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New Media Resistance: Barriers to Implementation of Computer Video Games in the Classroom

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Computer video games are an emerging instructional medium offering strong degrees of cognitive efficiencies for experiential learning, team building, and greater understanding of abstract concepts. As with other new media adopted for use by instructional technologists for pedagogical purposes, barriers to classroom implementation have manifested in tandem with rising interest in the medium. This article draws upon a broad analysis of current research dealing with the educative impact of computer video games in the classroom, with a focus on these barriers to implementation. This study was a qualitative review of several scholarly papers exploring the use of computer video games in the classroom. Papers were chosen for inclusion in the review based on their focus on educational video game research. Review of the papers led to six major barriers, which are identified and summarized in this article. Barriers included negative perceptions toward video games as educational components; the difficulty of providing state of the art graphics in educational video games; a lack of adequate computing hardware in the classrooms to run advanced video games; a school day divided by short class periods which hindered long term engagement in complex games; a lack of real world affordances; and a lack of alignment to state standards. Implications for each barrier and suggestions for future research round out the findings. [abstract ends]

Introduction

Computer video games are an emerging instructional medium offering strong degrees of cognitive efficiencies for experiential learning, team building, and greater understanding of abstract concepts. As with other new media adopted for use by instructional technologists for pedagogical purposes, barriers to classroom implementation have manifested in tandem with rising interest in the medium. This article draws upon a broad analysis of current research dealing with the educative impact of computer video games in the classroom, with a focus on these barriers to implementation. Several scholarly papers exploring the use of educational video games in classroom settings were subjected to qualitative review. Candidates for inclusion in the review included research dealing with the educative impact of video games within classroom environments. For each paper, barriers to implementation of video games in the classroom were identified and summarized.

Definitions. Gredler (1996) defined educational games as unique opportunities for children to experience activities within a cognitive domain in which new knowledge can be introduced. For the sake of this article, the term *computer video game* simply extends Gredler's definition of games to computing environments. Computing environments involve the use of personal computers, and in the case of this article we are concerned with personal computers used specifically within classroom settings.

A wide variety of software exists for multiple platforms designed for home entertainment. Among these multiple platforms, besides computers, include portable gaming devices and home gaming consoles. Most of the articles covered in the analysis outlined in this article tend to eschew gaming consoles. Some researchers have commented on the phenomenon of gaming consoles' lack of classroom penetration. Some surveys indicate low power computers are commonplace in classrooms and able to handle instructional software of varying degrees in quality (see Becker, Ravitz, & Wong, 1999). Another, more speculative, reason for the paucity of articles covering gaming consoles may be their heretofore lack of customizability. Many computer video games can be modified by educators, developed from scratch by researchers or students, and played on equipment that is pre-existing in many classrooms. However, gaming consoles typically provide pre-made content that cannot easily be altered by end-users, and may be looked upon as pure entertainment devices by stakeholders (whereas the personal computer may be seen as more utilitarian in nature).

Some software in this review, particularly products developed specifically by educational researchers for instructional purposes, might not

be viewed as falling under strict guidelines of traditional video games by those who designed and researched the products. In particular, Dede, Ketelhut, Nelson, Clark, and Bowman (2004) took care to label their product an instructional environment rather than a game. For situations such as these, the papers in question were included in the qualitative review because the instructional products incorporated elements derived from traditional understandings of video games. In these situations, children engaging in the products may have considered them to be video games, or at least have been familiar with the notion of engaging in software that afforded various game-like activities.

Review Process. The review process invoked criteria focusing on papers dealing with research surrounding computer video games used for instructional purposes in the classroom. The primary focus of the review process involved identifying elements and/or characteristics of educational video games that hindered their usefulness or otherwise dissuaded stakeholders in adopting the video game elements for classroom implementation.

