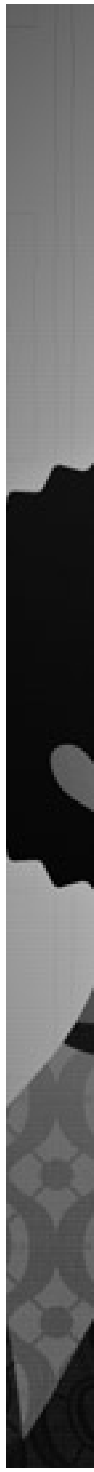
Serious Games: Incorporating Video Games in the Classroom



Games designed using sound pedagogy actively engage the Net Generation in learning

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Today's schoolchildren bear the label Generation N or the Net Generation because they have grown up in a networked world where technology is not a novelty but normal in everyday life. Current research suggests Net Gen students are more likely to engage in online games than to interact with other students or the instructor when in face-to-face learning environments.[1] The K–12 arena in particular—often lacking the technology that students expect in the classroom—has faced an uphill battle to engage these students.

Technological advances in the new millennium may evoke disquiet among administrators and teachers taxed with understanding how to harness new capabilities and merge them with sound pedagogy. To understand how gaming might bridge the gap between student interest and how lessons are taught, graduate students in science education at North Carolina State University (NCSU) took an online course that incorporated role-playing games.

Serious Gaming

The fascination with Pong in the 1970s is today paralleled by the popularity of online, multi-user games where people can compete or work together to reach a common goal. In 2002, the "serious games" movement prompted partnerships among educators, the military, corporations, medical fields, and video game designers. This movement embraces the power of video games to attract, engage, connect, and teach game players critical content in the games' respective focus area.

The game industry has boomed over the past 10 years. Game systems such as the Microsoft Xbox and Sony PlayStation 2 allow thousands of competitors to interact in virtual environments simultaneously. Unfortunately, most of the games created for these popular consoles are not designed to be educational. The NCSU graduate distance education course begins to bridge what kids do in school and what they do after school. Rather than listen to lectures or repeat equations, students can interrelate in immersed worlds.

This article describes the creation of the NCSU course, which combined content and pedagogy with a multiplayer educational gaming application (MEGA). The course design had two major goals:

- Find a viable source for synchronous, online course delivery in a MEGA.
- Pilot a project for in-service teachers to design and create role-playing video games in a three-dimensional (3D) virtual environment as a supplement to science teacher instruction.

Bryan Leister

Literature Review

Substantial research has explored the role of games and game theory in education. First we look at the possible educational roles for MEGAs, then applications of game theory as an educational tool.

MEGAs in Distance Education

Distance education is a type of virtual learning. Three-dimensional worlds provide various educational possibilities, such as an extension of the classroom and as a medium for distance education.[2] These worlds can also support the constructivist paradigm of instruction.[3] MEGAs allow for synchronicity through real-time chat or voice over Internet protocol (VoIP). These functions seem commonplace in the lives of both college and K–12 students.

Students today use virtual communities to discuss shared interests (communities of interest), to develop social relations (communities of relationships), and to explore new identities (communities of fantasy).[4] Bruckman[5] and Riner[6] found that text-based virtual worlds support constructivist learning through meaningful collaboration and interactivity. They proposed that 3D simulations, as well as allowing the visual learner to be immersed in a 3D setting, should have a text-based chat module. Virtual reality research suggests that participation in a 3D environment also supports the constructivist paradigm of instruction and may bridge the gap between experiential learning and information representation.[7]

Another interesting development follows generational lines: Students now arrive on campus with greater abilities in online learning than previous generations and with the expectation of learning in an on-demand manner. Even more intriguing, these students' brains are likely to have been shaped by very visual, rapid-movement, hypertexted environments.[8]

Zemsky and Massey[9] reported that students desire e-learning technologies for three reasons. They want to

- be connected to one another;
- be entertained through games, music, and movies; and

- present themselves and their work.

A MEGA is an immersive, 3D virtual learning environment in which an avatar, or graphic representation of the user, interacts in real time with other avatars, computer-based agents, digital artifacts, and virtual contexts in a visually rich simulated world. By design, the MEGA environment evokes a sense of virtual presence—a sensation of being in another place and belonging to a community while visiting a virtual environment.[10] The feeling of presence is engendered by visual representations of people and places, and in part by adding the power of suggestion, which activates the students' imaginations in a simulated learning environment.[11] Barfield and Hendrix[12] distinguished virtual presence from real-world presence by the extent to which participants believe they are somewhere different from their actual physical location while experiencing a computer-generated simulation.

