Chapter XXIII

Inhabited Virtual Learning Worlds and Impacts on Learning Behaviors in Young School Learners

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ABSTRACT

The paper outlines a new paradigm and its underlying rationales for implementing networked learning environments that is emerging from new technologies such as multi-user platform, virtual worlds, virtual learning community, and intelligent agents. The proposed paradigm of the networked learning environments is described as inhabited virtual learning worlds (IVLW), which is a shared learning space in 3-D format and populated with avatars that are the representations of learners who are geographically dispersed around the world. The virtual learning worlds are also composed of objects such as intelligent agents and learning materials. A pilot system is created based on the discussed rationales of inhabited virtual learning worlds. A preliminary empirical study focusing on the selected learning behaviors in young learners also has been conducted with the pilot system. The results of the empirical study and suggestions for enhancing the pilot system are discussed in the closing section of the article.
INTRODUCTION

There is much discussion pertaining to the potential of information technology to transform strategies of learning and create a learning society that values the principles of knowledge economy. However, the potential has yet to be realized due to a lack of sound networked learning paradigm and rich digital content. Furthermore, after decades of endeavors by the researchers and practitioners in the field, the search for a profound pedagogy for the application of Internet in education continues (Concord Consortium, 2002). It is obvious that there remains a great deal to be learned about networked learning or virtual learning, especially in the issues of designing networked learning environments and digital learning content.

After much hype for several years in the field of education, especially at K-12 levels, networked learning has come to redefine itself for reality. To date, there exists no clear evidence that Internet or information and communication technology has brought significant “added values” to conventional education or learning approaches (Lin, 2001a). It seems that a sufficient and sound networked learning environment has not revealed yet.

In addition to a lack of qualified digital content, the existing networked learning environments or Web-based learning platforms function more as an information warehouse than as a learning space. Above all, most Web-based networked learning environments currently available are in a teacher-centered or information delivery paradigm. This paradigm of networked learning usually discourages learning engagement and creates strong student isolation. This type of learning is passive and unable to engage student in active learning. Online students may find it difficult to follow the learning tasks and to monitor their progress (Lin, 2001b). Learning community and learning supports that are needed for motivating learning in online learning are completely missing in the teacher-centered or information delivery model. Hence, learner engagement of learners is absent.

A new paradigm in designing networked learning environments that is different from the existing Web-based teacher-centered or information delivery paradigm is needed. Based on the current study in the field and advent of new information technologies (Concord Consortium, 2002), one solution is the incorporation of inhabited virtual learning worlds with the support of intelligent agents.

The fundamental rationale for inhabited virtual learning worlds (IVLW) is creating a shared and immersive learning space that is in 3-D format and populated with avatars where they can pursue collaborative learning activities and form a vibrant learning community (Vlearn3D, 2002). Avatars, the representations of learners in the space, can talk, walk, move, gesture, point within the IVLW and interact to each other or with objects in the IVLW, which contributes to intense social and intellectual interactions. Furthermore, IVLW can be seamlessly integrated with existing Web pages and teleported to other learning resources. The features thus extend the accessibility of information to avatars in the IVLW (Lin, 2002).

According to Gilbert’s definition, an intelligent agent is “software that assists people and acts on their behalf” and it could make “computer systems easier to use by allowing people to delegate work back to the computer” (Gilbert, 1997). Research on intelligent agents has mushroomed in the past few years. There are two conflated areas of the research on intelligent agents currently (Isbister, 2005). One focuses on the use of artificial intelligence (AI) techniques to create software that performs information filtering and other autonomous tasks such as computing or searching for learners. Intelligent agents of this sort, referred as autonomous agents, may or may not display any explicitly anthropomorphic features. The other focuses on the agents acting as an interface metaphor that assists the learner in interacting with the system or environments. The latter, also known as interface agents, may or may not incorporate new AI techniques. The
essential function of interface agents is to act as effective bridges between a learner’s goals and expectations and the system’s capabilities. The agent metaphor is used to make the interface more intuitive and to encourage interactions that might be difficult to evoke with a traditional graphic user interface (GUI). Usually, an agent of this sort has its own unique anthropomorphic character and figure.

Creating learning community and providing learning supports are the two most essential pedagogical issues for the success of a networked learning environment (Lin, 2001b). In light of resolving these two issues, the combination of inhabited virtual learning worlds and intelligent agents constitutes some of the most appealing solutions.