Subjecting the papers to qualitative review resulted in the following six areas identified as barriers to classroom implementation of educational video games: negative perceptions among stakeholders; graphics quality and other issues surrounding computer graphics; lack of adequate hardware in schools to run newer gaming software; lack of instructional time in school periods to adequately engage in rich, cognitive video games; lack of affordances within artificial environments to adequately represent desired learning objectives; and lack of alignment for objectives within commercial gaming environments to state and local standards. This article will outline the six major identified barriers, discuss the implications of the barriers insofar as using video games in an educational context, and offer suggestions for future avenues of research that hopefully address the needs in overcoming the identified barriers.

Perceptions Among Educators

Perceptions hampering acceptance of even the best educational games for classroom use include a lack of understanding concerning the differences between arcade-style games, often the first exposure the general public has to video games, and more complex role-playing, graphically dense, and cognitively viable modern games. These advanced computer gaming products belong in a separately defined category. Virtual interactive environments (VIEs) are derived from several fields, including virtual reality and cogni-

tive science, in order to produce robust and engaging products offering users multiple opportunities for higher order thinking. However, many educators with little or no exposure to modern VIEs may, when asked to consider video games, conjure up mental impressions of lower cognitive arcade titles requiring little or no thought and simplistic gaming properties (Schrader, Zheng & Young, 2006). There also appears to be a general perception in the populace that many video games foster violence, with some research backing up this assertion (cf. Anderson & Bushman, 2001; Sherry, 2001). This may result in reluctance on the part of school personnel to adapt anything using the term *video game* as an instructional tool for classroom use.

In addition to the negative perceptions surrounding the term itself, actual instruction through video games requires a certain degree of relinquishing control of the classroom. Dede and Ketelhut (2003) noted a strong need for extensive professional development with teachers when implementing their multi-user virtual environment (MUVE). The game-like structure of the MUVE necessitated an approach to classroom management that relies more heavily on technology and constructionist principles, facets with which some teachers may be uncomfortable.

Implications. Many text-heavy environments such as the aforementioned MUVE involve the blending of traditional text-based instructional content within the context of a three-dimensional computer graphics environment. This combination of traditional educational elements within what has generally been considered an entertainment medium may ease the divide between traditionalists and early adopters. Some research has indicated that heavy use of scaffolding within VIEs, where students are guided carefully along select paths of instruction while exploring the environment, offers strong cognitive benefits (Warren, 2006).

Considerations for future research. Perceptions have a tendency to change over time, and as young teachers replace older ones, biases against digital instruction may simply vanish with successive generations. Nonetheless, several interesting research questions are open for studying the perceptions surrounding educational video games. Do parents and teachers hold different perceptions of instructional VIEs than students? If so, what attributes of the VIEs cause the differing perceptions? What ways could instructional video games be presented that result in more positive impressions among stakeholders? Ultimately, negative perceptions surrounding the use of computer video games for educational purposes may hinge upon a reluctance to meld what has been seen as a mindless waste of time with strong instructional content. For the negative perceptions to diminish, broader understanding of the power the medium of video games offers for instructional purposes will need to be realized in K-20 practice and literature.

Graphics

A team at Georgia Tech created a math game called AquaMOOSE using graduate programmers (Elliot, Adams, & Bruckman, 2002). Upon informing the school-aged experimental group they were going to play a game, the students initially expressed enthusiasm. However, graphics the students were used to from home consoles and traditional computer games proved superior to that of the team's trial program. Professionally developed games students are used to playing have a high degree of graphical sophistication, and creating educational products from scratch is thus a high barrier.

That barrier may be overcome by modifying existing commercial products which include the advanced graphics favored by players. Such an example was detailed in a paper describing Massachusetts Institute of Technology's experimental game Revolution, which is a modification of the *Neverwinter Nights* commercial game (Squire & Jenkins, 2003). Additionally, acceptable graphics quality may be implemented by using an existing three-dimensional environment such as the online Active Worlds, used by Harvard's River City (Dede, Ketelhut, Nelson, Clark, & Bowman, 2004) and Indiana University's Quest Atlantis (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2002).

