

# YOKOI'S THEORY OF LATERAL INNOVATION: APPLICATIONS FOR LEARNING GAME DESIGN

By

SCOTT J. WARREN\*

GREG JONES\*\*

\* Assistant Professor, Department of Learning Technologies, University of North Texas, Denton, TX .

\*\*Assistant Professor, Department of Learning Technologies, University of North Texas, Denton, TX .

## ABSTRACT

*There are several major challenges for instructional designers seeking to design learning games. These include the lack of access, the cost of rapidly advancing/expensive technology tools that make developing games uneconomical, the institutional time constraints limiting game use, and the concerns that schools lack sufficiently robust computer systems and bandwidth to allow their teachers and students to take full advantage of "bleeding edge" technology. This paper discusses how a theory of design from famed game system designer Gunpei Yokoi can be leveraged in learning game design by focusing on the use of mature technologies already widely present in schools. By thinking about older technologies in innovative ways instead of relying on the flash of the newest graphics to motivate learners, learning game design can deliver low-cost, engaging play for learning.*

*Keywords: Yokoi, Lateral Thinking, Game Design, Learning, Instructional Design, Mature Technologies.*

## INTRODUCTION

The use of digital games, simulations, and other complex systems to support learning in educational environments are at the forefront of the current push in the field of education, with the call coming from many quarters to seek out the motivating aspects of such constructs as a means of improving learning (Premsky, 2001; Squire, 2006). Research on these systems has been correlated to improve student motivation to learn (Tuzun, 2004), improve understanding of historical concepts (Squire, 2004), improvement in student writing (Warren, Barab, & Dondlinger, 2008), and understanding of complex science concepts and systems as well as social empathy and history content (Barab et al., 2007; Dede, Ketelhut, & Ruess, 2006). While these are promising results that bear further study, the projects that support the game worlds are often funded with millions of dollars in government funding, which makes employing the technologies and accompanying designs difficult for the average practitioner. The high-end graphics, long development times, and large staffs enjoyed by such projects allow for the development of game systems that are closer to what game companies are developing for commercial

entertainment uses. Since these resources are not normally available to educators interested in designing and building learning games, we must examine what is ideal and what is actually possible when creating learning games.

### Costs of the Bleeding Edge

So-called "bleeding edge" technologies may be defined as (i) so new that the user is required to risk stability and productivity to use it (ii) the tendency of the technology to be extremely expensive (iii) there is a lack of consensus about the best approach to design and (iv) there is a lack of knowledge about the technology in the particular field in which it is being used (Wikipedia, 2008a). In recent years, the term has also been used to refer to technology that is "ahead of cutting edge," but still within the reach of those technically sophisticated to attempt its use. Users of such technology should expect that it should not always work as expected. The first definition has been employed for this article.

What is problematic from this perspective is that there is a lot of knowledge in the field of game design about the best way to design for entertainment, but much of this is kept commercially secret in order to protect trade

secrets. While there have been many books and articles published on the subject of designing games in general, there are far fewer published about how to design games for learning. In the field of education, our knowledge of how to design educational games that allow us to reach learning goals is still nascent, with only a few researchers reporting empirical studies that have found significant differences for learning (Dondlinger, 2007; Hays, 2005).

Over the last decade, a lot of money has been spent developing bleeding edge games, simulations, and other innovative systems that have life-like graphics, sounds, and experiences for those that can afford the systems. The cost of developing digital games has soared from reports of \$3 to \$6 million a few years ago to \$10 to \$20 million and more to make today (Takatsuki, 2007). When the Sony PlayStation 3 was in development, it was estimated that the cost of a single console would run \$494, but only sold for \$399 with the maker seeking to make a profit from their licenses to develop games for the system (Gamespot Staff, 2005).

The existence of such bleeding edge systems for commercial entertainment that many students and teachers already have at home creates a difficult tension for instructional designers and researchers seeking to exploit the motivating power of the game constructs that have been developed for these systems. If the learning affordances of these systems stem only from the ever-evolving graphics, sound, and interactions available from these systems, how can a designer of educational games match the explosive developments coming from the game industry? Should designers even try to keep up with the massive corporate games or return to more traditional curricula? Will students reject educational games that lack the high-powered graphics and interactions that are present in commercial games? These questions pose a fairly serious challenge for educators seeking to use them in classrooms and for designers considering their use as a basis for instructional systems development.

Another challenge that comes from attempting to leverage these new systems is that many instructional designers are researchers without advanced technical or programming skills. Their role as a designer is on guiding a

process for system design, not on the physical creation of it. As a result, they must often turn to professionals with these skills, since most complex design projects are difficult to develop by a single professional. Even a small project requires several experts to provide the necessary technical skills to create something. Salaries for these experts range from \$55,000 US a year to a high of around \$85,000 US for an experienced game programmer (International Game Developers Association, 2008).

