instructional prompts, and recommend strategies for leveraging students' game experience for formative assessment purposes. Some of these resources were provided by game designers, and others were provided by BrainPOP as part of their GameUp platform. No matter the source, these kinds of resources provide valuable support for formative assessment, and guidance and choice for teachers. They can be

Our hope is that this study provides useful information to teachers about the ways games can inform and support their practice, and to the game development community about ways to continue to strengthen the support for learning and teaching provided by their games.

used to recognize the complex assessment and standards environments within which teachers currently work, and help bridge game play to localized classroom needs.

Effective instruction and assessment go hand in hand. Yet getting accurate and continuous information about students' learning progress is an ongoing challenge, particularly in large classrooms. It is not surprising that teachers' use of games in instruction is on the rise, as it is in the nature of games to present players with challenges, to allow for failure as well as success, and to provide ongoing feedback. It is also not surprising that educators recognize these features of games and increasingly turn to them as part of how they teach and how they assess students' learning in the classroom. But to have a positive impact on student learning,

formative assessment demands information that is both useful and used. Our study documented some of the ways teachers are indeed utilizing games for formative assessment purposes, and the potential value of these uses for these important classroom practices. These case studies explored common features in games that teachers could use for formative assessment. In addition to identifying ways these features are useful to teachers, we also identified many areas for improvement. The utility of games as instructional tools will continue to expand. Our hope is that this study provides useful information to teachers about the ways games can inform and support their practice, and to the game development community about ways to continue to strengthen the support for learning and teaching provided by their games.

APPENDIX A: METHODS AND DEMOGRAPHICS

In Winter and Spring 2014, we conducted case studies with 30 teachers in the New York City area. Our case study teachers taught grades 5-8 in both public and private schools. Teachers spanned the subject areas of English/Language Arts (ELA), social studies/history, math, and science. Each teacher was matched with one of 11 educational video games that fit his or her grade level and subject area(s). Teachers participated in an in-person professional development workshop to learn how to use BrainPOP's GameUp portal to access their chosen game prior to entering the study, and also received a general introduction to gameplay and to the features of their chosen game.

Although teachers were all located in the NYC area, the case study teachers and their schools varied greatly across many demographics. Nine of the case study teachers were male (30%), while the other 21 were female (70%). They have taught between 1 and 33 years, averaging over 11 years of teaching experience. At the time of the study, the teachers were between 23 and 70 years old, with an average age of nearly 40 (Note: one teacher declined to provide their age). Teachers were asked to indicate all of the grade levels they taught. Forty-three percent taught grade 5, 53.3% taught grade 6, 60% taught grade 7, and 46.7% taught grade 8. Teachers also reported a wide range of student performance levels. Precisely 13.3% of teachers reported that their students perform above grade level, 26.7% at grade level, 13.3% below grade level, and 46.7% reported their students were of mixed ability.

The case study teachers were split evenly between public and private schools. While 86.7% taught in urban schools, 13.3% taught in suburban areas. In terms of socio-economic status, 40% of the teachers classified their school as low income, 43.3% as middle income, and 16.7% as affluent. When asked if their school qualified for Title 1 funds, 43.3% of teachers responded yes, 36.7% responded no, and 20% were unsure. Half of
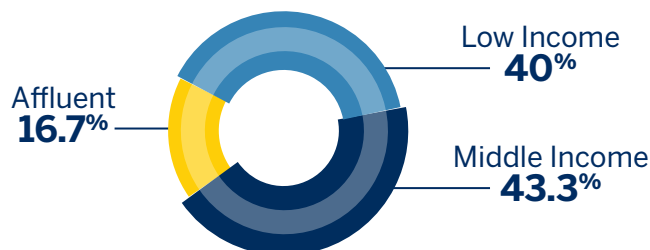
Gender of Case Study Teachers

