Efficacy of Second Life in Constructivist Learning Activities

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ABSTRACT

This research sought to determine whether learners would increase their knowledge of six types of accounting transactions using an interactive model of the accounting equation in the Multi-User Virtual Environment (MUVE) called Second Life. The experiment was conducted within the theoretical frameworks of cognitive constructivism and social constructivism. Participants worked in one of two experimental treatment types— solo (cognitive constructivism) or in small groups (social constructivism). All participants used the same written instructions, instructional movies, and practice problems to learn about six types of accounting transactions. Practice problems were used with a 3D model of the accounting equation in Second Life. The model provides immediate visual and text feedback to participants as they answer practice problems. Participants adjust their answers until the 3D model confirms it is correct. Results of pre- and posttests measured changes in participants' level of knowledge of these six transaction types and changes in the level of participant anxiety during the experiment. To obtain two sets of data, all the steps of the experiment were completed twice. The hypotheses predicted that, consistent with prior research in constructivism, participants working in small groups would experience greater learning gains and anxiety reductions than participants working alone. However, in both rounds of the experiment, participants who worked alone experienced greater learning gains and greater anxiety reductions than those who worked in groups.

This research resulted in a positive implication that Second Life can be used as a learning environment with reasonable expectation of learning. It also resulted in a new question: whether constructivism, as it is understood today, applies accurately to Multi-User Virtual Environments. Repetition of constructivist-based research in these environments is required to determine whether this result is consistent across populations and platforms. Expansion or revision of our understanding of constructivism may be required based on those findings.

ABOUT THE AUTHOR

Dr. Boland was awarded her Ph.D. in Education (specialization in Instructional Design for Online Learning) from Capella University in April 2009. She has over 8 years of expert field experience in the full spectrum of instructional systems design for both corporate and military clients. Her end-clients include: the US Veterans Administration, the US State Department, The Boeing Company, Autodesk, CA Technologies, Bank of America, Symantec, UnitedHealth Group, and Harcourt School Publishers. Her concentrated areas of expertise include: immersive virtual worlds, social learning, accessibility and usability. She is the author of the Practical Applications of Research column at eLearningFuture.com. She translates recent gains in learning research into easily understood and actionable intelligence for use in real world projects. She is an active advocate of the proper and effective use of social media tools for professional development, learning and marketing.

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PURPOSE OF THE STUDY

As new technologies become available, educators explore them to determine possible applications in education. One such new technology is the online three-dimensional (3D) virtual world called Second Life (SL). Individual educators and institutions currently use SL for one-time educational experiences, whole courses, and even entire virtual campuses. In all four fields of academic education, corporate training, government, and military training, the costs of using these environments has to be justified by showing that genuine learning results from their use.

Platform Examined: Second Life

Linden Research (Linden Lab) created and operates the 3D virtual world called Second Life. The Second Life platform has 1.3 million users accessing the system and is one that is deliberately designed to be open – which means the user determines what the platform is used for (Linden Lab, 2007). Places and activities inside SL include: music concerts, nightclubs, coffee shops, costume parties, fundraisers, poetry readings, fashion shows, religious gatherings, and sales of virtual items that people have created, such as virtual clothing for avatars to wear (Linden Lab, 2007). Educational activities include classes in how to create virtual items, cooking classes, yoga classes, museums run by real-world museums, libraries run by real-world librarians, corporate training events and complete virtual university campuses (Linden Lab, 2007).

Application to Instructional Systems Design

Educators and instructional designers can use the results of this study to help make decisions about whether to use individual or group learning when constructing learning experiences in SL. This study explored learners' anxiety before and after the experience and reports the advice from learners about how to improve the SL learning experience. This exposed issues which impeded learners' ability to use SL. This provides educators and instructional designers a framework of the kinds of support, modeling and scaffolding which learners need for successful learning experiences within SL.

