Approaches and Strategies in Next Generation Science Learning

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Chapter 8
Teachers and Teaching in Game-Based Learning Theory and Practice

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ABSTRACT

Interest in game-based learning has grown dramatically over the past decade. Thus far, most of the focus has not included the role of teachers. This chapter first summarizes the theoretical research on game-based learning and the implications of that research for the role of teachers. The authors next review the game-based learning literature that has specifically articulated a role for teachers or achieved an empirical description of teacher action within a game-based learning context. They then connect these accounts with more general research on teachers and technology use, elaborating on points of contact and identifying differences that may signal special challenges. Finally, the authors articulate an expanded role for teachers in game-based learning practices in terms of game-based learning research and new scholarship on the psychology of games.

INTRODUCTION

Digital games are an influential and ubiquitous presence in the lives of young learners. A 2008 study by the Pew Internet and American Life Project found that 97% of teens ages 12-17 play digital games, and 50% of them report daily or nearly daily play (Lenhart, Jones, Macgill, & Pew Internet and American Life Project, 2008). With increasing access to computers, consoles, and cell phones, young people are finding that opportunities for gaming are everywhere. The emergence of video gaming as an important leisure activity among young people called into question what

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effects, if any, these games may have. Initially, psychologists and sociologists set out to discover whether or not video gaming is a harmful activity for children (e.g., Anderson & Bushman, 2001; Hauge & Gentile, 2003; Anderson, 2004; Skoric, Teo, & Neo, 2009); although the findings from this line of research remain controversial (e.g., Hall, Day, & Hall, 2011; Murray, Biggins, Donnerstein, Menninger, Rich, & Strasburger, 2011), there is still an enduring perception among the general public that digital games are a negative influence on young people. Not all research, however, has cast digital games in a negative light. In particular, educational researchers are increasingly interested in the positive effects of gaming. In fact, a growing body of evidence indicates that digital games can be powerful vehicles for learning. Numerous studies have linked classroom use of learning games with increased learning outcomes and improvement in students' conceptual understanding, engagement, and self-efficacy (e.g., de Freitas, 2006; Clark, Nelson, Sengupta, & D'Angelo, 2009).

The past decade has seen significant advances in the sophistication and efficacy of games designed specifically to enhance learning in a school setting. Educators who want to include digital games in their classroom activities, however, may find themselves facing significant obstacles. From the outset, game-based learning contains at its core several assumptions about teaching and learning that differ, or even run counter, to the everyday business of classrooms. Additionally, educators may feel unsupported in using games for learning, unsure about which games to use and how to use them, or they may feel they lack the knowledge or gaming experience to guide their students effectively in this activity. Taken together, these obstacles may severely constrain the degree to which games are used effectively in the classroom.

Our goal in writing this chapter is to help educators create effective strategies for implementing game-based learning activities into their classroom practices. While educational gaming presents some elements of practice that are shared with other classroom uses of technology, educational gaming presents additional unique circumstances and opportunities that research has only recently begun to address. We will present some examples from the literature that illustrate the type of personal, technological, and structural resources that teachers need to use games effectively in their classrooms, and we will outline some of the potential advantages to building partnerships between teachers and researchers and creators of educational games.

RESEARCH ON GAMES AND LEARNING

Investigation into the use of games for learning has grown from a small niche area to a major focus of research over the past decade (e.g., Clark, et al., 2009; Dieterle, 2010; Honey & Hilton, 2011). In 2006, the Federation of American Scientists issued a widely publicized report stating their belief that games offer a powerful new tool to support education and encouraging governmental and private organizational support to increase funded research into the application of complex gaming environments for learning (FAS, 2006). In 2009, a special issue of *Science* (Hines, Jasny, & Mervis, 2009) echoed and expanded this call. Mayo (2009) characterized digital games in that issue of *Science* as "capable of delivering [science, technology, engineering, and mathematics] instruction to millions" (p. 79).

As computer games became nearly ubiquitous in the 1980s, gaming became a major cultural activity among young people in the United States, Europe, and Japan. Since that time, educators are increasingly intrigued by the potential of games to empower learning. A complete overview of the development and progress of game-based learning is outside the scope of this review. By way of a historical summary, we can say that sociologists

and behavioral psychologists began to conduct research on gamers as early as the late 1970s, but it was not until the early 1990s that gaming attracted significant attention from educational researchers. The earliest research efforts investigating games for learning grew out of earlier work on computer simulations, and thus inherited the theoretical focus on Piagetian notions of knowledge construction and experiential learning that has pervaded much research in that area (e.g., Papert & Harel, 1991).

In more recent times, a principal focus of educational games research has been to explore and explicate the deep links between learning and playing. Both learning and games, according to Shaffer, Squire, Halverson, and Gee (2005), "are transformative activities that are most powerful when they are personally meaningful, experiential, social, and epistemological all at the same time" (p. 105). Shaffer, Squire, Halverson, and Gee describe an effective and empowering mode of learning that, while highly sought-after in formal educational settings, is ubiquitous in digital games. Squire (2003, 2007) and Gee (2007) argue persuasively in favor of the unique affordances of digital games as learning tools and frame digital games as "the future of learning" (Shaffer, et al., 2005, p. 108) in terms of erasing barriers to learning, making knowledge accessible and personally relevant to the learner, and fostering communities of learning.

In two widely cited works, James Paul Gee (2004, 2007) grounded the discussion around games within the major theories of learning. On the subject of situated and embodied understanding, for example, Gee connects game-based learning to the works of George Lakoff, Jean Lave and Etienne Wenger, Michael Tomasello, and William Clancey. These works by Gee and work by Shaffer et al. established a theoretical frame for games for learning upon which later research largely agrees. This frame is supported around four core beliefs:

1. Games engage students in ways that normal school activities do not.
2. Games privilege experiential learning, i.e. students learn by doing.
3. Games promote identity-construction and self-efficacy.
4. Games provide opportunities for collaboration and participation in semiotic domains. (Gee, 2004).

