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Digital Game-Based Learning: Still Restless, After All These Years

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By Richard N. Van Eck

Nearly a decade ago, I wrote an article for *EDUCAUSE Review* about digital game-based learning (DGBL) and the challenges it faced.[1] I suggested that once proponents of DGBL were successful in convincing people that games could play a role in education, they would be unprepared to provide practical guidance for implementing DGBL. Just as when the person shouting to be heard at a party is suddenly the center of attention at the moment there is a lull in the conversation, we DGBL proponents had everyone's attention—but not much to say. In the article I also suggested that our sometimes overzealous defense of videogames (hereafter often referred to as "digital games") ran the risk of overselling the benefits (and underreporting the challenges) of using digital games in formal education.

Digital games, I said then and still believe today, are effective as embodiments of effective learning theories that can promote higher-order outcomes. Our inability to provide guidance in doing so a decade ago was ceding the DGBL front to digital games as tools for making didactic, instructivist learning (i.e., lectures) more "engaging." DGBL, I suggested, was effective not as a means for making learning "fun" or for "tricking" students into learning; DGBL was effective because it supported powerful learning strategies such as situated learning, authentic environments, and optimized challenge and support (scaffolding). What was needed was a renewed focus on (1) research about *why* DGBL is effective and (2) guidance on *how, when, for whom,* and *under what conditions* to integrate digital games into formal education.

I was not the only one with these ideas, but my timing and the venue combined to reach many people. That 2006 article has been cited more than 1,000 times since then.[2] Yet though these ideas continue to resonate with many people, much has changed in terms of research, practice, and to some extent, my own beliefs about the future of DGBL.

Where Are We Now?
Perhaps the first place to start is with the title of this article. I continue to use the term *digital game-based learning,* coined by Marc Prensky in his 2001 book by that title. Since then, many other terms have arisen to describe the study and practice of digital games: *serious games, ludology, educational games.* So why still use DGBL? I think Marc got it right in 2001. Although it is true that *game* today connotes videogames, there are games that are not digital (e.g., Monopoly). Unless all analog games (e.g., card games, word games, and board games) cease to exist, we will still need the term "digital" as a necessary modifier. I also believe that "game-*based*" is required because *digital game learning* would privilege the role of the game in ways that are not always accurate. And of course, *learning* is neces-

sary to distinguish the purpose of games for education rather than for advertising (advergaming), health (games for health), or social change (social impact games). *Learning* also captures the cognitive change process that results from the interaction of learner, content, and strategies, much as gameplay is the result of the interaction of the player with the mechanics of the game.

On the other hand, one thing that has changed in the article title is the absence of the term *digital natives,* also coined by Prensky in 2001. I now think that Prensky (and the rest of us) got this wrong. A funny thing happened on the way to the revolution: we found out that digital natives are not who we thought they were. Yes, students born after 1990 or so are extremely facile with technology. They are not afraid of new technology, can easily teach themselves

to use new forms, and make use of technology almost constantly in their daily lives. They are probably the best social networkers you will ever find and are highly sought after in areas such as marketing. Yet digital natives can also be surprisingly naïve and awkward with technology: they engage in cyberbullying, share inappropriate (sometimes dangerous) information via social media, and make spectacular blunders when attempting to cross generational divides with technology.

More relevant for our discussion here, digital natives are not necessarily the videogame savants we assumed they would be. Educators are surprised to learn that a significant percentage of gamers (23%) play videogames less than one hour per week.[3] As a result, the influx of digital natives into professional teaching positions neither ushered in an educational revolution nor produced the expected incoming classes of "restless" digital natives in higher education.

What Have We Learned about DGBL?
There is no point in arguing for the adoption of digital games to promote learning if there is no evidence that they can be effective in doing so. In 2006 I noted that reviews of the literature from the previous twenty years suggested that digital games could improve learning. Today it is fair to question whether such research (now twenty or more years

older) amounts to sufficient evidence for a change in educational practice.

Do Games Teach?