METHODOLOGY

Blended Learning Approach

To isolate solo versus group work as the experimental variable, all learners performed the experiment within the same context. All learners had the same experiment instructions, amount of time, content-based instructional movies, practice problems and hands-on 3D model in SL. The only difference was that 2/3 of learners worked solo and 1/3 of learners worked in small groups. In the case of the small groups, they also interacted with each other. They generated meaning and expanded their understanding of the function of the accounting equation and how different accounting transactions impact the equation.

Theoretical Foundation of the Study

Constructivism, as a learning theory, has two major branches called cognitive constructivism and social constructivism. Cognitive constructivism contends that learning is created within the mind of the individual as he makes sense of new information in terms of his existing knowledge (Perkins and Unger, 1999). Social constructivism holds that knowledge is created when learners work with each other, and perhaps with teacher guidance, to collaboratively create a common understanding by pooling their collective background knowledge and ideas as they consider the new material (Shapiro, 2006, p. 200). In both branches there is agreement that the learner will not necessarily just add the new information to their existing worldview, but may change their mental model of the world based on the new information. Albert Bandura described that in this experience learners "not only gain understanding through reflection, they evaluate and alter their own thinking" (1985, p. 35). While these branches of constructivism may seem to be clearly distinct, theorists and research in the field tends to overlap.

PARTICIPANTS

Source of Participants

Over 100 sets of data were gathered in each round. Since the database was not large, the sets of data were analyzed in their entirety, not by statistical sampling.

Participant background and context

Accounting class lectures took place on the UCF campus and were video recorded. Learners could choose to attend lectures in person, watch a video of the lecture online, or download it to a portable device for viewing anytime and anyplace. Learners were required to have access to a computer with Internet service and basic computing abilities such as the ability to use an Internet browser and a word processing program (Hornik, 2007). These course requirements ensured that study participants would each have a minimum level of technology equipment and skill.

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RESEARCH INSTRUMENTS

Learning Venue

The 3D accounting equation model used in this study was created by Dr. Steven Hornik, Associate Professor of Accounting at the University of Central Florida. It is in the SL learning environment as a 3D hands-on interactive exhibit. Figure 1 shows the researcher's avatar in front of the model.

Figure 1. Researcher's avatar using the 3D accounting model. Figure created by the author.

The purpose of the Interactive Accounting Equation Model is to provide the learner with practice in adjusting accounts in response to transactions. Learners can practice transactions proffered by the model. For instance, if the interactive model informs the learner that $650 has been received for goods sold, the learner would chat back to the model that the assets would increase by $650 and equity would increase by $650, making the accounts maintain balance. The model can also be used to practice transactions of the learner's choosing. This is an opportunity for the learner to visually demonstrate their understanding of the effect of transactions on accounts.

Learning Objectives

Round 1 TLO: When participants have completed the first SL learning experience, they will be able to explain the affects that a variety of transactions have on the accounting equation.

Enabling Learning Objectives

1. Explain how accounts are affected when the owner of a company makes an initial investment to start the company.
2. Explain how accounts are affected when the company buys supplies on account, with the promise to pay in 30 days.
3. Explain how accounts are affected when the company earns money for services rendered and is paid immediately.

The second round of the experiment had the same TLO. However, because it was later in the semester, the content had gotten more complex and the expanded accounting equation was used.

Enabling Learning Objectives:

1. Explain how accounts are affected when the company pays cash for stock it plans to hold as a short-term investment.
2. Explain how accounts are affected when the company accounts for a change in the market value change of a stock they are holding as an investment when closing their books at the end of the fiscal year.
3. Explain how accounts are affected when the company sells the stock at a gain.

These ELOs were assessed at Bloom's taxonomy level of Analysis (identify, explain). Each of these was assessed using multiple choice questions with three distracters and one correct answer. Learners had one try to answer each question, and did not receive feedback. This prevented an extraneous variable from occurring. If learners had been provided multiple attempts or feedback, the test would have become a learning experience in itself. Since the purpose of the experiment was to test the efficacy of SL as a learning experience, it was essential to avoid accidentally creating new learning during the test.