Later scholarship expanded this theoretical frame and connected it to other works. It is now largely accepted that games make it possible for learners to develop situated understanding, that is, a form of learning that is a product of activity and the context in which the learning is used (Lave & Wenger, 1991). In this regard, games afford a broad range of contexts and variants of activity that would be otherwise inaccessible to learners, such as city planning in the game *SimCity*. Games also promote content-grounded discussion among learners (Steinkuehler & Chmiel, 2006), in which the game acts as a touchstone for inquiry and rich discussion. Learners also benefit from the creative and generative control that games allow, fostering development of their identities and self-efficacy (Ketelhut, 2007; Pelletier, 2008). These benefits work together to help students engage with complex concepts and systems, and this engagement has an epistemic character, i.e., it enables learners to observe and preserve the links between knowing and doing (Shaffer, 2006).

Compared to more established areas of educational research, inquiry into game-based learning is a new endeavor, one that has come into its own only in the last decade. For the most part, researchers in the field focus their efforts on characterizing, producing, and assessing student learning and connecting the research findings to decisions about game design as a means to bring validity and attention to the research agenda as a whole. Because of the urgency in establishing this validity, and due to certain theoretical commitments which we outline later, research in game-based learning currently has much to say about learners and the process of learning but not as much to say about

teachers and the process of teaching. Since it is assumed that the efficacy of game-based learning is largely determined by the design principles that govern the way in which a particular game is built, and not by teacher action or the context of the classroom, research questions about game-based learning lend themselves to a process-product research paradigm (cf. Shulman, 1986) in which the focus is on the variables of change, i.e., how the game's design affects the student's learning. The process-product paradigm gives priority to the study of the discrete, controllable factors that, when controlled, directly produce better student learning. Since the teacher is not seen as a participant in the interaction between the learner and the game, nor as a factor that can be necessarily controlled for, research experiments into games for learning that follows the process-product paradigm generally does not attend to the role of the teacher.

While the process-product paradigm strengthens research aimed at discovering and refining principles of educational design, the lack of focus on the role of the teacher is problematic. We argue that, like any proposed classroom activity, educational games must provide a role for the teacher that, at the very least, provides him or her opportunities to assess, guide, and personalize learning. While well-designed educational games may support positive learning outcomes "in a vacuum," a teacher's influence and knowledge can greatly determine and multiply the game's beneficial effects in a classroom. Teachers are invaluable organizational resources to be leveraged in the design of games for learning; they are the principal driving forces behind the adoption of new learning tools, including games, and the key source of guidance and support for other teachers who might also want to feature digital games in their practice (Kirriemuir & McFarlane, 2004).

Several issues need to be clarified, however, if educational game designers and researchers are to ally with teachers and school administrators to increase the use and effectiveness of games for learning. Specific attention needs to be paid to: (a) the organizational and technological frameworks within which teachers locate their practice, (b) teachers' attitudes and beliefs regarding games for learning, and (c) the use of instructional technology more generally. With these prerequisites in mind, we briefly review the literature on technology use in the classroom with a focus on the resources and constraints that may affect teachers' attitudes and beliefs towards game-based learning. We also identify some tensions and limitations that operate specifically on educational gaming in the classroom in which the teacher has influence. We then review some of the game-based learning literature that has, directly or indirectly, articulated a role for teachers or achieved an empirical description of teacher action within a game-based learning context. Finally, we articulate an expanded role for teachers in game-based learning practices in terms of game-based learning research and new scholarship on the psychology of games. Our goal is not only to address the tensions, both theoretical and practical, of teaching with games, but also to propose forms of collaboration between creators of educational games and teachers. We see these collaborations as a key element in increasing the presence of games for learning in classrooms and in enhancing games for learning as more effective, fruitful, and productive parts of teaching practice.

TEACHERS' BELIEFS AND ATTITUDES TOWARD TECHNOLOGY

It is our view that, in some sense, the issues regarding game-based learning in the classroom can be better understood in the greater context of how teachers use digital technologies in their practice, which has been studied extensively (e.g. Office of Technology Assessment, 1995; Moursund & Bielefeldt, 1999; U.S. Department of Education, 2000). No particular trait of digital games suggests that our current understanding of how teachers employ computer technology should not apply to games. On the contrary, we argue that some

aspects of games highlight the tensions, issues, and difficulties that teachers face when integrating any computer-based technology into their practice. Since it is likely that teachers' attitudes and beliefs about gaming will be informed to some degree by their relationship with information technology and computer-based learning activities, it is important to review the salient findings in this area in order to better place digital games in their proper context.

Current thinking on teacher preparation stresses the importance of teachers' developing knowledge, skills, and dispositions to incorporate technology effectively into their students' lives (National Council for Accreditation of Teacher Education, 1997, 2008). Teachers themselves, however, can be a nucleus of sustained resistance to the use of technology. Mumtaz (2000) found that teachers' use of computer technology can be limited by a variety of causes, including personal and psychological factors attributable to teachers themselves. Cuban (1999) asked a more fundamental question: whether it was somewhat unrealistic to expect all teachers to use technology in light of other pedagogical and achievement goals that might be more pressing. Furthermore, teacher education programs generally do not train their students in the latest developments in educational technology (Sprague, 2004). According to Moursund and Bielefeldt's (1999) report for the Milken Exchange on Education Technology, "teacher-training programs do not provide future teachers with the kinds of experiences necessary to use technology effectively in the classroom" (p. 4). Sheingold and Hadley (1990) found that teachers who effectively use technology as a part of classroom practice describe themselves as self-taught with regards to computers. Thus, while teachers' individual styles, preferences, and experience influence the amount or kinds of technology used in classrooms, there is also a significant gap in the preparation that teachers receive to help them integrate technology in support of their practice.

It may be, however, that teachers' use of technology reflects not only attitudes or lack of training but also an absence of robust convincing classroom applications of technology. For example, Russell, Bebell, O'Dwyer, and O'Connor (2003) provide a comprehensive view of the use of computer technology by teachers. In a large-scale survey, they observed that teachers generally use computers more for preparation and communication than for delivering instruction or assigning learning activities. This finding suggests that teachers largely do not have a readily accessible "toolbox" of computer-based tools to support their classroom practice.