**THE SIGNIFICANCE OF INHABITED VIRTUAL LEARNING WORLDS**

Based on the results of networked learning studies (Lin, 2002; Concord Consortium, 2002), the current practice of Web-based learning pedagogy that focuses on publishing learning materials on the Internet could be replaced and transformed by the application of virtual reality technology. To achieve a success in networked learning, it is important to create virtual learning worlds that combine the strengths of 3-D spatial learning, immersion, high learner telepresence, immediate visual feedback, and interactivity.

As postulated by Damer, Gold, Marcelo, & Revi (1999), inhabited virtual worlds have distinguished themselves from a 3-D graphical space by infusing simulation of living systems and therefore can play an important role in community building in cyberspace. The persuading features of a virtual learning world are that it could transform the networked learning environments into to a 3-D shared learning space and the learners in the shared space could be represented with avatars. An inhabited virtual learning world also provides the common playground for human creativity for all the intelligent agents that are associated with learning. Ultimately, the significance of 3-D shared learning space is that it could help to promote interpersonal interaction among learners via spatial dimensions with the sense of immersion and build up learning community with its analogy to the social bond that would engage learners in learning activities. In essence, the virtual learning worlds could provide a shared learning space for inhabiting avatars that are analog to the physical social circumstances (Costigan, 1997; Concord Consortium, 2002).

**THE SIGNIFICANCE OF AVATARS**

Avatar is the representation of learners in the virtual learning worlds with characters or icons. Avatar embodies a type of intelligent agent and inhabits the virtual learning worlds representing individual learners. In other words, avatar is the resident of IVLW and is part of the virtual learning worlds.

Many researchers have asserted that people learn best through the medium of human relationships (Concord Consortium, 2002). This is the reason that current Web courses in the field emphasize the implementation of features such as student-to-student interaction or teacher feedback. The claim suggests the importance of learning community building in networked learning environments. However, some researchers assert that the richest communication occurs when people are physically face-to-face, which the most sophisticated technology for connecting people with audio and video cannot surpass (Costigan, 1997). Nonetheless, recent research has also found that the use of avatars in immersive 3-D worlds could provide a higher sense of telepresence than other conferencing systems (Chou, 1999). The question then is: which communication scheme is the best choice for learning community building?
Walther (1996) classified three types of computer-mediated communication (CMC): impersonal, interpersonal, and hyperpersonal interaction. Different types of interaction are appropriate for various purposes. Impersonal interaction can be fostered in anonymous commenting, brainstorming, and for equal participation without knowing the individual’s status. Interpersonal interaction contributes to a community of practice and establishes a more healthy relationship among the online learners. Hyperpersonal interaction could increase learner satisfaction and enrich learning experience. According to Walther (1993), computer-mediated communication (CMC) is no less impersonal than face-to-face communication. Different types of CMC systems could contribute to or constraint learner interaction. Therefore, CMC systems should be selected for the purposes that each system could provide the best capacity.

Online interpersonal communication for community building can be facilitated by CMC systems that include text-chat, audio conferencing, video conferencing and avatars in IVLW. Interpersonal communication relies heavily on both verbal and non-verbal cues. A quick comparison on the verbal and non-verbal capacities between different communication schemes could provide a good overview on how avatars can provide added values to community building and interpersonal communication.

In face-to-face communication, the communicators have relative positions, the abilities to point and gesture, and to use facial expression to convey meaning within a limited distance. In text-based chat, although the instant feedback allows quick interaction, the lack of visual and audio cues leaves many aspects of communication unfulfilled. In the audio conferencing mode, communicators are connected through audio without visual cues or shared space. In the video teleconferencing mode, the ability to use facial expression is still available, although there is no shared space, nor can one gesture in that shared space. In avatars-mediated interaction, although the ability to use facial expression is no longer available under the circumstances of current information technology, there remains a shared space and the ability to use gestures.

The comparison of the five communication channels suggests that without physical limitations such as size, distance, and time, the potential of avatars to convey messages beyond human capacity is very positive.

Furthermore, since the abilities to share a space and to gesture with relation to that space are important in communication, the amount and quality of information conveyed using an avatar should be similar to or greater than that of the face-to-face interaction (see Table 1). Hence, for the purposes of education or learning, the ability to share space and to have a presence whether real or virtual are more beneficial than the ability to see facial expressions in communication (Costigan, 1997). This indicates the value of avatars communication scheme in learning and education.