The pretest and posttest had the same number of questions per ELO. The questions were at the same level of difficulty, and presented in the same order. The content of the questions in the pretests were different from questions in the posttests, but made of parallel construction. Answer choices were randomized to avoid any possibility of the participant memorizing a pattern

of answers from the pretest to the posttest. The instructions for both tests were the same.

Participant Anxiety

To measure whether anxiety was a factor to consider when sending learners to work in SL, participants responded to a survey before and after the experience. The instrument used to collect this data was the Concept-Specific Anxiety Scale (CAS) developed by Dr. Gene Oetting. The CAS has been demonstrated to be a reliable and valid indicator of a wide range of concept-specific anxieties. It has high content and face validity, discriminates between anxieties associated with different concepts, and has been useful in studies that correlate other characteristics with anxiety and in studies look at the effects of treatment. (p. 39)

When I think about using the Internet for accounting class work, I feel
worried ○ ○ ○ ○ ○ ○ ○ serene
When I think about using Second Life for accounting class work, I feel
composed ○ ○ ○ ○ ○ ○ ○ disturbed

Figure 2. *Sample items from the modified CAS used in this study.*

In this experiment, the researcher wanted to measure changes in participants anxiety related to the use of SL for learning. To provide a baseline of the participants levels of anxiety they completed the CAS prior to using SL. After the SL learning session and posttest, participants took the CAS again. The self-reported anxiety after the SL experience showed whether participants became more or less anxious about using SL for learning.

Participant Reaction

As part of each posttest, participants were asked whether they experienced any difficulty within SL, such as: technology issues that prevented accessing the site, motion sickness, or misbehavior by other users which interfered with their ability to learn at the specified location. Participants were also asked to identify the best and worst aspects of the experience and to provide advice to educators for future use of SL for education.

PROCEDURES AND POLICIES

Timing of the Study

Timing each phase of the study to occur at the point in the semester where the participants are prepared, but have not already mastered the material was essential because the study seeks to measure the learning gains of the participant specifically based on their use of educational materials within SL.

Participants needed to have already learned sufficient background material to be capable of learning the material in the experiment. However, they must not have already mastered the material in the experiment.

The study was scheduled to take place in two phases with a few weeks in between each phase. The second phase repeated the steps of the first phase, but with more advanced accounting content. Having two phases served two purposes. First, it enabled the researcher to gather data that demonstrates how participants perform in SL when they are rather new at it, and again after they have had a few weeks experience with it. Second, it eliminated the possible achievement bias referred to as the novelty effect. Novelty effect occurs when the high-level of interest generated by trying to learn in a new way temporarily increases learner engagement and motivation. Later, the learners experience degrading levels of engagement and motivation once the method of learning is no longer new (Gall, Gall & Borg, 2003, p. 376).

Duration of the Experiment Experience

In each of the two phases, participants were asked to complete all parts of the experiment in a single sitting. It was expected that each phase of the experiment would take approximately two hours.

Platform Learning Curve

A set of basic skills for using SL for learning was identified and validated through e-mail conversation with education professionals using SL. Prior to the experiment, the participants were presented with the opportunity and support needed to develop the required SL skills. Participants had both instructional movies about using SL provided by the researcher and personal SL orientations.

DATA ANALYSIS

Primary research question.

By what amount can participants improve their knowledge of six specific accounting transactions by using a 3D interactive model of the accounting equation in Second Life?

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Hypothesis: Participants will experience some level of accounting knowledge gain as a result of using the 3D interactive model of the accounting equation in SL. The higher level of interest in using a more graphical and engaging learning method will result in higher levels of accounting knowledge.

Research question 1.

By what amount do learning gains differ depending on whether participants work alone or in small groups?