Implications. The graphical barrier looms strongest against researchers and educators wishing to customize instructional content within a gaming environment while also desiring to maintain a high degree of professional quality. Modern video games are akin to movie production, with multiple people and high dollar budgets. As the Georgia Tech team experienced, professional grade gaming environments are costly and time consuming, potentially beyond the will and means of university researchers. The Harvard and Indiana teams found they could work within a commercially available environment, provided they were willing to submit to the restrictions and programming constraints inherent within that environment. Thus, graphical quality may be of increasing concern to researchers in the field, if they desire strong customizability. If researchers are willing to conduct their observations within existing environments, ones in which someone else has spent the time and money programming, graphical quality will be less of an issue in terms of development time.

Considerations for future research. Questions surrounding the graphical aspect of the video game medium might involve its effect on user experience and questions such as: What level of graphical capabilities offered within a gaming environment is acceptable for students to suspend their disbelief? Laurel (1991) asserted the level of quality did not need to be very

high. However, since the time of her writing, computer graphical quality has increased considerably, and young game players have come to expect a certain degree of graphical sophistication that is found in their entertainment products. Could an empirical study point to evidence that top of the line graphics in a game support characteristics that promote higher order thinking? On the other end of the scale, at what point do inferior graphics interfere with instructional content? Can players spoiled by ever increasing graphical quality find a game based on a ten year old graphics engine to be beneath their dignity to play? If a game compensates inferior graphics with quality text and audio, can any limitations in the learning process be overcome? If so, how easily? Ultimately, high quality graphics (and, correspondingly, complex video games) will likely depend on the appropriation of existing products for research purposes. Whether quality graphics or the lack thereof adversely affects learning facilitation remains open for research.

Hardware

An even more significant problem to widespread use of computer video gaming in the classroom may be the lack of machines available for students in many schools. Although 99% of all teachers reportedly have access to computers in schools, one-to-one ratios for students appear to be far from reality (NCES, 2000). Computers that are available for student use traditionally are older and less powerful machines. Some survey authors have suggested lower-level games from the edutainment category, such as those in the Math Blaster series, may likely be placed on school computers because of low processing power requirements (Becker, Ravitz, & Wong, 1999).

Advanced games often require newer hardware and tend to be resource hogs, thus potentially limiting their adoption for classroom use. Innovative educational products created for research purposes, such as those based on the Active Worlds environment, often use fewer resources, making them more likely to be feasible on classroom machines and networks. This idea was a key consideration of Jones and his colleagues when creating software designed for an online three-dimensional classroom. The game-like software was designed to run on older computers, built in 1999 (the year the popular online video game EverQuest debuted) or later (Jones, 2004).

Implications. Strong computer gaming environments are resource intense, placing demands on RAM and hard drives. Educational games, especially those designed with the classroom in mind, may have to be oriented toward lower-end machines if survey data continues to support the notion

that many or most classroom computers are underpowered. A strong educational video game that requires a new computer with robust capabilities may prove to be of limited value within a majority of educational settings. Any educational video game may be limited in its effect if the environment it is implemented in has a shortage of machines available for student use.

Considerations for future research. Older and slower machines may necessitate simpler instructional video games that can adequately perform on dated computers. Researchers may want to consider if opportunities for educational benefits may be limited by older graphics and computing capabilities. Research questions may focus along the lines of such questions as, What are the typical specs on a classroom computer in operation this year? With the progression of technology, how long can a video game hold educational value? Are there detrimental attributes to using dated software with students accustomed to newer software and hardware?

Time Divisions Within the School Day

Squire (2004) noted the time limitations of the bell schedule hampered his efforts to use Civilization III in formal classroom environments. The game is challenging and complex, and users can spend several hours a session playing and learning. Informal learning environments such as afterschool and summer programs, and other situations in which the bell schedule is not as critical in dividing learning periods, may prove to be better times for engaging in rich cognitive VIEs. Otherwise, the video games will need to be specifically designed so that learning objectives can be typically achieved within 30-45 minutes. This is a tactic taken by some researchers when designing games for classroom use. Squire and Jenkins (2003) indicated Revolution was designed with time constraints of the typical class period in mind.