In addition, as the comparison in Table 1 has highlighted that the use of avatars for interaction could be equal to or provide more advantages than face-to-face communication for the following reasons. First, avatars allow participants to interact with one another directly in a virtual environment, as much as face-to-face interaction does. Second, avatars provide learners with the ability to communicate nonverbally through position and gesture, which, again, makes it similar to face-to-face interaction. In video conferencing, interaction is possible only through the two dimensional screen, and nonverbal cues can only be observed from the image on the screen. Indeed, the space of interaction is not shared among participants of communication in video conferencing. Third, the sharing of space and immersion of learners are more important in education or learning processes than the ability to see and interpret facial expression.

In essence, avatars provide strong personal identity and telepresence to learners in networked
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Table 1. The comparison of communication schemes

<table>
<thead>
<tr>
<th></th>
<th>Verbal interaction</th>
<th>Facial Expression</th>
<th>Shared Space</th>
<th>Gestures in the Shared Space</th>
<th>Physical Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-Face</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Text-chat</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Audio-conferencing</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Video Conferencing</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>Avatars in IVLW</td>
<td>✓</td>
<td>?</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Legends ✓: full support ❓: limited support x: unavailable

learning environments. It is a necessary tool for learners to perceive their learning circumstances and help them gain the sense of belonging and ownership of the networked learning environments. Avatars allow learners to take residency in the learning environments with full immersion and strong engagement, which are the necessary ingredients for building a vibrant learning community.

THE SIGNIFICANCE OF INTELLIGENT AGENTS

In recent years, the research and application of intelligent agents have advanced by leaps and bounds. Intelligent agents, in addition to avatars, are proposed to provide imperative learning supports in customized and individualized manners for learners in IVLW. In essence, intelligent agents could provide all kinds of learning support and make adaptive learning possible in the networked learning environments. In other words, the roles of intelligent agents are to monitor learners’ learning behaviors, to record learning processes, to understand learners’ progress, and to assist learners in an adaptive fashion at any time. Thus, intelligent agents could increase the learning activities in the networked learning environments dramatically (Lin, 2001b).

In order to achieve the above-mentioned goals, we propose that an ideal networked learning environment should include these five intelligent agents: (1) learning companion, (2) moderator, (3) genie, (4) digital librarian and (5) evaluator (Lin, 2002).

Learning Companion

As the name implies, learning companion is an assistant or friend for every individual learner who would accompany the learner along the learning paths all the time. The roles of a learning companion in IVLW are to learn together with learners, provide support to them, interact with them and reduce their learning difficulties in a scaffolding manner. The learning companion would also suggest learning styles suitable for each individual learner respectively. For instance, Best Cyber Academy implements a learning companion—WuKong—and several studies already demonstrated that, with WuKong’s assistance, the motivation and learning performance of learners in Best Cyber Academy were improved dramatically (Lin, 2001b).
Moderator

Collaborative learning activities and interpersonal communication are crucial tenets in constructivist learning and essential to networked learning. Some scholars have contended that providing moderating strategies is a key to the success of collaborative learning projects or activities (Roussos, Johnson, Moher, Leigh, Vasilakis, & Barnes, 1999). In practice, a moderator could direct the collaborative learning activities by tracking learning procedure and monitoring learning process. An experienced and intelligent moderator would guide learners to interact with other effectively and increase the quality of team works.

In a virtual learning space such as IVLW, the role of a moderator is essential in engaging learners in collaborative learning activities effectively. Even though deploying well-trained human moderators in IVLW is possible, the price could be high. It would be unrealistic or implausible to adopt the human moderator when the learning space is populated with crowded learners. Therefore, one best way to install moderators in IVLW is to utilize intelligent agents.

Genie

A genie acts as the mentor to learners in networked learning environments. A genie can examine and search the learner profile, understand the learning situation and difficulties, answer learner's inquiries, and provide learners with appropriate assistance. Genie is the opposite of learning companion in terms of tenderness and strategy of learning support toward learners.

Digital Librarian

Inquiry-based and project-based learning strategies are common for designing networked learning content or activities. Searching for resources in networked learning environments is one of the essential learning activities. However, searching tools such as search engines are not the best solutions for kids and the general public, nor are they suitable for learning purposes. A digital librarian is proposed to assist young learners and civilians alike for searching learner resources, filtering, and organizing information to suit individual needs and to automatically handle information overflow in the virtual learning space. Through the help from the digital librarian, learners can receive the information they really need in a just in time fashion and allow them to focus on learning tasks.

