Second Life as a Pedagogical Tool for Improving Statistics Homework Sessions

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Abstract:

Learning statistical concepts can be difficult for students because of the content as well as interactions between learning styles and content presentation. Although homework is given to promote time-on-task and student learning, it is largely unguided. This project used the multi-user virtual environment, Second Life, as a way to direct learning through interactive and collaborative virtual homework sessions. The content matter for this exercise focused on hypothesis testing and types of statistical error. Students met in groups on the Second Life Ohio University campus in the Human Factors and Ergonomics virtual lab. They initially worked in teams to solve statistical questions related to usability research on cell phone performance. After working in teams, students re-assembled in the lab to perform independent assignments. These independent assignments utilized a modified version of the Groupthink exercise (originally developed at the Massachusetts Institute of Technology (MIT)) and rewarded students for their individual answers as well as entire team performance. Optimal performance required correct individual answers as well as correct answers for the entire team. In this way, the groups who communicated the most during the exercise and proceeded with the game only when everyone understood the concepts, scored the highest. This paper will discuss pedagogical issues with learning in virtual worlds, discuss the effectiveness of the game, and suggest methods to improve learning. Future research will focus on the use of Second Life for expanded statistics sessions and for human factors and ergonomics labs.

1. Introduction

The purpose of this study was to enhance Industrial and Systems Engineering (ISE) 306 with technology with the intended goal of improving student learning during homework sessions. ISE 306 is the first course in a two-course sequence in engineering probability and statistics. It is a required course for all ISE undergrads and serves as a service course for other engineering and technology undergraduate students.

The material taught in ISE 306 includes confidence intervals, types of error, statistical power, hypothesis testing, analysis of variance, and simple and multiple linear regression. Typically, a student's grade is composed of some combination of in-class participation, homework assignments, quizzes, and tests.

Although teachers direct the quality of in-class learning experiences, out-of-class experiences are largely unregulated unless the student comes in during office hours. Students may choose to work with other students or they may not. During the course of studying, students often do not have means for feedback on their work. This can lead to frustration, inefficient learning, or even learning of incorrect knowledge that could then result in negative transfer of knowledge.

This paper documents the use of a virtual homework session that was done in the multiple-user virtual environment, Second Life. The session was composed of two parts: the first part where students worked in groups to solve the problems and then a second part where they were required to work independently. A modified version of the Groupthink Exercise (from MIT) was used for the part where students worked independently. Grades for the homework assignment were comprised of scores from the group exercise as well as the part where students worked independently.

2. Theoretical Framework

The goal of this study was to create an interactive way for students to meet outside of class for supportive homework experiences. The proposed out-of-class learning environments would serve as a place where students could discuss homework problems, analyze concepts in more detail, explore different iterations about problems to better understand principles, and receive immediate feedback during this learning period. We used the virtual world, Second Life, as a way to create such a learning environment.

The content for this project was hypothesis testing and types of statistical error. These are basics covered in ISE 306, but they contain concepts that are often difficult to understand through traditional teaching techniques. In hypothesis testing, the types of error (Type I, Type II and subsequently Statistical Power) are presented. Hypothesis testing involves determining the null and alternate hypotheses, establishing the critical regions, calculating the test statistic and determining whether to reject or to fail to reject the null hypothesis. These are spatial concepts that can be difficult to describe in two-dimensions. Students need to learn the concepts, devise experiments, and complete iterations to determine experimentally how alpha, beta, sample size and effect sizes are related. They need immediate feedback to their questions and ways to visualize equations.

In traditional homework assignments, students are basically "on their own" to complete the given problem set. This structure creates potential problems because students do not have the ability to get feedback when needed. Lack of feedback can lead to frustration, preservation and the inability to achieve the correct answer, and lack of interest in the subject. Statistics as a concept is difficult to teach to begin with because many students take the course before truly understanding why the course is valuable to them in their careers.

Much research has been completed on how to improve student learning through homework sessions. Although early research focused on the notion that students would learn more just by completing more examples, more resent research has studied the relationship of providing worked examples to student learning. [1] Krippen and Earl found that studying worked examples and engaging in self-explanation were good strategies to promote learning.[1] Worked examples have been linked to skill acquisition strategies because they are thought to lessen the working memory load.

Other research has demonstrated the role of feedback in student learning. Worked examples are a form of feedback, but feedback is also possible through web-based programs that provide the student with instructor feedback in-between class sessions.[2]

Statistics as a discipline also poses unique challenges.[3] Conners, McCown and Roskos-Ewoldson have listed the challenges for teaching undergraduate statistics as: motivating the student to learn material that they think is uninteresting, handling math anxiety, dealing with performance extremeness, and making the learning memorable.[4] In the engineering curriculum, part of the difficulty lies in the ordering of the courses. Students take ISE 306 as a pre-requisite for their major classes. Although the professor can try to use relevant examples, students often do not link the process of statistics with the conclusions that they need to make as engineers. This lack of relevancy can cause a disinterest in the student and a lack of motivation to learn the material. In addition, statistics is conceptual. If students do not spend the time to learn the concepts (rather than just plugging in numbers), memorable learning will not occur.