Implications. Instructional units are perforce constructed around the school bell. Time spent on complex video games, much as long novels or lengthy movies, will need to be parsed according to the restrictions of the class period. Consequently, researchers desiring to investigate complex VIEs within instructional settings will focus on those with brief components within their broader contexts. For instance, a VIE offering users a large and robust world to explore may have a variety of short learning objectives that can be accomplished in 30 minutes or less. Alternatively, educators and researchers may want to investigate simpler, more narrowly focused video games containing only one or two learning objectives. Conceivably, these

simpler instructional video games may be ideal for the short time slots afforded by school schedules.

Considerations for future research. If the bell schedule is a barrier to the use of complex video games in the classroom, researchers may seek to investigate questions surrounding continuing versus short activities. If a student is interrupted while in the process of engaging in a learning objective within the gaming environment, do the interruptions interfere in the student's learning process? Conversely, can the interruptions of the bell schedule be turned into something advantageous for the learner? Do students who are allowed to engage in complex VIEs over longer periods of time, such as during an after school program, retain more knowledge gleaned from the game than those who engage in it piecemeal?

Lack of Affordances

Affordance Theory was proposed by Gibson (1977) as a way to describe the relationship between an entity and its environment. The more affordances offered by an environment, the greater opportunities for interaction become apparent to entities within the environment. Within three-dimensional electronic learning environments, upon which many game-based instructional efforts are based, the current level of software sophistication is insufficient for highly advanced affordances. Dickey (2003) noted that the lack of affordances in some three-dimensional environments to completely simulate real life pedagogy may hinder desired instructional processes. Particularly, she noted limited movements of avatars within the Active Worlds environment resulted in less than realistic experiences among users in synchronous distance learning efforts. Those leading classes, for instance, could not engage in complex gesturing, drawing on a chalkboard to dynamically illustrate points, or other actions easily afforded within real world classrooms.

Implications. Virtual worlds are likely to continue to hold some lack of affordances otherwise available in the real world until perhaps technology has advanced considerably from its present point. Conversely, virtual worlds will always allow opportunities for simulated experiences not as easily available in the real world. Simulated science experiments, teamwork over distances, and facilitated communication offer three demonstrable examples of these opportunities. The benefits and disadvantages inherent in the medium will need to be weighed by educators in the course of decision making insofar as instructional content for the classroom.

Considerations for future research. Gibson's (1977) Affordance Theory offers an intriguing angle for educational video game researchers to explore. Specific components within instructional video games can be analyzed and quantified, with survey research to follow up after the experiment concludes. Participant actions can be gauged as to the number of times an affordance is used within the gaming environment. Survey questions might focus on reasons behind the popularity of certain components within the VIE, or the lack of popularity for other components. Research questions might focus on whether certain affordances within the game facilitate or hinder instruction. A greater understanding of affordances within VIEs that assist in transferring instructional content might assist in the development of more efficient video game based learning environments in the future.

Lack of Alignment to Standards

Squire (2004) noted a need to develop his own curriculum and alignment of standards when implementing Civilization III within classroom environments. Widespread commercial gaming products are designed primarily for entertainment purposes rather than educational purposes, though informal learning may occur through using the products. Teachers wishing to use the games within their classrooms must often develop alignments on their own, a significant hindrance to adoption due to the added time and effort required.

Deubal (2002) indicated that a requirement for any software, including video games, to be successfully used in classrooms is to provide capabilities for dynamic teacher adjustments. Thus, products such as PowerPoint are thoroughly dynamic and find widespread use within classrooms. Products allowing few or no outside adjustments by teachers may find stiffer resistance to adoption. Therefore, if a video game is to find widespread adoption within classrooms as an instructional component, each teacher adopting the game must be able to adapt it to his or her specific state and local standards rather than seeking to adapt the standards to the product.

Implications. State standards are increasingly important for any product adopted for classroom use. Instructional video games will be no exception. Complex video games may be rated by teachers as conducive toward higher order thinking (Rice, 2007). However, whether the higher order thinking induced within VIEs is related to what will be on the students' state assessments is another matter. It seems a commercial video gaming product pre-aligned to state standards would have an easier time selling itself in

the educational marketplace, relieving early adopter educators from the time consuming need of providing the alignment themselves.