Evaluator

In networked learning environments, dynamic learning assessment is required from time to time for adjusting the learning paths or providing adaptive learning supports. An evaluator is proposed to conduct assessment on artifacts and learning performance to individual learners or groups. The evaluator can also provide input on assessment results to learner profiles. After evaluation, the evaluator could also provide immediate feedback or live online guidance to other intelligent agents such as moderator or genie.

Among these five intelligent agents, learning companion and genie are interface agents who are responsible for interacting with avatars directly. The other three agents (i.e., moderator, digital librarian, and evaluator) are autonomous agents who will process the information in the background of networked learning environments and support interface agents.

IMPLEMENTATION ISSUES

After analyzing the pedagogical values of IVLW, avatars, and intelligent agents for enriching the networked learning environments, the issues of implementation are the focus of this section. There are several essential features that are worthy of
consideration when implementing the inhabited virtual learning worlds with intelligent agents.

Learner Profile

A learner profile is similar to a student model in expert systems, which represents each individual learner’s learning behaviors and status dynamically. It is the essential ingredient for embedding intelligent and adaptive features into the networked learning environments. A learner profile is the heart of the brand new pedagogical approach of virtual learning.

Logging Mechanism

The logging mechanism in IVLW is essential and is designed to keep track of all the learning activities that happen on it. The data collected by the logging mechanism stored in log files is the primary resource for constructing learner profile and providing intelligence to the intelligent agents.

Spatial Dimension

A learner profile usually is composed of data of a specific learner’s personal information and learning status and behavior. In IVLW, these data are not enough to characterize the learning model and social space of any individual learner. The data in learner profile should be transformed to 3-D spatial dimension in order to utilize the environments of IVLW. By including the data of 3-D spatial dimension, IVLW then has the opportunity to demonstrate the relationship among learners in it. In other words, conventional student model or learner profile holds the information of learners pertaining to their characteristics and learning status; nonetheless, spatial dimension could represent the relative relationship among learners in IVLW and provide information on patterns of learner interaction in a 3-D environment.

Virtual Interaction

Interpersonal interaction (i.e., the virtual interaction) takes place in virtual learning worlds that resemble the actual physical settings. Therefore, the virtual interaction in IVLW should combine the features of visual, gestural, and verbal communication. With these features, the learners in the virtual learning worlds would be able to apply the communication skills that resemble the tangible social interaction environments.

Archives

IVLW is a persistent learning world. For creating the sense of a learning community, there is a need to record the significant events or histories of the worlds for newcomers of the community. Archives of the historical events that have occurred in the worlds will do the job.

THE PILOT SYSTEM

The new paradigm of networked learning environments has been outlined and described as above. For fulfilling the framework and making it work, much effort has been directed to the design of the multi-users platform in 3-D format. A pilot system of IVLW with fewer features, entitled The Best Inhabited Virtual Learning Worlds (Best IVLW), has been implemented for usability analysis; Figure 1 is the architecture of the pilot system.

The architecture of the Best IVLW is drawn extensively from the technology of MUDs, which have existed for almost three decades and are a rich resource of reference about the structural aspects of virtual worlds (Vellon et al., 1998). Since the essence of the new paradigm is learning community of practice, the architecture emphasizes supporting the structural social mechanisms. To better facilitate the coordination of activity and the implementation of persistent world state,
the Best IVLW chose client/server architecture over peer-to-peer. In addition, the architecture incorporates a very dynamic object model in the sense of software engineering in order to support the ability to add methods and properties to 3-D objects at run-time.

In essence, from technical point of view, the Best IVLW architecture possesses following features: (1) it is a distributed architecture metaphorically represented by 3-D virtual world that allows multiple users to interact in the shared space. (2) Objects in the virtual world are persistent over time. (3) It is extendable and scalable with runtime editing capability. It allows users to extend and make changes to it while it is running.

3-D World

The 3-D World provides a metaphor of the virtual shared learning space, which features avatars and objects such as learning materials and teleports. It is the primary component of the IVLW system.

The graphical presentation of the space allows a group of people to interact socially and see each other’s actions and responses. The interface of the virtual world subsequently requires social functionality for avatars’ talking and gesturing. The topology of the space is defined by “room” objects, representing discrete locations and which are interconnected by portal objects. There are

Figure 1. The system architecture of Best IVLW
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also artifact and avatar objects in the world that configure “things” and people respectively.

