3-17-2006

Digital Game-Based Learning: It's Not Just the Digital Natives Who Are Restless

Richard Van Eck
University of North Dakota, richard.vaneck@und.edu

Illustration by Steve McCracken, © 2006

Digital Game-Based LEARNING

By Richard Van Eck

It's Not Just the Digital Natives Who Are Restless

After years of research and proselytizing, the proponents of digital game-based learning (DGBL) have been caught unaware. Like the person who is still yelling after the sudden cessation of loud music at a party, DGBL proponents have been shouting to be heard above the prejudice against games. But now, unexpectedly, we have everyone's attention. The combined weight of three factors has resulted in widespread public interest in games as learning tools.

The first factor is the ongoing research conducted by DGBL proponents. In each decade since the advent of digital games, researchers have published dozens of essays, articles, and mainstream books on the power of DGBL—including, most recently, Marc Prensky's *Digital Game-Based Learning* (2001), James Paul Gee's *What Video Games Have to Teach Us about Learning and Literacy* (2003), Clark Aldrich's *Simulations and the Future of Learning: An Innovative (and Perhaps Revolutionary) Approach to e-Learning* (2004), Steven Johnson's *Everything Bad Is Good for You: How Today's Popular Culture Is Actually Making Us Smarter* (2005), Prensky's new book *"Don't Bother Me, Mom, I'm Learning!": How Computer and Video Games Are Preparing Your Kids for 21st Century Success and How You Can Help!* (2006), and the soon-to-be-published *Games and Simulations in Online Learning: Research and Development Frameworks*, edited by David Gibson, Clark Aldrich, and Marc Prensky. The second factor involves today's "Net Generation," or "digital natives," who have become disengaged with traditional instruction. They require multiple streams of information, prefer inductive reasoning, want frequent and quick interactions with content, and have exceptional visual literacy skills[1]—characteristics that are all matched well with DGBL. The third factor is the increased popularity of games. Digital gaming is a $10 billion per year industry,[2] and in 2004, nearly as many digital games were sold as there are people in the United States (248 million games vs. 293.6 million residents).[3]

One could argue, then, that we have largely overcome the stigma that games are "play" and thus the opposite of "work." A majority of people believe that games are engaging, that they can be effective, and that they have a place in learning. So, now that we have everyone's attention, what are we DGBL proponents going to say? I believe that we need to change our message. If we continue to preach only that

Richard Van Eck is Associate Professor at the University of North Dakota, where he has been the graduate director of the Instructional Design & Technology graduate program since 2004. He began his study of games with his dissertation in 1999 and has taught a graduate course in games and learning every year since 2001.

games can be effective, we run the risk of creating the impression that *all* games are good for *all* learners and for *all* learning outcomes, which is categorically *not* the case. What is needed now is (1) research explaining *why* DGBL is engaging and effective, and (2) practical guidance for *how* (when, with whom, and under what conditions) games can be integrated into the learning process to maximize their learning potential. We are ill-prepared to provide the needed guidance because so much of the past DGBL research, though good, has focused on efficacy (the message that games can be effective) rather than on explanation (why and how they are effective) and prescription (how to actually implement DGBL).

This is not to say that we have ignored this issue entirely. Many serious game proponents have been conducting research on how games can best be used for learning,[4] resulting in a small but growing body of literature on DGBL as it embodies well-established learning principles, theories, and models. On the other hand, many DGBL proponents have been vocal about the dangers of "academizing" ("sucking the fun out of," as Prensky would say) games. This is partly the result of our experiences with the edutainment software of the last decade or so, which instead of harnessing the power of games for learning, resulted in what Professor Seymour Papert calls "Shavian reversals": offspring that inherit the worst characteristics of both parents (in this case, boring games and drill-and-kill learning).[5] Many argue that this happened because educational games were designed by academicians who had little or no understanding of the art, science, and culture of game design. The products were thus (sometimes!) educationally sound as learning tools but dismally stunted as games. Yet if we use this history and these fears to argue, as some have, that games must be designed by game designers without access to the rich history of theory and practice with games in learning environments, we are also doomed to fail. We will create games that may be fun to play but are hit-or-miss when it comes to educational goals and outcomes. The answer is not to privilege one arena over the other but to find the synergy between pedagogy and engagement in DGBL.