This expense may in turn require the constant seeking of grants from governmental and private sources, which further reduces the time that the instructional designer has to supervise the game's design. It therefore makes more sense to focus less on "bleeding edge technologies for improving learning" and more on "bleeding edge innovations that leverage technology for improving learning" using existing or re-examined technologies. Another possibility is to examine our thinking about how we leverage technology to design games for learning. Yokoi's theory has been used for several decades and can provide some ideas for teachers and instructional designers with small or no budgets and limited technology proficiency.

#### **Yokoi's Theory: Lateral Thinking about Withered Technology**

Gunpei Yokoi was a long-time designer of game system components for the Nintendo Company of Japan, currently well-known for its *Wii* game console as well as popular video game characters like Mario and Donkey Kong (Crigger, 2007; Wikipedia, 2008b). His most notable achievement was designing Nintendo's highly successful *Game Boy* system. This evolved from his personal philosophy of design, which he called "Lateral Thinking of Withered Technology". This was originally depicted in a book of interviews with the famed Nintendo game system designer called "Yokoi Gunpei Game House". Lateral thinking has been conceived in the research literature as non-linear, creative or critical thinking that allows for multiple, often innovative solutions to problems (Barak & Doppelt, 1999; DeBono, 1968; Waks, 1997). The term "withered" simply refers to technologies that have matured to the point that they are inexpensive,

understood by the general public, and require little training on the part of the user to be implemented easily (Wikipedia, 2008b). By applying linear thinking to such mature technologies, his theory stated that they could be employed in innovative ways that would engage users without adding unnecessary cost to the products.

What matters in the context of this theory is that the novelty of the play and the interactions between player and system are intrinsic motivation rather than having top-end graphics and high-end computer processor power (Crigger, 2007). By employing this philosophy, it was revealed that it is more cost effective to rely on older, proven technologies for design rather than bleeding edge technologies and he even went so far as to suggest that employing advanced technologies may interfere with designing innovative products because of excess focus on the technology rather than on the innovate use of it. Further, the design and development time is lower when applying lateral thinking about mature technologies than it is for "bleeding edge" products, because they are proven to work effectively even as they save both the developer and user money. In many educational settings shrinking budgets and reduced grant funding are recurrent problems. How then can be Yokoi's theory leveraged in the field of education as we seek to design games for learning?

### Re-examination

The basic principle of lateral thinking is to generate new ideas and approaches, without regard to order or sequence (Barak & Doppelt, 1999; DeBono, 1968; Waks, 1997). This forces the examination of technologies that are already abundant in specific education settings in creative ways that force instructional designers to think differently about how things must be done. Instead, designers must think about alternatives to the existing ways of using a well-known technology that are more engaging for the learners by challenging them to act in novel ways in response to our instructional designs. For example, the authors have read numerous books about game design ranging from Salen and Zimmerman's *Rules of Play (2004)* to Crawford's *Art of Interactive Design (2003)* that have each provided concrete ideas about

what a game must include and processes by which games should be designed. By synthesizing rules that are offered by both of these authors, we may be led to state that a game must include a) a rule-based interactive system, b) a quantifiable outcome characteristic, c) artificial conflict and play characteristics, and may also include d) a modeling reality characteristic (Dondlinger & Warren, in press).

What is problematic is that if a designer takes these as hard and fast rules instead of employing lateral thinking, they may be constricted by thinking that each element must be present or that they must follow prescribed design process in order to reach the goal of designing a game. This also artificially restricts what may be viewed as a game. For example, some systems do not include an artificial conflict, but instead incorporate a real one such as in Jane McGonigal's *World Without Oil* (Ernst, 2007). This example could be disqualified, using the rules above, as being "game." However, the average person engaged in this system may clearly identify it as a game, because it has a sufficient number of characteristics from those that they have played in the past for them to categorize them as such.

If the designer can discard preconceived notions of what constitutes a game, what technologies must be present, and what technologies are valuable for designing learning systems whether they come in the form of game, simulation, or instructional module, they free themselves from the conceptual boxes that say that a game must be the same as what has come before it. Further, if the designer can re-examine technologies that are perceived as "withered," they may find utility in employing them in an unintended, innovative manner that sparks meaningful learning. The authors' research related to learning game designs employed in several instructional settings ranging from K-12 to corporate and higher education and the assorted challenges facing each that include limited bandwidth, tight budgets for software, older hardware, and limited training opportunities (Barab et al., 2007; Jones & Warren, 2008; Jones & Kalinowski, 2007; Warren et al., 2008; Warren & Dondlinger, in press). This has led to the idea, borrowing from Yokoi's, that

educational games should avoid seeking bleeding edge solutions, and should instead leverage mature, disparate, and sometimes discarded technologies in innovative ways that stem from re-examination and analysis of the underlying learning affordances of these technologies, rather than relying on the development of entirely new systems. There are five basic principles that should be considered when re-examining mature technologies that we frame in terms of the following questions:

- Is it a mature technology?
- Is it widely available?
- Is it well understood?
- Is the technology inexpensive?
- Can the technology be used to develop innovative pedagogy?

