GEARS a 3D Virtual Learning Environment and Virtual Social and Educational World Used in Online Secondary Schools

Jonathan Barkand[1 2] and Joseph Kush[2]
[1]National Network of Digital Schools, East Liverpool, USA
[2]Duquesne University, Pittsburgh, USA
Jonathan.Barkand@nndsonline.org
Kush@duq.edu

Abstract: Virtual Learning Environments (VLEs) are becoming increasingly popular in online education environments and have multiple pedagogical advantages over more traditional approaches to education. VLEs include 3D worlds where students can engage in simulated learning activities such as Second Life. According to Claudia L'Amoreaux at Linden Lab, "at least 300 universities around the world teach courses and conduct research in Second Life." However, to date, VLEs have been very limited in use for K-12 education. One option for secondary schools was developed by Game Environment Applying Real Skills (GEARS) and can be used in online or traditional schools. The 3D VLE is named ARC*: The Impending Gale*. This program has been used successfully for over a year as part of the Lincoln Interactive online curriculum. ARC allows students to create their own custom avatar and enter the educational environment. The actual content of the game differs depending on the subject the student is taking. Current courses include earth science, geography, pre-algebra, and spanish. The 3D VLE experience is designed to serve as a reinforcement of the concepts learned in the traditional lessons. The game environment itself has been very well received by students primarily because many of the continued development features were derived from student suggestions. One unique feature that was most requested was the inclusion of voice chat. Voice chat was only added as part of the ARC headquarters where students were able to meet before going out into the game world for their own specific content. The students are also highly motivated to progress through the content. ARC has been a great success for Lincoln Interactive and its parent company the National Network of Digital Schools. The social aspect of ARC was limited, and the ARC Headquarters prompted a plan to create a 3D Virtual Social and Educational World (VSEW) for the 15,000 students that had access to the Lincoln Interactive curriculum in 2009. With the inclusion of a social component, the concept of an online community was evaluated. Garrison's et al. (2000) Community of Inquiry framework is used to explore the Lincoln Interactive Community. The VSEW contains a 3D social space with custom avatars, chat, Voice Over Internet Protocol (VOIP) communication, social objects in the form of community musical instruments, and a tutor zone for teachers. In 2009 four educational games are included in the VSEW. These educational games focus on basic concepts in the three disciplines of math, social studies, and language arts. Garrison et al, (2000) Social Presence, Cognitive Presence, and Teaching Presence are each explained in regards to the VSEW. Both ARC and the VSEW are implemented, and as of November 2009 they are currently being used by students. While there is still much to learn and explore in regards to 3D VLEs and Social Worlds, practical application by GEARS in an online secondary school has been positively accepted by faculty and students. National Network of Digital Schools: http://nndsonline.org/ Lincoln Interactive Curriculum: http://www.lincolninteractive.com/ Game Environment Applying Real Skills: http://gears.nndsonline.org/ 3D Virtual Social and Educational World: http://www.learnwithfriends.com/

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1. What is a Virtual Learning Environment?

The term Virtual Learning Environment (VLE) can be used in very broad terms. The virtual component of VLEs usually refers to an online, internet, or web-based component. Virtual systems by nature are able to be accessed from remote locations. The learning component is the identifying difference between an educational environment and other environments such as Multi-User Virtual Environments (MUVEs). The environment component is simply a location in which users can gather together in a social context.

The environment of a VLE can range from web sites to virtual classrooms to 3D immersive worlds. When considering websites, a set of web pages does not constitute a virtual learning environment unless there is social interaction about or around the information (Dillenbourg, 2000). A few examples of virtual social interactions may be instant messaging, discussion boards, emails, blogs, and podcasts.

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The type of Virtual Learning Environment that will be explored in this paper will be 3D. A 3D VLE adds immersive content to the standard VLE. A 3D VLE allows the student to explore and learn at his or her own pace and time schedule. Users can visit virtual communities at any time, with any computer, and from any location (Lu, 2008). This flexibility makes the connection to asynchronous online coursework a great partnership.

A 3D VLE that has been widely used in higher education is Second Life. Second Life provides the ability to create an avatar and travel around a 3D world. Universities have begun establishing their own private islands in Second Life where classes can be conducted. Private islands are a great way to maintain a safe and controlled learning environment within a world with almost infinite possibilities.

For distance education classes, Second Life can be a great way to bring the class together and meet in a 3D VLE. The actual lectures make the students feel as though they were in a real class. Before class, students can be found standing in groups and talking amongst themselves. Also, depending on the distance and angle from the professor, the professor's voice would be soft or loud and be heard from the left or right.

