Opportunities, Obstacles and Outcomes in Educational Gaming: Teaching to the Common Core, 21st Century Skills and Beyond

Cat McManus, Rachel Ebby-Rosin, and Barbara Kurshan

10 February 2014

Background

Since the first official spelling bee in 1925, countless American educators have used games in the classroom as a way to foster excitement about learning and engagement with the curriculum. While games have long had a place in schools, the advent of electronic, video and computer-based games in the classroom is a far more recent phenomenon, one that appears to be accelerating as technology becomes ubiquitous in classrooms and homes alike (Squire 2005).

That electronic games are omnipresent is no surprise: games are enduringly popular among humans, and we are in a “sweet spot” with regard to the affordability of technology as well as its accessibility. Within the K–12

setting, the rise of electronic games largely took place in the 1980s and 90s, with CD-ROM-based pioneers such as Oregon Trail, Where in the World Is Carmen San Diego and Reader Rabbit, all of which were inspired by traditional arcade games. Now, in the 21st century, we are in the midst of a revolution in game-based learning (GBL), with games currently including sophisticated Web-based applications that make use of social networking and virtual reality platforms.

In his 2007 book Digital Game-Based Learning, Marc Prensky argues that "before today's teenagers have grandchildren, [GBL] will be totally taken for granted as the way people learn" (Introduction, e-version). According to Prensky, this scenario is likely because gaming meets both the needs and the learning styles of today's learners. Simply put, education gaming is motivating because it is fun. Additionally, Prensky points out that education gaming is "enormously versatile, adaptable to almost any subject, information, or skill to be learned, and when used correctly, is extremely effective" (2013, Introduction). In fact, many teachers are taking the concept of computer games and the potential of game-based learning to promote learning one step further by having students conceive, design and create their own computer games using ready-made platforms such as Gamestar Mechanic or Minecraft or by using code. It is not surprising that electronic games continue to make their way into classrooms as technology becomes more affordable and

more accessible and as knowledgeable teachers continue to dream up new ways of engaging their students.

According to a 2011 study by the National Research Council on the impact of education gaming in science education, GBL has tremendous potential to impact teaching and learning because of its ability to "individualize learning to match the pace, interests, and capabilities of each particular student and contextualize learning in engaging virtual environments" (2011, p. 67). A recent systematic review and meta-analysis by SRI International, an independent research center, of studies published between 2000 and 2012 on computer gaming indicates, however, that research linking computer gaming with measurable outcomes in skills and knowledge is only in its formative stage (2013). Based on the 77 journal articles reviewed by SRI as part of this study, the authors did find that "games can enhance student learning as measured by cognitive competencies relative to traditional instructional approaches" (SRI International, 2013, p. 2). The authors point out, however, that we cannot make a blanket statement about gaming's efficacy, because the design of the game and its implementation are important factors in determining cognitive, intrapersonal and interpersonal outcomes.

Purpose

In this article, we seek to understand more clearly how

educators are using games in their classrooms, especially as a means of helping students meet the standards outlined in the Common Core State Standards (CCSS). We also examine the benefits educational gaming can provide in fostering ancillary skills not included in the CCSS, like creativity, problem solving, collaboration and teamwork. Additionally, we share teachers' experiences with gaming and professional development. Lastly, we examine the role of assessment by asking how, if at all, teachers know that educational game playing is an effective strategy to promote learning and not just fun and games.

We conducted phone interviews with six local, tech-savvy educators who employ some form of gaming in their classrooms. The teachers we interviewed represent a broad range of professional roles and settings, and their personal experiences and histories with educational gaming vary. Two of the interviewees teach computer science in private schools, although one works with students in grades K–8 and the other with students in grades 6–12. Two of the other teachers we interviewed both work in middle schools; one teaches social studies and reading in a private school for students with language-based learning disabilities, and the other teaches literacy in a in a public school in Philadelphia. The last two teachers we spoke with work in a suburban public elementary school. In addition, in order to learn specifically about the role of assessment in the new

SimCityEDU release, we spoke with a middle school social studies teacher from New Jersey whose classroom was chosen as a beta testing site. We spoke with these teachers to get a deeper contextual understanding of the pros and cons of using computer gaming as an instructional strategy in the classroom.