Independent Variable: Method of using the 3D model of the accounting equation in SL, alone or in small groups. Approximately two-thirds of the participants used the 3D model alone (one at a time). The other third used the 3D model in small groups (up to six participants at the same time).

Hypothesis: Participants working in small groups will have greater learning gains than those who worked alone. Past educational research, referenced earlier, comparing learning gains of learners working in isolation to learners working in small groups shows support for the hypothesis.

Research question 2.

To what degree do participants self-report measures of anxiety about using SL to learn accounting concepts change during the course of the experiment?

Hypothesis: Participants will initially report high levels of anxiety when considering the use of SL for learning accounting knowledge, but will then report at the end of the experience that they have low to no anxiety about their ability to use SL for learning accounting. This will be caused by the positive and well-supported learning experiences they have had using the 3D model in SL.

Means and Standard Deviations of Anxiety

The first type of data that was collected, after the participant had consented to participate, was each participant's Concept-Specific Anxiety about using SL for learning. The data was collected after the participants have experienced an in-class introduction to SL that includes a live demonstration of using SL. To get an overview of participant concept-specific anxiety at the outset of the experiment, two measures were calculated: mean and standard deviation. Using the mean provided a benchmark number that represented the starting anxiety level of participants. The mean is a parameter that measures the central tendency of the group, or a representative number for the group as a whole. Standard deviation illustrated how homogenous the learners were in anxiety level by indicating how compact or close the scores were to each other. A lower standard deviation number indicates a higher level of homogeneity within the group. Anxiety data was taken again at the conclusion of the first round of the experiment, and again before and after participants completed the second round of the experiment. Having four sets of anxiety data allowed the researcher. Since participants had the option of completing just one round or both, taking anxiety data before and after each round provided a complete picture of anxiety for any round the participant completed.

Means and Standard Deviations by Experimental Treatment Type

The next set of data gathered was participant performance on a pretest and posttest surrounding their first educational use of SL for this experiment. To ensure consistency throughout the experiment, accounting questions were developed with five parallel variants and standard types of errors for distracters.

Participants were in one of two types of experimental treatment. Each either worked alone or as part of a small group. As an important distinction, the data was treated individually. The focus of this study was the individual performance of each participant, even if they worked in small groups. Participants who worked in small groups were not given group scores. Means and standard deviations were calculated for the pre- and posttests to establish a single number that best represents the performance of participants in each experimental treatment type.

The second phase of the experiment occurred about two weeks later, using more difficult accounting problems that were parallel to what learners were about to study in class. The same calculations were done using the entire set of data to establish a singular number that best represented participant performance in each experimental treatment type in the second round. These means and standard deviations were done with the same methodology as done for the anxiety data.

For each pretest and posttest, the following calculations were done for participants who worked alone and participants who worked in groups: (a) mean (b) standard deviation, and (c) Pearson's index of skewness.

DATA COLLECTION AND ANALYSIS

Data Collection

Data was collected in two phases. Each round of the experiment consisted of the consent form, pretest, experimental treatment, and posttest. The two experimental treatment types were participants who worked alone and participants who worked in groups. The pre- and posttests for each round tested participant accounting knowledge and recorded participant self-reports about anxiety related to the use of technology for college work.

Background Information About Participants

As part of the pretest, participants were asked a few questions about themselves and their use of SL.

Over 88% of participants in both rounds of the experiment fell within the age range of 18 to 23 years old. Less than one percent of participants had used SL prior to starting the accounting class. Prior to the experiment a) 87% or more of experiment participants had visited Dr. Hornik's educational site within SL, b) 79% or more had worked with the 3D accounting model in SL, and c) 66% had attended an SL orientation session offered by Dr. Hornik.