Second Life has been very effective for higher education, though K-12 education has been more difficult to implement in Second Life. As a K-12 educator looking to use Second Life for his or her classroom, it is important to look at some specific requirements. Some other virtual worlds are intended for children, but not Second Life, except for its "Teen Grid," or on safely walled-in private "estates," which some schools have established (Trotter, 2008). The ability to control the learning environment will be a critical part of using 3D VLEs in K-12 institutions. This has led to many organizations creating 3D VLEs that are specifically designed for K-12 and are closely monitored and controlled.

2. Pedagogical advantages

The pedagogical advantages of using a 3D VLE are a critical component. Using a 3D VLE in an educational setting needs to reinforce student learning. The potential to have a full course in a 3D VLE is possible, but a close look at the amount of content and assessments is necessary. There exists a need to classify using games for education and using games for learning. A meaningful and relevant context provides a springboard for inquiry, information-gathering and sharing, and reflection of theoretical concepts and relationships, and norms and practices (Lim, 2008).

There currently exists considerable research on the use of games in the classroom. Using games as a classroom becomes a possibility with 3D VLEs. The ability to facilitate and guide learning is a very important part of using games in an educational setting. Learning can occur in many forms, and a key feature is in reinforcing a concept that is being taught. This is where designing games to match content can make 3D VLEs more effective teaching tools. The ability to teach a lesson on construction and management and have the students build and manage a theme park in *Roller Coaster Tycoon* is a good reinforcement tool, but it could be better. If that same lesson was integrated into a 3D VLE and the game matched the lesson concepts and provided an immersive learning experience, the overall learning effect on the student would be increased.

A 3D VLE also provides a different learning experience that appeals to students' personal learning styles. Students who learn more effectively in a visual and hands-on environment would also excel in a 3D VLE. Constructivist learning theory can be easily shown in a 3D VLE. An example of students in a guided social constructivist approach using a 3D VLE is *River City*. Several experiments have been conducted and compared against a similar paper-based control group classroom. The examination of the results indicates that on average, students in a guided social constructivist experimental group (GSC) achieved 16% higher scores on the post-test in biology than students in the control group (Clark et al. 2006). The guided parts of *River City* were messages that would give students hints or help when accessed. This allowed the game environment to act as a facilitator of learning. A similar approach was used in the following 3D VLE that was developed by GEARS.

Student motivation has been shown to be a very powerful factor that contributes to learning. Motivation for students to access the 3D VLE doesn't appear to be a problem for many of the current educational games on the market. This is likely due to students pre-disposition to using interactive games. When combining time spent with computer games and video games into a measure of total interactive gaming it is revealed that interactive games consume more than an hour daily of U.S. 8 to

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18-year olds' time. (The Henry J. Kaiser Family Foundation, 2005). Students already enjoy interactive game environments and adding an educational component to the more than an hour per day can serve as a learning tool as well. When considering how many different types of interactive games that exist, it might be concluded that students will not be willing to add another game into their daily lives. A study done by The Henry J. Kaiser Family Foundation in 2005 has shown that many young people do not limit themselves to just one kind of interactive game platform, and that when all interactive gaming is taken together, gaming occupies a substantial portion of U.S. childrens' media time.

3. Game Environment Applying Real Skills (GEARS)

GEARS is a division of the National Network of Digital Schools (NNDS). NNDS offers comprehensive technology solutions and delivers high quality curricula to students, teachers, and administrators. NNDS also provides innovative and effective educational experiences. GEARS is integrated with the Lincoln Interactive curriculum that is exclusively distributed, maintained, and developed by experienced educators and professionals at NNDS. The courses are supported by certified teacher facilitators both in the online curriculum and within the game world. The Lincoln Interactive curriculum is designed for K-12 online delivery and can be used by both online schools and traditional brick and mortar schools. The curriculum consists of over 250 asynchronous online courses and in 2009 these courses were available to over 15,000 students.

Four Lincoln Interactive asynchronous courses were chosen to be integrated with the 3D VLE. Students enrolled in Earth Science Parts 1 and 2, World Geography Parts 1 and 2, Introduction to Algebra Parts 1 and 2, and Spanish Parts 1 and 2. Each course is a full year course broken in two parts that are one semester each. These courses are offered with and without the GEARS 3D VLE integration. GEARS integration is part of the course assessment and is calculated as 40%. All GEARS courses are designed to reinforce and provide application of the concepts learned in the asynchronous course. The ability to actively engage in the content as well as interact with other students and teachers in the 3D VLE provides a great social learning system for students.