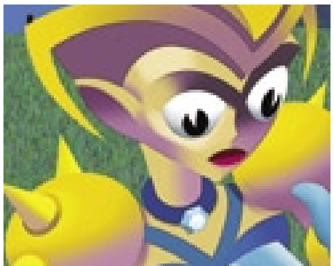
In this article, I will outline why DGBL is effective and engaging, how we can leverage those principles to implement DGBL, how faculty can integrate commercial off-the-shelf (COTS) DGBL in the classroom, what DGBL means for institutional IT support, and the lessons we can learn from past attempts at technological innovations in learning.

The Effectiveness of DGBL

If we are to think practically and critically about DGBL, we need to separate the hype from the reality. Many who first hear about the effectiveness of games are understandably skeptical. How much of the research is the result of rigorous, controlled experimental design, and how much is wishful thinking and propaganda? A comprehensive analysis of the field is not possible here and, in any case, has already been done by others. Several reviews of the literature on gaming over the last forty years, including some studies that use rigorous statistical procedures to analyze findings from multiple studies (meta-analyses), have consistently found that games promote learning and/or reduce instructional time across multiple disciplines and ages.[6] Although many of these reviews included non-digital games (pre-1980), there is little reason to expect that the medium itself will change these results. A cursory review of the experimental research in the last five years shows well-documented positive effects of DGBL across multiple disciplines and learners.

What accounts for the generally positive effects found in all these studies about games and learning? These empirical studies are only part of the picture. Games are effective not because of what they are, but because of what they embody and what learners are doing as they play a game. Skepticism about games in learning has prompted many DGBL proponents to pursue empirical studies of how games can influence learning and skills. But because of the difficulty of measuring complex variables or constructs and the need to narrowly define variables and tightly control conditions, such research most often leads to studies that make correspondingly narrow claims about tightly controlled aspects of games (e.g., hand-eye coordination, visual processing, the learning of facts and simple concepts).

Games are effective not because of what they are, but because of what they embody and what learners are doing as they play a game.



As Johnson says in *Everything Bad Is Good for You*: "When I read these ostensibly positive accounts of video games, they strike me as the equivalent of writing a story about the merits of the great novels and focusing on how reading them can improve your spelling."[7] Although it's true that games have been empirically shown to teach lower-level intellectual skills and to improve physical skills, they do much more than this. Games embody well-established principles and models of learning. For instance, games are effective partly because the learning takes place within a meaningful (to the game) context. What you must learn is directly related to the environment in which you learn and demonstrate it; thus, the learning is not only relevant but applied and practiced within that context. Learning that occurs in meaningful and relevant contexts is more effective than learning that occurs outside of those contexts, as is the case with most formal instruction. Researchers refer to this principle as *situated cognition* and have demonstrated its effectiveness in many studies over the last fifteen years. Researchers have also pointed out that play is a primary socialization and learning mechanism common to all human cultures and many animal species. Lions do not learn to hunt through direct instruction but through modeling and play.[8] Games, clearly, make use of the principle of play as an instructional strategy.

There are other theories that can account for the cognitive benefits of games. Jean Piaget's theories about children and learning include the concepts of assimilation and accommodation. With assimilation, we attempt to fit new information into existing slots or categories. An example of an adult assimilating information might be that when a man turns the key in the ignition of his car and the engine does not turn over, and in the past this has been due to a dead battery, he is now likely to identify the problem as a dead battery. Accommodation involves the process whereby we must modify our existing model of the world to accommodate new information that does not fit into an existing slot or category. This process is the result of holding two contradictory beliefs. In the previous example, should the man replace the battery and experience the same problem, he finds that the engine not starting both means and does not mean a dead battery. This process is often referred to as *cognitive disequilibrium*. Accordingly, our stranded motorist must adjust his mental model to include other problems like alternators and voltage regulators (although perhaps only after an expensive trip to his auto mechanic). Piaget believed that intellectual maturation over the lifespan of the individual depends on the cycle of assimilation and accommodation and that cognitive disequilibrium is the key to this process.

Games embody this process of cognitive disequilibrium and resolution. The extent to which games foil expectations (create cognitive disequilibrium) without exceeding the capacity of the player to succeed largely determines whether they are engaging. Interacting with a game requires a constant cycle of hypothesis formulation, testing, and revision. This process happens rapidly and often while the game is played, with immediate feedback. Games that are too easily solved will not be engaging, so good games constantly require input from the learner and provide feedback. Games thrive as teaching tools when they create a continuous cycle of cognitive disequilibrium and resolution (via assimilation or accommodation) while also allowing the player to be successful. There are numerous other areas of research that account for how and why games are effective learning tools, including anchored instruction, feedback, behaviorism, constructivism, narrative psychology, and a host of other cognitive psychology and educational theories and principles. Each of these areas can help us, in turn, make the best use of DGBL.