When applying these principles as part of lateral thinking towards innovation, it is suggested that the process that has emerged from the authors' own design work takes advantage of the fairly simple ADDIE model of instructional design (Bichelmeyer, 2005) which consists of (a)nalysis, (d)esign, (d)evelopment, (i)mplementation, and (e)valuation. Figure 1 presents this process.

### Defining the technologies

In terms of leveraging technology in the service of learning, the authors do not seek to limit the reader to a small number of possibilities. Instead, a small number of

approaches are offered that stem from existing applications of the principles of re-examination noted in the preceding figure. Most notably, two efforts that have served in their own instructional design and development projects or have been evident in the work of other major projects have been focussed in which either "mature/withered" or popular and widely available technologies have been leveraged to support learning.

### Mature technologies.

Several technologies have made strides in terms of ease of use and improved features since original research in the late 1990s and early part of this decade found no significant differences when employed to support learning and achievement (Fertig, in press). Given that products that leverage hypertext, simple graphics, word processing, and other tools that have existed for over a decade, users who may have found them challenging or even frightening to use initially, have likely developed substantially improved or even mastery over skills needed to use the products successfully. As such, each should be reexamined in terms of their utility for education and be accompanied by a liberal application of lateral thinking about how they may be used in innovative ways in schools to support learning and/or instruction.

By leveraging such technologies, instructors and/or instructional designers can generate a product in a fairly short period of time using existing tools that their students have high access to, as well as comfortable with in terms of daily use. Further, many of these technologies have morphed into Web 2.0 tools such as simple online word processors like *Google Docs* and open-source tools like those included in Sun's *Open Office.org* software suite. Being widely available at no cost, students and teachers use these often in classrooms to create projects on existing computers while requiring little to no bandwidth and does not require high processor speeds to function well.

However, access alone to the product(s) does not engender use (Cuban, 1988; Cuban, Kirkpatrick, & Peck, 2001). By employing lateral thinking about how *Google Docs* may be used to encourage something like

## Process of Technology Re-examination

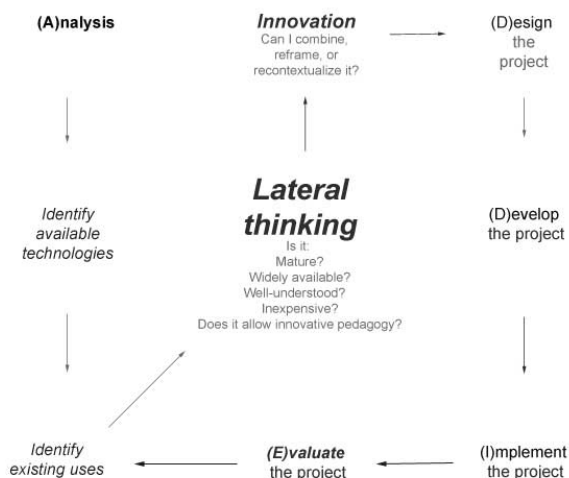


Figure 1. Suggested process for Technology Re-examination



collaborative storytelling, the focus is taken off the technology product itself and is instead focused on using it in an innovative manner to engage in learning tasks. Other innovative uses could include using inexpensive wireless, global positioning system-enabled (GPS) handheld computers to send students to investigate pre-developed science inquiry spaces (Wikipedia, 2008c). Using the devices to perform experiments that leverage the existing functions of the device could then allow students to upload the data to a classroom computer. Using this computer in conjunction with an LCD projector would then allow the class to challenge each group's findings or make evidence supported inferences about problems posed by the teacher.

Alternatively, teachers could allow students to design problems collaboratively online using hypertext links and images to resources that other groups of students would have to solve as they investigate real historical problems depicted in artwork found on the web pages of numerous museum collections. In this case, the students become the designers of the learning activities themselves and use the technologies simply as a tool to show deep learning about the concepts of history, art, and inquiry. This aids in taking the focus off the technology as necessary for learning and instead places it in a category of technology as means of supplementing student critical thinking, creativity, and communication with peers and teacher.

#### *Popular technologies*

There is utility remaining in technologies that are not "bleeding edge" and these may be leveraged to improve learning game design. Technologies in the form of social networks such as MySpace and Ning.com or online digital video sharing sites like YouTube are (i) supported by past research but still open to new questions as they evolve, (ii) maturing in terms of user familiarity and facility, (iii) less costly than "bleeding edge" technologies in both development time and funding, and (iv) can incorporate the motivational, social, and narrative properties of bleeding edge technologies. Examples of games that employ these technologies include online alternate reality games like *Cathy's Book*

(Canadian Broadcasting Center News, 2006), *The Lost Ring* (Terdiman, 2008), and *World without Oil* (Egner, 2007). Within each of these games, players are sent to numerous web sites, videos with embedded text and links, and social networks to discover and discuss clues to the numerous puzzles and mini-games. By examining each, engaging in creative and critical thinking, and working with peers through numerous forms of online communication, players unravel the larger mysteries that are at the heart of each game.