Students are supported by teachers in their online asynchronous course which is offered through Blackboard. The course provides content, quizzes, exams, and assessments. The students are also supported by teachers in the 3D VLE. The 3D teachers can help students with quests, glitches, or other issues. A student support forum for GEARS is also available for students to suggest improvements, ask questions, and get technical support. The teachers and technical support are also available by email or phone. Email responses during business hours Monday through Friday from 8 a.m. to 4p.m. EST on average are within 1-3 hours, and outside business hours a response will be within 24-48 hours.

4. ARC: The Impending Gale

ARC: The Impending Gale is a product developed by GEARS. ARC stands for Active Response Corps, which is an organization in the game world that provides disaster relief assistance. The students are part of ARC and have a significant role in setting up relief efforts and preparing an emergency response system. The game was originally released to a small group of students in fall 2007. Due to the success of the program, ARC was released to an even wider audience for spring 2008. Content zones and expansions have been continually added since the release in 2007 and the current content for the game spans an entire year long course. The GEARS program is still operating and has approximately 100 currently active students in the 2008-2009 school year. Roughly 200 students participated in the first year of GEARS courses for the 2007-08 school year.

ARC is an adventure game with role-playing game elements. Students use problem solving skills to work through a variety of quests and overcome obstacles. The role-playing element exists because each student has specific goals and objectives depending on the course enrollment. Each student must do course specific objectives in order to help the relief effort. A few objectives may range from setting up weather monitoring equipment to translating Spanish communications or relics.

Reinforcement of the curriculum based content is a large part of the GEARS environment. There are also additional features such as socialization. Students will meet other students from all four courses and can work through content and help each other. More often a student that is further along or more experienced will help the new students. There is also a monitored chat system for in-game communication. This is a more instantaneous form of communication as opposed to discussion

boards. The students can interact with fellow students and engage in dialogue in a more informal classroom setting.

There are also cultural, geographical, and political aspects of the game. The game world is located on Municipio Peninsula de Taxtapal in Central America. There are small villages, a large port city, and Mayan ruins. The city is very wealthy and the surrounding villages are economically depressed. The students will be interacting with the locals. There is also a political side of the game where the players must interact with the mayor and understand the struggle between the government and the local Indios. The cultural blend of the game and attention to details and local cultural references gives the students the feeling of being in a different country and many of them begin to understand the local customs as they progress through the game.

Students have the ability to create their own custom avatars. They can either represent themselves or be creative. While students' personal identification is not shown to everyone in the game world, each account maintains their personal information for assessment purposes. There are also leisure activities that provide the players with in-game money. These games often have the students accessing the game world even in their free time. Most students that are in the game world will talk with other students and usually complete a curriculum based lesson as well. Students can also purchase customizable clothing, equipment, and accessories to further personalize their character. Students have reacted favorably to creating their own character instead of having a pre-defined character which is the case in other 3D VLEs.

5. Missing social interaction

ARC was originally designed to be a multiplayer online game in which four students would work together as a group to progress through the curriculum. The four students would be from each discipline of math, science, social studies, and foreign language. The original plan called for all students to be online at the same time to complete quests/assignments. In one such quest, it was not possible to enter the temple unless the Spanish student was present to translate the mechanism to open the door. The multiplayer feature was dropped due to the asynchronous mode of delivery. The VLE was trying to impose synchronous time limitations on an asynchronous curriculum.

The system originally assigned students to groups, so if a student was sick or not present the other student could not pick up another team member. Also, due to the curriculum being asynchronous some students were lessons ahead of the group content and had to go back to work they had already completed. It was decided that removing the group component and allowing students to progress through their content at their own pace was best. The social interaction and collaborative learning component in ARC was minimized due to the asynchronous method of delivery.

After breaking the group dynamic structure into individualized instruction the system was modified to enhance communication and a sense of community. While completing quests and progressing through the content, students can communicate with students from all courses in the general in-game chat. This allows for the mentoring system in which veteran students can help new students with basic information on getting started and finding some of the locations within the game world. The students are not able to actually see any of the other students in the main game world because each student gets their own version of the game world in which they are the only player present.