Generalizing to a Larger Population

Minimal personal data was collected from participants in order to maintain and protect their privacy. Each participant was asked to identify themselves by age range, and to specify whether they visited Dr. Hornik's SL academic site, attended one of Dr. Hornik's SL orientations or interacted with the 3D model. They were also asked to rate their perceived anxiety about using SL for learning. The results of this study can be generalized to first year college students. It is not necessarily possible to generalize to a larger group such as all college students because this study has not gathered data across all years of college. What was known about these participants in advance was that they were first year college students, attending three classroom sessions each week in person or by watching podcasts. If they were in the school of business, this was a required course. If they were in a different school, this was an elective course. Specific demographic characteristics of this group were not known in advance.

Limitations

The researcher did not attempt to directly control participant behavior, but did provide specific guidance about using the SL site to learn the target material. What the participants do while at the SL site could not be directly controlled. The researcher was dependent on the participants following the provided directions.

Participants who were expected to work independently may have found themselves not alone during their scheduled time. They were instructed to not communicate with others and not to observe others working with the accounting equation. This possible issue should be limited by participants being scheduled for exclusive use of the site for a specific time period

MEASUREMENTS OF LEARNING

In each round, the pretest measured the participant's starting knowledge level for three accounting transaction types. The posttest measured each participant's ending knowledge for the same three accounting transaction types, using different questions. The difference between the pre- and posttest scores exposed the extent to which the participant was able to learn about these three accounting transaction types during the experiment.

Means of Learning Difference Scores

The pre- and posttest each consisted of four accounting questions. The best possible score for a participant in either the pre- or posttest is four—if he answered all questions correctly. The worst possible score for a participant in either the pre- or posttest is zero—if he answered all questions incorrectly. The difference scores were found by subtracting the posttest score from the pretest score for each participant.

The mean of the difference scores provided a single number that represented the change in accounting knowledge for all participants. The mean difference scores were calculated for all participants, and then again separately by experimental treatment type. This exposed whether learning results were different for participants who worked alone compared to those who worked in groups. Table 1 summarizes means of learning difference scores. In both rounds, participants who worked alone performed better than those who worked in groups.

Table 1. Percent Learning Gains for All Participants and by Experimental Treatment Type

Round 1			Round 2		
All (N=134)	Group (*n*=42)	Solo (*n*=92)	All (*N*=163)	Group (*n*=51)	Solo (*n*=112)
4.66%	2.98%	5.43%	14.26%	7.35%	17.41%

Validating Means as Representative of Whole

It was important to check whether the data surrounding the mean was reasonably compact around the mean as a guide to how well the mean represented the participants on the whole. The empirical rule provides the guideline that "about 68% of the area under an approximately normal distribution lies within one standard deviation of the mean, about 95% of the area under the curve lies within two standard deviations of the mean, and nearly all of the distribution lies within three standard deviations of the mean" (Byrkit, 1987, p. 73). All distributions were found to be normal. Pearson's index of skewness was calculated for each experimental treatment type, per round. Table 2 provides the skewness numbers, which all fell within the acceptable range of -1.00 to 1.00. This confirms the findings in the normalcy calculations. The means are accurate representatives of the experience of the participants.

Table 2. Pearson's Index of Skewness for Mean Learning Difference Scores

Round 1			Round 2		
All (*N* = 134)	Group (*n* = 42)	Solo (*n* = 92)	All (*N* = 163)	Group (*n* = 51)	Solo (*n* = 112)
0.79	0.53	0.90	0.68	0.52	0.85

Measurements of Anxiety

As part of both the pre- and posttest, each participant was asked to self rate on 14 questions about seven concepts of anxiety related to using technology for college work. An anxiety difference score measures the change in participant anxiety level from the start of the pretest to the end of the posttest. The difference between each participant's pre- and posttest anxiety ratings expose the extent to which the participant's anxiety increased or decreased as a result of participating in the experiment.

Once each participant had an individual total anxiety score, the mean of all participants' anxiety scores was calculated to provide a number that represents the anxiety of all participants. This was repeated separately for participants who worked alone and for those who worked in groups, to determine anxiety levels by experimental treatment type. The data for both rounds is summarized in Table 3. In round one, anxiety dropped by 8.45% over all participants. In round two, anxiety dropped by 5.79% over all participants.