At their core, alternate reality games (ARG) are those that take the substance of everyday life and weave it into new worlds that, while easily recognizable by players, is different enough that it drives cognitive dissonance in the learners and includes a narrative that drives both play and learning (M.J. Dondlinger & Warren, in press). Each of the technologies employed to develop an ARG are widely available for free or can be constructed using the software that can be downloaded for free or arrives pre-loaded on most personal computers such as simple video editors, word processors, and image manipulation programs like Google's *Picasa*.

In this case, the maturing technologies are used laterally by linking them together in innovative ways to create innovative games without the cost of developing bleeding edge games that often require high levels of expertise and a large, highly trained staff. While the game may not have all of the intense graphics of the latest XBOX 360 titles, they include the underlying motivating contexts and challenges. When employed in games, these strategies drive players to engage in creative problem solving and collaborative play towards achieving the learning and play goals of the design.

With these suggestions offered, it is important to note that there are several projects that have developed educational games, simulations, and other innovative learning environments that have knowingly or unknowingly applied one or more of these principles in their designs. These have often been constrained by the public school technology systems with which they worked, financial limitations of the project or users, and in some instances team member values that restricted

developing a high-cost product. Over the past few years, several projects have been developed in which instructional designers have applied these in response to the needs of their learners and have noted important achievement, motivation, and attitudinal gains stemming from innovative uses of matured technologies. In the following section, several projects that leverage these principles to develop engaging games and other forms of online environment are described.

### Specific designs that leverage these principles

#### *Quest Atlantis and River City: Active Worlds.*

Both *Quest Atlantis* (Barab et al., 2007) and *River City* (Dede, 2006), stemmed initially from the United States' National Science Foundation (NSF) which provided grant funding for projects that targeted science inquiry learning for elementary and early secondary students. In each case, the underlying system that the projects relied on was Active Worlds, which is a 3D virtual world building platform that includes both free building spaces as well as private worlds developers can purchase (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). This particular technology was originally created in 1994 and has undergone several evolutions in technology since that time. When the educational projects began in the early part of this decade, the Active Worlds web browser could still run on a personal computer (PC) running Windows 95 with minimal video and memory requirements, which would allow most schools to run the game worlds. Figure 2 shows an example of the level graphics from one of *Quest Atlantis'* worlds.

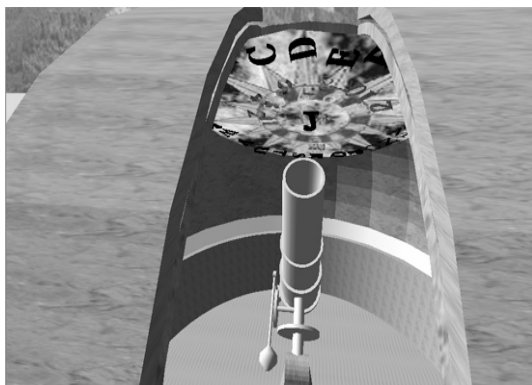


Figure 2. The observatory's linguistic cipher in *Quest Atlantis'* Anytown world.

In both cases, the lateral thinking about the technology came in the form of the particular instructional designs and the actions that learners could take in each project's world. In the case of *River City*, students engage in the role of someone transported in time to investigate water pollution problems leading to community illness in a historical simulation (Dede et al., 2006). The learning activities, as well as the accompanying game activities, would force students to both understand the science concepts as well as the historical context within which it occurred. In *Quest Atlantis*, students are engaged in an open-ended fantasy space in which they are asked to help the fictional Council of Atlantis, which consists mainly of fictional characters approximately the same age as the students themselves (Barab, Warren, & Ingram-Goble, in press). Players complete science and other subject-area inquiry and problem-based learning activities in several different worlds where the fictional scenarios ask students to complete simulated science experiments (Barab et al., 2007). Student work is contextualized as helping the Council to better understand their own world, while players here on Earth receive game rewards, additional narrative elements, and new virtual spaces to explore. In both projects, the mature technology of Active Worlds, which is proven and has been developed over nearly fifteen years, and the lateral thinking by the project designers has come through innovative use of the technology to contextualize subject matter that is often resisted in the age group that they have created these spaces to serve (Anderman & Leake, 2005; Anderman, Maehr, & Midgely, 1999).