Avatars have evolved into a creation of the user. Participants can be anyone or anything they want to be by creating their own avatars. Dickey[13] and Duffy and Cunningham[14] agreed that a major goal of constructivist learning environments is to find activities that support ideological interchange and reflexivity. The ability to take on multiple roles allows players to gain multiple perspectives of a given scenario.

In MEGA environments, team building is essential.[15] MEGAs provide diverse learning experiences with diverse activities to support the classroom curriculum. They motivate learning by challenging students, rousing their curiosity, and offering beauty, fantasy, fun, and social recognition. They reach learners who do not do well in conventional settings.[16]

MEGAs also enable development of higher levels of learning and collaboration skills.[17] Problem-based learning and collaborative learning, for example, are the most powerful educational options in higher learning if the technology combines with sound pedagogy.[18] Through teaching and learning in collaborative environments, problem-based activities can come to life. MEGAs entice students to explore beyond the boundaries of the given material, encouraging a proactive and exploratory approach that empowers the student to become a self-directed learner.[19]

MEGA platforms are currently used for multiple applications. As students become more engrossed in gaming, MEGAs offer a viable solution to their visual and cognitive needs.[20] Teachers need to evaluate MEGAs from an educational perspective to determine whether they can be embedded into teaching practices.[21] For example, digital technologies can immerse the learner in worlds that not only represent scientific phenomena but also behave according to the laws of physics.[22]

Linn[23] examined the pedagogical implications of computer technology-mediated science. She proposed four meta-principles to support knowledge integration: making science accessible, making thinking visible, helping students learn from each other, and promoting autonomous learning.

Game Theory as an Educational Tool

Three features mark modern literacy. First, it includes not only text but also image and screen literacy. Second, it involves navigating information and assembling knowledge from fragments.[24] Third, user-friendly technology when integrated effectively into a learning environment helps engage students in the "active" process of learning. Incorporating problem-based learning in a game simulation context within a MEGA is an ambitious attempt to harness the benefits and synergy of these three features.

According to Foreman,[25] "Games expose players to deeply engaging, visually dynamic, rapidly paced, and highly gratifying pictorial experiences that make almost any sort of conventional schoolwork (especially when mediated by a lecture or text) seem boring by comparison" (p. 15). Neal[26] and Prensky[27] believe game technology will replace classrooms, lectures, tests, and note-taking with fun, interactive learning environments. Averill[28] supported Neal and Prensky by stating that computer games have the potential to instruct students about what they know and assess their recall of what they have been told. Suler[29] suggested that video games create heightened emotional reactions because they mimic sensory experience. They provide not only realism but also suspense, since objects move toward and away from you. Players don't know what is around the next corner.

Designing a Synchronous Distance Course in a MEGA

Designing a new course is not easy. Designing a distance-learning course in an environment that allows for synchronicity and visual stimulation is not only challenging but also extremely risky. High risk can yield high rewards, however.

This inaugural course incorporated a combined synchronous and asynchronous learning model for 13 graduate students at NCSU, all of whom were either pre- or in-service K–12 teachers. One NCSU faculty member audited the course. Most of the students were science teachers, although one taught history at a local high school. Most lived within approximately a 50-mile radius of the NCSU campus. The course was conducted entirely online. The students could access WolfDen (the name of the MEGA created for the course) largely on their own schedules.

Course Description

The lead instructor (Len Annetta), with the assistance of two technical contractors (Mike Cuales and Alan Youngblood), built WolfDen using proprietary Web-based software from ActiveWorlds, Inc. The course had both synchronous and asynchronous components. For example, regularly scheduled live lectures were held in the virtual classroom building, while students had round-the-clock access to WolfDen to build their game simulations. The ActiveWorlds browser contains an imbedded telegram system in which assistance could be summoned from the course instructor, who often frequented WolfDen outside of the scheduled lectures, providing live advice and assistance to the students.

