A Case Study of Communication and Social Interactions in Learning in Second Life

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Abstract
In this paper we report on a case study of learning in Second Life. A system view of education guided this preliminary work to focus on communication and social interactions in learning in Second Life. Two undergraduate Computer Science courses were observed. Significant differences are revealed in required instructor direction and signs of negative engagement. Despite instructor engagement and novel environmental attractions, student communications with peers and with the instructor remain paramount to student engagement. Besides regular academic evaluation such as assignment grades and course-related communication, two unanticipated learning outcomes were reported.

1. Introduction
With the fast development of communication technologies and the Internet, distance learning has become a mainstay for many institutions of higher education. Course Management Systems (CMS) like WebCT and Blackboard have become popular in supporting both face-to-face and online classes. More recently, multi-user virtual environments (MUVEs), and Second Life (http://secondlife.com) (SL) in particular, have been developed to provide even richer environments to support communication and social interactions in online learning. However, few empirical studies have been conducted to evaluate them.

Virtual environments are perceived as a viable and attractive means for students to attend class in a shared space unbound by physical location. Additionally, virtual environments lend capabilities beyond the physical dimension, as is found in virtual simulations. Overcoming limited instructional space, matching instructional delivery to students’ availability, and exploiting the affordances of communicative technologies are benefits e-learning offers. While online learning in all its variations has the potential to enable anytime-anywhere access to content and facilitate student interaction, do these environments help or hinder student acquisition of skill and knowledge? The purpose of this study is to identify how communication and social interaction manifest in two undergraduate courses delivered in SL, as a measure of learning.

2. Background
Research efforts in studying the applicability for learning in MUVEs, and in 3D virtual environments like SL in particular, are currently favored. Attention from the research community stems from SL’s universal access as a free download, and “persistent world” quality [8]. Unlike online gaming environments, SL is an ongoing social system where individual participants are necessary for the action to continue. In many respects, the SL environment is an open system, highly dynamic, and a perfect laboratory for study.

Looking to SL as a learning environment, some educators hope to capitalize on 21st century students’ innate interest in and ability for gaming as a natural extension to online learning [2][12]. A study [15] with a subject pool of nearly 30,000 gamers reported that the majority of participants surveyed in multi-user, online role-playing games claim they distinguish little difference in their interactions with others, whether it’s online or offline. Online and in-world interactions appear to hold similar importance to users of these virtual worlds as do those interactions occurring in the physical world. Therefore, SL is a free /low-cost, computer-mediated social environment, and is widely adopted by educators interested in technology-rich learning environments [4].

2.1. Learning in MUVEs
De Freitas and Neumann [5] assessed how students transfer learned content from the educational immersive environment to their physical worlds. They conclude MUVEs provide increased opportunities for student exploration and experiential learning. This novel environment does, however,
shift the traditional learning paradigm for both instructor and student, in terms of the design of instructional activities, simulated experiences, and scenario manipulation. Rice’s [10] work on evaluating higher order thinking in video games found evidence that advanced computer games engage learners in higher cognitive processing.

2.2. Communication in Educational MUVEs

Communication in SL is conducted through voice, text stream and instant messaging. In SL, a representative character created by the user, the “avatar”, is the individual’s vehicle for activity, communication and interaction. Avatar derives from the Sanskrit *avatara*, which translates to a personification of one’s character. Feldon and Kafai [7] found that altering one’s avatar appearance correlates to their activity investment—participants who continually refined and changed avatar appearances were more socially interactive than those who did little modifying.

To evaluate conversations among virtual characters, [13] employed a phenomenological approach and conclude that individuals interact with virtual characters, just as if they were human. Results from [11] research indicate that “significant emotional responses” (p. 168) can be realized even when users understand they are interacting with a computer-controlled virtual resident.

In SL, the potential exists to imbue avatars with non-verbal communicative cues; e.g., eye gaze, facial expressions and body movements, although this capability is utilized by expert users.