The ARC headquarters was created to allow students face to face meeting in which students can see each others avatars and use the different gesture commands to communicate. The ARC headquarters was designed to be a meeting ground where students could communicate before heading out to complete their work. This was originally text based but the edition of Voice Over Internet Protocol (VOIP) allowed students to use headsets/speakers and microphones for verbal communication.

6. Virtual Social and Educational World

The ARC headquarters laid the groundwork for a plan to create a social environment for online secondary students. The new virtual world would not be tied to a specific course. It would be an immersive environment for students to socialize and play educational standards-based games. Based on research findings, Warburton (2009) explained that the immersive nature of the virtual world, crossing physical, social and cultural dimensions, can provide a compelling educational experience, particularly in relation to simulation and role-playing activities.

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The Virtual Social and Educational World (VSEW) has two main components that will be explored. The first component is the multiplayer competitive educational games. The second component is the social and community building aspect. The VSEW was developed due to fully online students missing a key social piece in education. Students in the VSEW are building a sense of community, making friends, talking about courses, studying, and playing educational games. Figure 1 is a screen capture of the social space with student and teacher specific information removed.

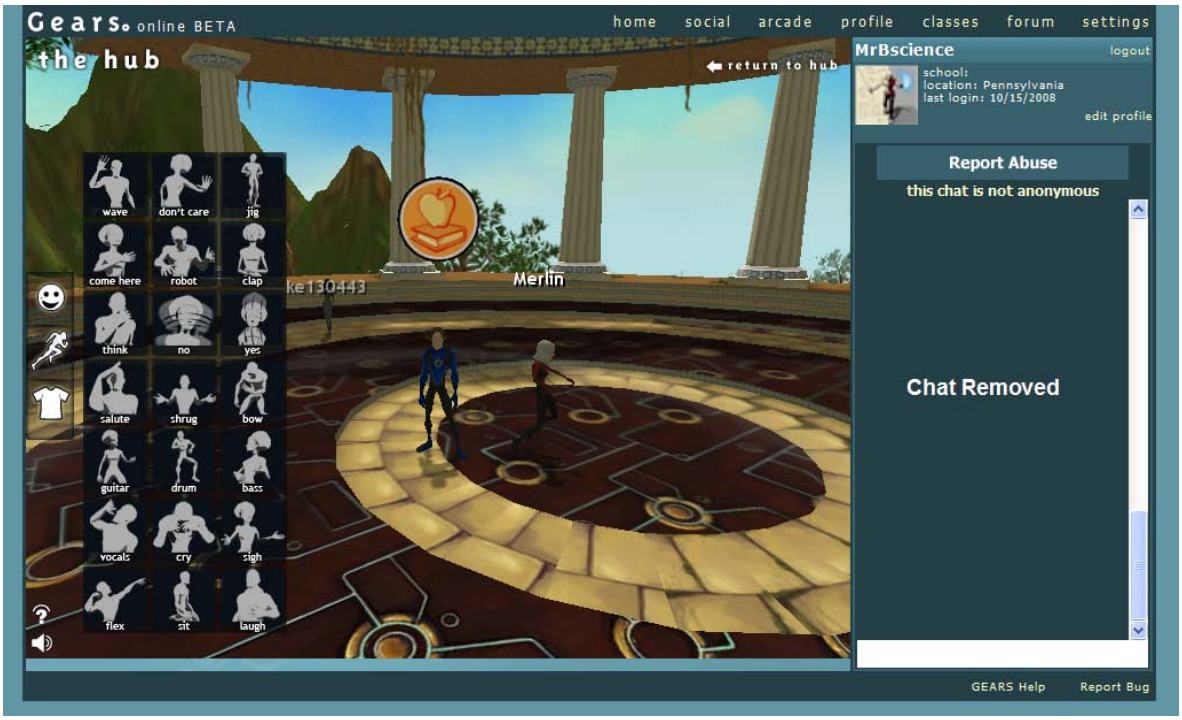

Figure 1: 3D virtual social world with the gesture menu open

Key Components and Sub-Components:

- Location: Mediterranean Island
- Theme: Ancient Roman Architecture
- Time Period: Modern/Semi-Futuristic
- Custom student avatars
- Variety of gestures and emotes
- Teacher Avatars with Icon designation
- Vendor to purchase new items
- Field Trip Dock (future use)
- Tutor Zone
- Collaborative Music Area
- Hall of Heroes
- Deep Factor Game
- Pizza Chop Game
- Fountain of Knowledge Game
- Spell Hex Game
- Forum

The VSEW is browser based and only requires the installation of a web plug-in. The ARC game system was a stand alone software install. When running the game, it was very difficult to switch to online course materials or other resources. A browser based system also opens opportunities for

more students to use the VSEW. Instead of opening a program, they can just open a new browser tab or window.