Games that are too easily solved will not be engaging, so good games constantly require input from the learner and provide feedback.

Implementing DGBL

The positive effects of DGBL seen in experimental studies can be traced, at least partially, to well-established principles of learning as described earlier (e.g., situated cognition, play theory, assimilation and accommodation) and elsewhere by others.[9] This means that DGBL can be implemented most effectively, at least in theory, by attending to these underlying principles. How, then, can we use this knowledge to guide our implementation of DGBL in higher education?

A review of the DGBL literature shows that, in general, educators have adopted three approaches for integrating games into the learning process: have students build games from scratch; have educators and/or developers build educational games from scratch to teach students; and integrate commercial off-the-shelf (COTS) games into the classroom. In the first approach, students take on the role of game designers; in building the game, they learn the content. Traditionally, this has meant that students develop problem-solving skills while they learn programming languages. Professional game development takes one to two years and involves teams of programmers and artists. Even though this student-designed approach to DGBL need not result in commercial-quality games, it is nonetheless a time-intensive process and has traditionally been limited to computer science as a domain. It is certainly possible for modern game design to cross multiple disciplines (art, English, mathematics, psychology), but not all teachers have the skill sets needed for game design, not all teach in areas that allow for good content, not all can devote the time needed to implement this type of DGBL, and many teach within the traditional institutional structure, which does not easily allow for interdisciplinarity. For these reasons, this approach is unlikely to be used widely.

In the second case, we can design games to seamlessly integrate learning and game play. Touted by many as the "Holy Grail" approach to DGBL because of its ability to potentially address educational and entertainment equally, and to do so with virtually any domain, this professionally designed DGBL process is more resource-intensive than the first option. This is because the games must be comparable in quality and functionality to commercial off-the-shelf (COTS) games, which after all are very effective in teaching the content, skills, and problem-solving needed to win the game. The development of such "serious games" is on the rise, and the quality of the initial offerings is promising (e.g., *Environmental Detectives*, developed by the Education Arcade; *Hazmat: Hotzone*, under development at the Entertainment Technology Center at Carnegie Mellon University; *Virtual U*, originally conceived and developed by Professor William F. Massy; and *River City*, developed by Professor Chris Dede, the Harvard Graduate School of Education, and George Mason University). However, the road to the development of serious games is also littered with Shavian reversals (poor examples of edutainment in which neither the learning nor the game is effective or engaging). Consequently, fewer companies are willing to spend the time and money needed to develop these games, for fear of revisiting their unprofitable past, and so the number of games that can be developed is limited. Although this professionally designed

DGBL approach is clearly the future of DGBL,[10] we are not likely to see widespread development of these games until we demonstrate that DGBL is more than just a fad and until we can point to persuasive examples that show games are being used effectively in education and that educators and parents view them as they now view textbooks and other instructional media.

Quality is maximized by leaving the design of game play up to game designers and the design of learning up to teachers.

The third approach—integrating commercial off-the-shelf digital game-based learning (COTS DGBL)—involves taking existing games, not necessarily developed as learning games, and using them in the classroom. In this approach, the games support, deliver, and/or assess learning. This approach is currently the most cost-effective of the three in terms of money and time and can be used with any domain and any learner. Quality is also maximized by leaving the design of game play up to game designers and the design of learning up to teachers. I believe that this approach to DGBL is the most promising in the short term because of its practicality and efficacy and in the long term because of its potential to generate the evidence and support we need to entice game companies to begin developing serious games.

This approach is gaining acceptance because of its practicality, and research shows that it can be effective.[11] Entertainment Arts (EA), a game-development company, and the National Endowment for Science, Technology, and the Arts (NESTA) in the United Kingdom have entered into a joint partnership to study the use of COTS games in European schools, and similar initiatives are being proposed in the United States. If the United States is like the United Kingdom, where 60 percent of teachers support the use of games in the classroom,[12] the United States may be well-positioned to begin generating the evidence (through the use of COTS games) that the game industry needs to begin developing serious games.