#### *Whyville: Adobe Flash™.*

This project was also funded in part by the NSF as well as other organizations and it was intended to increase the interest of children in science learning through multi-disciplinary contexts. Research has found that girls have had an especially strong affinity for the virtual world, which is important since girls have traditionally not been as interested in science learning as boys (Foley, Jones, & McPhee-Baker, 2002). Beginning in the late 1990s, the project leveraged the Adobe *Flash™* software to develop an online, collaborative world in which students could

communicate about what they learned, as well as build virtual items and businesses as part of a virtual economy similar to those in commercial games described by Castranova (Castranova, 2001). The innovative use of widely available, mature commercial software such as *Flash* allowed the development of a strong virtual space that was both innovative when it emerged and continues to evolve today with a reported three million users.

#### *The Door: Web 2.0.*

This project, intended for undergraduate students at community colleges and universities, leverages numerous Web 2.0 technologies such as Facebook and MySpace social networks, Podcasts for digital audio sharing, YouTube digital videos, and Linden Labs' *Second Life* (Warren, Dondlinger, & Whitworth, 2008). These were used to develop a distributed, online course game modeled on alternate reality games (ARG) like *ilovebees.com* and *World Without Oil* (Dondlinger & Warren, in press; Ernst, 2007). Within the context of the game, students learn the basics of computer tools such as word processors and spreadsheets, as well as important concepts of group problem solving and working for clients as they are immersed in a multi-tiered narrative mystery that challenges students to uncover the real motives of the characters with which they communicate with through e-mail, online forums, and with digital avatars. This project employed lateral thinking about how courses could be designed to use low or no-cost technologies with a proven track record to design and develop a dynamic curriculum that would engage and motivate learners without the costs associated with developing other educational games (Warren, Dondlinger, & McLeod, 2008; Warren & Dondlinger, 2008).

#### *Chalk House: CRG Framework using Sun's Java™.*

This 3D online learning environment focuses on immersing middle school students in a narrative-based game intended to improve literacy skills: namely, reading and writing. *Chalk House* is the first of series of learning modules being developed using the CRG 3D Framework (Jones & Warren, 2007; Warren & Jones, 2008). The digital framework, developed in Java™, has been designed with

the target goal of improving formal student achievement related to vocabulary, reading comprehension, and written language skills as a supplement to classroom instruction. *Chalk House* immerses students in an authentic writing role, a newspaper reporter, assigned to unearth the mystery of a purportedly haunted mansion in which several victims have disappeared. Numerous puzzles, linguistic challenges, and game structures place students in a world where assessment emerges naturally from their interactions with characters and environment, with the goal of leading students increased engagement to reading and writing. As the group engaged in lateral thinking about the technology needed to support school use of the system that would drive *Chalk House*, a framework emerged that dictated that the game would (i) operate under Windows, Macintosh, and Linux operating systems, (ii) require minimal hard drive space, bandwidth, and computer memory, and (iii) deliver 3D graphics capable of being displayed in the majority of schools in the United States today. Figure 3 shows an example of the level graphics from *Chalk House*.

Java's™ computing performance several years ago made it an unlikely choice for developing a real-time multi-user online game. However, upon re-examining it today, the combination of improved computer performance, pervasive use on multiple computer platforms, and Java's™ better operating characteristics make it a good choice for educational game design.

#### *Civilization III: Commercial gaming serving learning*

This seven year-old turn-based strategy simulation game



Figure 3. A view of Chalk House within the Created Realities engine.



comes from the world of commercial gaming and has been used in a support role for students coming to appreciate historical concepts (Squire, 2004, 2006). In this case, the lateral thinking about the technology has come in the form of determining how the game system may best support learning and then developing outside activities in the face-to-face classroom to interrogate the lessons that students learned as well as correct misconceptions they brought to the experience. Further, there are free versions of the original 1991 *Civilization* game simulation that can be downloaded and used that do not have the high end graphic quality of the more recent versions of the series, and may be a better option for designer's with tight budgets. While this is definitely one possible approach to applying lateral thinking, the fact that 'the underlying system may encourage some misconceptions about linear historical thinking because the game may not be intended to accurately simulate real events', using older commercial games for learning should be done with caution.

### *Augmented Reality Games: Handhelds.*

These should not be confused with the previously discussed Alternate Reality Games. Augmented reality games (AuRG) combine real world and computer-generated data. The Massachusetts Institute of Technology (MIT) Teacher Education Program has created several educational AuRGs (Massachusetts Institute of Technology, 2008). The lateral thinking involved in designing AuRGs stems from using (i) handheld computers, which are far less expensive than providing laptop computers to students and can provide one-to-one computing, (ii) it allows the designer to leverage the portability of the units and, when equipped with GPS, they provide location to key into data, while (iii) blend nearly cost free real-world activities with low cost technologies for creating content (Muir et al., 2006). Thus, AuRGs take advantage of real-world assets by overlaying the required new reality on top of the existing reality using the technology. Figure 4 shows students using handhelds during an augmented reality game experience.