2.1 Second Life

Second Life (see http://www.secondlife.com) is a multiple-user virtual environment that was created by Linden Lab in 2003. Since its inception, it has provided both commercial and educational applications. In Second Life, people buy and sell things through the virtual currency, the linden dollar. People can

walk or fly around Second Life; they can interact with other avatars through IM chat or through voice chat. People in Second Life can customize their avatar's appearance and are also able to use many pre-programmed gestures (e.g. yawning or dancing). Such abilities to communicate and express oneself provide a more personal approach to virtual communication.

In addition to commercial ventures, many universities have virtual campuses in Second Life. Researchers at Ohio University have or are currently working on a number of projects related to the educational use of 3-D online virtual environments (see http://vital.cs.ohiou.edu). They have learned from these projects not only the technical know-how to build appealing virtual environments and functional learning tools, but also accurate and deep understanding of when 3-D objects, tools, and environments are effective in engaging learners, when they are not, and how learning takes place and transfers.[5-8] Figure 1 shows Ohio University buildings that either represent real or imagined buildings on campus.

Figure 1. Left: *Virtual structures that resemble real-world buildings on Ohio University campus (Stocker Center),* Right*: A welcome center that does not resemble any real-world buildings on Ohio University campus.*

2.2 The Groupthink Exercise

The Groupthink exercise was originally developed by Michael Ernst at M.I.T. as a way to demonstrate the importance of team communication in software specification processes.[9] The original version of this exercise was based on paper and pencil. It was time consuming and error prone to tally the results of the exercise by the instructor or the teaching assistant. To improve the speed and accuracy of result calculation, and to further engage students, Liu and his students developed the Groupthink learning aid in Second Life.[9] Researchers at Ohio University have used the Groupthink exercise and the Second Life Groupthink learning aid in their software engineering classes and it has been field tested by students at both Ohio University and the University of Mary Washington.

During the original use of the Second Life Groupthink learning aid, students were engaged in a software design process and discussed software specifications. The exercise presented a situation where there could be multiple correct answers but the team needed to agree on a set of parameters. During the session the professor would ask questions of the students and then students entered their data in a display that would appear in the upper right corner of the screen. Since there was no correct answer, the purpose was to see if the students discussed the problem and then all agreed in their respective answers.

Our students re-programmed the exercise to work differently and thus modified the Second Life Groupthink learning aid. In our exercise the point was to determine if students could work independently after participating in the team exercise. Students were presented a statistics question during the

Groupthink exercise and then had to respond to a pop-up display with the correct multiple-choice answer. Students were awarded more points if the entire team entered the correct answer. Figure 2 shows students involved in this study during the Groupthink Exercise.

Figure 2. Left: *The Groupthink Exercise during the statistics homework session with printout that the teacher can see listing team members.*

3. Methods

This project was designed to have two statistics homework sessions in Second Life. During the early part of the quarter, students volunteered to participate on an informed consent basis (10 students volunteered to do the Second Life sessions out of a total class size of 36). There was no remuneration for their participation nor was there any extra credit. Students were awarded a score for the homework just as if they completed the assignment via traditional methods. The same types of questions were asked during the Second Life session as were asked in the traditional homework assignment. Second Life homework sessions were held outside of class time.

Early in the quarter the students were familiarized to Second Life and were asked to get an avatar. The night of the session was the first night that most students had spent any time in Second Life. The session was conducted in the ISE computer lab at Ohio University. Three teams of students (ranging from 2-4 students for a total of 10 students) participated in the project. The teams were arranged in rows and were given a color designation (Team Red, Team Blue and Team Green). Each student had the opportunity to access a written set of instructions and a glossary of statistical terms that were presented electronically.

As soon as everyone appeared in the virtual Human Factors and Ergonomics Laboratory at Ohio University, the game began. Students went to their respective carrel to start the game. The game utilized a theme of cell phone usability studies as the content for the statistics questions. Four different phones were created for the game and data was generated for either dialing a number or retrieving an address.

This subject matter was chosen because it was believed that its content was more relevant to the students. Once in the carrel, the students were instructed to click on the cell phone for question 1 and get the data. They then clicked on the button to start the game. See Figure 3 for images of the team sessions.

Figure 3. Left: *View of the lab and the students engaged in the team exercise,* Right: *Students engaged in the team exercise within the carrel.*

The game began by a pop-up appearing in the upper right corner of the screen. The pop up displayed questions and then asked the students to choose the correct answer. Students were instructed that they needed to chat with team members before making a decision. Correct decisions were awarded one point but incorrect decisions resulted in a subtraction of one point. This scoring system was established so that the entire team would participate in the decision-making process and not just the lead students. Once the game was finished, students were instructed to continue with the other questions until they finished all the questions within the carrel (this ended the team work game session).