Conversely, teachers who do have technological tools at their disposal tend to be more convinced of their value in supporting learning. Russell et al. (2003) find that by far the strongest predictor of instructional use of computers is the teacher's belief in the educational importance of technology. Among teachers who use technology for instruction delivery (the form of use that is most resonant with game-based learning), Russell and colleagues find that confidence in one's own skill with technology is an important factor in determining the quantity and quality of technology use. They also find that correlations exist between positive perceptions of access to technology, higher personal confidence in the ability to use technology, belief in the importance of teacher-directed computer use in the classroom, and the previously mentioned belief in the overall importance of technology for teaching. Their findings support previous work by Sheingold and Hadley (1990), who surveyed 600 4-12th grade teachers selected on the basis of their advanced level of classroom technology use. Sheingold and Hadley determine that a similar spectrum of traits underpin these advanced classroom practices including (a) belief in the importance of technology for teaching, (b) high personal confidence in the ability to use technology, and (c) access to computer resources. Russell and colleagues also note that there is a trend among newer teachers

(i.e., those with one to five years in service) to exhibit greater confidence in technology use, more positive beliefs about student-centered teaching practices, and more openness to the value of technological tools for teaching, regardless of whether or not they have access to them in their everyday practice.

This last finding, suggesting younger teachers' uniform acceptance *in principle* of the value of technology for teaching, coupled with an almost generational divide between teachers who are more receptive to and assertive in using technology and those who are not, resonates with the distinction made in Prensky (2001) between what he terms "digital natives" and "digital immigrants." The former are defined as "native speakers" of the digital language of computers, digital games, and the Internet. The latter are those who adopted and accepted these elements of technology but have largely been educated and socialized in a pre-computerized way. Prensky makes his argument at a time when adoption of technology, while prevalent in other settings, was far from universal in schools. This distinction may be more relevant now than in 2001. Not only are most students "digital natives," but also so are most newly tenured teachers. Because of this, teachers and students increasingly share not only beliefs about the value and use of technology but also the cognitive skills (e.g., rapid information processing, multi-tasking, and collaboration), modes of communication, and media-participation habits of "digital natives." Whether or not this common ground may support game-based learning implementations is a question we will address in the following section.

These findings, taken together, support a view that if teacher preparation programs are not doing enough to encourage technology use by teachers, then such use is likely to be a result of teachers' beliefs and aptitude acquired from their personal experiences. There is, however, also an evolutionary process at work as newly trained teachers import technology-enabled forms of classroom practice from their own experiences as students and from modalities of technology use that have, in some sense, always been a part of their lives. Teachers who make productive use of technology in the classroom may not see technology as a teaching tool specifically (i.e., a tool that is defined and circumscribed by their professional activities as teachers), but see technology rather as a kind of "life tool" with affordances and benefits across contexts and activities.

While the literature may suggest a bleak outlook on the possibility of integrating games for learning into classroom practice in the short-term, it is important to note that not all teachers feel bound by lack of formal preparation, lack of effective applications, or other perceived limitations. A recent survey conducted by the Joan Ganz Cooney Center and BrainPop (Millstone & Levy, 2012) found that 50% of teachers who use educational games in their classrooms are self-taught with regards to which games to use and how to use them. Furthermore, 35% of the teachers surveyed first explored the educational possibilities of digital games through self-directed study.

SCHOOL-CENTERED AND ORGANIZATIONAL TENSIONS WITH GAMES

Moving beyond general research on teachers and technology, theoretical work on games generally agrees that the theories of learning embedded in games often run counter to the social organization of schooling (e.g., Gee, 2004, 2007). This section reviews some of these tensions between school organization and game-based learning and provides some analysis as to which of these tensions can be remediated. Generally speaking, schools have moved slowly to embrace game-based learning. Compared with established computerized learning environments such as *WISE* and *NetLogo*, games for learning hold a small share of classroom technology time. Some research has explored the sources of resistance to increasing game-based

learning in schools, although this research focus is not particularly extensive. In broad terms, this research focuses on (a) teachers' activity within the school and specific relationships to game-based learning and (b) tensions between gaming and the organizational contexts of schools.

Much of our discussion up to this point has examined internal teaching factors (such as beliefs and attitudes) that constrain the integration of technology (or specifically games for learning) into classroom practice. There are also externally driven factors, however, that involve the teacher as a practitioner within the organizational setting of school. Teachers themselves appear in the literature as the most frequent reporters of these factors, and we interpret the tension produced by these external factors as part of the pragmatics of the modern school setting. Simpson and Stansberry (2009) identify several barriers perceived by teachers to efforts to bring games into their classrooms. Chief among these barriers are (a) the underdeveloped state of theory on facilitating learning through digital games and (b) the lack of familiarity most teachers have with digital games. A recurring theme in the literature we reviewed underscores the lack of articulated theories of game-based learning that resonate with teachers in terms of classroom implementation and pedagogical value. Along these lines, Kirriemuir and McFarlane's (2004) survey of teachers, curriculum, and technology experts finds that teachers:

1. Face challenges in determining which games are suitable for learning purposes,
2. Feel that they lack the time and skill to familiarize themselves with the games,
3. Feel that games largely do not provide adequate support and assessment materials, and
4. Feel unsupported in using games in classrooms in terms of available technological infrastructure.

Ertzberger (2009) reaches similar conclusions after surveying 390 in-service and pre-service teachers. Teachers in Ertzberger's study cited the lack of relevance to the curriculum, lack of time to design or adopt a game to their specific needs, and lack of available technological resources. Summarizing thirteen previous studies and surveys, Kebritchi, Hirumi, Wendy, and Kappers (2009) find that teachers and school media specialists experience several different categories of obstacles to integrating educational games in classroom settings, including time constraints, lack of sufficient technical training, scheduling issues, and concerns with keeping students on-task.

Another source of tension involves the fact that gaming is, by its open-ended and dynamic nature, an activity that runs counter to some established views of schooling, which stress orderly progress towards pedagogically significant goals (Gee, 2007). Several authors have defined this tension in terms of (a) teachers' sense of academic accountability, (b) issues of organization of time, and (c) availability of technology resources and support.