Figure 4. Students participating in the Charles River City Augmented Reality from the MIT website (Massachusetts Institute of Technology, 2008)

### Discussion

Despite the argument that in education it is important to re-examine "withered technologies," we also believe that research and design conducted with "bleeding edge" technologies is also important in education. Grant-funded projects by the United States' National Science Foundation (NSF) and National Institutes of Health (NIH) as well as their counterparts in other countries have contributed substantially to the forward thinking orientation of researchers and theorists in the field of education as they seek innovations that help students and instructors at every level of education. In fact, several of the projects mentioned here began as inquiries into the use of, if not bleeding edge, then at least forward-thinking technologies to be leveraged to improve teaching and learning (Table 1).

Project	Uses mature technology	Uses widely available, well understood technology	Uses inexpensive everyday technology	Uses innovative pedagogy and technology
Quest Atlantis	X	X		X
River City	X	X		X
Whyville	X	X	X	X
The Door	X	X	X	X
Chalk House	X	X		X
Civilization Series		X		X
Augmented Reality Games		X	X	X

Table 1. Design projects that have leveraged older technologies.



The data and dynamic understandings of the role of technology in education that have been reported by these well-funded basic research projects has been invaluable in terms of moving forward everyday teachers and learners as they prepare for the conceptual age work of the 21<sup>st</sup> century.

However, because of the costs of developing “bleeding edge” technologies and the lack of access to these projects for the majority of teachers and students, it is important to identify the unexplored learning, instruction, and media affordances of inexpensive existing and mature technologies to determine how instructional designs that lead to the same improved motivation, critical thinking, creativity, organizational skills, and self-efficacy found in well-designed video games can be developed. The field has not sufficiently conducted research on these products to determine which of their constituent parts will lead to improvements in these psychological constructs in order to build our own effective games, simulations, or virtual environments (Dondlinger & Warren, 2008). Further, if other instructional development products can be developed without the monetary, manpower and time cost, by including the underlying elements of these products, it is a service to the learners, instructors, and field as a whole. If other designers or educators cannot recreate the reported successes of a “bleeding edge” product due to inadequate reporting of instructional designs, research failures and successes, and the general price to be paid for the “bleeding edge,” it does not contribute to the field and advance the general knowledge.

What are some of the concerns that stem from this approach? It is possible that if we do not remain on the “bleeding edge” with the media and complex digital structures used for teaching and learning, students may lack engagement and interest because older designs are competing with the computer games and other advancing media they are engaged with. If the media generated is sub-par because of lack of facility to develop good instruction, they will be lost anyway. Further, the success of Nintendo's *Wii* game console (a descendant of those designed using Yokoi's theory) and

its innovative game play and physical structures helps to answer this critique. The *Wii*, which has less graphics and computing power of competing consoles from Microsoft and Sony, has been the best-selling game unit in the world for the past two years (Carst, 2008; Richtel, 2007), while selling for less than the competing systems.

### Conclusion

By focusing too much on the media (e.g. video games, simulations, virtual environments), we often fail to generate strong, replicable instructional game designs, distracted by the need to compete with the beauty of high resolution graphics. It is important to note that over the last forty years, there has been a lot of costly, difficult to play games and simulations on the market and have failed commercially and have become laughing stocks in mainstream media. This stems from the fact that they do not complete their task of entertaining well and the underlying system structures make them unusable. If instructional game designs are generated that use “bleeding edge” technologies that also do not do their task of educating well, the designer's time, the learner's time are wasted and we do not advance the field in general. Most importantly, it is believed that moving forward in the area of learning game design should be conducted with an acute awareness of the costs of pursuing bleeding edge technologies that most educators cannot afford to accept.

### References

- [1]. Anderman, L. H., & Leake, V. (2005). The ABCs of Motivation: An alternative framework for teaching preservice teachers about motivation. *Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 78(5), 192.
- [2]. Anderman, L. H., Maehr, M., & Midgely, C. (1999). Declining motivation after the transition to middle school: Schools can make a difference. *Journal of Research and Development in Education*, 32, 131-147.
- [3]. Barab, S. A., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: *Quest Atlantis*, a game without guns. *Educational Technology Research & Development*, 53(1), 86-107.