Table 3. Means of Anxiety for All Participants

	Round 1 (*N* = 134)			Round 2 (*N* = 163)		
	Pre-test	Post-test	Change	Pre-test	Post-test	Change
Number	19.41	15.86	-3.55	18.31	15.88	-2.43
Percent	46.21	37.76	-8.45	43.60	37.81	-5.79

Means of Anxiety Difference Scores by Experimental Treatment Type

The next calculation compares anxiety differences between the experimental treatment types. Table 4 summarizes the results of this calculation for both rounds. In both rounds, anxiety was reduced for all participants – but with stronger anxiety reductions amongst those who worked alone.

Table 4. Means of Anxiety Difference Scores by Experimental Treatment Type

	Round 1 (*N* = 134)		Round 2 (*N* = 163)	
	Group (*n* = 42)	Solo (*n* = 92)	Group (*n* = 51)	Solo (*n*=112)
Number	-2.42	-4.08	-1.65	-2.79
Percent	-5.76	-9.71	-3.93	-6.64

Again, the means were validated to determine whether they reasonably represent all participants. All distributions were found to be normal. This indicates that the mean of anxiety difference scores for all participants, in both rounds, is an accurate measure of the anxiety difference for all participants. Pearson's index of skewness was calculated for each experimental treatment type, per round. The skewness numbers all fell within the acceptable range of -1.00 to 1.00. This confirms the findings in the normalcy calculations. The means accurately represent the experience of the participants.

RESEARCH RESULTS

Next, each research question was answered using the analyzed data. Whether each hypothesis was rejected is also explained.

T Test for Repeated Measures

To determine whether the apparent differences in learning gains and anxiety reductions were genuine differences or a result of chance, the *t* test for repeated measures was applied. The maximum time permitted between the pretest and posttest was less than 2 hours to minimize any potential outside influences on learning or anxiety. Thus, the results obtained from performing the *t* test for repeated measures can be considered highly reliable for this data.

T Test Results and Interpretation

The results of the *t* tests (p-values) are displayed in Table 5. Generally, where a *t* test result is a p-value of 0.049 or less, the result is statistically significant, and we can reject the null hypotheses. Where a *t* test result is a p-value of 0.05 or greater, the result is not statistically significant, and we cannot reject the null hypothesis (Thornton, 2009).

Table 5. Impact of T Test Results on Null Hypotheses

	All Participants	Group Participants	Solo Participants
P-value (learning)	0.0046	0.0720	0.0002
Impact on null hypothesis	Rejected	Not rejected	Rejected
P-value (anxiety)	0.0028	0.4300	0.0040
Impact on null hypothesis	Rejected	Not rejected	Rejected

Summary of T Test Results

For all participants together, the null hypothesis (that they would experience no learning gain) was rejected. The null hypothesis for anxiety (that they would experience no change in anxiety) was also rejected. We know they did learn and reduce anxiety as a result of the experiment.

For participants who worked solo, the null hypothesis was rejected. The null hypothesis for anxiety was also rejected. We know this subset of the participants did learn and reduce their anxiety as a result of the experiment.

For participants who worked in groups, the null hypotheses were not rejected for learning or anxiety. This means we do not know for certain that the learning gains and anxiety reductions we saw in small groups were a direct result of the experiment or chance.

Analysis

The overall (all participant) and work-alone results, for both learning and anxiety, were judged to be not resulting from chance. The results for participants who worked in small groups, whether for learning or anxiety, could not clearly be said to be a direct result of the experimental treatment. It is possible that those results happened by chance.