The question of whether digital games teach has been answered definitively by DGBL research since 2006. Digital games have been shown to promote general educational skills such as spelling and reading; domain-specific learning outcomes in physics, health, biology, mathematics, medicine, and computer science; and a wide range of cognitive abilities including spatial visualization, divided attention, and knowledge mapping.[4] On average, a well-designed game improves learning by between 7 and 40 percent over a lecture, effectively erasing the difference between failing students and those working at a "B" grade level.[5] Several meta-analyses in the intervening years have also found advantages for digital games over conventional instruction, including "significantly higher cognitive gains . . . versus traditional teaching methods."[6] Most recently, a meta-analysis of digital games found that learners in game-based instruction performed 0.33 standard deviations (as much as one full letter grade) better when compared with learners in non-game-based instruction in general.[7]

So, the question of *whether* digital games can teach or not seems to be settled science. But that is not the only question we should be asking. A better question is, what can digital games *best* teach, and why?

Digital Games for Different Outcomes

Among the inclusion criteria for the studies examined in the meta-analysis noted above was that each study had to address at least one 21st-century skill: critical thinking, problem solving, collaboration,

effective communication, motivation, persistence, or learning to learn.[8] These skills lie in stark contrast to many "traditional" learning outcomes, which tend to focus on mastery of facts and conceptual knowledge. Many DGBL experts now believe that the true power of digital games lies in their ability to promote these 21st-century skills through the learning strategies that digital games support and the unique way in which those strategies are synergized through gameplay.

Among these skills, problem solving may be one of the most important. Problem solving is at the highest taxonomic outcome level, making it one of the most difficult to teach. Less than 2 percent of U.S. classroom instructional time is spent on problem solving, which may explain why more than 70 percent of the rest of the world does better in this area.[9] Problem-based learning (PBL) has been shown to be effective in promoting problem solving, but it is often not used because it is difficult and time-consuming.[10] In the typical approach to teaching problem solving, students study prerequisite skills (e.g., facts, concepts, definitions, and principles or rules), and only after they have mastered that material do they tackle problems in a given domain. PBL turns this process on its head and presents the problem upfront as a way to generate prerequisite knowledge, thus making that learning relevant.

Digital games, it turns out, are *themselves* a form of PBL. Digital games are marketed on the basis of a problem to be solved: for example, an ancient civilization that seeded the galaxy with humanity's forebears has returned to wipe us all out, and the survival of the human race depends on one soldier—you! Like PBL, digital games present a problem up-front—one

that the player has no idea how to solve and for which the player has not mastered most of the prerequisite skills. Games also, like PBL, make learning directly relevant. The problem the game-player faces from the start requires learning *only* what he/she needs to survive.

Many serious games (digital games designed to teach) promote problem solving and other 21st-century learning outcomes. *Citizen Science,* from Kurt Squire and Filament Games, helps students learn science in authentic, if fantastic, contexts (e.g., reducing pollution in a local lake by time traveling). Triad Interactive has built and tested several similar STEM games to teach mathematics (*PlatinuMath; Contemporary Studies of the Zombie Apocalypse*) and natural science (*Project NEO*).

The increased availability of high-quality serious games theoretically leads to a corresponding increased capacity to promote problem-solving skills. Yet just as in 2006, serious game proponents may have everyone's attention—but they do not necessarily have the research to guide the design (or claims) for digital games to promote problem solving. There are at least eleven different kinds of problems, for example, delineated by structure (ill- to well-structured), cognitive composition (logical, analytic, strategic, systems, and metacognitive thinking; analogical reasoning), and required domain knowledge.[11] We do not yet know enough about how the specific design characteristics of different digital games interact with their ability to support these different kinds of problems or the cognitive skills each problem requires. In another article, my colleague and I have proposed a framework that may serve as a first step in this process,[12] but it will require the combined efforts of many DGBL researchers and digital games to provide empirically derived heuristics to promote problem solving through digital games.

DGBL Practice

In 2006, I suggested that there were three ways to use digital games in learning

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environments: have students design digital games; build digital games from the ground up to teach students specific content and skills (i.e., serious games); and integrate commercial off-the-shelf (COTS) digital games into the existing curriculum. I maintained that integrating COTS digital games was the most practical approach because it would allow us to generate a large body of DGBL research to understand how and why digital games are effective for learning. That research could, in turn, provide good design heuristics and principles for DGBL practice. Finally, the combination of a large body of DGBL practice and design heuristics might then persuade commercial game companies to build high-quality digital games for learning in sufficient quantities to transform education.