The course consisted of two inquiry-based, exemplary game simulations on varying science topics. Knowledge of the topics presented in each simulation was helpful but not critical. The simulations were designed so that the students' prior knowledge would direct them through the virtual worlds. The students invariably gained greater knowledge of the science phenomena through the process of solving the proposed problem(s).

Course Objectives

The course aimed to advance student achievement in science by integrating collaborative/competitive simulation games in the classroom curriculum. This required new pedagogy and skills in integrating instructional technology. The online course used game simulations extensively to help current and future science teachers understand gaming theory and to teach them how to design and construct games for use in their classrooms.

Specific objectives of the course were for students to:

- Demonstrate a developing understanding of game theory, storyboarding, and online multi-user role-playing games.
- Prove their competence in developing skills of instructional, communication, and assessment strategies to support, motivate, and monitor student learning.
- Show developing knowledge, skills, and dispositions that encourage reflective practice, collaborative action, and lifelong inquiry into teaching and learning.
- Develop an understanding for technology and cross-curricular integration into the science classroom.

Course Overview

WolfDen provided an immersive environment, rich in graphic representations of objects, computer agents, and the avatars, or visual representations, of each student. An important feature of the MEGA technology is that it enabled the instructor to use a variety of simulated environments during the course. A virtual classroom built to resemble Poe Hall, an actual building on the NCSU campus, served as a lecture hall. A Game Room provided a central point from which WolfDen students and visitors could teleport to various instructional locations in the virtual world. A Tutor Room provided links to resources and instructions. The remaining space in WolfDen consisted of a Building Area with nearly 1,000,000 square meters of unimproved real estate available to students for game creation.

Two model instructional games created by Annetta and his assistants originated in the Game Room. These games, "Phases of the Moon" (Figure 1) and "Who Killed the Pharaoh?" guided students through the technical design and layout, content, and game features they were to create during the course.

The course syllabus did not require specific texts. Readings for the class, posted periodically online, consisted of current literature in science and game theory education. These readings gave students the basic knowledge and skills needed to understand and create an educational game using the principles of game theory and problem-based learning in the MEGA, while providing the scaffolding to create a functional virtual game simulation.

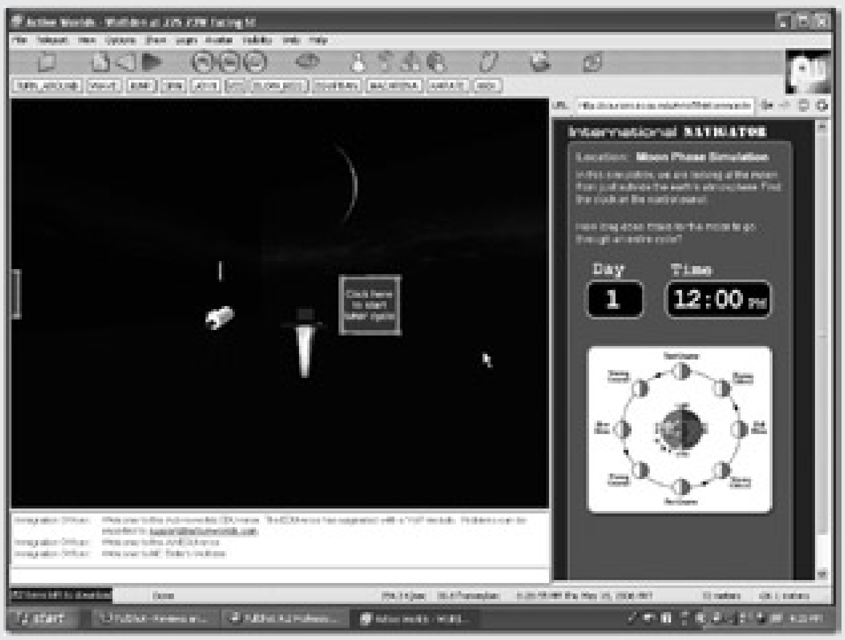
Technology, Knowledge, and Skills Prerequisites

The heavy reliance on Web technology was a significant factor of the course. Students had to deal with technology on two levels—technical and psychological. From the purely technical standpoint, the hardware requirements were fairly stringent. To operate the ActiveWorlds browser effectively, each student needed access to a relatively robust computer as well as a microphone and speaker/headset for the VoIP feature of the course. Additionally, the ActiveWorlds browser is optimized for high-speed Internet connection, such as DSL or cable modem. Operating within the virtual world using computers connected to the Internet via a dial-up modem would have significantly hindered the students, regardless of the speed of their computers.