On the whole, we can say that the results indicated that participants can learn about accounting concepts using a 3D model in SL and generally experience a reduction in SL-related anxiety along the way. We can also say that participants who worked alone reliably experienced both learning gains and anxiety reductions. What cannot be said is whether the learning gains and anxiety reductions experienced by participants who worked in groups was genuine or chance. Therefore, our ability to determine whether there is a genuine difference in learning gains or anxiety reduction between the experimental treatment types (work solo, work in groups) is thwarted.

RESEARCH QUESTION 1 ANAYLSIS

The first research question asked about the extent to which participants could learn accounting concepts using Second Life. In both rounds, the participants experienced learning gains. The mean learning gain decimal number is the mean number of test points of learning gain between the pre- and posttests. The mean learning gain results for all participants are summarized in Table 6.

Table 6. Mean Difference of Learning Scores for All Participants

	Round 1	Round 2
	All (N = 134)	All (N = 163)
Number	0.19	0.57
Percent	4.66	14.26

Since the participants did experience learning gains as a result of participating in the experiment, and the mean difference was determined to be not caused by chance, the research hypothesis was not rejected. The alternative hypothesis—that learners would experience a loss in their accounting knowledge—was rejected. The null hypothesis—that there would be no net change in learning—was also rejected.

RESEARCH QUESTION 2 ANAYLSIS

The second research question sought to determine whether the experimental treatment type (solo or group) had an impact on learning results. In both rounds, the experimental treatment type of working solo appeared to result in greater learning gains. Results were summarized in table 1.

The results of the *t* test indicated that results relating to the learning or anxiety of those who worked in groups are possibly due to chance. From the *t* test analysis, we know that we can not reject the hypothesis that participants working in small groups would experience greater learning gains than those who worked alone, even though the raw numbers and percent suggest they did not. The alternative hypothesis—that learners working solo would having greater learning gains than those who worked in small groups—was not rejected. This is not to imply that the alternative hypothesis was found to be accurate. Since the *t* test indicates that the results for groups could be chance, we don't have a reliable way to compare solo against group. The null hypothesis—that learning gains would be equal regardless of experimental treatment type—was not rejected. Although the raw numbers and percent results suggest that the participants working solo did experience learning gains, it is possible, according to the *t* test results, that the learning gains

and anxiety reductions found in the participants who worked in groups was a result of chance.

RESEARCH QUESTION 3 ANAYLSIS

The final research question examined whether participation in the experiment resulted in a change in the participants' anxiety related to using SL for college work. The results were summarized in Table 4.

Although the *t* test results lead to the rejection the null anxiety hypotheses for all participants and for those who worked solo, it did not reject the null hypothesis for those who worked in groups. The *t* test analysis of the data determined that there was a 43% chance that the anxiety reduction numbers for group participants could have happened by chance. It is possible that the experimental treatment had no effect on the group participants.

PARTICIPANT REPORTS OF ADVERSE IMPACTS

As part of the posttest participants were asked to report if they experienced any of several listed adverse impacts. More than 57% of all participants reported no adverse impacts. Of those that did report adverse impacts, the most frequently reported issues were: the SL platform was very slow, confusion (what should I do?), SL platform froze, disorientation (where am I?), loneliness, SL caused computer to crash, can't log in, delays while forced to update client software, and dizziness (feel like might fall down).

Participants Critique the Experience

Participants were offered the opportunity to provide feedback about the best and worst parts of the experience along with advice for improvements. Their feedback was not limited to the experiment, but to all the experiences they've had since starting use of SL for this course.

What participants liked most

Participants consistently rated their use of the 3D accounting equation model as their favorite part of being in SL. The remaining favorites, listed in order of popularity included: that the learning was visual, that learners felt they understood the material better than they could have without the 3D model, the ability to interact with peers and teachers, being able to use SL from any real location, that the instructional videos helped them learn, the beautiful environment and scenery, that the 3D model supported hands-on learning, and that they got extra credit for participating in this study.