**Bird’s Eye View**

This is an overview map of the world with radar function that could spot the locations of the online avatars respectively. Learners could approach any avatar on the map by clicking it with their mouse. In addition, learners could also search for the current location of wanted avatar by keying the name in the search box in the map.

**Message Pane**

There are two kinds of message in the world. One is the interaction message generated by avatars and the other one is the broadcasting message initiated by the system. The message pane provides both functions of sending and receiving message in text format.

**Profile Pane**

Learners who are online are displayed with their icons of avatars and names in the profile pane. Learners could access anyone’s learner profile as long as it is online by clicking on the respective icon of the avatar in the profile pane. There are twelve variables in the learner profile and they could be divided into three different categories.

1. **Personal identity**: The data in this category is static and associated with learner’s personal identity information. It is composed of full name, gender, affiliate, and city pertaining to individual learners respectively.
2. **Learning behaviors**: The data in this category are dynamic and accumulated and are related to learner’s learning behaviors online. The data are tracked and recorded by the system automatically. The data in this category are composed of frequency of login, frequency of upload (submitting artifacts), frequency of chatting, and charisma, which represent the learner’s frequency of being included in other’s friend list.
3. **Personal portrayal**: The data in this category is also static and associated with personal information. However, the values of variables in this category are editable to learners at any time. It is composed of

*Figure 2. Interface of the best IVLW*
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hobby and interests, personal photo, and friend list.

Figure 2 is a screen shot of the interface of the pilot system.

A PRELIMINARY EMPIRICAL STUDY

An empirical study is conducted with the pilot system to collect the experience of utilization of IVLW in learning and investigate the effects of learner profile on selected learning behaviors of elementary school learners. The independent variable is the presentation mode of learner profile, which has two values that are “click presented” and “collide presented.” In “click presented” mode, the learner profile pops up on the screen when the avatar is clicked by the learner with mouse. As to the “collide presented” mode, the learner profile pops up on the screen when the avatar is collided by a controlled avatar. The system tracks and records four learning behaviors when learners are online, which are frequency of reviewing peer’s profiles, frequency of chatting, frequency of reviewing its own profile, and frequency of modifying its own profile. These are the dependent variables that the study has focused on.

Research Questions

Since the Best IVLW is only a pilot system and the purpose of the preliminary study is to gain first-hand experience of utilizing IVLW in young school learners for setting the guidance of future studies, several practical research questions in the following are of primary concerns at the moment. What are the student feedbacks after using IVLW? What are the student attitudes toward the IVLW? In the Best IVLW, how do learners interact to each other? Does a learner profile play an important role in interpersonal interaction? Does a learner profile impact the learning behaviors?

Experimental Design and Treatments

There were 191 5th and 6th graders, from six different classes in two schools, who participated in the experiment during 16 class periods respectively. They were guided to login to the Best IVLW in their computer labs respectively and asked to complete several project-based learning programs within 16 class periods. The project-based learning programs were implemented with interactive Web pages and were teleported in the Best IVLW. In the first eight class periods, the subjects had to click on the avatars with the mouse to access their peers’ learner profiles. In contrast, the learner profiles automatically popped up when the controlled avatars collided with other avatars within a specific distance in the world in the later eight class periods.

Results

The quantitative data were collected with the logging mechanism of the Best IVLW and an online questionnaire. Statistical methods such as the frequency of distribution and z test were

<table>
<thead>
<tr>
<th>Treatment in Learner Profile</th>
<th>Number of Subjects</th>
<th>Frequency</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Click Presented</td>
<td>66</td>
<td>435</td>
<td>6.59</td>
<td>3.85</td>
<td>-2.568*</td>
</tr>
<tr>
<td>Collide Presented</td>
<td>66</td>
<td>510</td>
<td>7.73</td>
<td>4.71</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05

Table 2. The frequency of reviewing peer’s learner profiles in two treatments
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utilized to analyze data. There are only 66 subjects who completed the programs to the end of the experiment. The study accepts the 66 subjects as the sources of data analysis.

Frequency of Reviewing Peer’s Learner Profiles

Table 2 shows the difference in frequency of reviewing peer’s learner profiles between two treatments. The average frequencies of reviewing peer’s learner profiles in Click Presented treatment and Collide Presented treatment are 6.59 and 7.73 respectively.