70% Female   **30%** Male

Range of Teaching Experience

1 Year — 33 Years

AVG: 11 Years

Range of Teachers' Ages

23 Years Old — 70 Years Old

AVG. AGE: 40

Grade Levels Taught

Grade	Percent
Grade 5	43%
Grade 6	53.3%
Grade 7	60%
Grade 8	46.7%

86.7% Urban vs. **13.3%** Suburban
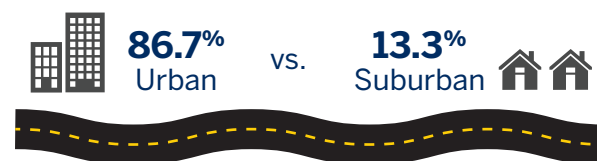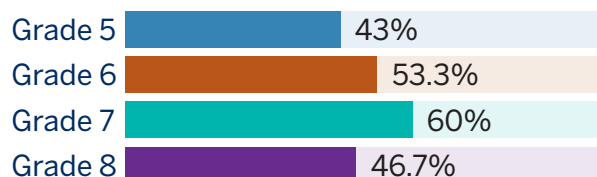
Teachers Classified Schools as

Affluent **16.7%**   Low Income **40%**   Middle Income **43.3%**

the teachers taught in schools where fewer than 20% of students qualified for free- and reduced-price lunch, and 30% taught in schools where 80% or more of students qualified for free- and reduced-price lunch.

The case study teachers varied in their use of digital games for teaching and personal use, as well as in their comfort using games in the classroom. Thirty percent of the teachers used games for personal use on a daily basis, 20% did so weekly, 13.3% monthly, and 36.7% rarely or never used games for personal use. In contrast, 13.3% of the case study teachers used games on a daily basis for teaching, 30% did so weekly, 26.7% monthly, and 30% rarely or never used games for teaching. Despite the wide range in using games for teaching, all teachers in the study expressed some level of comfort using games in their teaching; 46.7% were very comfortable using games in their teaching, 43.3% moderately comfortable, and 10% slightly comfortable.

Members of the research team arranged to visit each teacher's classroom to observe them using the game with students, and followed each classroom visit with a phone interview to discuss their experience using the game and how it fit in to their formative assessment practices. Written notes were made during classroom visits. All phone interviews were recorded and notes were taken during the interviews. The research team generated a list of game features related to formative assessment across the 11 games in the study, and then coded the notes from the observations and interviews to create a database of all mentions of each game feature, along with related quotations from the interview recordings. This database was then used to write the cases related to each feature.

Use of Digital Games for...

PERSONAL USE:
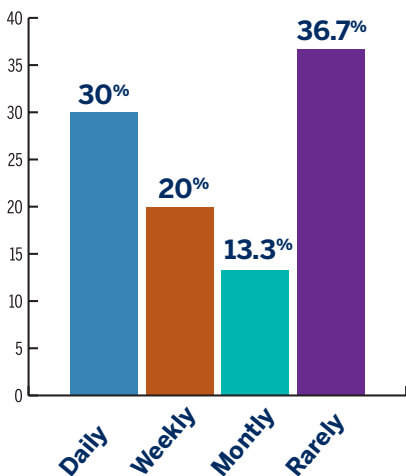
TEACHING:

Comfort Using Games for Teaching

46.7% Very Comfortable

43.3% Moderately Comfortable

10% Slightly Comfortable
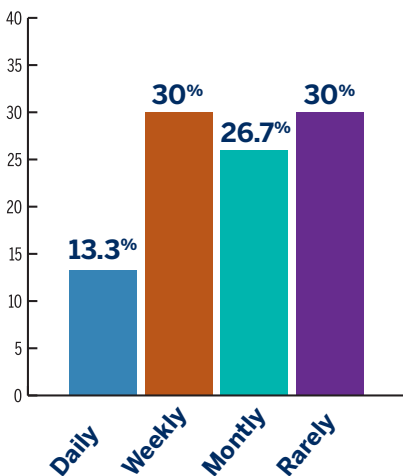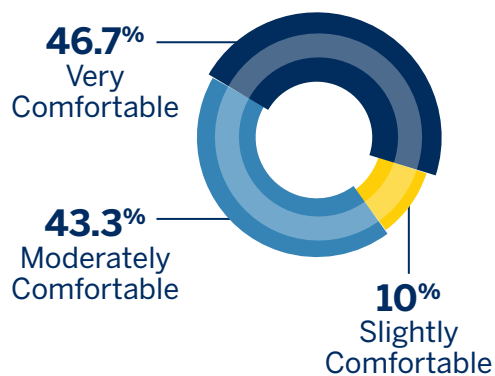
APPENDIX B: GAMES USED BY CASE STUDY TEACHERS

Games are available through brainpop.com/games except as noted. Some descriptions and portions of descriptions are used with permission from GameUp.

Please note: not all games can be used on tablets, please check BrainPop's website[4] to learn more.

English/Language Arts and Social Studies Games

Do I Have a Right? by iCivics — icivics.org

In **Do I Have a Right?**, players run a law firm that specializes in constitutional law. They must identify whether potential clients "have a right" as they bring various complaints to the firm's office. When students successfully resolve cases by matching clients with the correct attorneys, their law firm grows. As the game goes on, staff lawyers increase their areas of expertise, and "prestige points" can be used to hire additional attorneys; purchase new furniture for the office; or advertise in a local newspaper. During game play, students will learn to identify whether a constitutional right is being violated; match a given legal right to the constitutional amendment that protects it; plan strategically and sequence tasks; and work on informational text reading skills.

Drafting Board by iCivics — icivics.org

Does the U.S. Constitution guarantee students the right to wear whatever clothing they want to school? Should the U.S. President be elected by the Electoral College or by the national popular vote? Do special interest groups help or harm our political system? These are some of the issues explored in **Drafting Board**, a game that engages students in an evidence-based evaluation of issues. *Drafting Board* is an online essay-building platform that guides students through the process of producing clear and polished persuasive essays. Students learn to make a claim and support it with evidence and reasoning in order to produce a structured and effective argument.

Mission US by THIRTEEN, American Social History Project, and Electric Funstuff — mission-us.org

The **Mission US** game series immerses students in U.S. history through interactive role-playing experiences. In *A Cheyenne Odyssey*, students take on the role of Little Fox, a Northern Cheyenne boy whose life is changed by the encroachment of white settlers, railroads, and military expeditions in the 1860s and 1870s. In *For Crown or Colony*, players are put in the shoes of a printer's apprentice in 1770 Boston, where they interact with both patriots and loyalists. When tensions rise after the Boston Massacre, they must choose where their loyalties lie. In *Flight to Freedom*, players take on the role of a 14-year-old slave in Kentucky. Students must help Lucy navigate her escape and journey to Ohio against the backdrop of the 1850 Fugitive Slave Act. *Mission US: A Cheyenne Odyssey* is available on GameUp. The other *Mission US* games are available at mission-us.org.

Quandary by Learning Games Network —
learninggamesnetwork.org

In *Quandary*, players take on the role of a citizen in a new planetary colony who must make difficult decisions in situations where there are no clear right or wrong answers. These decisions will have important consequences—
for themselves, for others in the colony, and for the fictional planet Braxos. Students will need to analyze issues from multiple perspectives, distinguish fact from opinion, and weigh evidence while judging potential solutions. As students evaluate the claims and arguments that other characters make, they'll need to validate their reasoning and ensure that the evidence they present is relevant.

The Sports Network 2 by Classroom, Inc. —
classroominc.org

The Sports Network 2 is a self-directed literacy learning game that puts students in the role of managing director of a sports media company. During their "day at the office," students will experience authentic workplace situations, including interacting with colleagues and reading various informational texts in the form of typical workplace communications. Students' overall assignment is to prepare for an on-air interview, which allows them to review key concepts and best practices for research projects in real life. Reading comprehension skills are continually assessed as students move toward the final interview.