After finishing the team session, students assembled at their respective tables (e.g. the green table for Team Green) to begin the Groupthink Exercise. The Groupthink exercise tested their independent answers but also rewarded teams where the entire team answered correctly. Five points were awarded for a correct answer and then everyone received an extra point if the entire team answered correctly. At the end of this exercise, scores were summed for both parts and a total score was given.

4. Results

This paper presents the results for the first homework session. During this session, students completed three team questions and two questions independently. They also completed a survey regarding their perceptions about Second Life and the homework session.

4.1 Session Scores

Three teams of students participated in the sessions. Two teams had four members and one team had 2 members (due to students being sick). The scores for individuals ranged from 96% to 98% on the team exercise to 58% to 95% on the entire session (including the independent answers). Although the session was designed to have 4 team questions and 5 questions to be answered independently (Groupthink), students were only able to complete 3 team questions and 2 questions independently. We believe this was due to the long initial period in getting all of the students logged on and into the lab. In the future, we believe that we will be able to cover more material.

4.2 Relationship between Students Participating in the Second Life Session and their Test Grade

During the week following the session, students were given their second test for the quarter. The test covered much of the same material that was included in the homework session. Results using a two-sample t-procedure with unequal variances indicated that the students who participated in the Second Life session had higher average test scores than those students who did not participate in the Second Life homework session (M_{SL} = 75.9 and SD = 20.2 vs. $M_{N\text{-}SL}$ = 59.0 and SD = 16.8, t_0 = -2.34, p = 0.017). Interestingly, the students who participated in the Second Life session did not have statistically significant higher test scores on the first test (M_{SL} = 73.4 and SD = 21.1 vs. $M_{N\text{-}SL}$ = 67.0 and SD = 19.5, t_0 = -.83, p = 0.209).

4.3 Survey Data about the Homework Session.

At the end of the session all students (n = 10) completed a survey about their perceptions about Second Life and the homework session. The questions for the survey were:

1. Before completing this assignment, I believed that Second Life was mostly an entertainment site.

2. Sometimes I have difficulty doing traditional homework assignments because I can't get feedback when I'm trying to complete the assignment.

3. I believe that the homework assignment in Second Life contributed to the learning of the material.

4. I believe that the feedback provided during the Second Life sessions helped me to more efficiently learn the material.

5. I enjoyed working with a team during the Second Life sessions.

6. I believe that I learned more about the material during the Second Life sessions than through traditional homework methods.

7. After completing the assignment, I believe that Second Life can be successfully used for educational purposes.

The students answered by circling a 5-value Likert scale:

1=strongly disagree 2=disagree 3=N/A 4=agree 5=strongly agree

The summary data is below in Figure 4. Interestingly, most students agreed that Second Life was an entertainment site yet they also believed that it could successfully be used for educational purposes. They also liked working with teams and receiving feedback from the sessions. The lowest median scores resulted from the students' perceptions about the relative value of the Second Life session to traditional homework sessions.