We used word of mouth and networking at Ed Tech events in Philadelphia to identify teachers who employed educational gaming in the classroom. While examples of game-based schools exist, (e.g., Quest-to-Learn in New York City and Chicago and the Playmaker School in Los Angeles), the teachers we spoke with are generally serving as pioneers in their buildings, working to introduce educational gaming not only to their students but to their teaching colleagues as well. All seven of the respondents (including the teacher from New Jersey) noted that their principals were extremely supportive of the idea, and several of the teachers noted that they were collaborating with colleagues to spread the reach of gaming in their schools.

The teachers we spoke with employed education gaming to achieve two primary objectives: 1) to further learning objectives included in the CCSS by playing prepackaged simulation or Web-based games available in the mass market or 2) to foster creativity and problem solving by having students use code, with game creation tools such as Scratch and Minecraft or the invention kit MaKey MaKey to design their own computer games for use by

their peers and their teachers.

Despite the apparent differences between the teachers we spoke with, four common themes emerged from our conversations in particular: the connection between games and the Common Core; games as a means of fostering intrapersonal and interpersonal development; the ongoing difficulty of assessing the outcomes of using games in learning contexts; and the challenges and obstacles to implementing game-based learning in schools. We will address each of these topics in the sections below.

Games and the Common Core

In their 2013 book Teach Math with the Wii, the author-teacher team Meghan Hearn and Matthew Winner focus on the use of the Nintendo Wii game system as a tool for teaching math and include a rubric listing each of the Common Core standards for mathematical practice and the corresponding evidence of that practice when using a particular game (The International Society for Technology in Education, 2013). The teachers we spoke with also talked about the use of games in the classroom as a means for teaching to the new standards mandated by the Common Core, although some executed this teaching in unexpected ways.

One middle school teacher, for example, incorporated video game development as a way to give his students an

incentive to complete a language arts assignment. This teacher noted that students had to master the content of the book they were reading, including deep knowledge of characters, key ideas and concepts, before they could begin game construction. In other words, the prerequisite to the fun of game creation was the hard work defined by the Pennsylvania Academic Standards.

In addition, complex simulation games, like SimCityEDU and Civilization, provide students with multiple opportunities to read, analyze and incorporate detailed information, including graphs, maps, charts and text, skills that are all included in one form or another in the CCSS. As one of our respondents observed, "the Common Core mandates what we need to teach but not how we need to teach it." By using gaming in the classroom, this teacher discovered that educational gaming offered students an alternate path to mastering important skills and concepts, which is especially helpful for students who might be struggling with a more traditional, text-based approach.

In yet another example, teachers also use computer games as a way to make practicing basic math skills more entertaining and engaging for students. While the focus is on rote learning and basic skills, these games help build number fluency and reinforce basic concepts, like greater than and less than, ordering numbers and place value, while eliminating some of the drudgery associated with traditional worksheets. One teacher pointed out that using computer games in this way serves students well because

they need to master basic facts and concepts before taking on more complex operations included in curriculum.

Beyond the Common Core – Soft Skills and Gaming

For some teachers, the real strength of games in the classroom is their unique ability to simultaneously teach traditional content as well as "softer" skills like creativity and collaboration. Several teachers we spoke with also mentioned that educational games with leaderboards serve to promote friendly competition among students, which in turn helps motivate them to play more so that they can reach the next level.

When asked about his objectives in teaching students to build games, for example, one teacher reeled off a long and multifaceted list that included skills similar to those described in the work of University of Pennsylvania professors Angela Duckworth and Martin Seligman on grit, tenacity and resilience. This teacher uses game-based learning to teach "hard" skills such as "systems thinking and logic…[and the] if/then conditional statements that come with programming." Additionally, GBL provides his students with an opportunity to build the skill of reflecting on one's own work and checking for errors. As this teacher explained, it also fosters among students

…the sense that "I can figure it out on my own"…and "How

do I check what's wrong without coming to [the teacher?]"...Setting up that self-paced learning, self-reliance and...confidence [among students and a sense of] "Hey, I can figure this out!" This is, for me, the objective.

Our interviewees spoke often about the utility of games in preparing students to learn rather than preparing them to access particular content they have already mastered, and they emphasized the potential of games to prepare students for life in the modern age. When asked about his specific objectives in using games in his classroom, the middle school literacy teacher responded that he was trying to develop "critical 21st century skills," underlining the importance of creativity, collaboration and communication. As this teacher explained:

We live in a creative economy. Our kids have to be creative to compete in the global marketplace. And again, sometimes we so narrow down on testing, testing, testing that we forget that, and that's a disservice to our kids. Second...is collaboration. Our kids have to be able to collaborate...and figure out their role in groups...[third is] communication skills. They have to develop these skills to [be able to] share their work with the world...[and finally] career connections...it's not like we're saying, you know, "This is going to prepare you for this job," but it's like that [ability] to critically question...Preparing them for the world of work where they're going to have to be able [to do all these things.]