Barring the introduction of such a product, the issue of standards alignment will remain a barrier for individual games in the classroom. One solution might occur in the form of individual teachers posting their alignment work on the Internet. Such public parsing of large projects has been feasible in open source programming, and a form of open source standards alignment may coalesce in the future around such popular products as the Civilization series.

Considerations for future research. Is informal leaning of merit within formal learning environments? Can learning by doing, within the context of VIEs, transfer to formal assessments that are traditionally text-based by design? These are key issues facing the broader question of viability for educational video games within school settings. The question of transference may never be fully resolved, but will remain an important issue. State assessments are generally text-based; video games are action-oriented. Can engagement in video action lead to higher text-based achievement? Do video games that simply reformat traditional text-based learning within a digital context induce higher engagement and longer amounts of time on task? Can a video game teach students concepts by means other than text that can be transferred to a text-based state assessment?

Conversely, perhaps educational video game research should focus on areas other than achievement on state exams. Are video games best suited as catalysts for increased learning outside the classroom? Should success in implementing video games within the classroom be marked by increased attendance, more time on task, or a higher number of books checked out from the library? These are the sort of questions that will perhaps intrigue researchers in the years to come.

CONCLUSION

Wider acceptance of video games as an instructional medium in the classroom is hampered by negative perceptions held by educators. The graphics quality of educational video games needs to be sufficiently advanced to provide strong engagement by the students. While modifying existing products may be a work-around to creating graphical environments from scratch, time and programming skill remain necessary for many implementations. Creators of the more successful educational game-like environments use three-dimensional software that walks a fine line between

graphical sophistication and low resource requirements. This programming compromise will likely continue to be necessary so long as older machines remain common in schools. Newer advanced gaming environments tend to maximize use of computer resources, and consequently will likely remain in entertainment venues rather than quickly finding their way to educational markets. School days remain divided into hour long or less class periods, while advanced VIEs can engage students for hundreds of hours. Finally, many of the best cognitive video games are typically created for mass market consumption, rather than purely educational purposes, resulting in the need for additional efforts by teachers wishing to align them to their curricula.

The training benefits of complex computer games in military and business efforts are well documented (see Prensky, 2001). The pedagogical benefits of educationally appropriate video games, including strong cognitive efficiencies for the grasping of abstract concepts, development of team-building skills in multi-player environments, as well as strong experiential learning, are being researched with promising results (cf. Squire, 2004; Warren, 2006). Facts and details, material usually best covered in dense media at lower learning levels and found in high-stakes tests, remain prime components of older media involving text, lecture, and video. Complex understandings, broad experiences, higher level thinking, and consequential decision making are all approached in many advanced computer games now offered in the marketplace and occasionally co-opted by teachers or created specifically for academic environments. As greater understanding of the pedagogical potential of VIEs increases, acceptance of this new instructional medium is poised to increase as well.

Computer video games promise to be a strong and vibrant medium for interaction and instruction. While this article has focused on barriers to the appropriation of video games in classroom settings as gleaned from the literature, it is by no means certain that these barriers will continue standing. Indeed, each barrier will ideally be overcome by programmers, stakeholders, and researchers, leading to more robust learning environments in the years ahead.

Programmers should take heed of theory and research found in the literature. Presently, good learning theory seems to be incorporated by commercial programmers, but primarily for the sake of entertainment (Gee, 2003). The combination of good commercial programming with strong instructional content, along with alignment to state standards, should result in promising educational products.

Stakeholders, including parents and teachers, should remain open to innovative means of instruction. Biases concerning the mental acumen needed

to engage in a VIE need to be subordinated to the present reality. These are not games on the level of Pong or Windows Solitaire. Finally, researchers need to continue thinking about and working in this fascinating field and dreaming up many more questions to ask. Computer video games hold the potential for providing phenomenal learning experiences for users. Programmers, educators, and researchers can work together to offer exciting new worlds for children to explore, meet others, and learn.

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Notes

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