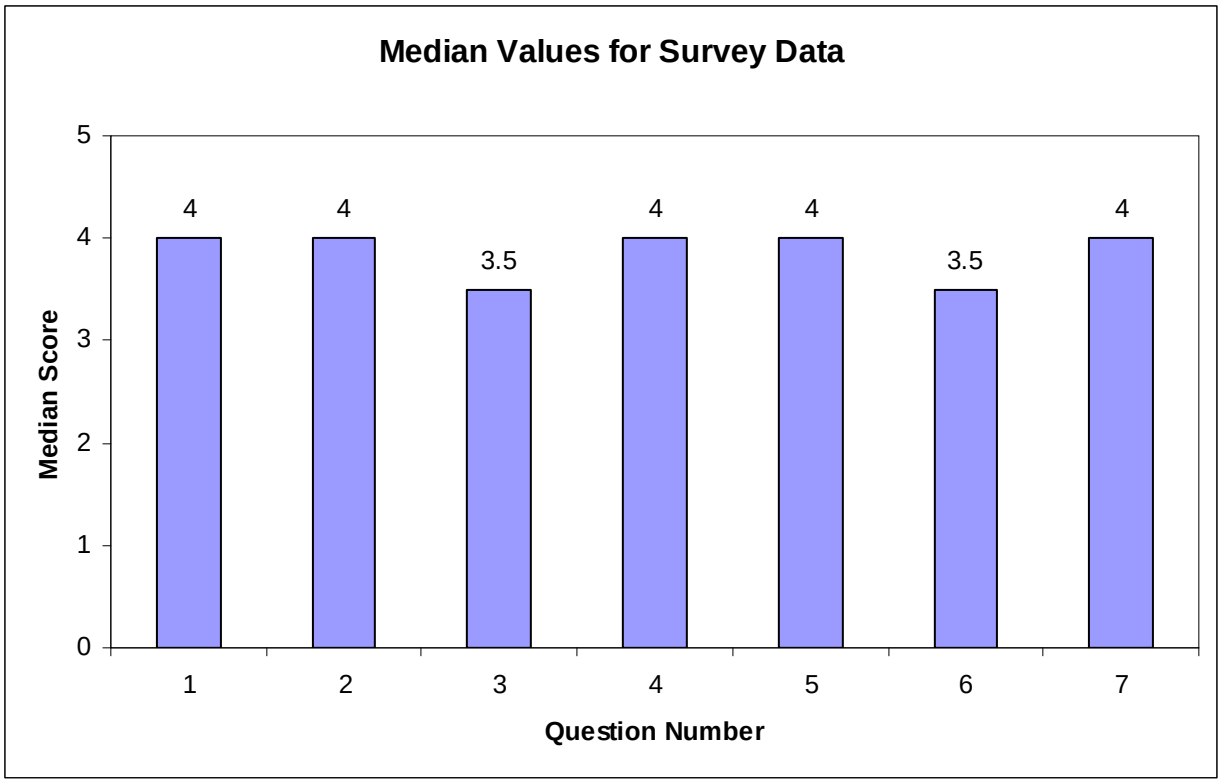

Figure 4. *Bar chart showing the median values for the survey (questions listed above).*

5. Conclusions

This paper discussed a virtual statistics homework session that was conducted in the virtual world, Second Life. The session utilized a team work session and also a session where students answered questions independently. The research focused around several questions: 1) could the use of a virtual homework session facilitate learning, 2) would the feedback made possible through the session improve student learning, and 3) would initial team work sessions improve independent performance. The session lasted two hours and was conducted outside of class time.

Results indicated that the students who participated in the Second Life session performed better on a following test than did those students who did their homework via traditional methods. This was true even though these same students did not perform statistically different on the first test from the students who did homework the traditional way. We acknowledge that this was a small sample size and that there could be a motivation factor in that those students who volunteered to do the Second Life session could have been more motivated to learn and perform well in the class. In a survey completed at the end of the session, students agreed that Second Life could be used successfully for educational purposes. Students seemed to enjoy the session and had fun navigating through Second Life.

6. Discussion

The use of the multiple-user virtual environment, Second Life, provided the opportunity for students to work in teams and then answer homework questions independently. Feedback was provided to the students via an electronically presented glossary, feedback on the answer screens explaining the answers, and through team chat. During the sessions team sat together, an idea which was anticipated to help the

chat. Experience, however, showed that students sitting together only facilitated chat in the groups where the students did not know each other. In the groups where the students were friends, the chat was abandoned in favor of just talking with one another. It was suggested that if we spread out the students, that they would be forced to use the chat function more.

Students also believed that working in teams of four was a little cumbersome. They would have preferred to work in teams of two. Perhaps this was due to unfamiliarity with the team members or it could have stemmed from the fact that students worked in homework pairs for their normal homework assignments. A future session will test this suggestion. In addition, it would be interesting to compare an online study session with a regular (face to face without Second Life) group study session.

Curiously, one of the characteristics of the session that students did not like was the timed element. The research team thought this element would be appreciated because the students could complete their homework in two hours. Some students said that they like having time over several days to complete assignments. This suggestion is being taken into consideration for future projects. It could be possible to design a game so that students could complete it at their own pace over the course of several days.

Future research will focus on expanding the content and creating games that are more visual in nature. The use of interactive graphics will be utilized to help those students who learn better by visual methods and provide alternative ways of learning. We plan to investigate more efficient ways to download student scores and facilitate team interaction. In addition, we plan to investigate the use of Second Life for additional statistics sessions as well as virtual experiments in the field of human factors and ergonomics.

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Biographical Information

Diana J. Schwerha is an Assistant Professor in the Industrial and Systems Engineering Department at Ohio University. She earned her doctorate in Industrial and Management Systems Engineering from West Virginia University. Diana's research interests focus on improving the safety, productivity, and job satisfaction of older workers. She teaches classes on statistics and ergonomics and is currently working on several funded projects.

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Ozercan is a master's graduate student in Computer Science at Russ College of Engineering at Ohio University in Athens, OH. Ozercan earned his Bachelors degree of Computer Science from Troy University in Troy, AL. Among his interests are software engineering, computer networking and computer architecture.

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Neiman is a Computer Science undergraduate at Russ College of Engineering, at Ohio University. In his free time he enjoys reading, nature and learning new things. In the future he would like to concentrate in computer graphics and work on developing new human-machine interfaces utilizing 3D graphics.

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