Science Games

Citizen Science by Games+Learning+Society —
gameslearningsociety.org

In *Citizen Science*, students play a teen concerned about a local lake threatened by eutrophication, a condition in which a body of water becomes starved of oxygen. Set in Madison, WI, the game brings players back in time to the 1960s, where they must uncover and solve specific pollution problems faced by the lake. Returning to the present and finding that the lake continues to face eutrophication threats, players take corrective steps to solve more recent problems. *Citizen Science* serves several key pedagogical functions: First, through continual evidence-based argumentation, players master the art of crafting reasoned arguments as a way to persuade others using established facts. Second, through models and simulations of scientific data collection, players learn about the factors that influence lake health, including exotic species introduction; manure and fertilizer runoff; fishing regulation; and wetland restoration. Finally, players gain an understanding of how citizens can make positive changes to their communities.
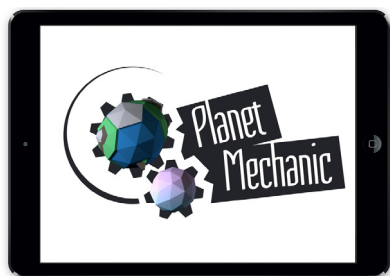
Guts & Bolts by BrainPOP —brainpop.com/games

It's a dark and stormy night, and in the shadows of his garage laboratory, Moby tries to create a new friend with a combination of organic parts and re-purposed household objects. Working from Moby's point of view, students must arrange and connect organs and systems into increasingly more complex configurations. Through the game's 11 levels, students will make inferences and test hypotheses about the basic components and functions of the circulatory system, respiratory system, and digestive system.

Planet Mechanic by Filament Games —
filamentgames.com

Planet Mechanic is an online earth and space science game that invites players to explore and control a planet's attributes in order to change its behavior. In this game, players have the ability to experiment with a planet orbiting a star, and alter a planet's core attributes of atmosphere, tilt, rotation, and moon. Players adjust the different features of a planet to meet the needs of its quirky alien inhabitants. The aliens will require changes in temperature, atmosphere, seasons, day length, tides and even eclipses to meet their demanded living conditions from level to level. Through their actions, players will see how all of a planet's attributes work together to impact the properties and conditions of that world. *Planet Mechanic* is no longer available on GameUp, but can be found at filamentgames.com.

Math Games

Battleship Numberline by Playpower Games —
playpowergames.com

Estimating numbers on a number line can be a blast! ***Battleship Numberline*** is specifically designed to help students quickly and confidently estimate the size of different fractions. Did you know that a student's accuracy in number line estimation correlates with their standardized achievement scores? This game was developed specifically for students to build a strong and robust number sense, which is the foundation for future success in math.

Lure of the Labyrinth by MIT Education Arcade, Maryland Public Television, and FableVision —
education.mit.edu

In the ***Employee Lounge*** game, the monster boss desires a snack, and players need to figure out how much items cost in the vending machine. This requires students to solve problems using algebraic representation. As your students explore the game and develop strategies, help them make mathematical connections. Each turn can be written and evaluated as an algebraic expression. In the ***Employee Cafeteria*** game, students enter the cafeteria of the Labyrinth, where hungry monsters come to feed. Players must figure out what the monsters want to eat by using their knowledge of proportions, ratios, multiplication, division, and prime numbers.

Monster School Bus by New Mexico State University Learning Games Lab — mathsnacks.com

How many ways are there to combine numbers to add up to 10? What about combining decimals to add up to 1? As the new monster bus driver, players plan routes to pick up as many monsters as they can in as few trips as possible. When they combine groups to create a full load, they earn potions and transform buildings into monstrous structures. *Monster School Bus* teaches ways of representing numbers; conveys relationships among numbers and number systems; helps players visualize numbers as sets and quantities; reinforces addition of integers and decimals; and builds new mathematical knowledge through problem solving.