Students also needed a base level of proficiency in using the Web (browsing, searching), to quickly obtain an understanding of the ActiveWorlds interface, and to gain the skills required to create and manipulate objects placed in their game simulations. Students who did not possess a working knowledge of creating HTML pages and performing basic opera-

Figure 1

Screen Shot of "Phases of the Moon" Game



tions using audio files had to gain these skills to complete course tasks. Technical assistance provided by the course instructor and other course participants enabled those lacking the requisite skills to complete their assignments.

Integrating Pedagogy and New Technology

To integrate problem-based learning and game theory, the course required students to create a problem that addressed at least one objective or goal from the North Carolina Standard Course of Study. They also had to create a game with a story narrative that fostered principles of problem-based learning. Participating students were already familiar with this principle, and a synchronous lecture in the first week of the course provided instruction on game theory.

Since game theory and development were typically new to the students, assigned readings and a storyboard template complemented regularly scheduled synchronous lectures held in the virtual classroom. Live audio (VoIP) from the course instructor facilitated the lectures. The storyboard template facilitated the generation of a game narrative.

The final game produced by each student required a basic proficiency in building within the ActiveWorlds MEGA and the ability to embed triggers and commands through basic scripting language specific to the ActiveWorlds browser. Triggers and commands include moving, linking to HTML pages in pop-up windows, and bumping objects to cause various actions, such as playing audio files, teleporting (moving the player's avatar to another location within WolfDen instantaneously or over the terrain in a straight line of motion), and dynamically moving objects (up, down, forward, backward, laterally) within the game.

Students typically worked alone in designing the game. They were encouraged to collaborate freely with each other and the instructor, however, to resolve technical issues such as locating desired objects, creating non-player characters from avatars, mastering object and avatar actions, and so forth.

At the end of the course, students presented their games, initially to selected classmates and ultimately to the class as a whole. The formative evaluation assisted the game creators in clarifying the objectives and play of their games through peer feedback.

Results

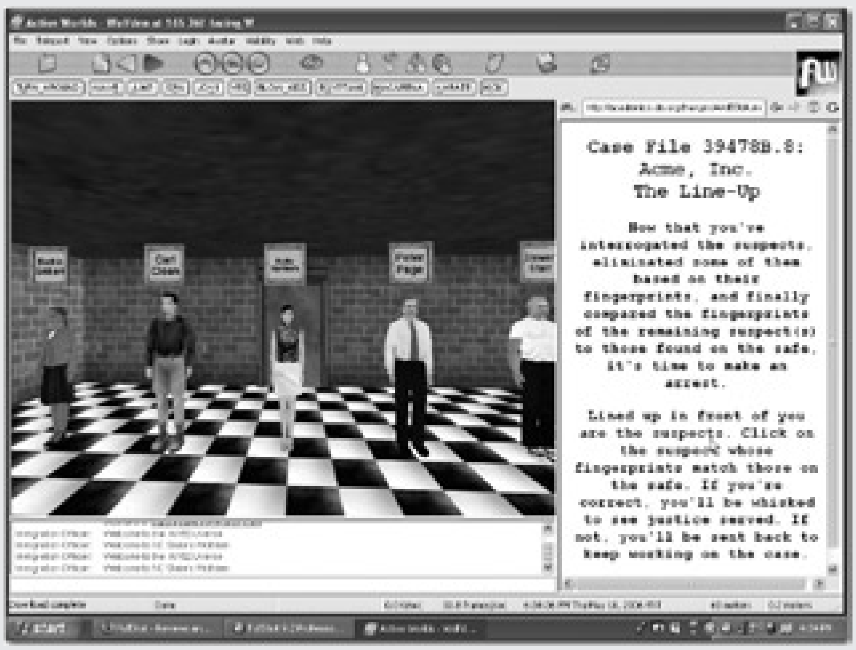
Despite the diversity in technology comfort level and computer skills among the students, each created an end product with excellent educational qualities, as demonstrated by an evaluation rubric for game design and educational quality designed by course instructor Annetta.[30] Games targeted grades 5 through 12 and aligned with the North Carolina Standard Course of Study. They also required problem-solving skills from the game players. Figure 2 shows a screen shot taken from "Acme, Inc.," a crime-scene game simulation created by one of the students in the course.