- [4]. Barab, S. A., Warren, S. J., & Ingram-Goble, A. (in press). Conceptual Play Spaces. In R. Fertig (Ed.), *Handbook of Research on Effective Electronic Gaming in Education*. Hershey, PA: Idea Group Reference: IGI Global.
- [5]. Barab, S. A., Zuiker, S., Warren, S. J., Hickey, D., Ingram-Goble, A., Kwon, E.-J., et al. (2007). Situationally embodied curriculum: Relating formalisms and contexts. *Science Education*, 91(5), 750-782.
- [6]. Barak, M., & Doppelt, Y. (1999). Integrating the cognitive research trust (CoRT) programme for creative thinking. *Research in Science and Technological Education*, 17(2), 139-151.
- [7]. Bichelmeyer, B. (2005). The ADDIE Model: A metaphor for the lack of clarity in the field of IDT. *IDT Record* (AECT 2004 IDT Futures Group Presentations).
- [8]. Canadian Broadcasting Center News. (2006). Alternate reality: Nora Young on a new form of storytelling. Retrieved July 7, 2008, 2008, from <http://www.cbc.ca/news/background/tech/alternate-reality.html>
- [9]. Carst, A. (2008). Wii -The Best Selling Console [Electronic Version]. *eNews 2.0*. Retrieved July 2, 2008 from [http://www.enews20.com/news\\_Wii\\_The\\_Best\\_Selling\\_Console\\_08640.html](http://www.enews20.com/news_Wii_The_Best_Selling_Console_08640.html).
- [10]. Castranova, E. (2001). Virtual worlds: A first-hand account of market and society on the cyberian frontier. In *The Gruter Institute working papers on law, economics, and evolutionary biology* (Vol. 2): The Gruter Institute.
- [11]. Crawford, C. (2003). *The art of interactive design*. San Francisco, CA: No Starch Press.
- [12]. Crigger, L. (2007, December 25, 2007). Searching for Gunpei Yokoi. *The Escapist*, 129.
- [13]. Cuban, L. (1988). *Teachers & machines: The classroom use of technology since 1920*. New York: Teachers College Press.
- [14]. Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, 38(4), 813-834.
- [15]. DeBono, E. (1968). *New think: The use of lateral thinking in the generation of new ideas*. New York: Simon and Schuster.
- [16]. Dede, C. (2006). MUVEEs Project. Cambridge, MA: Harvard University.
- [17]. Dede, C., Ketelhut, D., & Ruess, K. (2006). Designing for motivation and usability in a museum-based multi-user virtual environment. Retrieved 3/11/2006, 2006, from <http://www.gse.harvard.edu/~dedech/muvees/documents/AELppr.pdf>
- [18]. Dondlinger, M. J. (2007). Educational video game design: A review of the literature [Electronic Version]. *Journal of Applied Educational Technology*, 4, 1-11. Retrieved July 19, 2007 from <http://www.eduquery.com/jaet/index.htm>.
- [19]. Dondlinger, M. J., & Warren, S. J. (2008). *Learning Through Designing: Game Development as Capstone Experience*. Paper presented at the Association for Educational Communication and Technology Annual Convention.
- [20]. Dondlinger, M. J., & Warren, S. J. (In press). Alternate Reality Games as Simulations to Support Capstone Learning Experiences. In D. Gibson & Y. K. Baek (Eds.), *Digital Simulations for Improving Education: Learning Through Artificial Teaching Environments*. Hershey, PA: IGI Global.
- [21]. Egner, J. (2007, May 29, 2007). One story with 1,700 authors. *Current*, May 29, 2007.
- [22]. Ernst, N. (2007, June 1, 2007). World Without Oil in retrospect. *Group Action* June 1, 2007. Retrieved July 5, 2008, 2008, from <http://groupaction.blogspot.com/2007/06/world-without-oil-in-retrospect.html>
- [23]. Foley, B., Jones, M. S., & McPhee-Baker, C. (2002). *Why girls got to Whyville.net: A girl friendly online-community for science learning*. Paper presented at the American Educational Research Association, New Orleans, LA.
- [24]. Fertig, R. (in press). *Handbook of Research on Effective Electronic Gaming in Education*. Hershey, PA: Idea Group Reference: IGI Global.