Integrating COTS games is not without its drawbacks. Commercial games are not designed to teach, so topics will be limited and content may be inaccurate or incomplete. This is the biggest obstacle to implementing COTS DGBL: it requires careful analysis and a matching of the content, strengths, and weaknesses of the game to the content to be studied.[13]

There are ways to minimize these drawbacks, some of which I will discuss later, but the elephant in the room is that in our conversations about DGBL, we rarely acknowledge that the taxonomy of games is as complex as our learning taxonomies. Not all games will be equally effective at all levels of learning. For instance, card games are going to be best for promoting the ability to match concepts, manipulate numbers, and recognize patterns. *Jeopardy*-style games, a staple of games in the classroom, are likely to be best for promoting the learning of verbal information (facts, labels, and propositions) and concrete concepts. Arcade-style games (or as Prensky and others refer to them, "twitch" games) are likely to be best at promoting speed of response, automaticity, and visual processing. Adventure games, which are narrative-driven open-ended learning environments, are likely to be best for promoting hypothesis testing and problem solving. Many games also blur these taxonomic lines, blending strategy with action and role playing, for instance.

It is critical, therefore, that we understand not just how games work but how different *types* of games work and how game taxonomies align with learning taxonomies. This is not a new idea. In perhaps one of the most ambitious and rigorous examinations of the use of games to teach mathematics, a 1985 study undertaken for the National Council of Teachers of Mathematics developed eleven games for different grade levels using 1,637 participants. The study authors intended their eleven separate game studies to examine if and how games could be used to teach mathematics at varying learning levels.[14] Games, they hypothesized, might be better at promoting learning at some levels than at others. Further, they distinguished between three types of game use: pre-, co-, and post-instructional, based on when games were used in relation to the existing curriculum. The study authors found that there were indeed differences by learning level and by whether games were used prior to, during, or after other instruction and also that there were interactions between these two factors. They concluded that although drill-and-practice-type games at the time made up the vast majority of edutainment titles, instructional games could be effective for higher learning levels if designed and implemented well. Though this seems to support the development of serious games, the core principle—that games can promote learning at higher taxonomic levels—is as applicable to COTS games, which require and promote problem-solving and situated cognition *before* they are integrated with instructional activities or content.

Integrating COTS DGBL in the Classroom

It is important to understand how the theoretical issues outlined here relate to the use of games to teach. Although this section gives a practical description of the issues, it is meant more as a heuristic for understanding the issues involved than as a prescriptive tool. There are a wide range of other factors that must be considered, such as using the game outside of the classroom (as with all homework), balancing game play and other instructional activities, and rotating students' use of the computers in classrooms where there is not a one-to-one student-computer ratio. Many of these issues are not unique to DGBL, however, and are adequately treated by authors of texts that emphasize integrating computer technology into the learning process.[15]

Choosing a Suitable Game

A good number of COTS games are suitable for use in the classroom, and there are many examples of COTS games already being used in the classroom, including *Civilization*, *CSI*, *Age of Empires II*, *The Sims 2*, *Age of Mythology*, and *SimCity 4* (e.g., see <http://www.Silversprite.blogspot.com>). Prensky has put together a list of five hundred "serious" games that can be used to teach different content. Many of these can be found at <http://www.socialimpactgames.com>, and his new book and accompanying Web site (see <http://www.gamesparentsteachers.com>) provide even more guidance on using games for learning. These games can be a good match for DGBL depending on whether the explicit content is a match for the classroom content. Examples include *Civilization* to teach history, *CSI* to teach forensics and criminal justice, and *SimCity* to teach civil engineering and government. But they can also be a good match based on whether the underlying strategies and the game play match the content of the course. Games like *RollerCoaster Tycoon* and *Cruise Ship Tycoon*, for example, do not seem at first glance to be good candidates for DGBL. A closer examination of these titles, however, reveals a different story. In *RollerCoaster Tycoon*, students build roller-coasters to different specifications, which is what engineers do. And though the game does not require students to use calculus or learn physics, the principles are certainly present in the game. By asking learners to take on the role they are given in the game (the engineer), we can extend the game into the classroom by asking them to perform the tasks that an engineer in charge of the roller-coaster would do. Management might require safety reports that include maximum load capacity, force tolerances and structural integrity, speed estimates, and weight limits, for example, all of which would require the use of calculus, a demonstration of physics knowledge, and the ability to communicate (write) in ways that are authentic to real-world engineers. Both *RollerCoaster* and *Cruise Ship Tycoon* also require learners to manage a business, including monitoring expenses, revenues, and customer satisfaction. These are the same skills expected of business students, who as professionals will need to develop business plans, write reports, and manage budgets. Although the games do not cover instruction in all of these areas, we can easily augment the game with instructional activities that preserve the context (situated cognition) of the game (e.g., by extending the goals and character roles of the game into the classroom). Attending to the underlying structure of games opens up the instructional potential of nearly every game. As an extreme case in point, I could envision using *Grand Theft Auto* to teach ethics, morality, citizenship, and law enforcement. However, this is not to say that every game would be suitable; a host of other questions must be answered first.