7. Educational games

Deep Factor, Pizza Chop, Fountain of Knowledge, and Spell Hex games each have an education outcome in mind. The games do not hide the fact that they are educational, but rather they embrace the concept. Focusing on basic concepts allows the age range of players to be very diverse. Each game also has a specific theme and is designed to have a high level of replayability. Three external motivation factors are used within the VSEW games. These factors are competition, multiplayer, and reward. The top ten highest scores are visible on each games homepage. Eventually added is the top player from each game will have his or her avatar displayed in the Hall of Heroes in the 3D virtual world. While each game does have a single player practice mode, the fun part is playing against a friend. Students will challenge their friends to a game that does not involve who gets the most headshots first, but who can solve math problems the quickest. The reward for playing provides reputation and money. Every student that plays receives reputation and money, but winning provides the student with double reputation and money. Reputation is used to qualify for theme specific outfits to wear in the 3D virtual world. The money is used to purchase the additional articles of clothing. Students that play certain games may want to show off their talents by wearing a full themed outfit of their favorite game.

The four current games are Deep Factor (math), Pizza Chop (math), Fountain of Knowledge (social studies), and Spell Hex (language arts). All four games load within the main window in Figure 1, this allows chat and navigation to be accessible at all times. Deep Factor is a math based puzzle game that focuses on addition and multiplication. The students use quick mental math to earn the most points and slow down their opponent. Deep factor is a two player game. Earning reputation points unlocks the diving suit in the virtual social space.

Figure 2: Deep Factor in single player mode

Pizza Chop is also math based, but focuses on fractions. The fractions are displayed on the orders for how the pizza should be chopped into pieces. The students use accuracy, speed, and points

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earned to defeat their opponent. Pizza Chop is a two to four player game. Earning reputation points unlocks the ninja outfit in the virtual social space.

Figure 3: Pizza Chop in single player mode

Figure 4: Fountain of Knowledge in single player mode

Fountain of Knowledge is a trivia game with general social studies questions. Students must also explore the map searching for the fountain of knowledge while gaining knowledge points. The game can become quite competitive because the students can attack each others knowledge points and slow their search for the fountain. Using special items at the right moment can mean the difference between victory and defeat, which adds a strategic element to the game. Fountain of Knowledge is a two to four player game. Earning reputation points unlocks the conquistador outfit in the virtual social space.

Spell Hex is a turn-based spelling game. Each word placed on the board must be used to build other words. It is a timed game with a twist because letters are destroyed if they sit unused for 20 seconds. Not only must students spell correctly, but they must spell quickly. The player with the most points at the end of the game is the winner. Spell Hex is a two player game. Earning reputation points unlocks the wizard outfit in the virtual social space.

Figure 5: Spell Hex in single player mode

Demo versions of the games, social world, videos, social networking information (twitter/facebook) are currently available at the following website: http://www.learnwithfriends.com/.

8. Creating an online educational community

A sense of community is a key part in every student's education. Community exists in a traditional brick and mortar school, but it is more difficult to create in a fully online secondary school. In order to evaluate an online community, the Community of Inquiry framework (Garrison et al, 2000) was chosen. While this framework was not originally directed at asynchronous online learning, Garrison has revisited the framework in numerous follow-up articles. In his review of the framework, it is mentioned that to date there are very few studies that examine the three elements of the framework simultaneously (Garrison & Arbaugh, 2007). The three elements of the Community of Inquiry framework are Social Presence, Cognitive Presence, and Teaching Presence (Garrison et al, 2000). The framework is a great fit for the Lincoln Interactive online curriculum, and the recent edition of the social space allows all three elements to be met.

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Social presence in online learning has been described as the ability of learners to project themselves socially and emotionally, thereby being perceived as "real people" in mediated communication (Gunawardena & Zittle, 1997). Virtual courses have difficulty in projecting social and emotional communication with both students and teacher. The ability to have a 3D avatar that can do gestures, use moods, and custom appearance is part of projecting a presence. The ability to be "face-to-face" with a teacher for tutoring or with other students for a study session provides a social space. Students might work at a distance and individually, and thus, they are not necessarily aware of the activities of other students (Dalsgaard & Paulsen, 2009). It is difficult to feel a sense of belonging to a community when students are not even sure where they belong. If the students were more aware of their "class", information sharing, collaboration, and discussion would be enhanced by social presence. Studies of online socialization within distance learning have found positive correlations between opportunities for socialization and students' perception of learning (Edirisingha et al., 2009).