The z test indicates that the difference in the frequency of reviewing peers’ learner profiles between two treatments is significant. The result implies that when subjects were presented with their peers’ learner profiles automatically, they did wish to know more about those with whom they interacted.

Frequency of Chatting

Table 3 shows the difference in frequency of chatting between two treatments. The average of frequency of chatting in Click Presented treatment and Collide Presented treatment are 3.59 and 4.83 respectively.

The z test indicates that the difference in the frequency of chatting between two treatments is significant. The result implies that when subjects were presented with their peers’ learner profiles automatically, they intended to initiate interaction actively.

Frequency of Reviewing Its Own Learner Profile

Table 4 shows the difference in frequency of reviewing its own learner profile between two treatments. The average of frequency of reviewing its own learner profile in Click Presented treatment and Collide Presented treatment are 4.73 and 6.06 respectively.

The z test also indicates that the difference in the frequency of reviewing its own learner profile between two treatments is significant. The result implies that most of the subjects did care about the data presented in their own learner profiles.

Frequency of Modifying Its Own Learner Profile

Table 5 shows the difference in frequency of modifying one’s own learner profile between two treatments. The average of frequency of modifying one’s own learner profile in Click Presented treatment and Collide Presented treatment are 1.48 and 1.18 respectively.

Probably because subjects had already modified their learner profile in the first eight class pe-

Table 3. The frequency of chatting in two treatments

<table>
<thead>
<tr>
<th>Treatment in Learner Profile</th>
<th>Number of Subjects</th>
<th>Frequency</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Click Presented</td>
<td>66</td>
<td>237</td>
<td>3.59</td>
<td>4.33</td>
<td>-3.177*</td>
</tr>
<tr>
<td>Collide Presented</td>
<td>66</td>
<td>319</td>
<td>4.83</td>
<td>4.98</td>
<td></td>
</tr>
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</table>

* p < 0.05

Table 4. The frequency of reviewing its own learner profile in two treatments

<table>
<thead>
<tr>
<th>Treatment in Learner Profile</th>
<th>Number of Subjects</th>
<th>Frequency</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Click Presented</td>
<td>66</td>
<td>312</td>
<td>4.73</td>
<td>4.75</td>
<td>-3.895*</td>
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<tr>
<td>Collide Presented</td>
<td>66</td>
<td>400</td>
<td>6.06</td>
<td>5.79</td>
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</tbody>
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* p < 0.05
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Table 5. The frequency of modifying its own learner profile in two treatments

<table>
<thead>
<tr>
<th>Treatment in Learner Profile</th>
<th>Number of Subjects</th>
<th>Frequency</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Click Presented</td>
<td>66</td>
<td>98</td>
<td>1.48</td>
<td>1.66</td>
<td>1.093</td>
</tr>
<tr>
<td>Collide Presented</td>
<td>66</td>
<td>78</td>
<td>1.18</td>
<td>1.40</td>
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Table 6. Responses to four Likert-style questions in questionnaire

<table>
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<th>Questions</th>
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<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>13</td>
<td>19.7</td>
<td>26</td>
<td>39.4</td>
<td>19</td>
</tr>
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<td>10.6</td>
<td>25</td>
<td>37.9</td>
<td>25</td>
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<tr>
<td>C</td>
<td>17</td>
<td>25.8</td>
<td>26</td>
<td>39.4</td>
<td>19</td>
</tr>
<tr>
<td>D</td>
<td>21</td>
<td>31.8</td>
<td>28</td>
<td>42.4</td>
<td>17</td>
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Table 7. Suggestions to the future enhancement of the IVLW

<table>
<thead>
<tr>
<th>Answers</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide Costumes for Avatars</td>
<td>64</td>
<td>97.0</td>
</tr>
<tr>
<td>Provide More Sophisticated Virtual World</td>
<td>63</td>
<td>95.5</td>
</tr>
<tr>
<td>Provide Gestures in Avatars</td>
<td>59</td>
<td>89.4</td>
</tr>
<tr>
<td>Provide More Objects in the World</td>
<td>56</td>
<td>84.9</td>
</tr>
<tr>
<td>Provide More Roles and Selections of Avatars</td>
<td>55</td>
<td>83.3</td>
</tr>
<tr>
<td>Provides Voice in Avatars</td>
<td>53</td>
<td>83.3</td>
</tr>
<tr>
<td>Provide More Information in Profiles</td>
<td>37</td>
<td>56.1</td>
</tr>
</tbody>
</table>

Table 5 shows the frequency of modifying one’s own learner profiles between two treatments. The results indicate that there is no significant difference in the frequency of modifying learner profiles between the two treatments.