We will now examine each of these factors separately. With regard to teachers' sense of academic accountability, Kirriemuir and McFarlane explain that "it is difficult for teachers to identify quickly how a particular game was relevant to some component of the statutory curriculum, as well as the accuracy and appropriateness of the content within the game" (Kirriemuir & McFarlane, 2004, p. 18). Simpson and Stansberry (2009) build on this idea, explaining that "if teachers have not prepared the students to be able to respond to very specific knowledge based content driven assessments, the school and their jobs could be in jeopardy. Digital games are viewed by teachers as being an 'unknown' (p. 169). In these senses, teachers often perceive conflict between gaming as an activity that is productive for learning and the standards to which they and their students are accountable.

In terms of issues of organization of time, "the most frequently encountered perceived or actual obstacles were […] the lack of time available to teachers to familiarize themselves with the game" (Kirriemuir & McFarlane, 2004, p. 3). As Sanford and colleagues explain:

Many teachers found the fixed length of lessons to be constraining in both the planning and implementation of games-based learning in schools. In part, this seemed to be a result of the novelty of the activity: teachers were unsure how much time an activity might take, and several expressed confidence that if they were to try similar activities again they would be able to manage classroom time more effectively. The fact that the available time was fixed meant that the impact of any technical issues (loading times, crashes, etc.) was more keenly felt than might have been the case had there been more flexibility in the timetable (Sanford, Ulicsak, Facer, & Rudd, 2006, p. 23).

Thus time constraints, costs, and unknowns also represent significant barriers for teachers in integrating game-based learning into their teaching.

In terms of availability of technology resources and support, "59% of all teachers would be willing to consider using such games in the future [but] 49% believed that there would be a lack of access to equipment capable of running the games" (Sanford, Ulicsak, Facer, & Rudd, 2006, p. 16). Similarly, the 390 teachers surveyed by Ertzberger "indicated the biggest deterrents to the use of video games were […] lack of the needed technology" (Ertzberger, 2009, p. 1827). Indeed, the diffusion of computer technology into classrooms has remained problematic, even as computers have become less expensive. According to the National Center for Educational Statistics, the ratio of students-to-instructional computers in U.S. public secondary schools improved rapidly until the year 2000 but has remained largely unchanged since 2005, with 3.3 students per computer in 2005 and 2.9 students per computer in 2008 (Snyder & Dillow, 2011).

This scarcity of instructional computers is very problematic for any game-based learning practice, as most (if not all) computer games are designed around a ratio of exactly one player per computer. That said, there are at least two trends that may help mitigate this problem. First, there is the recent expansion of educational games into consoles, mobile platforms, and tablet computers, which are less expensive for schools to own and easier for teachers to operate. Second, personal ownership among older students of devices capable of running educational games is growing rapidly. According to data from the Pew Internet & American Life Project covering the same period of time, smartphone ownership by teens increased from 41% in 2004 to 71% in 2008 (Pew Internet and American Life Project, 2011). Either of these trends, or both together, could signal significant progress towards solving the problem perceived by teachers with regards to access to technology capable of supporting game-based learning practices.

In summary, game-based learning initiatives have yet to achieve wide-scale implementation, partly due to underlying tensions between the activity framework of game-based learning and the organizational constraints perceived by teachers, as well as the practical realities of everyday school activity. The literature is more articulate on limitations expressed by teachers, indicating that there may be elements of game-based learning that teachers do not fully accept. These limitations may partially originate with the nature of educational gaming as a computer-centered activity, and these limitations may therefore be understood in the more general terms of how teachers prepare, plan for, and evaluate the use of technological tools for learning. Another possible explanation, which we will explore in the next section, is that researchers and designers of games for learning have generally not articulated or communicated a role for teachers in educational gaming. Without

a guiding narrative of how they "fit in" to the activity, teachers may feel particularly excluded or unprepared to scaffold their students' learning in the context of educational games.

UNDERSPECIFIED ROLE FOR TEACHERS IN GAME-BASED LEARNING PRACTICES

Thus far, we have outlined the barriers to integrating games for learning into classroom practice. A common thread in the accounts of these barriers is that it is *teachers*, not researchers or administrators, who are most keenly aware of them. The effect of these barriers is then exacerbated by the fact that the literature and research on game-based learning does not clearly articulate a position for the teacher in the classroom, so teachers lack guidance as to what their role should be, beyond simply doing their best to bring educational games into their classrooms in some form or another. For example, Kerbitchi et al. (2009) found that, out of ten educational games surveyed, only four provided a teacher's manual, and only one provided teacher aids, lesson plans, or unit plans. We must note, however, this lack of support for teachers is not a deliberate oversight on the part of educational game designers and researchers, but rather it may be a consequence of the audience for whom the game was developed or the envisioned classroom implementation from which it was designed. In a sample of reports of instances of classroom use of games for learning present in the educational research literature, Ng, Zeng, and Plass (2009) found that only 13% of the documented cases involved educational games intended for classroom use, while 68% of the documented instances featured games that were either marketed as entertainment titles or developed specifically for research purposes. Designers of the games represented in this latter 68% typically do not focus on creating teaching aids, lesson plans, and unit plans for teachers. Without a clear narrative of what teachers can do to improve the design and to facilitate the implementation of educational games, however, teachers may understandably feel unsupported in providing guidance, feedback, and scaffolding to their students in order to maximize the learning with digital games.

We believe that it is the role of educational researchers to generate, disseminate, and circulate these narratives. The current predominant absence of these narratives from game-based learning research is a complex issue, but the core reasons may stem from the same theoretical foundations underlying the perceived potential of games as tools for learning. Generally speaking, literature on games for learning features two theoretical positions that may imply, either directly or indirectly, that there is no need to articulate a role for teachers in their frameworks. First, there is the assumption that games engage learners through a channel that is completely direct. The designer and the developers of the game have created the experience and encoded the curriculum. Within that curriculum, the students' actions, attitudes, and motivation are what drive learning. This limited perspective by designers and developers does not recognize the critical intermediation of the teacher in facilitating learning in the classroom.