Any game designed to be engaging will tend to privilege that aspect over accuracy and completeness of content.

Aligning the Game with the Curriculum

The 1985 study on using games to teach mathematics, discussed earlier, made the distinction between whether a game was used as a preinstructional strategy (for an advance organizer), a co-instructional strategy (for examples and practice of learning in a domain), or a post-instructional strategy (for assessment and synthesis). This decision is partly determined by the curriculum and partly by the game. A balance between the needs of the curriculum and the structure of the game must be achieved to avoid either compromising the learning outcomes or forcing a game to work in a way for which it is not suited.

Aligning the Game with the Content

Educators recognize this as the biggest limitation of COTS games in DGBL. Any game designed to be engaging will tend to privilege that aspect over accuracy and completeness of content. So when we evaluate these games, we have to ask ourselves several questions. What *is* covered in the game? A game may take a breadth or a depth approach to the topic. Games like *Civilization* will cover a huge range of history across continents and cultures (breadth), whereas games like *Call of Duty* will focus on one narrow slice of history (depth). Obviously, this has implications for how the games align with the curriculum.

Just as important as what is covered in the game is what is *not* covered. Missing topics (for games that focus on depth) and missing content within topics (for games that focus on breadth) are key issues. What prerequisite knowledge is required to interact with the game content in a way that is appropriate for the curriculum? What does the game get wrong? One of the biggest misconceptions among educators is that if a game is missing content or has inaccurate content, it cannot be used responsibly for DGBL. However, educators can use these teachable moments to create cognitive disequilibrium (through instructional strategies and activities) by presenting or designing activities by which *students* discover information that conflicts with the game and the student's knowledge.

In other cases, the games may present information that, though not technically incorrect, is nevertheless misleading. There may also be alternative viewpoints and perspectives that are not represented by the games. The game *Conquest of the Americas* involves several cultures over a three-hundred-year period, but as evidenced in the title, the game privileges the Western point of view. The indigenous populations of present-day Florida would tell a decidedly different story of Columbus's landing, just as those living in what is now the upper northeast of the United States would have a different account of the landing of the *Mayflower.* The curriculum may require incorporation of these viewpoints even when the game does not.

Designing and Evaluating the Game

Once we have chosen a game, and have analyzed it for content, we have to decide what to do about missing and inaccurate content. What content will have to be created to address gaps? Who will provide this content? Some believe that this is the teacher's responsibility, but current thinking in education suggests that the more students are responsible for in their learning, the more they will learn. Certainly, there is some content that will not be practical for students to address on their own, but wherever and whenever we can maximize student responsibility, we should.

And the *way* we choose to maximize student responsibility is also important. Because we are going to have to go out of the game environment and into the classroom, we run the risk of eliminating what is fun and engaging about the game. So, rather than simply providing additional reading or handouts with the missing or accurate information, we should strive to design activities that are logical extensions of the game world. Learning is integral to the story of the game world—players are never asked to step out of the game world to do something (although they frequently do so when stuck). The constant cycle of cognitive disequilibrium and resolution—the engagement—is what leads to the experience that Professor Mihaly Csikszentmihalyi refers to as *flow*.[16] Flow occurs when we are engaged in an activity (physical, mental, or both) at a level of immersion that causes us to lose track of time and the outside world, when we are performing at an optimal level. Good games promote flow, and anything that causes us to "leave" the game world (e.g., errors, puzzles that require irrational solutions) interrupts flow. If we were to simply design "traditional" classroom activities (workbooks, textbook reading, teacher handouts, etc.) that addressed the missing, misleading, or inaccurate content in the game, we would be interrupting the flow experience. Granted, anytime we ask the players to stop the game and do something else, flow will be interrupted. But to the extent that we can keep these additional activities "situated" within the game world (i.e., connected to the problem being solved, the characters solving it, and the tools and methods those characters use or might use), we will minimize this interruption of flow. For the same reasons, we should make sure that students spend enough time in the game to promote flow and, correspondingly, significant time in the extended instructional activities. Even if these extended activities do not promote flow, the more frequently students move from the game to other activities (even those related to the game), the more frequently flow will be interrupted in each activity.

We have to ask ourselves if the amount of potential learning is justified by the amount of work and time that will be needed to implement the game.