Using off-the-shelf multiplayer games can also promote teamwork among students. For the social studies teacher who uses the game Civilization in his classroom, seeing his students work together and help each other problem solve has been one of the game's biggest benefits. This teacher observed, moreover, that in the gaming context, students who were usually less verbal and more reserved in class were eager to participate. These same students also sought help willingly from their peers when they were unsure of how to interpret or act in one of the game's myriad scenarios.

The middle school literacy teacher who had his students use GameStar Mechanic to build games also connected education gaming with teamwork and collaboration. This teacher grouped students into "pods" and explicitly did not assign a leader but rather let the students negotiate roles and discover how best to complete the task at hand. Similarly, the teacher whose classroom beta-tested SimCityEDU made comparable observations, noting that when one student was ahead of the curve in terms of strategy, she would often have a group of students gathered around her to exchange tips and information.

Giving students the opportunity to create their own games, moreover, allows students to exercise creativity, problem solving and playfulness in a context that implies that someone other than themselves will see and engage with their work. As one teacher explained:

When a student programs a game, there is immediate buy-in because there is an implied audience. For students, the game isn't a worksheet that no one's going to see. Someone's going to play it, a friend, a parent...and that's really compelling for students.

The osmosis of educational gaming

All of the teachers reported collaborating with colleagues to increase the reach of gaming in their schools. For one teacher, spreading the word means introducing colleagues to existing games that might help advance the curriculum. For another teacher, collaboration with colleagues around gaming and technology involves joint projects that cross disciplines and grade levels. For example, students in the high school physics class and the advanced computer science class at this school are collaborating to build robots. While the physics students are designing and building the hardware, the computer science students will program the robots with artificial intelligence.

Despite generally enthusiastic support for education gaming from their principals and building heads, none of the teachers we spoke with reported receiving any school-based professional development specific to education gaming. Several of the respondents attend conferences and Ed Tech events on their own, however, as a means of learning about new programs and staying current while others keep an eye on Twitter to learn from

colleagues from around the country and the world. Other teachers we spoke with had learned about games from specialists within their buildings, like the math support teacher and the gifted specialist. Only one teacher of the six we spoke with noted what appeared to be fear or caution on the part of his teaching colleagues as to the amount of work GBL represents. When asked about why he thought others in his middle school building didn't adopt computer gaming, he replied:

With teachers…they say to me, *"The stuff that you're doing [the games], it's like, that's hard work…everybody's not like you"*

This teacher noted that when he tries to share new ideas for gaming that he has learned at conferences, his colleagues often respond with an attitude that says, *"Oh, you're creative; I'm not creative like that."* These kinds of interactions indicate that some teachers may feel a sense of intimidation by innovation, a (mis)perception that the ability to work with new technologies and games is somehow an innate skill rather than a competency that can be acquired through professional development.

Obstacles and Challenges

While game-based learning has great potential to promote engagement and creativity in the classroom, several obstacles to greater adoption and implementation exist, especially in schools with limited resources. One

survey of pre-service and in-service teachers in educational technology classes showed that only half of the survey respondents intended to use games in their classrooms. This study, conducted in 2010, intended to understand pre-and in-service teachers' perceptions of video games in the classroom. The authors surveyed 98 in-service and pre-service teachers drawn from a mid-Atlantic university in the United States. Perhaps unsurprisingly, given that the respondents were in educational technology classes, the authors found that 85 percent of in-service teachers and 84 percent of pre-service teachers "agreed that gaming was a good use of technology for learning" (Pastore & Falvo, 2010, p. 51). They also found, however, that only half of respondents used or intended to use games in their classrooms, though a majority felt that gaming would grow considerably in the next five years.

Though this survey did not explore the reasons relatively few of the teachers would use games, a number of reasons seem plausible. A cross-survey comparison by the Joan Ganz Cooney Center, for example, indicates that limited access to technology and limited funds for software and hardware serve to limit computer-based gaming in the classroom (EdSurge, Inc., 2013). In addition to material constraints, many teachers also remain wary of GBL because of a dearth of evidence connecting computer-based games to standardized achievement outcomes and measures (EdSurge, 2013). Some teachers

are also reluctant to use game-based learning because of preconceptions that video games have a negative impact on academic skills and student behavior, including the ability to communicate face to face and to maintain an attention span (Common Sense Media, 2012).