Table 6 shows the responses to these four questions. Referring to the Likert 5-point scale, answer 5 in the table represents the strongest degree of agreement or preference. In contrast, answer 1 represents the least degree of agreement or preference.

Based on the data in Table 6, most of the subjects indicate that: (1) they like the immersive 3-D learning space; (2) avatars accompanied with learner profiles do assist their communication with others; and (3) the quality of the Best IVLW is not quite acceptable.

Question A: Do you like our 3-D world?
Question B: Does the 3-D world help you to communicate with others?
Question C: Does avatar make your chatting with others more interesting than merely through text box?

Question D: Is the information in learner profile helpful in making the acquaintance of others?

Responses in Questionnaire

An online questionnaire was presented to subjects at the end of the experiment. The questionnaire consists of five questions, four of them are regarding the subjects’ experiences in using or attitude toward IVLW (using Likert 5-point scale), and one is a multiple-choice question regarding their suggestions for enhancement of the IVLW. The four Likert-Style questions are as following:

Table 7 shows tabulated responses to the multiple-choice question regarding suggestions for future enhancement of the Best IVLW.

The responses in Table 7 could be characterized as revealing that information contained in
the learner profile is sufficient at the moment to the subjects. However, the responses also indicate that a well-designed virtual world, more functionalities and attractiveness in avatars, better customization of avatars, and rich content for exploration are all needed for meeting the promises of the IVLW.

Furthermore, only 34.6% (66 out of 191) of the subjects completed the assignment in the experiment. This implies that the Best IVLW was somewhat amusing to learners in the beginning but of low relevance to their curriculum.

Although the pilot system of IVLW is far from acceptable and practical in terms of virtual learning space, the results of this preliminary study reveal that: (1) learners hold positive attitudes toward the 3-D virtual worlds and the utilization of avatars, (2) the presentation of learner profile in IVLW could have a significant impact on learners’ learning behaviors and experiences. It seems that learner profile could trigger more communication among learners, which may result in better learning performance in terms of constructive learning. (3) Learners acknowledge that the enhancements of the quality of IVLW and the interactive functions of avatars are needed (i.e., more vivid look of avatars, voice communication function in avatars, personalized appearance of avatars, more virtual scenes and 3-D objects, and merging curriculum into the virtual worlds).

CONCLUSION

Based on the experience in the field of networked learning during these past two years, we found that telepresence, learning communities, and learning supports in networked learning are the top issues to be resolved before a full implementation of virtual learning in education. This article proposes a new paradigm of designing networked learning environments that abandons the current practice of Web-based teacher-centered or information delivery paradigms. The suggested approach is to create a virtual learning world that could provide a 3-D shared learning space as the residence of avatars, which are the delegations of individual learners in the learning environments. In practice, each individual learner will be represented with an avatar in the virtual learning worlds and supported by a variety of intelligent agents who also reside in the networked learning environments.

Through the use of avatars with learner profiles, geographically separated learners are simultaneously presented in the virtual learning worlds and the utilization of the visual, gestural, and verbal interaction are becoming available. These considerations are important to the fostering of a vibrant learning community and development of unique collaborative experiences to learners. The new paradigm utilizes the strengths of virtual reality: a combination of immersion, telepresence, immediate visual feedback, and interactivity.

With the proposed paradigm, it is possible to create a networked learning environment that not only resembles the real-life school learning environments, but also augments the value of traditional education by removing its shortcomings and implementing the virtual learning space and extending in the new horizon of learning experience. It holds the high promise that the issues of learning communities and learning supports in networked learning could be resolved with the new paradigm of networked learning environments.

However, the preliminary study shows that it is never easy to claim the promise of the new paradigm. IVLW is an emerging learning environment and research on the field remains much needed. The enhancement of the pilot system, the Best IVLW, is currently underway based on the experiences gained from the empirical study and will be the test bed for further studies. In addition, several digital content projects designed with role play simulation and game genre are also in the phase of development (Lin, 2005). It is expected that more insights into this new paradigm of networked learning environments could be achieved with further empirical studies.

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REFERENCES