RESEARCH TEAM

Barry Fishman, Ph.D. is Professor of Learning Technologies in the University of Michigan School of Information and School of Education. His research focuses on: teacher learning and the role of technology in supporting teacher learning, video games as models for learning environments, and the development of usable, scalable, and sustainable learning innovations through design-based implementation research (DBIR). He was co-author of the Obama Administration's 2010 U.S. National Educational Technology Plan, served as Associate Editor of The Journal of the Learning Sciences from 2005-2012, and was the 2001 recipient of the Jan Hawkins Award for Early Career Contributions to Humanistic Research and Scholarship in Learning Technologies. He received his A.B. from Brown University in English and American Literature in 1989, his M.S. from Indiana University in Instructional Systems Technology in 1992, and his Ph.D. in Learning Sciences from Northwestern University in 1996.

Jan L. Plass, Ph.D. is the Paulette Goddard Professor of Digital Media and Learning Sciences at NYU Steinhardt and founding director of CREATE. Dr. Plass is also the co-director of the Games for Learning Institute. His research is at the intersection of cognitive science, learning sciences, and design, and seeks to enhance the design of highly interactive visual environments. His current focus is on cognitive and emotional aspects of information design and interaction design of simulations and educational games for math and science education. Dr. Plass received his MA in Mathematics and Physics Education and his Ph.D. in Educational Technologies from Erfurt University (PH Erfurt, Germany).

Michelle Riconscente, Ph.D. is Director of Learning and Assessment at GlassLab. Dr. Riconscente brings expertise in evidence-centered assessment design, formative assessment, psychometrics, cognitive science, and instruction to the Lab's innovations in creating game environments and support materials that strongly link learning and assessment. Previously an Assistant Professor of Educational Psychology and Technology at the University of Southern California, she authored the first controlled study of an iPad learning app, and her published research on student motivation includes mixed-methods investigations of U.S. and Mexican students' subject-matter interest. Dr. Riconscente has served as a consultant to several organizations, including Harvard University, MIT, GameDesk, Scholastic Inc., The Carnegie Corporation of New York, UCLA's CRESST, Motion Math Games, and the U.S. Department of Education. She holds a bachelor's degree in mathematics-physics from Brown University and a Ph.D. in educational psychology from the University of Maryland, College Park.

Rachel Snider is a doctoral candidate in Mathematics Education at the University of Michigan School of Education. Her research focuses on teacher knowledge and reasoning and teacher education. Rachel's dissertation looks at the mathematical knowledge for teaching and reasoning secondary mathematics teachers use as they plan for and carry out the teaching practices of giving explanations and selecting examples. In graduate school, she has spent 2 years as a field instructor for pre-service teachers. Rachel received her M.S. and B.S. from the University of Michigan in Mathematics. Before graduate school, she spent 3 years teaching high school mathematics in Westwood, Massachusetts.

Tzuchi Tsai is a doctoral candidate in Educational Leadership at the New York University Steinhardt School of Culture, Education, and Human Development. His research focus is on empowerment and the experience of New York City public school principals. Tzuchi is a research assistant for CREATE and holds an M.Ed. in School Leadership from Harvard University, an M.A. in Mathematics Education from Columbia University, and a B.S.E. in Biomedical Engineering from Tulane University. Before graduate school, he spent 6 years in New York City public schools teaching middle school mathematics. In his spare time, he enjoys video games and is a fan of Little Big Planet and Portal.