So what have the intervening years revealed about my predictions regarding these three approaches, and what other approaches have arisen?

Students and Game Design

Despite the prevalence of long-lived development tools such as *Scratch*, *GameMaker*, *Gamestar Mechanic*, *Python*, *Alice*, and *Adventure Maker* and their newer counterparts *Inkle*, *Pixel Press*, and *Tynker*, having students build digital games remains a challenging means of DGBL for most public education

environments. Although the tools have become more powerful and easier to use, and many remain free, they all present the same hurdle for teachers: they require the teacher to develop additional expertise *before* designing lessons. This may not be hard for some teachers—for example, those who teach programming as a subject—but for other teachers, the extra time needed to learn the tool can present an insurmountable hurdle. Still, there are hundreds of great examples of this form of DGBL, which will surely grow and expand with initiatives such as Quest to Learn (Q2L), where game development is only one part of an integrated approach to using games in myriad ways across all grades and subjects. As a whole-school intervention (with the resources and support to back it up), this is one of the most effective means of reaching all students.[13]

A related strategy lies in what has come to be known as the "maker movement," which has a lot in common with PBL. This sociophilosophical movement emphasizes the creation rather than the consumption of artifacts and tools. The maker movement has found its way into educational settings, both formal and informal, in the form of workshops, instructional videos, and school lessons (especially in science). Using technologies such as 3-D printers, circuit boards, and cloud-based software tools, students

can learn to create products in a process that requires learning-related skills Problem-based learning: A review of literature on its outcomes and implementation issues along the way (e.g., writing marketing materials and instructions; designing logos and artwork; performing mathematics calculations). Although the maker movement is not about videogames per se, it is a compatible approach that shares the same conceptual focus in that tools like *Minecraft* and *MinecraftEdu* blur the line between being a maker and being a *game* maker.

Serious Games

Building digital games from the ground up is still the most promising DGBL strategy and still the hardest to do. However, a confluence of several factors has made this DGBL strategy far more prevalent today than I predicted in 2006. First, just as teachers who wanted to have *students* build digital games have benefited from more powerful, numerous, and easy-to-use design tools, so have those who want to build digital games *for* students. Tool sets like *Torque*, *Unreal Engine*, and the almost universally adopted *Unity 3D* have allowed nonexperts to build digital games that rival all but the latest console games for functionality and beauty.

At the same time, academics have become better at game *design*, again in part because of more accessible and more powerful tools but also because of practice—the results of which they publish and share with each other. The design teams built during this learning process are far more interdisciplinary than early attempts in the 2000s. In addition to the content experts, teams began to add instructional designers, who themselves had begun to research and publish on how digital games could be best married to instructional outcomes. One of the

key ideas that has emerged from this synergy is evidence-centered design (ECD). ECD is a method for embedding assessment into the very fabric of a game—what Val Shute has termed "stealth assessment."[14] Its use in digital games arose out of the prevalent mismatch between game tasks and assessment methods found in early serious game development. For example, content experts would sometimes build a game to promote problem solving but then use paper and pencil pre- and posttests, which are best suited to measuring decontextualized factual and conceptual knowledge. Other attempts to build digital games to teach factual and conceptual knowledge routinely resulted in poorly designed games in which the content interrupted or prevented engaging gameplay.

Once instructional designers began to study how to align game strategies with appropriate outcomes and assessment tools, it became clear that the game must both teach and assess at the same time, in the same ways, and without disruption. ECD allows this by specifying first what the outcomes are supposed to be (the competency model), then the behaviors that would demonstrate competency (the evidence model), and finally the tasks that would generate the evidence for, and against, that competency (the task model). Digital games that use ECD dynamically collect and analyze data related to all three models and use statistical procedures like Bayesian networks to analyze where the learner is in terms of learning through the game, thus assessing and adapting to the knowledge level of the player.

Interdisciplinary design teams have also included game designers themselves. Interest in videogames has generated at least 150 game design degree-granting programs at the undergraduate and graduate levels, according to the *Princeton Review*.[15] Although critics suggest that the number of graduates of such programs far exceeds the industry demand, these programs have been a boon to academic game designers, who have found that the value of individual specializations in team member expertise (e.g., content, instructional design, game design) is exceeded only by the synergistic (if sometimes contentious!) result of interdisciplinary design.