Although it is not possible to stay entirely within the game world (and therefore to keep students in flow) when implementing COTS DGBL, there is another reason we should strive to keep the activities we design situated within that game world. Malone and Lepper identify fantasy (endogenous and exogenous) as one of four main areas that make games intrinsically motivating.[17] Endogenous fantasy elements are those fantasy parts that are seamlessly integrated with the game world and story; exogenous fantasy elements are those that, though in the game, do not appear to have much relation to the story or game world. Endogenous fantasy elements not only help make games intrinsically motivating; in theory, they should also promote flow. So whenever we ask students to not be *in* the game, we should strive to keep the activities and roles they take on (the fantasy) endogenous *to* the game.

Thus, the roles we ask them to take on should be extensions of the roles they play in the game. These can be main characters, ancillary characters, or characters that could hypothetically be part of the game. The activities we ask them to perform as these characters should be authentic to the goals of the game world and the professions or characteristics of these characters. Some examples of endogenous activities might be to develop budgets, spreadsheets, reports/charts, and databases; to write diaries, scientific reports, letters, legal briefs, dictionaries, faxes; to design, duplicate, and conduct experiments; to conduct and write up feasibility studies; and to assess the veracity of game information or provide missing data. We should not be so naïve as to think that students will find these activities to be as engaging as the games, but given our need to meet curricular goals and our desire to tightly integrate the games with the learning process, this seems a good way to meet in the middle.

Making the Call

Ultimately, after this investment of time in analysis, we have to be willing to abandon a game if it is not a good fit. We have to ask ourselves if the amount of potential learning is justified by the amount of work and time that will be needed to implement the game. If it is not, we have to resist the temptation to hang on to something simply because we have invested so much effort.

DGBL and Institutional IT Support

Aside from the practical aspects of implementing DGBL, colleges and universities face significant challenges when attempting to support DGBL at the institutional level. There are several areas in which IT can help.

Documentation and Training Support

If colleges and universities leave DGBL entirely up to the faculty, some will do a good job, and some will not. Everyone will spend unnecessary time reinventing the wheel and rediscovering the principles needed to make the innovation work. Institutions should provide documentation and training for what DGBL can look like in general and within the context of the institution specifically. They should strive to provide heuristics and job aids for planning and analysis in order to address the critical issues and decisions outlined here. Faculty members need training to analyze, design, develop, implement, and evaluate DGBL. Staff members need training to support faculty during this process. Everyone involved in the design, development, or implementation of DGBL needs training on what DGBL is and how it is supported and implemented institution-wide (e.g., labs, procedures, guidelines).

Examples of best practices in DGBL should be collected and disseminated. Since DGBL requires pedagogical approaches that will be unfamiliar to many faculty members, pedagogical support should be provided to those interested in exploring DGBL. Colleges and universities should hire instructional designers who have experience with games and learning to assist with the design of DGBL and should support one-on-one development just as they have begun to do with online learning. Colleges of education can provide expertise in technology integration. They have been doing this for twenty-five years and can be invaluable resources both for establishing the models and pedagogical support mentioned above and for implementing DGBL.

Technical Support

Clearly, the technical challenges of DGBL are significant. Faculty need assistance during development and implementation of DGBL, and students need support during implementation. This means that institutions need to train help desk staff and provide documentation (e.g., common questions, current lab configurations and procedures for DGBL, course materials for ongoing DGBL classes) so that they understand the issues and can provide support when needed.

Financial Support

Although COTS DGBL is among the more inexpensive options, there are still financial issues involved. Just as it has done with productivity software, the IT unit should strive to provide assistance with licensing through volume licensing agreements with companies and negotiated discounts for students (who will, after all, have to play these games outside of class). Financial incentives for faculty to develop DGBL should be provided, as they often are for online learning, and should be tied to the established institutional models and procedures for DGBL discussed earlier.

Infrastructure Support

The existing higher education infrastructure is ill-prepared to support DGBL. Computer labs must be appropriately configured, meaning that they are not locked down to prevent adjustments to video resolution or installation of proprietary drivers and game patches and that they allow for the ability to save and retrieve games. Equipment that is not standard, such as headphones, speakers, and high-end sound and video cards, must be included in lab specifications. Given the increase in the popularity, power, and sophistication of gaming consoles like the Xbox 360, higher education institutions that are serious about supporting DGBL may even want to change the footprint of one or more labs to be consoles rather than PC boxes. Finally, labs must be accessible for game play outside of class, not just during class. This will place a heavier load on the labs, of course, and will necessitate the formulation of additional usage policies.

Research and Development Support

Finally, institutions will need to take an active role in R&D, just as they are beginning to do now with online learning. Colleges and universities should start by identifying those faculty members who are doing research in games and learning and should bring them into the planning, implementation, and evaluation process. These instructors are most commonly in the instructional design, education, and cognitive psychology fields, although faculty in virtually every area and domain are exploring DGBL.