Second, as alluded to earlier, games reify forms and ways of learning that are largely incompatible with schooling as it is currently conceived. Teaching, in the model underlying the prevailing paradigm of schooling, is characterized as an activity likewise incompatible with games for learning (Shaffer, et al., 2005; Squire, 2005). Proponents note that students learning with educational games are placed in a central active role in the learning activity to such a degree that the activity, in fact, cannot proceed without the full participation of the learner. This complete engagement hinges on the fact that players of digital games enjoy a large degree of freedom and agency to play the game on their own terms. Gamers set their own goals and standards of performance, advance at their own pace, and add a highly individualized

interpretation and meaning to the experience of play. The contrast between this description and the pervasive vision of the state of affairs in the typical classroom is constructed by some games and digital media researchers as a critique of established modes of school (Prensky, 2005; Shaffer, Squire, Halverson, & Gee, 2005).

In our view, the assumption that underpins both of these positions is that games and schools are largely inflexible cultural forms that supposedly exist in natural opposition to each other on the subject of teaching and learning. It is not uncommon for teachers, administrators, and policy-makers to hold the view that digital games are an oppositional force to learning and, vice versa, some proponents of educational gaming are very critical of formal schooling. For example, the highly influential game designer Chris Crawford wrote:

Games are… the most ancient and time-honored vehicle for education. They are the original educational technology, the natural one, having received the seal of approval of natural selection. We don't see mother lions lecturing cubs at the chalkboard; we don't see senior lions writing their memoirs for posterity. In light of this, the question, 'Can games have educational value?' becomes absurd. It is not games but schools that are the newfangled notion, the untested fad, the violator of tradition. Game-playing is a vital educational function for any creature capable of learning (Crawford, 1984, p. 16).

Crawford's position, while phrased in strong terms, is generally echoed throughout the scholarly literature on games and schools. Researchers such as Squire (1995), for example, have emphasized the limiting nature of school as a cultural form that would seek to include games. "As challenging as it is to design a good educational game," Squire writes, "it may be more challenging to design a good educational system for educational games to flourish in. […] Our contemporary educational systems do not know how to sustain a curricular innovation built on the properties that make games compelling" (Squire, 1995, p. 6). Thus, if teachers' roles are defined as the embodied presence and spokesperson for the traditional cultural form of school, they are positioned as a natural nucleus of resistance to game-based learning initiatives.

It is clear, however, that these perspectives, whether based on received cultural forms or arguments stemming from theories of learning, are neither necessarily accurate nor constructive. We have previously stated our belief that games, like all forms of classroom activity, must articulate the role of teachers and leverage their expertise to maximize learning opportunities for students. The teacher is the ideal flexible interface between the cultures of schooling and games, capable of modulating and aligning the affordances and structures of each.

Some proposals in the literature describe such a role for teachers, while maintaining the focus of inquiry squarely on the interactions between the learner and the game. For example, Wilson (2009), writing from the perspective of the software industry and its interest in increasing the use of games and simulations in the classroom, envisions a central role for teachers that strongly emphasizes a "guide on the side" pedagogy. According to Wilson, a teacher can prepare students with the necessary background knowledge, intervene with advice during play, and guide reflective conversation after play about what students learned and how it can be applied elsewhere. Halverson (2005) casts teachers in a dual role: (a) as expert gamers who can facilitate gaming experiences for students and (b) as guides to enable reframing of game-content into forms which align with the curriculum. Becker (2007) envisions teachers as both careful critics of games and capable gamers. In Becker's format, the teacher's selection, discussion, and framing of particular games to reach curriculum goals constitute a form of instructional design. The effectiveness of each proposed role and how each role affects the teacher-perceived barriers to the inclusion of games in the classroom have not been addressed by the literature.

Reform perspectives on science learning stress the fact that teachers have a central role in student learning even when the tools that support that learning have their own embedded forms of guidance. For example, the influential NRC report *Taking Science to School*, states that software tools (e.g., simulations or games) "offer useful structure to student learning activities, but they cannot dictate learning. The teacher plays a critical role in realizing these designs" (Duschl, Schweingruber, & Shouse, 2007, p. 268). Although games might appear to be rigidly prescribed, with no classroom adaptation necessary or even possible, the teacher's skills and understanding of the students are critical to the success of the activity. The teacher, not the software, can orchestrate discussion, help students form and test hypotheses, guide students in forming explanations and organizing evidence, and integrate multiple strands of activity into coherent learning outcomes. As with any classroom activity, the ultimate potential of educational gaming is profoundly shaped by teachers and their beliefs, talents, and perspectives.

THE "MISSING LINK": TEACHERS' IDENTIFICATION AS GAMERS AND MAKERS OF GAMES

How might teachers and schools connect with designers and researchers of educational games in order to develop a more productive understanding of each other's affordances for enhancing student learning? Up to this point, we have based our analysis on arguments and evidence presented in the research literature on educational technology, teaching, and games for learning. We identified the divisions and places of tension. We will now explore ways in which these might be resolved. What roles or constructs might better integrate educational gaming into classroom practice?

One possible answer involves extending Prensky's distinction of "digital natives" versus "digital immigrants." This distinction touches on dual issues of identity and teaching capacity. "Digital immigrant" teachers may have fewer resources to leverage digital games for learning, whereas "digital native" teachers may have more evolved experiences and resources to connect gaming with their professional practice. Very little published research directly addresses this hypothesis. Schrader, Zheng, and Young's (2006) survey of 203 pre-service teachers found that most of the pre-service teachers had played digital games. More than half of the teachers surveyed played digital games with some frequency, but most respondents stopped short of identifying themselves as gamers. Shrader and colleagues also found that the pre-service teachers they sampled were generally positive about using digital games as learning contexts. Shrader and colleagues do not claim a causal link between the teachers' game playing experience and their generally positive attitudes toward games for learning, but it seems reasonable to assume that the pre-service teachers' own affinity for games may have contributed in some measure to their positive attitudes toward games for learning. The converse, however, may not be true (i.e., that positive attitudes towards educational gaming lead teachers to play more digital games in their personal time). In his dissertation work, James (2007) found no significant difference between teachers who are gamers and those who are not in measures of overall instructional technology usage, overall participation in innovative teaching strategies, and overall comfort in completing job-related technology tasks. This finding suggests that the "gamer" component of identity is not a necessary component of the "digital native" identity. It follows from these two findings that, while most people who view themselves as gamers are "digital natives," not all "digital natives" view themselves as gamers.