The time it takes to explain to students how a game works, moreover, can be a barrier to bringing games into the classroom. One teacher we spoke with explained that he had spent 40 minutes, an entire class period, explaining to students how to play Civilization, and he still was not able to cover all of the different scenarios and complexities that had arisen while playing in class.

While gaming and computer games are effective means for reinforcing concepts, one teacher we interviewed cautioned that it is a "misguided vision" to use them to introduce new material, adding, "I really value interpersonal relationships in my classroom…It is a wasted opportunity to explore new concepts just between [an individual student] and a computer screen." An additional challenge to game-based learning is the addictive nature of some programs, which can create friction when children need to stop playing and move on to another activity. As one teacher explained, "The kids become obsessed with using them—it's great—but they become entranced with the computer screen." On the flip side, games aimed at promoting rote learning and basic skills can also become boring if used too often. Many skills-

focused games, moreover, do not offer students a way to show their work or to demonstrate understanding, making it possible for students to get a correct answer by guessing or by sequentially selecting all of the answers given until they find the right one.

In an era of accountability and intense scrutiny of teachers, it is perhaps not surprising that many teachers stick to what is familiar despite ever-growing evidence that games and gaming in the classroom can benefit students through increased engagement, content mastery and individualized instruction (EdSurge, 2013). On the opposite end of the spectrum, however, some schools are promoting educational gaming as a way to prepare students for standardized tests. Students in some schools, for example, spend time playing computer games that closely mirror the computer-based standardized tests that the district uses to monitor student progress and to make class placement decisions. In one example, teachers match students' test scores with a corresponding level in the computer games in order to give students practice in math and reading comprehension that is tailored to their specific level. At times, these games include questions related to material that the students have not yet been taught, which can cause frustration but which also gives them a greater chance of getting the problem correct when it is test-taking time. This new practice begs the question, Is gaming to the test going to replace teaching to the test?

There are also challenges specific to using the creation of games as part of a lesson plan. The K–8 technology instructor we interview noted that

…a lot of times when you get caught up in…those creative projects, you get so caught up in the look of it that you forget the technical [lesson objectives]…[This is] especially [true] when you think about different learning styles and people who definitely lean more towards the artistic way of looking at things.

This teacher acknowledged that he sees this as a legitimate source of hesitation on the part of some teachers when considering game design and creation as instructional tools. Interestingly, this teacher's observations suggest that while on the surface GBL may raise a new set of challenges for classroom teachers, at base, the issue is the perennial challenge of how to keep students on-task and engaged.

The problem of assessment: How do we know educational computer games are effective?

A 2012 review of literature on educational gaming concluded that "many educationally interesting games exist, yet evidence for their impact on student achievement is slim" (Young et al., 2012, p. 80). As mentioned earlier, a similar judgment was reached by in

2013 by SRI International (2013).

Pathbreaking work linking educational gaming with formative assessments was recently developed by the research and design organizations Glass Lab and Institute of Play (http://www.instituteofplay.org/about/context/history-of-games-learning/) in their 2014 release of SimCity: Pollution Challenge! Through their partnership with a collection of powerhouse gaming and assessment-focused organizations—including Electronic Arts; Educational Testing Service; Pearson's Center for Digital Data, Analytics & Adaptive Learning; and the Entertainment Software Association—this latest iteration of SimCity now includes both student and teacher leaderboards. Students can see their own progress through the six challenges ("missions'") as compared with their peers, and teachers can see the class's overall progress towards the completion of the missions. Also included is a teacher's dashboard, which allows him to see specific information, related to student learning. For instance, a teacher can use his or her dashboard to see how individual students are faring while comparing them to others in the room, and, using a local leaderboard, can also see how the student compares with other students in the region.

The teachers we spoke with observed a host of benefits accruing to their students through GBL, from improved collaboration and teamwork to heightened engagement

and higher levels of intrinsic motivation. Teachers' conclusions, however, did not arise from data delivered through a game's dashboard. Instead, they arose from observation of affinity groups forming in their classrooms, student-created wikis detailing tips and strategies and the fact that, as one teacher observed, many students were playing games at home, working to best their own records and class records and to beat the leaderboard. Though they refer to it as "the metagame," this focus on the social aspects of learning is in fact a strategy recommended by researchers Young et al. after their extensive review of the literature on game-based learning (2012, p. 82–83).