2.3. Social Interactions in MUVEs

Previous research on learning in MUVEs conclude that they provide an opportunity for experiential learning and hold promise for engaging learners in higher levels of cognitive processing. This related work also suggested that interpersonal interactions among students, their instructor and their virtual environments mirrors the traditional classroom dynamic. Wahlstedt et al [14] point to virtual learning environments’ quality of providing both physical space and social place that contribute to students’ desire to be there. Similarly, Eliëns et al [6] perceived the success of their educational island to the hybridizing of space and place. Persistent world builders are interested in how design and structure influence behavior. Cheng et al [3] found evidence that users want an environment to support social exchanges with customizable identities that are contextualized to specific communities and enriched with graphical representations; these variables correlate to [10] cognitive viability index. De Lucia et al [4] reproduced real classrooms and open areas for collaborative activities on their university’s island, and observed their construction supported synchronous communication and social interaction. They also noted students were eager to participate and helped one another and newcomers in orienteering and navigation. MUVEs are social and technology-rich environments that support real-world interactions, which may facilitate learning.

2.4. A System View of Education: Input, Transformation and Output

A systemic view of education empowers the observer to understand and distinguish the complexity of technology-enhanced, dynamic, and recursive causal properties of a particular environment. Banathy [1] argues for such a view of educational systems, defining them as a subset of human activity systems. These systems, he describes, are comprised of groups of individuals and the corresponding environmental assets, merging for a shared purpose. The functional success of a system is driven by the participants’ combined and individual goals that arise out of cooperation with one another.
The environmental model, adapted from [1], situates the two courses in an atmosphere located on a private, virtual island, located in SL. Input consists of communication, and are found in the class policies, requirements, expectations and rules of a course; input resources stem from the students, instructor, course content, and virtual facilities. One of the aims of the process of evaluating input is to sort out the relevance of signals entering the system, and to prepare this information for the transformation process. “The mode of interaction between a human activity system and its environment is communication” [1] (p.105). Communication signals, then, are input to the system. Input are received by the system and are then evaluated and accepted, based on the suitability of the input to the purposes of the system.

At the heart of the system is interaction, and the method of interaction is communication. Signals of value to the system are the resources and information the students need to transfer what they learn. Input includes instructor-selected content, lectures, and in-class discussions that provoke and help individuals articulate content-related issues.

The process of transformation mediates between input and output processing. The mission of an educational system includes student learning as a main goal. Student thinking is altered when new information supplements their prior knowledge; cognitively, new understanding can then be used to build neural pathways towards developing greater fluency in using what they have learned. Students and instructors provide cognitive attention to a shared purpose resulting in a transformation within those participating in the system.

Output is representative of learning artifacts created by the students, mediated by the instructor, and resulting from feedback within the system. The goal of output processing is to identify and assess the product of what the system has transformed. In the courses featured in this case study, output are tangible results including completed assignments and written essays, and intangible yields including the growing understanding and accumulated knowledge. Such knowledge and understanding feeds back into the constructive experience of learning, the transformative process.

3. Methods

3.1. Participants

In this study, a total of 18 undergraduate students from two Computer Science-related courses participated in this study. The mean ages are 21.8 for one class and 21.3 for another class, ranging between 20 and 26 years. These participants were predominantly male with one female student in each course.

3.2. Course Description

Two undergraduate computer science courses were chosen to be delivered in SL. One is an introductory course to multimedia (ITR, Information Transfer and Recall), covering types of media, e.g., text, images, animations, sound and video. The other is a programming course for game design (CS, Computer Science). There were weekly assignments for both courses, and each course ran for the length of a semester.

3.3. Procedure

The classes began with two weeks of traditional face-to-face classroom sessions. The next few sessions covered the basics of using SL as well as the initial content of the course. Students were then given the opportunity to attend class virtually. Some chose to attend class from home, some from their dorm rooms or from the school lab, all according to their preference.