Having established this distinction, we must ask what a "gamer" identity affords teachers in terms of successful integration of games for learning that the more general "digital native" identity does not? Are there specific practices that can be

traced back to teachers who identify as gamers, or particular beliefs that may or may not inform practice? No study that we could locate provides an answer to this question, although some inferences may be drawn from the reviewed literature. Some synergy exists, for example, between Halverson's (2005) vision of a teacher as a "master gamer" and the view expressed by Kafai, Franke, Ching, and Shih (1998) that teachers benefit from the design of games for learning. More specifically, it is possible that teachers who view themselves as gamers may be better prepared and motivated to successfully design games for learning or to design curricula in support of games for learning.

In terms of the vision of teachers as designers of games, Kafai et al. (1998) studied a group of 16 pre-service teachers as they participated in game-design activities where the product was a game that would help students to learn fractions. As the teachers became more familiar with the processes and constraints of game design, the games that the teachers created became more content-integrated (i.e., fraction content and game material were more closely tied together) and contained more of the teachers' knowledge of the development of children's thinking. Kafai and colleagues' study contains no information as to whether these games were more effective at helping students learn fractions, but the authors point to Loef's (1991) findings that teachers were more successful when their practice integrated both the content and their own knowledge of the development of children's mathematical thinking. Thus, game design can be seen as an activity that can drive teachers' sophisticated reasoning about student learning and ultimately empower their practice. These findings also serve to link game design with the greater framework of Pedagogical Content Knowledge (PCK) proposed by Shulman (1987), which conceives the teaching process as grounded precisely in these forms of knowledge that integrate both content and understanding of the students' learning processes.

There have been several efforts to place the tools and know-how of educational game design directly in the hands of teachers, and the results are encouraging. For example, Annetta, Mangrum, Holmes, Collazzo, and Cheng (2009) observed positive learning out comes for fifth-graders when playing *Dr. Friction*, a game designed to support a unit on simple machines. *Dr. Friction* is notable because it was created entirely by the classroom teacher. This game was created as part of the HI FIVES project, in which teachers were trained in the use of a game creation toolkit that was especially designed for users without any knowledge of programming or computer graphics design (Annetta, 2008). Another HI FIVES game, *The stolen fortune of I.M. Megabucks*, was found to help high school students develop 21st-century skills (i.e., digital literacy, inventive thinking, effective communication, and high productivity), and even helped improve the teacher's design (Annetta, Cheng, & Holmes, 2010). One important thing to note in these examples is that the teacher, as the designer and principal creator of the game, enjoyed a position within the classroom gaming activity that was central, active, and prestigious. The teacher/game designer was intimately familiar with the game, could answer students' questions about its workings, guide students when they encountered difficulty, and moderate interaction and discussion about the game's subject material.

Perhaps more feasible on a general level, teachers who view themselves as gamers may be better situated to be designers of curricula that integrated games for learning. Such game-based curricula designed by teachers who are gamers might more effectively leverages the affordances in terms of the specific knowledge that teachers possess about students' thinking and learning as well as in terms of specific knowledge about game mechanics, curriculum focus, assessment needs, and time constraints that influence their particular context. Educational game designers and researchers will find great value in partnering with teachers to help craft game-based learning

initiatives. Teachers bring perspective and real-world experience that is difficult for non-teachers to access. In our own work, we have often relied on teachers not just for access to their classrooms so we can conduct our research, but also for their extensive experience and wisdom in terms of assessment, curriculum priorities, technological needs and limitations, and the current sociopolitical climate surrounding public education. Our experience with these collaborations has been uniformly positive and fruitful, and so we are constantly looking for ways to include our teacher advisors into the design and iteration process. As this form of collaboration becomes more commonplace, we believe it has strong potential to address, and perhaps successfully navigate, the issues of accountability described in Kirriemuir and McFarlane (2004) and the concern over curricular relevance expressed by Ertzberger (2009), as the assumptions and priorities that are encoded in game design would be in the hands of teachers in their classrooms.

On another level, it can be said that the capacities of a game designer are, in fact, of great value to the practice of teaching, even in systems of activity that are not computer-based. For example, an approach to instruction that is informed by game design would be more interactive, learner-centered, collaborative, and engaging; assessment, classroom management, and participation are all elements of classroom practice that could be inlaid with game elements to improve their efficacy. This process of "gamification" of school processes is advocated by McGonigal (2011) in her recent book *Reality is Broken*. McGonigal suggests that games are a unique way to structure experience and provoke positive emotion, to inspire participation, and to motivate hard work; these elements are not only highly desirable in the everyday business of classrooms but are also part of the experience that students consistently receive from games, and find nowhere else. A teacher/game designer would be able to infuse instruction with the powerful, compelling narratives of gaming, which according to McGonigal, are:

1. **Satisfying work:** Clearly defined activities that allow us to see direct impact from our efforts.
2. **Experience, or at least hope, of success:** To feel power in our own lives and show others what we are good at.
3. **Social connection:** Sharing experiences and building bonds with people we care about.
4. **Meaning:** To belong to and contribute to something that has lasting significance beyond our own individual lives (McGonigal, 2011, p. 49).

In this view, the potential of game-based learning to improve education is dwarfed by the potential of the "gamification" of learning. Students are not only engaged and motivated in the comparatively brief interludes spent playing a learning game in their classrooms, but their entire experience of school is game-like in terms of being more engaging, connected, and meaningful. Yet this transformation requires a teacher who, along with all his or her other professional capacities, is a game designer: a skillful creator of game structures and game-like experiences, challenges and rewards, what McGonigal terms a "happiness engineer."