- [25]. Gamespot Staff. (2005). Report: PS3 to sell for \$399, cost \$494 to make [Electronic Version]. *Gamespot News* from [http://www.gamespot.com/news/2005/06/28/news\\_6128295.html](http://www.gamespot.com/news/2005/06/28/news_6128295.html).
- [26]. Hays, R. T. (2005). *The effectiveness of instructional games: A literature review and discussion* (Technical Report No. 2005-004). Orlando, FL: Naval Air Warfare Center Training Systems Division.
- [27]. International Game Developers Association. (2008). Breaking in: Path Programming. Retrieved July 2, 2008, 2008, from [http://www.igda.org/breakingin/path\\_programming.htm](http://www.igda.org/breakingin/path_programming.htm)
- [28]. Jones, J., & Warren, S. J. (2008). *Chalk house: A 3D online learning environment for literacy*. Paper presented at the Society for Information Technology and Teacher Education International Conference.
- [29]. Jones, J. G., & Kalinowski, K. E. (2007). Touring Mars online, real-time, in 3D for math and science educators and students. *Journal of Computers in Mathematics and Science teaching*, 26(2), 123-136.
- [30]. Jones, J. G., & Warren, S. J. (2007, June 24-27, 2007). *Chalk House: Iterative Design in a K-12 Literacy game*. Paper presented at the National Educational Computing Conference, Atlanta, GA.
- [31]. Massachusetts Institute of Technology. (2008). MIT Handheld Augmented Reality Simulations. Retrieved July 7, 2008, 2008, from <http://education.mit.edu/ar/>
- [32]. Muir, M., Owen, A., Knezek, G., Christensen, R., Soloway, E., Norris, C., et al. (2006). *Lessons learned from 1-to-laptop initiatives: reflections on critical components*. Paper presented at the Society for Information Technology and Teacher Education, Orlando, FL.
- [33]. Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.
- [34]. Richtel, M. (2007, May 18, 2007). In the game of games, Wii outshoots Sony. *New York Times*.
- [35]. Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, Mass.: MIT Press.
- [36]. Squire, K. (2004). *Replaying history: Learning world history through playing "Civilization III"*. Unpublished Dissertation, Indiana University-Bloomington, Bloomington, IN.
- [37]. Squire, K. (2006). From content to context: Videogames as designed experience. *Educational Researcher*, 35(8), 19-29.
- [38]. Takatsuki, Y. (2007). Cost headache for game developers [Electronic Version]. *BBC News*. Retrieved July 2, 2008 from <http://news.bbc.co.uk/2/hi/business/7151961.stm>.
- [39]. Terdiman, D. (2008, April 1, 2008). 'The Lost Ring' ARG players discover 'lost' Canadian sport. *CNET News.com*.
- [40]. Tuzun, H. (2004). *Motivating learners in educational computer games*. Unpublished Dissertation, Indiana University, Bloomington, IN.
- [41]. Waks, S. (1997). Lateral thinking and technology education. *Journal of Science Education and Technology*, 6, 245-255.
- [42]. Warren, S., Barab, S., & Dondlinger, M. (2008). A MUVE towards PBL writing: Effects of a digital learning environment designed to improve elementary student writing. *Journal of Research on Technology in Education*(Fall, 2008).
- [43]. Warren, S., & Dondlinger, M. J. (in press). Designing Games for Learning. In R. Fertig (Ed.), *Handbook of Research on Effective Electronic Gaming in Education*. Hershey, PA: Idea Group Reference: IGI Global.
- [44]. Warren, S., Dondlinger, M. J., & McLeod, J. (2008). *Data-driven decision-making about curricular redesign: Using PBL and game design to transform instruction in a large enrollment course*. Paper presented at the American Educational Research Association Annual Meeting,.
- [45]. Warren, S., & Jones, J. (2008). *Developing a complex game system: Digital and instructional design in an adventure game*. Paper presented at the Association for Educational Communications and Technology, Orlando, FL.
- [46]. Warren, S. J., & Dondlinger, M. J. (2008). *Objective*

*achievement in a PBL course: Findings from a study on the first iteration of a problem-based learning course game.* Paper presented at the Association for Educational Communications and Technology, Orlando, FL.

[47]. Warren, S. J., Dondlinger, M. J., & Whitworth, C. (2008). *Power, Play and PBL in Postsecondary Learning: Leveraging Design Models, Emerging Technologies, and Game Elements to Transform Large Group Instruction.* Paper presented at the American Educational Research Association Annual Meeting.

[48]. Wikipedia. (2008a, January 2008). Bleeding Edge. Retrieved July 2, 2008, from [http://en.wikipedia.org/wiki/Bleeding\\_edge](http://en.wikipedia.org/wiki/Bleeding_edge).

[49]. Wikipedia. (2008b). Gunpei Yokoi, Retrieved July 3, 2008, from [http://en.wikipedia.org/wiki/Gunpei\\_Yokoi#Lateral\\_Thinking\\_of\\_Withered\\_Technology](http://en.wikipedia.org/wiki/Gunpei_Yokoi#Lateral_Thinking_of_Withered_Technology).

[50]. Wikipedia. (2008c). Global Positioning System. Retrieved August 10, 2008, from <http://en.wikipedia.org/wiki/Gps>.

---

## ABOUT THE AUTHORS

*Dr. Scott J. Warren works as an Assistant Professor of Learning Technologies at the University of North Texas. He holds a Ph.D. in Instructional Systems Technology from Indiana University-Bloomington. His current research examines the use of emerging online technologies such as immersive digital learning environments, educational games and simulations, and open source course management tools in complex systems in K-20 settings. Prior to working in higher education as a teacher, researcher and designer, he taught both social studies and English in urban and suburban settings for nearly a decade.*



*Dr. Greg Jones interest is in expanding the way technology can be used to further the creation and distribution of knowledge and learning. His research focuses on the areas of emerging technologies for learning, which include visualization systems for Education, Virtual communities, Tele-mentoring, and 3D online learning environments (virtual environments). These technologies support learning by the distribution of interaction and feedback across both time and space via interactive forms of multimedia. <http://courseweb.unt.edu/gjones>*