During each class session one student volunteer attended class from the school’s usability lab. In the usability lab the student’s actions were monitored and recorded using the Morae™ screen capture software. Recorded information included the student’s computer screen activity such as mouse movements, keyboard strokes, various dialog boxes and windows. Students’ body movements and voice were also recorded. Students’ local chat stream and IM streams were collected. Behavior coding analysis of each participant’s social interaction activities were conducted afterwards.

Each class met twice a week. After being welcomed by the professor, students receive content by a lecture presented by the instructor’s avatar. This lecture was typically supplemented by a presentation projected on a virtual screen in the virtual classroom. Often, the instructor provided handouts by way of note cards, which are text documents disseminated between avatars. Each of the two courses consisted of typical classroom artifacts with which student avatars interact. For example, clicking on a globe provided access to resources available on the Internet, and with another mouse click on in- and outboxes on a desk, instructions and assignments were exchanged.
3.4. Measures

Using Banathy’s system view of education to guide our work, three measures were developed for this study: communication activities, social interactions, and academic outcome.

3.4.1. Communication. Communicative functions are delivered through audio and text exchanges. In Banathy’s theory, communication activities are the input to the educational system. In a virtual environment, when students lack face-to-face interactions with the instructor and among themselves, it is important to provide them with an easy communication channel which public chat affords. However, the fear of embarrassment in the public domain lends a private IM chat channel necessary. Therefore, two types of communication were measured in our study: number of chat entries in the public chat and number of chat entries in the private IM (instant message) exchanges.

3.4.2. Social Interactions. Based on the MUVEET instrument developed by [9], six types of social interactions were identified and measured in this study:

- **SI-1.** Direct instructions to respond in the chat stream. Ex: “Everyone confirm they understand this point by indicating yes or no in the chat stream.”
- **SI-2.** Direct references to lecture slides. Ex: “Tell me what you see on the slide” as a way to elicit student interpretation.
- **SI-3.** Direct instructions for using SL interface Ex: “Do you see the blue folder on the desk?” as a way to elicit student interpretation.
- **SI-4.** Professor engagement (joking and atypical pedagogical action explained below.)
- **SI-5.** Student positive engagement (joking, asking questions, applying content to different contexts).
- **SI-6.** Student negative engagement (non-responsiveness, lack of preparation).

Observations were conducted in-world via an avatar representing the observer. The observer avatar was non-assuming and non-participatory in classroom activities. Early in the semester, students occasionally asked about the avatar. The instructor explained that the avatar was their in-class observer, and they quickly adjusted to disregarding the observing avatar’s presence.

Observations from within the classes were recorded into an Excel spreadsheet in real time, as the classes were conducted. Situated within the classes, the observer was exposed to live audio conversations, text-based chat conversations within the classroom, as well as in-class lectures and activities. Learning events in the classroom were identified by their functional, participatory nature; e.g., attendance-taking, slide-based lectures, instructor questions, student questions and answers, joking and laughing, in-class activities and engagement strategies employed by the instructor. Individual events were recorded and time-stamped for seven classes for each of the two courses over the course of two months. Classroom activities were observed in the aggregate rather than for any particular student. As the class was in session, a descriptor was selected from a pre-defined menu of potential events, time-stamped and noted for exceptional behavior. These data were sorted into six distinct event types: chat stream instructions (SI-1), specific references to slides (SI-2), instructions to use a tool in the interface (SI-3), professor engagement (SI-4), and finally, positive (SI-5) and negative (SI-6) signs of student engagement. Data sheets were then sorted by course type and date, and by these events demonstrating interaction between the SL environment and its participants.

Professor engagement (SI-4) was observed in events that reflect the instructor’s interpersonal interactions with students. In these instances, the professor was observed making jokes or showing his own enjoyment and other affective responses. At times the professor responded in ways that varied from typical, pedagogical transactions. As an example, the instructor encouraged students to pursue individual interests in technology-related disciplines, encouraging them to become the musicians and game designers they dared to dream, or offered suggestions for managing complexity while the students explored new disciplines. These instances were recorded as professor engagement events.

