Problem-Based Learning Activities in Second Life

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Abstract

Problem Based Learning (PBL) that is important for engineering education and has been a tool for creative engineering design can enhance creativity and has been used to successfully carry out many experiments in the real world. Researchers in the US and Japan (the authors) are pursuing studies about its use in a virtual environment, one with cutting-edge technology and opportunities for complementary activities between face to face learning and electronic learning. Here students can work from anywhere in the world, at any time, and with their own pace. Student teams from the US and Japan have already carried out several problem-based learning projects in Second Life (SL). The US teams' successful projects are presented and compared.

Keywords

Problem-Based Learning; Second Life; Engineering Education

Introduction

Problem-based learning provides students with challenging, ill-structured problems related to their daily lives. The students receive guidance from their teachers and work cooperatively in a group to seek solutions to the problems. Student teams from the US and Japan have worked on different problems in Second Life (SL), an online three-dimensional community. Each team consisted of three students between the ages of 16 and 18 years old. All of their activities took place on a virtual island owned by Nagaoka University of Technology, Japan. Students met in virtual classrooms that resembled those seen in real life, with items such as tables and chairs. This arrangement gave the team members a sense of reality. For the first two activities, students' conversations and discussions were based on the chat function in SL.

Participants typed text messages in the input box at the bottom of the screen to exchange ideas and thoughts with each other. All of the dialogue was recorded as files written by the Linden Script Language. Then it was sent to a web server, and finally saved as CSV files. This information was accessed (by the teacher and students) for analysis by using various web browsers. Students used avatars in the virtual environment to carry out activities on behalf of them. Their avatars constructed items such as houses by preparing prims (three dimensional objects, also called primitives, written by the Linden Script) in a space referred to as a sandbox, located in front of the virtual classroom. (See Figure 1) The teams participated in three PBL projects that took place in SL (a pilot study, an eco car activity, and a nuclear energy safety lesson). These projects are presented and discussed.

FIG. 1 US STUDENTS' AVATARS PRACTICE MAKING PRIMS.

Pilot Study

Since PBL has been very useful in real classrooms, the
authors wondered if it would be an effective teaching tool in Metaverse. To confirm this, they tried a Pilot Study in 2009 for a PBL project in the virtual world. This project was carried out in Second Life by student teams from the US and Japan in virtual classrooms built and owned by Nagaoka University of Technology (NUT). (See Figure 2) (The small dark blue rectangle on the wall is the dialogue recording box.) Each team worked independently on the same PBL project. They received guidance from their teachers. The student teams were asked to solve the following problem. What will the typical house look like in the near future, during the global warming era? The participants from both countries enjoyed and successfully completed this project.

It should be mentioned that in order for the students to carry out projects in SL, they had to perform various functions in the virtual world. At start, they registered and named an avatar to carry out activities on behalf of them; then made their avatars move by using tasks such as walking, running, and flying; followed by using the teleport function to transport their avatars to different locations in SL. For this Pilot Study, the students brainstormed, participated in group discussions, and made decisions (in the virtual classroom) by using the chat function. Also they designed and prepared prims (three-dimensional objects, such as cubes, written in Linden script) to build their houses of the future.

Each student also completed a survey to provide more information about the project. The US and Japan teams both found prim making to be a hard task while the teleport task was relatively easy. The US team felt the task of chatting (communication) easier than the Japan team. On the other hand, the Japan team found the basic avatar movements easier than the US team. All of the students were satisfied with this PBL class in Metaverse and successfully completed the project. The US house of the future was a dome-shaped structure with solar panels on the roof and a floor made of synthetic wood to preserve the Earth’s trees. Japan’s team built an energy efficient dome-shaped house with a ceiling that automatically opened so that cool breezes could flow through it. (See Figure 3) The results of the Pilot Study clearly indicated that this kind of PBL class was possible for actual e-learning in engineering education. Therefore, the researchers decided to pursue their studies with two additional projects.

**Eco Car Project**

This project also took place in SL on an island owned by Nagaoka University of Technology (NUT) in Japan. Researchers at the University built new virtual buildings containing virtual classrooms so that the eco car project and others could be carried out in SL. These classrooms included red chairs, tables, a podium, white boards, and a recording box to collect chat dialogues. The US instructor used Power Point slides to present the car problem and to provide general information about three types of cars (a solar car, a nuclear car, and a fuel cell car). The instructor’s team was to select one of the three cars to be their best eco car of the future. (See Figure 4)
The team began their project (in the virtual classroom) by brainstorming and holding discussions about possible solutions to the problem they were asked to solve. They needed to select one type of car to design and build as their eco car of the future. In order to make a decision, the three possible car types were compared in terms of energy efficiency, ecological friendliness, and safety.

The students emphasized safety and felt overall that the best car would be a solar car. They made some important points about the cars; and said that the solar car is an electric car powered by an available source of energy (the Sun). Therefore, our natural resources will not be depleted. They also stated that the solar car was the safest and that the technology for making it was already available. In regards to the other two cars, the team agreed that the nuclear and fuel cell cars were energy efficient but had safety issues. They were concerned about radiation and the storage of wastes for a nuclear car and about the flammability of hydrogen for the fuel cell car.

The next part of this project involved the design of their solar car. The team prepared a simple sketch of their car designed by using special tablets and Bamboo software. The students also practiced making prims so that they would be able to build their car of the future. Finally the students decided (as a result of chat discussions) how they would build the car as a team. Avatar Fountainer 14 built the car’s body by making a long, green rectangular solid prim. Avatar Alilovleylights built the small passenger section for the front of the car by starting with a green hemisphere prim. Avatar Swimmywimmy 15 made the wheels and took the lead in making the solar panels (the flat blue items). Their car is displayed in Figure 5.