FINAL THOUGHTS

Games hold great potential to enhance education, but generally speaking, teachers have not been sufficiently supported in using games for learning in the classroom, nor has teachers' expertise been optimally leveraged in the design of games for learning. While research has suggested that teachers should have more input into the forms and content of learning games, the development of games for learning remains firmly in the hands of educational researchers or commercial game

developers. In light of the constraints teachers face when implementing game-based learning activities, this represents a missed opportunity; teachers bring specific knowledge about the limitations imposed by organizational time, curriculum, and available technology, which could be integrated into the designs of games that would be more viable and useful for classroom use.

Not only do teachers have much to offer to the game design process, but the discipline of game design also has much to offer the practice of teaching. Teachers who understand game design could integrate more and more of the compelling dynamics of gaming into a school environment that desperately needs them. As Prensky (2005) noted, "Today's kids are not ADD, they're EoE (Engage or Enrage)" (p. 1). If research were to validate the capacity of teachers as game designers and teacher preparation programs were to include it, the goal of engaging more students in deep meaningful learning may be closer at hand.

REFERENCES

Anderson, C. A. (2004). An update on the effects of playing violent video games. *Journal of Adolescence*, *27*(1), 113–122. doi:10.1016/j.adolescence.2003.10.009

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science*, *12*(5), 353–359. doi:10.1111/1467-9280.00366

Annetta, L. A. (2008). Video games in education: Why they should be used and how they are being used. *Theory into Practice*, *47*(3), 229–239. doi:10.1080/00405840802153940

Annetta, L. A., Cheng, M., & Holmes, S. (2010). Assessing twenty-first century skills through a teacher created video game for high school biology students. *Research in Science & Technological Education*, *28*(2), 101–114. doi:10.1080/02635141003748358

Annetta, L. A., Mangrum, J., Holmes, S., Collazo, K., & Cheng, M.-T. (2009). Bridging realty to virtual reality: Investigating gender effect and student engagement on learning through video game play in an elementary school classroom. *International Journal of Science Education*, 31.

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M.-T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education*, *53*(1), 74–85. doi:10.1016/j.compedu.2008.12.020

Becker, K. (2007). Digital game-based learning once removed: Teaching teachers. *British Journal of Educational Technology*, *38*(3), 478–488. doi:10.1111/j.1467-8535.2007.00711.x

Clark, D., Nelson, B., Sengupta, P., & D'Angelo, C. (2009). *Rethinking science learning through digital games and simulations: Genres, examples, and evidence*. Paper presented at Learning Science: Computer Games, Simulations, and Education Workshop Sponsored by the National Academy of Sciences. Washington, DC.

Crawford, C. (1984). *The art of computer game design: Reflections of a master game designer*. New York, NY: Osborne/McGraw-Hill.

Cuban, L. (1999). The technology puzzle. *Education Week*, *18*(43), 58.

de Freitas, S. (2006). *Learning in immersive worlds: A review of game-based learning*. Bristol, UK: Joint Information Systems Committee (JISC) E-Learning Programme. Retrieved March 11, 2008, from http://www.jisc.ac.uk/media/documents/programmes/elearninginnovation/gamingreport_v3.pdf

Dieterle, E. (2010). Games for science education. In Hirumi, A. (Ed.), *Playing Games in School: Video Games and Simulations for Primary and Secondary Education* (pp. 89–112). Eugene, OR: International Society for Technology in Education.

Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington, DC: The National Academies Press.

Ertzberger, J. (2009). An exploration of factors affecting teachers' use of video games as instructional tools. In *Proceedings of the Society for Information Technology & Teacher Education International Conference 2009*, (vol. 1, pp. 1825-1831). IEEE.

Federation of American Scientists. (2006). *Summit on educational games - Harnessing the power of video games for learning*. Washington, DC: Federation of American Scientists.

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. London, UK: Routledge.

Gee, J. P. (2007). *What video games have to teach us about learning and literacy* (2nd ed.). New York, NY: Palgrave Macmillan. doi:10.1145/950566.950595

Hall, R. C. W., Day, T., & Hall, R. C. W. (2011). A plea for caution: violent video games, the Supreme Court, and the role of science. *Mayo Clinic Proceedings*, *86*(4), 315–321. doi:10.4065/mcp.2010.0762

Halverson, R. (2005). What can K-12 school leaders learn from video games and gaming. *Innovate: Journal of online. Education*, *1*(6).

Hauge, M. R., & Gentile, D. A. (2003). Video game addiction among adolescents: Associations with academic performance and aggression. *Child Development*, *40*(306), 1–3.

Hines, P. J., Jasny, B. R., & Mervis, J. (2009). Adding a T to the three R's. *Science*, *323*(5910), 53. doi:10.1126/science.323.5910.53a

Honey, M. A., & Hilton, M. (Eds.). (2010). *Learning science through computer games and simulations*. Washington, DC: National Academy Press.

James, C. (2007). *Playing the game: Comparing teacher gamers to non-gamers.* (Unpublished Doctoral Dissertation). The University of Alabama. Birmingham, AL. Retrieved from http://proquest.umi.com/pqdlink?RQT=568&VInst=PROD&VName=PQD&VType=PQD&Fmt=7&did=1379569531&TS=1302994639&fromjs=1

Kafai, Y. B., Franke, M. L., Ching, C. C., & Shih, J. C. (1998). Game design as an interactive learning environment for fostering students' and teachers' mathematical inquiry. *International Journal of Computers for Mathematical Learning*, *3*(2), 149–184. doi:10.1023/A:1009777905226

Kebritchi, M., Hirumi, A., Kappers, W., & Henry, R. (2008). Analysis of the supporting websites for the use of instructional games in K-12 settings. *British Journal of Educational Technology*, *40*(4), 733–754. doi:10.1111/j.1467-8535.2008.00854.x

Ketelhut, D. J. (2007). The impact of student self-efficacy on scientific inquiry skills: An exploratory investigation in river city, a multi-user virtual environment. *Journal of Science Education and Technology*, *16*(1), 99–111. doi:10.1007/s10956-006-9038-y

Kirriemuir, J., & McFarlane, A. (2004). *Literature review in games and learning*. Bristol, UK: Futurelab.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press. doi:10.1017/CBO9780511815355

Lenhart, A., Jones, S., Macgill, A. R., & Pew Internet and American Life Project. (2008). *Adults and video games*. Retrieved February 3, 2012, from http://www.pewinternet.org/~/media//Files/Reports/2008/PIP_Adult_gaming_memo.pdf.pdf

Mayo, M. J. (2009). Video games: A route to large-scale STEM education? *Science*, *323*(5910), 79–82. doi:10.1126/science.1166900

McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. New York, NY: Penguin Press.