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What participants disliked most

The single largest complaint was the technology hassles related to using SL. The remaining issues, in order of popularity were: personal issues (distraction, confusion, disorientation), SL learning curve, 3D model learning curve, interpersonal issues (crowding, annoyance with others), that it was required for class, and lastly – doubts as to its learning value.

Participant Recommendations for Improvement

In any project, the people best able to direct improvements are those who have lived the experience. Participants were asked to provide guidance for future use of SL as a learning environment. The top recommendations for improvement from the participants focused on having more of the 3D models (to help handle the large number of students trying to use them), having more instructional videos similar to the ones in the experiment as part of the course, having the choice whether to use SL and getting more help learning to use it. They also recommended that SL be used for small study groups which would provide the benefits of face-to-face time with peers with the anywhere convenience.

CONCLUSIONS AND RECOMMENDATIONS

Results

The primary research question returned an expected result—that learners could enhance their knowledge of accounting using Second Life. The overall learning of all participants increased and anxiety decreased. The secondary research questions each returned both positive and curious results. While it was expected that learners working in small groups would perform better on the knowledge tests, the opposite was found to be true. Those who worked in small groups had greater increases in learning accounting and greater decreases in concept-specific anxiety than those who worked in small groups.

Interpretation of the Results

The current study demonstrated that these participants, in their current circumstances, with these tools, were able to use SL to learn accounting concepts. This study also demonstrated that while experiment participants are learning, they are also experiencing concept-specific anxiety reductions. We noticed that there is both an achievement difference and an anxiety reduction difference when comparing those who worked solo with those worked in small groups. This is encouraging news for those who wish to use SL for teaching or training. They can confidently propose SL learning initiatives for their organizations knowing that the funds spent in developing the environment and

manipulatives or 3D models will be an investment, not a waste. Currently, it would not be fair to recommend SL to be used for a one-time event. The learning curve to adjust to SL is steep. Time is needed for learners to get accustomed to operating an avatar and navigating the environment. Additionally, acquiring virtual land in SL and developing an environment for learners to inhabit takes time. At this time, Second Life is best used for a longer term, such as a semester of college or a full year in corporate training.

Recommendations for Future Research

The investigations described below were out of scope for this experiment. However, these additional investigations could provide insights that will help shape the instructional approach to using MUVEs such as SL.

Researchers can repeat the Current Study using: a) controlled and supervised environment, b) established stock avatars, c) different age groups, d) different content, e) participants with MUVE experience, f) starting assessment of overall content mastery level (which may contribute to high performance on pre-tests and lower anxiety overall), and g) content Analysis of Chat Logs Recorded During a Learning Experience (difficulties encountered, strategies used by learners)

While the scope of this experiment focused on three research questions, it is clear that additional research in this field is needed. The unexpected finding in this research—that learners who worked alone had greater learning gains and greater anxiety reductions—causes us to consider the potential impact on constructivist theory.

Revisiting the Theoretical Framework

The theoretical framework for this study was comprised of the paired concepts of cognitive constructivism and social constructivism. Based on prior research within this framework, it was anticipated the results would show that learners who worked in groups would achieve greater learning gains than those who worked alone. The prior research that informed both cognitive and social constructivist theories was done in a variety of venues—but not in a MUVE.

The surprising result, that participants who worked alone achieved greater learning gains than those who worked in groups, raises questions about whether existing constructivist theory will need to be revised or expanded for specific application to MUVEs. What is not known about the surprise result is which factors in the MUVE experience may have caused the difference. Moreover, since this study has only been done once, we do not have confirmation that the results would be the same if the study was repeated by other researchers in different settings and using a less homogenous group of participants.

Alternative explanations for the surprise result were discussed above, along with the identified areas of possible improvement or expansion of this experiment. Repeating the experiment in a highly controlled environment could narrow the possible list of explanations. Interviewing learners whose results indicated that working solo was advantageous may help identify the exact causes of this and whether it relates to the use of the MUVE (novel experience) or other factors.

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