ACKNOWLEDGMENTS

REFERENCES

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5–31. doi:10.1007/s11092-008-9068-5

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education, 5*(1), 7–74.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Butrymowicz, S. (2013, November 6). Making the Next Generation of Educational Video Games. *Time*. Retrieved from http://nation.time.com/2013/11/06/making-the-next-generation-of-educational-video-games/

Fishman, B., Riconscente, M., Snider, R., Tsai, T., & Plass, J. (2014). *Empowering Educators: Supporting Student Progress in the Classroom with Digital Games*. Ann Arbor: University of Michigan. gamesandlearning.umich.edu/agames

Means, B., Chen, E., DeBarger, A., & Padilla, C. (2011). *Teachers' ability to use data to inform instruction: Challenges and supports*. Washington, DC: U.S. Department of Education. Retrieved from http://www.eric.ed.gov/PDFS/ED516494.pdf

Mislevy, R. J., Oranje, A., Bauer, M. I., von Davier, A., Hoa, J., Corrigan, S., ... John, M. (2014). *Psychometric considerations in game-based assessment*. New York: GlassLab.

Plass, J. L., Homer, B. D., Hayward, E. O., Frye, J., Huang, T. T., Biles, M., Stein, M., & Perlin, K. (2012). The effect of learning mechanics design on learning outcomes in a computer-based geometry game. e-Learning and games for training, education, health and sports: Lecture notes in computer science, vol. 7516/2012, 65–71. doi: 10.1007/978-3-642-33466-5_7.

Plass, J. L., Homer, B. D., Kinzer, C., Frye, J., & Perlin, K. (2011). *Learning Mechanics and Assessment Mechanics for Games for Learning*. G4LI White Paper # 01/2011. Available online at g4li.org.

Richards, J., Stebbins, L., & Mollering, K. (2013). *Games for a digital age: K12 market map and investment analysis*. New York: The Joan Ganz Cooney Center at Sesame Workshop.

Salen, K., & Zimmerman, E. (2005). Game design and meaningful play. In *Handbook of computer game studies* (pp. 59–79). Cambridge, MA: MIT Press.

Salen, K., & Zimmerman, E. (2003). *Rules of Play: Game Design Fundamentals*. Cambridge, Mass: The MIT Press.

Sandford, R., Ulicsak, M., Facer, K., & Rudd, T. (2007). *Teaching with games: Using off-the-shelf computer games in formal education*. FutureLab.

Shute, V. (2011). Stealth assessment in videogames to support learning. In S. Tobias & J. D. Fletcher (Eds.), *Computer games and instruction* (pp. 502–523). Hershey, PA: Information Age Publishers.

Siemens, G. (2013). Learning analytics: The emergence of a discipline. *American Behavioral Scientist, 57*(10), 1380–1400. doi:10.1177/0002764213498851

Soloway, E., Guzdial, M., & Hay, K. (1994). Learner-centered design: The challenge for HCI in the 21st century. *Interactions, 1*(2), 36–48.

Takeuchi, L., & Vaala, S. (2014). *Level up learning: A national survey on teaching with digital games*. New York: The Joan Ganz Cooney Center. http://www.joanganzcooneycenter.org/wp-content/uploads/2014/10/jgcc_leveluplearning_final.pdf

ENDNOTES

1   apps.leg.wa.gov/documents/billdocs/2013-14/Pdf/Bills/Senate%20Bills/6104.pdf

2   www.usatoday.com/story/tech/gaming/2014/09/12/white-house-video-games/15393169

3   gamesandlearning.umich.edu/a-games/downloads

4   www.brainpop.com/games

5   www.joanganzcooneycenter.org

6   www.commonsensemedia.org

7   g4li.org

8   learninggamesnetwork.org

9   www.gameslearningsociety.org

10 learninggameslab.org

11 gamedesk.org

12 education.mit.edu

13 www.cse.ucla.edu

14 glasslabgames.org

15 www.sri.com/work/projects/glasslab-research

16 gamedesk.org/platforms/educade

17 playfullearning.com

18 www.graphite.org

**SCHOOL OF
INFORMATION**
UNIVERSITY OF MICHIGAN

A REPORT OF THE **A-GAMES PROJECT:** ANALYZING GAMES FOR ASSESSMENT IN MATH, ELA/SOCIAL STUDIES, AND SCIENCE