Of course, no amount of progress or increased popularity would have made much difference had it not been for a simultaneous public and governmental emphasis on science, technology, engineering, and mathematics (STEM) education. STEM jobs are among the fastest-growing segment of the U.S. economy, yet the supply of potential majors is insufficient to meet demand. Performance on tests of STEM areas is poor, and students are not selecting related majors in high-enough numbers. Many who choose to pursue STEM majors often switch to other majors, and the problem is particularly acute for minorities and women. At the same time, shifts in related standards such as the Common Core and the Next Generation Science Standards have emphasized the very kinds of outcomes and strategies (e.g., inquiry-driven learning or learning to think like a scientist; demonstrating science in real-world contexts) for which digital games are ideally suited. In response, public and private funding agencies have begun to actively solicit proposals to promote STEM outcomes and recruitment, and higher education has followed the lead. Not all of these solicitations have specifically sought digital games as interventions, but many DGBL researchers have proposed and been awarded funding for digital games.

There are so many serious games available today that the problem is no longer one of capacity. The problem now is access. How do teachers find serious games? How can they know whether

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serious games are of high quality and/or geared for their audience and grade level? Several groups have begun to build clearinghouses for those who want to distribute or find serious games for use in schools. GlassLab provides empirical data about the efficacy of different serious games as well as ECD expertise for designing serious games. ThinkZone, a new project, will help serious game developers connect with schools by organizing serious games into a searchable database by content area, grade, setting, and other characteristics.

Serious games remain relatively rare compared with textbooks and lectures, but they have been closing the gap quickly. Because they are increasingly of high quality, meet future standards, and can potentially reach an unlimited number of students, serious games may yet signal the advent of a minor revolution in K–20 education.

COTS

The third DGBL approach that I delineated in 2006 focused on the integration of digital COTS games. I suggested that this approach would provide high-quality digital games (in the absence of well-designed serious games) and instruction (thanks to the teachers who would design lesson plans around them). Today, this process remains the most practical for teachers to do and is the most prevalent approach overall. Every year since 2003, I have taught a games class in which K–20 teachers have used a detailed design process[16] to develop lesson plans for nearly every grade level and subject. Teachers share such game-based lesson plans on dozens of websites. However, full lesson plans

that address significant topic areas (often requiring one to two weeks) and that do so by taking advantage of the power of digital games to situate learning at the problem-solving level remain relatively scarce. Even with good models for doing so, designing COTS DGBL is still more time-consuming than designing "traditional" instruction—time that teachers continue to find hard to come by. Further, although Common Core may increase the need to demonstrate critical thinking, current assessments do not yet measure such outcomes.

Still, COTS DGBL is a practical means for an individual teacher to integrate digital games in order to address the standards that all schools will be using in the next few years.