![FIG. 5 THE US TEAM’S SOLAR CAR.](image)

The students successfully completed this project. They designed and built a virtual car of the future. To obtain more information about this Problem Based Learning (PBL) activity, each student was asked to complete a questionnaire. Questionnaire (Part 1) and the US results for this questionnaire were provided. Each question included five possible choices. For most of them, the choices were as follows: #1: Very much, #2: Pretty much, #3: Neutral, #4: Not so much, #5: Not at all.

**QUESTIONNAIRE (PART 1) QUESTIONS & RESPONSES OF THE 3 STUDENTS**

1. Did you enjoy your overall activity? Choice: Pretty Much (3 students)
2. Did you chat with other colleagues and the teacher effectively? Choice: Neutral (3 students)
3. Did you feel that the discussion was easy? Choice: Pretty Much (1 student). Choice: Neutral (2 students)
4. Did you feel that the sketch making was easy? Choice: Pretty Much (3 students)
5. Did you feel that the prim making was easy? Choice: Pretty Much (2 students). Choice: Neutral (1 student)
6. What was the most enjoyable? Choice: Avatar’s Movement (2 students). Choice: Prim Making (1 student)
7. What was the most difficult? Choice: Discussion (3 students)
9. Do you want to join such a project again in the future? Choice: Pretty Much (2 students). Choice: Neutral (1 student)
10. Please write your impressions, ideas, etc., freely. Student number 1: “It was fun and enjoyable. We would like more time individually to play with and create the car.” Student number 2: “It was fun. We would like more time on the car and more prims available.” Student number 3: “We would like more time to individually build the car.”

The results showed that the US team members enjoyed this activity and would be interested in participating in another similar project. Overall, they appeared comfortable performing functions (such as walking, making prims, etc.) in SL. The students said it was easy drawing sketches and making prims. Two of them thought that the avatar’s movement was the most enjoyable, while one liked prim making the best. Participants expressed a need for more time to complete the project. They all felt that discussion was the hardest task, even though they had good
brainstorming sessions in the virtual classroom. These results suggested that the students may be more relaxed in speaking than writing (which was required for the chat function). Therefore, the voice option in SL was selected for use in the next activity (Nuclear Safety Energy Project).

**Nuclear Safety Energy Project**

The US instructor (Barry) used the voice (speech) function to carry out the nuclear safety project with her students. They met in the new virtual classroom, where Barry gave a forty minute Power Point presentation. Her lecture consisted of several components. Dr. Barry introduced the topic by mentioning the importance of nuclear energy; then described the tragedy at Japan’s Fukushima power plants caused by a big earthquake and huge tsunami in March 2011. The instructor told her students that the US and other countries could experience similar problems because they rely on nuclear energy.

Another part of this lecture emphasized protection from radiation. The teacher stressed the importance of the material used to make the shield. She gave the students the following equation to calculate a material’s shielding capability from radiation.

\[ I = I_0 e^{-\mu t} \]

\( I = \) x-ray intensity after penetration; \( I_0 = \)incident x-ray intensity; \( \mu = \)coefficient of decay; \( t = \)the thickness of the shield

The group did a sample calculation together in the virtual classroom. Then the following problem was proposed. What kind of metals can affectively protect human beings from radiation? The students calculated the shielding effects of copper and aluminum and compared the results. They also determined the effect of thickness on shielding. (See Figure 6)

The students quickly and correctly solved these problems as a team by using calculators and the voice function in SL. (This function required the use of microphones and headsets.) The teacher and students verbally discussed the quantitative answers and their scientific implications for nuclear safety. It has been learnt that copper is a better shield than aluminum. Also they showed mathematically that a thicker shield can reduce the radiation (penetration) intensity. Now the US team has a better understanding about what is safe and what is not safe for nuclear energy. At the end of this activity, the students were asked to complete survey forms. The results of this project confirmed that the students were more relaxed speaking than writing and that they understood the Power Point presentation very well. Therefore, this type of PBL class is possible for actual e-learning about nuclear safety and for engineering education.

**Conclusions**

Problem-Based Learning (PBL) is important for engineering education, which is essential for the sustainability of our Global Community. We depend on engineers to detect and creatively solve the challenging needs and problems of our ever changing world. PBL can enhance creativity and has been used to successfully carry out many experiments in the real world. Therefore, researchers in the US and Japan (the authors) have pursued studies about its use in a virtual world. Their PBL projects seemed to be well applicable to the e-learning environment offered in Second Life (SL). The participants enjoyed the activities which were great exercises in engineering design. PBL projects were successfully carried out in SL by using the chat function for discussions and by preparing prims (also called primitives) for making their PBL products: the house and eco car of the future.

As a result of their work, the researchers have identified benefits that SL offers to PBL as follows: The virtual world appeared to be a relaxed and comfortable setting for discussions and decision making activities. The virtual classroom was bright and cheerful, and provided a private gathering place where the students could focus on their PBL activity. Also decision making in the virtual world was quicker and easier than in the real world. To design and build a car in the real world would require lots of time and money, along with major decisions like what kind of materials to be used for the car, where to buy these materials, where to build the car, etc. Also the virtual
world allowed for creative decision making because it has less restrictions (examples: in terms of time, money, and space). Students were free to expand their thoughts and to consider more options (for possible solutions) to the problems they were solving. In addition, Second Life’s voice option (for communication) was very useful to the participants of the Nuclear Energy Safety project. This activity’s results showed that the students were more relaxed speaking than writing. They understood the Power Point presentation very well and could express their emotions and excitement during discussions. Overall it can be said that the described projects confirmed the effectiveness of PBL in Second Life for a variety of engineering education topics.

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REFERENCES


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