Our interviews with teachers appeared to indicate that it is the engagement and experiential learning engendered by game play that is the biggest factor in students' learning. In other words, teachers did not simply draw a direct line from game playing to student achievement; rather, the line passes through the teaching coming from the actual teacher. The teachers we spoke with used games as a tool in their toolboxes. When we asked one of our interviewees how he knew his students were actually getting the intended lessons, he said, "I can definitely answer that... it's called...I don't want to sound glib, but it's just called teaching." Like the teacher who commented on the importance of interpersonal relationships in facilitating learning, this teacher was similarly devoted to instructing rather than relying on the game alone to teach the lesson. He explained his strategy for assessing students:

I told them right out that I won't assess their in-game play because…I told them that it's counterintuitive for me to grade how well they do in a video game that encourages them to learn by failing…and to learn by trying and to be iterative. So how can I possibly grade that?

Instead, this teacher had students write short paragraphs each evening reflecting on their game play and strategies; these were interspersed with facilitated discussions. The culminating activity was then an individual student portfolio reflecting on game play in order to teach students to see complexity and the interconnectedness of systems. In essence, this teacher was combining the information given to him by his teacher dashboard with the information he gleaned from more traditional measures like written reflections.

In the case of games that emphasize practicing basic skills, teachers rely on students' increased fluency with the material as evidence that the games are effective. Even in this case, however, it is difficult to draw a line between increased gaming and greater proficiency. Some of these games provide reports to teachers that indicate which types of problems students have mastered and which ones they still need to address. While they are certainly helpful, many of these reports require teachers to pay an extra fee, limiting their utility in budget-strapped schools.

Conclusion

While GBL has great potential to promote engagement and creativity in the classroom, several obstacles to greater adoption and implementation exist, especially in schools with limited resources. Additionally, as with any pedagogical tool, games are bound to be useless in the hands of those who do not implement them well. Some teachers—like the innovators interviewed here—are simply people who will always take it into their own hands to educate themselves and, by extension, their students. But for a host of reasons, many teachers may never adopt games in their classrooms, while others will need an extra push from an experienced colleague, a solid dose of professional development or a personal "ah-hah" moment. The question then becomes, if games do indeed have benefits that, under certain conditions, span the spectrum from socio-emotional benefits to improved skills and knowledge, how can we help more teachers adopt them appropriately?

References

Common Sense Media. (2012). Children, teens and entertainment media: The view from the classroom. San Francisco, CA: V. Rideout, VJR Consulting, Inc. Retrieved from http://www.commonsensemedia.org/research/children-teens-and-entertainment-media-the-view-from-the-classroom

EdSurge, Inc. (2013). Beyond good and bad: Applying games research to action. Burlingame, CA: M. Levine.

Retrieved from https://www.edsurge.com/n/2013-08-19-beyond-good-and-bad-applying-games-research-to-action

The International Society for Technology in Education (ISTE). (2013). Wii learning and the Common Core State Standards for mathematics. In M. Hearn & M. C. Winner, Teach Math with the Wii (pp. 23–32)¬. Washington, DC: ISTE. Retrieved from http://www.iste.org/docs/excerpts/WIIMTH-excerpt.pdf

National Research Council. (2011). Learning science through computer games and simulations. Washington, DC: The National Academies Press. Retrieved from http://nap.edu/catalog.php?record_id=13078

Pastore, R. S., & Falvo, D. A. (2010). Video games in the classroom: Pre- and in-service teachers' perceptions of games in the K-12 classroom. International Journal of Instructional Technology and Distance Learning 7(10), p. 49–56. Retrieved from http://itdl.org/Journal/Dec_10/article05.htm

Prensky, M. (2013). Digital Game-Based Learning (e-book). St. Paul, MN: Paragon House.

Squire, K. (2005). Changing the game: What happens when video games enter the classroom? Innovate: The Journal of Online Education, 1(6). Retrieved from http://website.education.wisc.edu/kdsquire/tenure-

files/26-innovate.pdf

SRI International. (2013). Digital games for learning: A systematic review and meta-analysis. Menlo Park, CA: D. B. Clark, E. E. Tanner-Smith, & S. Killingsworth. . Retrieved 1/14
from http://www.sri.com/sites/default/files/brochures/digital-games-for-learning-brief.pdf

Young, M. F., Slota, S., Cutter, A. B., Jalette, G., Mullin, G., Lai, B., ... & Yukhymenko, M. (2012). Our princess is in another castle: A review of trends in serious gaming for education. Review of Educational Research, 82(1), 61–89. doi:10.3102/0034654312436980