Gamification
In addition to the three approaches that I discussed in 2006, one new DGBL approach has gained steam: *gamification*. The process involves applying game mechanics and principles to nongame environments (e.g., education and business). It differs from DGBL in that there are (usually) no digital games involved at all. Rather, the metrics and processes of a "typical" class or training seminar are replaced by corresponding game mechanics. For example, digital games allow players to solve challenges in multiple ways, ensure early successes when skills are low, and award bonuses and achievements that provide additional "powers" as expertise builds. A typical class provides only one option for each major assignment (e.g., a paper), presents high-stakes assessment (an opportunity for success) after several weeks, and takes points away for every assignment submitted (since each is worth a set number of points 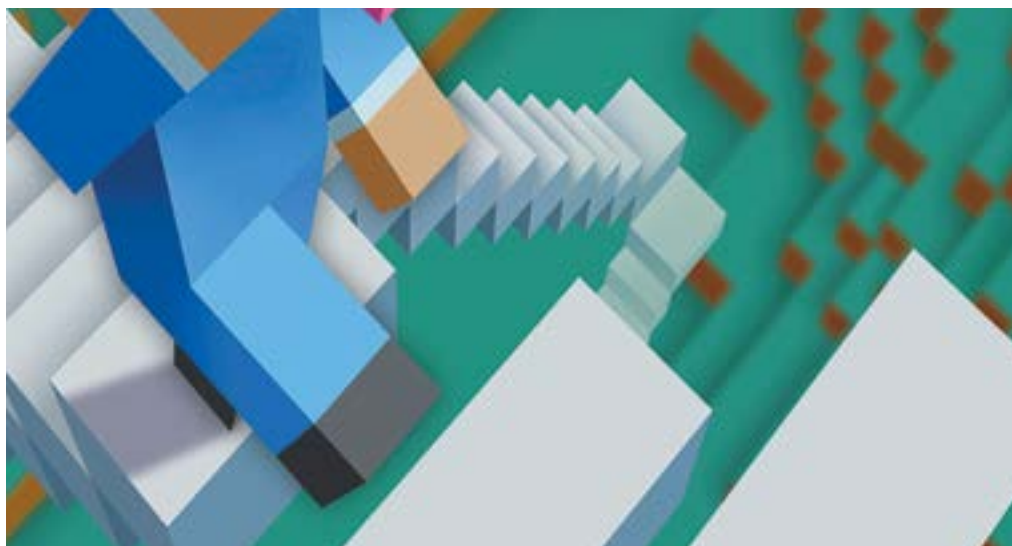and few get every point available). Gamification, on the other hand, creates multiple assignment options—more points than are required to demonstrate mastery—and creates frequent assessment opportunities that are graduated in difficulty. Other aspects of digital games such as having learners create "characters" with different skills and attributes, recasting assignments as "quests" that are connected by a cohesive narrative, and setting major projects and assignments as "boss" monsters that require teamwork to overcome are also mapped to existing course designs. At its best, gamification can make significant improvements in educational quality by adopting the effective synthesis of learning strategies used by digital games.

While gamification has great potential, it is unfortunately often misused and poorly implemented. Many educators mistake the trees for the forest and focus solely on surface-level design features such as leaderboards, experience points, and badges, without regard for the contextual interplay of player, game, and narrative. According to the noted game researcher Ian Bogost, such superficial focus "confuses the magical magnetism of games for simplistic compulsion meted out toward extrinsic incentives."[17] Superficial gamification relies on extrinsic motivators for those who are not necessarily already motivated to engage with a content or task, rather than activating intrinsic motivation as many digital games do. Extrinsic motivators lead to weak effects that dissipate over time once the motivators are withdrawn,[18] making them a poor substitute for existing teaching practices. This may partially explain the positive but short-term effects of many empirical studies of gamification.[19]

Gamification may have the most potential for adoption and diffusion across public and private education and training environments, but as with COTS DGBL, there is no shortcut for good design. Gamification is more than the sum of its parts and requires careful design and attention to detail if it is to be more effective than typical instructional approaches. There is no question that gamification could have a significant and immediate impact on K–20 education; whether educators and trainers recognize this and take the time to develop high-quality gamification DGBL remains to be seen.

Implications for Education
In 2006, I proposed that higher education hire instructional designers and DGBL experts as faculty and staff to help others learn how to build high-quality DGBL. I suggested that this was

necessary because digital natives would expect it when they arrived on campus. Obviously, this did not happen, perhaps in part because digital natives were not who we thought they were. At the risk of hubris, however, I prefer to think that the revolution has merely skipped a generation and that now is when the digital *game* natives are getting restless. As DGBL adoption, especially of serious games in K–12 schools, continues to accelerate, higher education will potentially face thousands of students who have had gameplay as a part of their formal education. The serious games being developed today are very effective learning tools, and even those who do not play such games for fun will appreciate their power in a way that most of us in higher education do not currently share.

It's not just schools that we'll have to thank for the rise of these digital game natives; digital gaming is becoming a cultural sports phenomenon that is predicted to eclipse the NHL and NFL in terms of audience as soon as 2017. E-sports—tournaments in which videogame players compete against each other in public venues—are changing the way younger generations view videogames. E-sports competitions are even played in real-life stadiums filled with spectators.[20] In addition, e-sports have begun to make their way into higher education. Colleges and universities now have competitive e-sports teams that compete with teams from other schools, just as has been done with traditional sports. Some are even offering athletic e-sports scholarships to students who compete in intercollegiate competitions.[21]

If I am right that the revolution skipped a generation, what should

> # I prefer to think that the revolution has merely skipped a generation.