Colleges and universities need to collect and disseminate research and examples of successful DGBL from within and without the institution. They should develop databases of examples and guidance for application and extension to additional domains. And higher education should encourage rigorous studies and game design so that we can extend DGBL as a field and we can continue to define and refine DGBL locally and abroad.

Faculty members need training to analyze, design, develop, implement, and evaluate DGBL.

The Ghosts of Technology Past

Of the several technology "learning revolutions" during the last quarter-century, most have failed to achieve even half of their promise. Although there are many reasons for this, the primary fault lies with our inability (or unwillingness) to distinguish between the medium and the message. Two examples of such technological learning innovations from our recent past are media technology and computing technology.

In the 1960s and 1970s, audio and video (and later, television) were touted as technologies that would revolutionize learning. We rapidly began implementing media wherever possible, regardless of grade, domain, or learners. Many studies were conducted during the 1970s to compare media-based classrooms to "traditional" classrooms, and some of the more sensational ones found their way into the public eye. By the 1980s, enough studies had been conducted to allow for meta-analyses and reviews of the literature. Most of these resulted in what has famously been called the "no significant difference" phenomenon—meaning that, overall, media made no significant difference to learning. This was not surprising to instructional designers, who argued that the implementation of media was not consistently of high quality and that the quality of the instruction in "media" versus "traditional" classrooms was not controlled. The key to understanding this issue lies in the difference between *use* and *integration* of media. *Using* media requires only that the media be present during instruction. Integrating media, on the other hand, requires a careful analysis of the strengths and weaknesses of the media, as well as its alignment with instructional strategies, methods, and learning outcomes. Weaknesses are then addressed through modification of the media or inclusion of additional media and/or instruction, and instruction is modified to take advantage of the strengths of the media. In cases where there is poor alignment, the media is not used.

Sadly, the history of the use of computing technology in learning parallels that of media use. The personal computer arrived in the 1970s, and predictions of revolutionized learning quickly followed. Schools spent hundreds of thousands of dollars on computers in the early 1980s, vowing to place one in every classroom. Studies comparing classrooms with computing technology and those without proceeded at the same pace as had studies comparing media-rich and media-poor classrooms. Once again, instructional designers and others pointed out that the quality of implementation varied greatly, making comparisons impossible. By the time there were enough studies to evaluate and review, the quality and diversity of the different implementations made it difficult to draw any meaningful conclusions. Once again, it seemed there was "no significant difference" between classrooms that used technology and those that did not. Once again, we had mistaken technology use for technology integration.

Eventually, though, educators learned from this and from prior experience with media. They began developing and testing better-integrated uses of computing technology. Since the early 1990s, educators have been moving toward technology integration and toward pre-service teacher training, emphasizing alignment of the curriculum with the technology. We must take what we have learned forward as we consider how, when, and with whom to implement DGBL in the future.

■ ■ ■

Many of us have been advocating for DGBL for twenty-five years—much of that time without any evidence of success. Over those same years, instructional designers and educators have been advocating for the intelligent integration of learning technologies, including DGBL, in accordance with established theory and the underlying strengths and weaknesses of the medium—much of that time watching schools mistake the medium for the message. It's not just the digital natives who are getting restless. We all want to see DGBL both accepted *and* implemented intelligently.

Will we continue to learn from the past? Will we realize the potential that DGBL has to revolutionize how students learn? This has much less to do with attitude and learner preferences than it does with a technology that supports some of the most effective learning principles identified during the last hundred years. If we learn from our past, and if we focus on the strengths of the medium and provide the support and infrastructure needed to implement DGBL, we may well be present for a true revolution. *e*