Millstone, J., & Levy, A. (2012). *What do teachers really think about using video games in the classroom?* Paper presented at the 9th Annual Games for Change Summit. New York, NY.

Moursund, D., & Bielefeldt, T. (1999). *Will new teachers be prepared to teach in a digital age? A national survey on information technology in teacher education.* Santa Monica, CA: Milken Exchange on Education Technology. Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED428072

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: A review of the literature. *Journal of Information Technology for Teacher Education*, *9*(3), 319. doi:10.1080/14759390000200096

Murray, J. P., Biggins, B., Donnerstein, E., Menninger, R. W., Rich, M., & Strasburger, V. (2011). A plea for concern regarding violent video games. *Mayo Clinic Proceedings*, *86*(8), 818–820. doi:10.4065/mcp.2011.0321

National Council for Accreditation of Teacher Education. (1997). *Technology and the new professional teacher: Preparing for the 21st century classroom.* Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED412201

National Council for Accreditation of Teacher Education. (2008). *Professional standards for the accreditation of teacher preparation institutions.* Retrieved from http://www.ncate.org/Portals/0/documents/Standards/NCATE%20Standards%202008.pdf

Ng, F., Zeng, H., & Plass, J. (2009). *Research on educational impact of games: A literature review*. Report No. 02/2009. New York, NY: Institute for Games for Learning, NYU/CUNY.

Office of Technology Assessment. (1995). *Teachers and technology: Making the connection*. Report No. OTA-EHR-616. Washington, DC: U.S. Government Printing Office. Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED386155

Papert, S., & Harel, I. (1991). Situating constructionism. In *Constructionism*. New York, NY: Ablex.

Pelletier, C. (2008). Gaming in context: How young people construct their gendered identities in playing and making games. In Kafai, Y. B., Heeter, C., Denner, J., & Sun, J. Y. (Eds.), *Beyond Barbie and Mortal Kombat: New Perspectives on Gender and Gaming*. Cambridge, MA: The MIT Press.

Pew Internet and American Life Project. (2011). *Teen internet usage over time*. Retrieved from http://www.pewinternet.org/Static-Pages/Trend-Data-for-Teens/~/media/Infographics/Trend Data/Teens/September 2009/Teen InternetUsageOverTime–Sep2009.zip

Prensky, M. (2001). Digital natives, digital immigrants part 1. *Horizon*, *9*(5), 1–6. doi:10.1108/10748120110424816

Prensky, M. (2005). Engage me or enrage me: What today's learners demand. *EDUCAUSE Review*, *40*(5), 60.

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use: Implications for preservice and inservice teacher preparation. *Journal of Teacher Education*, *54*(4), 297–310. doi:10.1177/0022487103255985

Sanford, R., Ulicsak, M., Facer, K., & Rudd, T. (2006). *Teaching with games: Using commercial off-the-shelf games in formal education*. Bristol, UK: Futurelab.

Schrader, P. G., Zheng, D., & Young, M. (2006). Teachers' perceptions of video games: MMOGs and the future of preservice teacher education. *Journal of Online Education*, *2*(3).

Shaffer, D. W. (2006). *How computer games help children learn* (1st ed.). New York, NY: Palgrave Macmillan. doi:10.1057/9780230601994

Shaffer, D. W., Squire, K. R., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan*, *87*(2), 104.

Sheingold, K., & Hadley, M. (1990). *Accomplished teachers: Integrating computers into classroom practice.* New York, NY: Center for Technology in Education, Bank Street College of Education. Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED322900

Shulman, L. S. (1986). Paradigms and research programs in the study of teaching: A contemporary perspective. In Wittrock, M. C. (Ed.), *Handbook on Research on Teaching* (3rd ed., pp. 3–36). New York, NY: Macmillan.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–23.

Simpson, E., & Stansberry, S. (2009). Video games and teacher development: Bridging the gap in the classroom. In Miller, C. T. (Ed.), *Games: Purpose and Potential in Education* (pp. 163–185). New York, NY: Springer. doi:10.1007/978-0-387-09775-6_7

Skoric, M. M., Teo, L. L. C., & Neo, R. L. (2009). Children and video games: Addiction, engagement, and scholastic achievement. *Cyberpsychology & Behavior*, *12*(5), 567–572. doi:10.1089/cpb.2009.0079

Snyder, T. D., & Dillow, S. A. (2011). *Digest of education statistics: 2010*. Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubs2011/2011015.pdf

Sprague, D. (2004). Technology and teacher education: Are we talking to ourselves? *Contemporary Issues in Technology & Teacher Education*, *3*(4). Retrieved from http://www.citejournal.org/vol3/iss4/editorial/article1.cfm

Squire, K. (2005). Changing the game: What happens when video games enter the classroom. *Innovate: Journal of Online Education*, *1*(6), 25–49.

Steinkuehler, C., & Chmiel, M. (2006). Fostering scientific habits of mind in the context of online play. In *Proceedings of the 7th International Conference on Learning Sciences,* (pp. 723-729). New York, NY: International Society of the Learning Sciences.

U.S. Department of Education. (2000). *Teacher's tools for the 21st century: A report on teacher' use of technology*. Washington, DC: National Center for Education Statistics.

Wilson, L. (2009). *Best practices for using games & simulations in the classroom guidelines for k–12 educators*. New York, NY: SIIA Education Division.