we do to prepare for this potential influx of digital game natives? First, as I argued in 2006, we should hire instructional designers to help improve our curriculum. DGBL is no panacea. It will not work and is not practical for all learners, all content, all the time—any more than are lectures or textbooks. Instructional designers will help us see when DGBL *is* and *is not* appropriate; they can help ensure that we use the right tools for the right situations. They will also help us avoid poor DGBL designs, which digital game natives will see through immediately. I have worked in public universities and colleges for twenty-three years, during which time I have watched instructional design become more prevalent—and also better known and respected—in technology-support infrastructures in higher education. But even though institutions have been consistently hiring instructional designers during this time, we do not have anywhere near enough to make a meaningful difference.

It is also not enough to hire just any instructional designer. Institutionally, we should invest in instructional designers who have experience with DGBL, including gamification. Gamification is potentially the biggest impact we can make across our institutions right now, and if we get it wrong, we may not get a second chance. In addition, colleges and universities should consider hiring or supporting game designers, perhaps graduate teaching assistants from our own game-design programs, to help inform the game design that our faculty do now and will do in the future. This will help faculty become more competitive in securing the grants that are increasingly important in today's world of

dwindling state support. These game designers may even help us build our own digital learning games as the ease of use and the cost of doing so continue to rise and fall, respectively. This may be the most critical for STEM programs, given the intense focus on STEM game design today, but we should not ignore other areas.

It may not be practical, desirable, or necessary to employ DGBL across the curriculum, but it *will* be practical, desirable, and necessary to have a broad range of DGBL solutions and opportunities available. Gamification can establish a kind of DGBL baseline that can be supplemented in key areas by serious games. But since not *all* students will be digital game natives when they arrive in K–12 or college/university classrooms, institutions should also consider building DGBL into orientations and technical support areas so that students new to DGBL can get the help they need to be successful. Summer workshops, special events, and special-topics courses can use digital games for learning and for fun to build capacity and interest in DGBL. E-sports competitions—whether intramural, athletic teams, or special events—are also a relatively easy way to meet the expectations and interests of digital game natives and to raise awareness and acceptance of games in education among faculty, staff, and administration.

New Challenges and Goals for the Next Decade

Several key DGBL questions remain unanswered, and some important, not-yet-addressed processes will continue to hold our field, and the implementation of DGBL, back. Research on aggression and digital games has given rise to a new area of emphasis in DGBL: the study of player experience. It is insufficient to ask what the "effects" of digital games are on players; we need to study how players make sense of their experiences with digital games. For example, a soldier playing a first-person shooter to help recode her experiences in a way that reduces PTSD will have a very different

experience than will a fourteen-year-old boy who likes to compete against his friends in a capture-the-flag mode of the same game.

To truly understand the conditions under which people's attitudes and beliefs (including aggression) can be influenced, we need to study these kinds of outcomes carefully, in addition to examining how outcomes like problem solving (in all its variations and forms) are promoted by different kinds of game mechanics. Likewise, we need to design careful, thoughtful experiments to see which kinds of game mechanics best align with which kinds of learning strategies, and we need to include more longitudinal designs in order to observe long-term DGBL outcomes such as attitudes, beliefs, and problem solving.

Finally, and perhaps most important, we must adopt interdisciplinary approaches to the study of DGBL. The answers to the most complex questions come at the intersection of multiple fields rather than from within any single one. Academics too often stay in their own silos of expertise, and whereas this gives us tremendous insights and tools

that we can bring to bear on significant problems, it also often blinds us to potential breakthroughs and related work in other fields. In 2010, when I edited a book on the interdisciplinary study of digital games, I solicited proposals from as many disciplines as possible, including from authors whose main area of research was not digital games. I shared copies of the chapters among all the writers so that they could benefit from the relevant aspects of each other's work. The resulting book represents twenty-two different disciplines and authors from seven countries. Such interdisciplinarity is crucial to the work that must be done in DGBL. Some of the best research on player experience is being done by media scholars in Belgium and the Netherlands.[22] Research on aggression and on artificial intelligence is being conducted by psychology faculty, game aesthetics research by artists and human factors experts, social construction of meaning and identity by linguists, and narrative construction by rhetoricians. DGBL cannot advance without the contributions of all—not individually, but collectively across multiple domains and countries.