Garrison, Anderson, and Archer (2001) described cognitive presence as the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse. Asynchronous online learning by design requires students to construct knowledge and reflect. Asynchronous learning does not place a time limit on learning and understanding. The Lincoln Interactive curriculum serves as the information exchange medium and also connects ideas. Due to the curriculum being created and viewed as a collective K-12 model, special attention can be paid to scaffolding and controlling prior knowledge. The integration of ideas to help trigger prior knowledge is a key factor of the cognitive presence. The lessons themselves are comprised of three parts to help differentiate instruction and are indicated through images. The three parts are Key Concept, Reinforcement, and Enrichment. The key concept is the goal or outcome and is tied to the standard(s) the lesson is addressing. Reinforcement is used to trigger prior knowledge or adjust instruction for students that struggle with the key concept. Enrichment is used to extend the lesson to real-world application or more advanced understanding of the key concept. The interactive multiplayer games described above can be used as reinforcement and can serve as a cognitive presence as well.

Garrison et al. (2000) contended that although both social and content-related interactions among participants are necessary in virtual learning environments, interactions by themselves are not sufficient to ensure effective online learning. They described teaching presence as the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes. The teachers for the Lincoln Interactive curriculum are called facilitators. Asynchronous course design places emphasis on the quality of the curriculum in the form of learner objectives. It also lends itself to facilitation more than direct instruction. Teacher facilitators in the Lincoln Interactive courses facilitate posts on the discussion boards. Discussion boards vary between courses and teachers, but usually involve assigned discussion board(s) and general open discussion boards. Discussion board policies and attention to on-task behavior is monitored. Direct instruction can occur in the form of additional tutoring within the 3D social space. There is a specific tutor zone where students and teachers can meet up and discuss real-time with voice, text, and gesture communication. The Lincoln Interactive teacher interacts both socially and in a content specific manner which according to Garrison et al. (2000) is necessary to ensure effective online learning.

9. Conclusions

Being a relatively new form of educational delivery, there is an urgent call for those who are utilizing 3D VLEs and VSEWs to collaborate and conduct research regarding their experiences and success for use in future program development. The creators of GEARS are constantly striving to improve the educational experience for students in the 3D VLE and VSEW. Eric Hardman, the Creative Director of GEARS states, "starting only with quality curriculum and a desire to develop social virtual experiences, we have worked directly with students and virtual classroom teachers to create something specifically tailored to online learning. Rather than a generic world, these are interrelated, purpose-built learning tools tuned to maximize engagement and generate rich social interactions."

The pedagogical elements underlying 3D VLEs continue to expand, and as the practical use of 3D VLEs in education is critically evaluated, the need for current research will becoming increasingly important. The Lincoln Interactive online asynchronous courses appear to be a practical and advantageous match for integration with GEARS 3D VLEs. However, the ability to use the GEARS environment in traditional face-to-face classroom instruction is another area that NNDS is currently

expanding. As K-12 school districts look at the future of education and experiences that traditional classrooms will be unable to provide, 3D VLEs and VSEWs will be the likely choice.

The 3D VSEW is helping create a sense of community in the Lincoln Interactive asynchronous environment. Many of the arguments against online learning state that the social environment is significantly lacking. Since the launch of the VSEW students have been discussing courses, interests, and most of all making friends. Many online students were either not given the time or the ability to communicate with their fellow classmates. The VSEW is also providing teachers the ability to appear to students in ways other than text or a voice from computer speakers. A traditional brick and mortar school allows students to talk with their teachers before and after class and talk with friends between classes. This is a key feature in building a sense of community. The VSEW discussed in this paper is an initial attempt to provide this feature and give socialization a chance in an online asynchronous environment.

Keeping pace with technological advancements is an ongoing process with a 3D VLE and VSEW. As new technology emerges in the game design market, the need to upgrade current systems will become necessary. There are already advances in avatar creation, rendering capability, and the overall graphics. The original ARC 3D VLE has existed for three years and will soon be replaced or integrated into the new VSEW. Based on experience, a 3D environment needs updated every three years to stay current or ahead in the 3D VLE and VSEW market. As 3D VLEs become more popular as education environments, there will be significant improvements to 3D VLE technology. Effective use of the new 3D VLE technology to promote student learning should be the objective for all online education institutions.

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