Notes

1. See Diana Oblinger and James Oblinger, "Is It Age or IT: First Steps toward Understanding the Net Generation," in Diana G. Oblinger and James L. Oblinger, eds., *Educating the Net Generation* (Boulder, Colo.: EDUCAUSE, 2005), e-book, available at <http://www.educause.edu/educatingthenetgen>, and Marc Prensky, " 'Engage Me or Enrage Me': What Today's Learners Demand," *EDUCAUSE Review,* vol. 40, no. 5 (September/October 2005): 60–65, <http://www.educause.edu/er/erm05/erm0553.asp>.
2. "$10B Gaming Field Inspires New Curricula," *eSchool News Online,* September 30, 2005, <http://www.eschoolnews.com/news/showStory.cfm?ArticleID= 5896>.
3. See Entertainment Software Association, "2005 Sales, Demographics, and Usage Data: Essential Facts about the Computer and Video Game Industry," <http://www.theesa.com/files/2005EssentialFacts.pdf>, and U.S. Census Bureau, Population Division, "Table 1: Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000, to July 1, 2005 (NST-EST2005-01)," December 22, 2005.
4. See, for example, L. P. Rieber, "Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds, Simulations, and Games," *Educational Technology Research and Development*, vol. 44, no. 2 (1996): 43–58; R. Van Eck and J. Dempsey, "The Effect of Competition and Contextualized Advisement on the Transfer of Mathematics Skills in a Computer-Based Instructional Simulation Game," *Educational Technology Research and Development,* vol. 50, no. 3 (2002): 23–41; Alexander Lewis Aitkin, "Playing at Reality: Exploring the Potential of the Digital Games as a Medium for Science Communication"(Ph.D. diss., Centre for the Public Awareness of Science, Australia, 2004); Simon Egenfeldt-Nielsen, "Beyond Edutainment: Exploring the Educational Potential of Computer Games" (Ph.D. diss., IT-University Copenhagen, Denmark, 2005); Kurt D. Squire, "Replaying History: Learning World History through Playing *Civilization III*" (Ph.D. diss., Indiana University, 2005).
5. Seymour Papert, "Does Easy Do It? Children, Games, and Learning," *Game Developer,* June 1998, <http://www.papert.org/articles/Doeseasydoit.html>.
6. See M. Szczurek, "Meta-Analysis of Simulation Games Effectiveness for Cognitive Learning" (Ph.D. diss., Indiana University, 1982); R. L. VanSickle, "A Quantitative Review of Research on Instructional Simulation Gaming: A Twenty-Year Perspective," *Theory and Research in Social Education*, vol. 14, no. 3 (1986): 245–64; and J. M. Randel, B. A. Morris, C. D. Wetzel, and B. V. Whitehill, "The Effectiveness of Games for Educational Purposes: A Review of Recent Research," *Simulation and Gaming*, vol. 23 no. 3 (1992): 261–76.
7. Steven Johnson, *Everything Bad Is Good for You: How Today's Popular Culture Is Actually Making Us Smarter* (New York: Riverhead Books, 2005), 24.
8. See Chris Crawford, "The Art of Computer Game Design," <http://www.vancouver.wsu.edu/fac/peabody/game-book/Coverpage.html>.
9. See James Paul Gee, *What Video Games Have to Teach Us about Learning and Literacy* (New York: Palgrave Macmillan, 2003), for a comprehensive examination of the mechanisms by which games teach.
10. For example, see the Games-to-Teach Project (http://www.educationarcade.org/gtt).
11. See Angela McFarlane, Anne Sparrowhawk, and Ysanne Heald, "Report on the Educational Use of Games: An Exploration by TEEM of the Contribution Which Games Can Make to the Education Process" (2002), <http://www.teem.org.uk/publications/teem_gamesined_full.pdf>.
12. NESTA Futurelab, "Close to 60% of UK Teachers Want Computer Games in the Classroom," January 13, 2006, <http://www.nestafuturelab.org/about_us/press_releases/pr11.htm>.
13. See McFarlane, Sparrowhawk, and Heald, "Report on the Educational Use of Games; and R. Van Eck and J. Gikas, "Gaming Theory as a Teaching Tool at All Levels," presentation for the annual meeting of Techsposium, Memphis, Tenn., March 31, 2004.
14. G. W. Bright, J. G. Harvey, and M. M. Wheeler, "Learning and Mathematics Games," *Journal for Research in Mathematics Education,* (1985), no. 1.
15. See Gary R. Morrison and Deborah L. Lowther, *Integrating Computer Technology into the Classroom* (Upper Saddle River, N.J.: Pearson/Merrill/Prentice-Hall, 2005); and Mark Grabe and Cindy Grabe, *Integrating Technology for Meaningful Learning,* 4th ed. (New York: Houghton-Mifflin, 2004).
16. See Mihaly Csikszentmihalyi, *Flow: The Psychology of Optimum Experience* (New York: Harper & Row, 1990).
17. See T. W. Malone and M. R. Lepper, "Making Learning Fun: A Taxonomic Model of Intrinsic Motivations for Learning," in R. E. Snow and M. J. Farr, eds., *Aptitude, Learning, and Instruction,* Volume 3: *Cognitive and Affective Process Analysis* (Hillsdale, N.J.: Erlbaum, 1987): 223–53.