In changing our practice as we strive to meet these challenges, we must also work to avoid repeating the mistakes of the past. The time for proselytizing is over, and we must guard against being pulled back into old habits. There is still a tendency among DGBL proponents to oversell the benefits of digital games. The truth is that DGBL is simply not appropriate for all outcomes, all learners, all the time. There remains a place—even a need—for lectures and workbooks. Why build a game to teach the multiplication table if flashcards already work well for students? On the other hand, why try to lecture to students about solving problems and learning to see the world as mathematicians and scientists do? When such outcomes are our goal, we should argue vigorously for the use of digital games; when digital games are not appropriate, we should be just as vigorous in saying so.

One area that presents a particular challenge to DGBL is the violence and aggressive behavior in videogames. Unfortunately, in their zeal to counter arguments that violent digital games necessarily lead to violent people and

should therefore be heavily restricted, DGBL proponents have occasionally appeared to take the equally untenable position that violent digital games *cannot* lead to violent behavior. It is simply not possible to argue, on the one hand, that digital games can be a force for social good by changing people's beliefs and actions and, on the other, that no harm can come from the very same mechanisms. Space does not allow even a brief overview of the main issues involved, although I have attempted to do so in another *EDUCAUSE Review* article.[23] In short, I believe that the concerns regarding violent videogames leading to violent behavior are unsupported by violent crime statistics and empirical research but that some videogames could indeed lead to aggressive behavior under the right conditions (e.g., length of exposure, lack of social mediating factors, mental disability, age).

Conclusion

What will DGBL look like in another ten years? Who knows? Maybe the digital game natives won't have arrived after all. Or perhaps they will be very different from what we are expecting—just as today's digital natives are not what we expected in 2006. Or maybe DGBL will help usher in a new era of effective (though not entirely game-based) teaching. What we do know today is that we have the evidence and the design tools to demonstrate that digital games are powerful learning tools. Whether we choose to take advantage of the opportunity before us is a completely different question. ∎

Notes

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17. I. Bogost, "Persuasive Games: Exploitationware," *Gamasutra: The Art & Business of Making Games,* May 3, 2011, http://www.gamasutra.com/view/feature/134735/persuasive_games_exploitationware.php.
18. R. Béna bou and J. Tirole, "Intrinsic and Extrinsic Motivation," *Review of Economic Studies* 70, no. 3 (2003), 489–520; E. L. Deci, *Intrinsic Motivation* (New York: Plenum Publishing, 1975).
19. J. Hamari, J. Koivisto, and H. Sarsa, "Does Gamification Work? A Literature Review of Empirical Studies on Gamification," *Proceedings of the 47th Hawaii International Conference on System Sciences,* January 5–8, 2014, Oahu, Hawaii.
20. In June 2015, Wembley Arena hosted the League of Legends Championship Series, which had already sold out Los Angeles Staples Center in 2013 and the 40,000-seat World Cup Stadium in Seoul in 2014. In fact, the number of viewers for the latter, albeit online rather than TV, was second only to the NFL Super Bowl. See http://www.ibtimes.co.uk/rise-esports-sees-pro-gaming-reach-scale-nfl-by-2017-says-betting-company-unikrn-1504181 and http://espn.go.com/espn/story/_/id/13059210/esports-massive-industry-growing.
21. For example, Harvard, Florida State, San Jose State, and California State, Fullerton all have competitive videogame teams. A recent competition between the last two was watched by more than 90,000 people online, and Robert Morris University Illinois now offers athletic scholarships for its competitive videogame team (http://www.nytimes.com/2014/12/09/technology/esports-colleges-breeding-grounds-professional-gaming.html?_r=0).
22. See, for example, the work of Steven Malliet (https://www.uantwerpen.be/nl/personeel/steven-malliet/), Wannes Ribbens (https://www.researchgate.net/profile/Wannes_Ribbens/publications), Bob De Schutter (http://aims.muohio.edu/faculty_staff/bob-de-schutter/), and the Game Experience Lab (http://www.gamexplab.nl).
23. Richard N. Van Eck, "What Can We Learn from Violent Videogames?" *EDUCAUSE Review,* October 12, 2015.

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