Although Annetta used VoIP almost exclusively in delivering lectures, the students were reluctant to move away from text-based communication to audio. When offered the opportunity to choose between using VoIP or continuing with the traditional text-based chat, they preferred to listen to the instructor via VoIP and to respond with text chat. Several students cited technical difficulties, such as delays in transmission, that prevented a smooth verbal exchange. Other technical challenges included hearing their own voices echoing through the listener's microphone, fading in and out of the signal, and faulty equipment. There was also an affective impact of using VoIP. One student commented, "I have absolutely no idea what I'm doing. I'm more comfortable (text) chatting."

All the course participants felt their students would react to MEGA activities enthusiastically. They felt that students would welcome the novel change from traditional classroom activities and consider the activity more like play than work. The environment might not limit the number of students involved, as with some video games, and the learning activity might use several learning styles. The combination of problem-based learning and game theory for solving problems was also considered valuable. Nonetheless, one participant suggested that K–12 student acceptance

Figure 2

Police Lineup from Who-Done-It Lesson



would depend greatly on the quality of the game design and the creativity of the designer and instructor.

Most of the participants expressed enthusiasm about implementing the MEGA technology in their classrooms, allowing their program to stand out from other programs. Several teachers decided to use the MEGA-based activity primarily because of the time and effort they had already put into developing it. Others cited their own enjoyment in learning through this medium or the anticipation that their students would enjoy it as well. They also saw an opportunity to stretch the limits of what a student can experience in the classroom.

Discussion

The in-service teachers generally responded to the course in a positive and enthusiastic way, tempered by the effort required to gain familiarity with the ActiveWorlds platform. None discontinued the course or failed to master the technology, however. Most participants felt they had sufficient resources and administrative support at their home schools to implement the course principles in their classrooms. The ultimate success of the course in motivating teachers to use MEGA technology will be determined by long-term observation.

Working with multiple learners in a MEGA project raises challenging problems of synchronization, tasking, discipline, and resource management. At the same time it offers the potential of unleashing for educational use one of the most powerful forces in the human psyche: social interaction.[31] The degree of social interaction among the course participants indicates the potential of the MEGA for engaging their own students in a similar fashion. Experience with non-educational versions of MEGAs similar to WolfDen has shown that the opportunity to build and create within a MEGA is a powerful motivator to users. The intensive time requirement for building MEGA-based projects may severely limit the number of projects a single teacher could undertake, but by creating communities of practice, teachers can work together to create a large number of projects to support many classrooms.

Gaming in the science classroom has the potential to deeply engage students

Generation N thinks in fundamentally different ways from previous generations, who have not spent thousands of hours engaged in small-group digital competitions. Gaming in the science classroom has the potential to deeply engage students, while providing a natural forum for integrating technology with dynamic visual representations of the natural world. Teachers using an application created for online chat (ActiveWorlds) can design 3D simulations and upload them to the Internet without paying the high price or acquiring intense knowledge of computer programming or 3D wireframe design. Games designed in this application won't be as rich as costly commercial games, but the environments can be modified based on the skill level of the competitors (students) involved.

The K–12 educational community has yet to embrace gaming theory even though studies have suggested students as young as second grade opted to play a geography video game rather than go to the park.[32] The course not only enhanced the science content knowledge of the mostly in-service teachers who took it, it also improved their knowledge of science pedagogical content and of effective technology integration.

Some might argue that games offer more fun than substance. One goal of this project was to generate fun Internet-based video games that were highly interactive and had a strong foundation of science content in the design. Teachers constructed a game for their students to play that aligned with the state curriculum guidelines and relied on real-world implications.

Conclusion

Enabling students to move from virtually no knowledge and skill in the use of virtual environments, gaming theory, and to some extent problem-based learning to possess the skills to create a functional, engaging, and educational game is an ambitious goal. Students at the beginning of the course possessed a wide range of comfort and proficiency with the use of technology, and none had previously worked within a MEGA setting. The experiences of this course portend real potential for prospective MEGA course developers to advance the use of gaming theory, problem-based learning, and a MEGA for the betterment of teaching science and a wide variety of other subjects at all educational levels. *e*

Acknowledgments

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Endnotess

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