Student engagement was evidenced in both positive (SI-5) and negative ways (SI-6). Positive engagement was observed in spontaneous questions posed by students as they applied current content to other situations, or took wild guesses to solve potential problems. Student comments questioning assumptions the instructor used were also coded as positive engagement. These positive encounters indicate students were thinking about the course material and connecting new understanding to prior knowledge. Student joviality, initiating questions and offering solutions, all illustrate their engagement in the process.

On the other hand, negative engagement (SI-6) manifested in communicative exchanges with the professor that were oftentimes met with silence, requiring the instructor to prod with clarifying questions or hints to progress through course
material. Throughout the observations, we noticed an interaction pattern that emerged. At times when student negative engagement (SI-6) produced little or no response to the instructor’s prompt for answers or feedback, the instructor employed a classroom management technique using the chat stream. Asking each member of the class to respond, one at a time, in the chat stream became a way to indicate student attention, much like raising a hand. With the increasing use of this technique producing the designed effect, the instructor employed this technique when student engagement appeared to drift. We interpret this loop as feedback from negative input (waning student engagement), and thus SI-1 was viewed as a negative indicator of student engagement.

3.4.3. Learning Outcomes. System output is evidenced in assignment completion and student learning. Learning outcomes are measured by assignment grades. The CS assignments include scripting various objects with different functionalities, and writing a term paper outlining ideas for a new game. The ITR assignments include learning a variety of multimedia tools for image and text display and concluding with a website. Corresponding with the seven week period of in-class observations, seven assignment grades for CS and six assignment grades for ITR are included in our analyses.

4. Results

First we will first report three sets of findings: communication (input), social interaction (transformation), and class assignment grades (output). Then we will report two interesting examples of unanticipated learning outcomes in SL.

In the following analysis, t-test in SPSS will be conducted to compare means of two classes (CS vs. ITR). The p value as well as mean and standard deviation (std) of the t-tests are reported correspondingly.

4.1. Communication Findings

Figures 2 & 3 show the total number of chat entries in public chat room and private IM chat.

The comparison of total number of chat entries in public chat room between two classes reveal a significant difference ($t(12)=2.47, p<.05$). The CS class presented more chat entries (mean=241, std=61.6) than the ITR class (mean=155, std=69.5).

![Figure 2: Total number of chat entries in public chat room by weeks and courses.](image)

![Figure 3: Mean of chat entries from the instructor and students in IM chat in two courses.](image)

4.2. Social Interaction Findings

The weekly data were pooled for the following social interaction analysis. Table 1 shows the result of social interaction data.

The two courses display significant differences in social interactions of SI-1, direct instructions to respond in the chat stream, ($t(12)=3.43, p<.01$) and
SI-6, students’ negative engagement, \((t(12)=2.28, p<.05)\). Other types of social interactions did not show a significant difference.

As illustrated in 3.4.2, SI-1 is a negative indicator of student engagement. Therefore when we sum six social interactions into one measure, SI-1 and SI-6 as shown in Table 1 are calculated negatively. The comparison of this overall social interaction (SI-all) reveals significant differences between two courses \((t(12)=2.78, p<.05)\). CS students showed significantly more social interactions than ITR students.

### Table 1: Total number of social interaction events by course

<table>
<thead>
<tr>
<th></th>
<th>ITR</th>
<th>CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI-1. Direct instructions to respond in the chat stream</td>
<td>27</td>
<td>14</td>
</tr>
<tr>
<td>SI-2. Direct reference to lecture slides</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>SI-3. Direct instructions of using SL interface</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>SI-4. Professor engagement</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>SI-5. Student positive engagement</td>
<td>37</td>
<td>94</td>
</tr>
<tr>
<td>SI-6. Student negative engagement</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>SI all*</td>
<td>2.7</td>
<td>18.1</td>
</tr>
</tbody>
</table>

* SI all = Sum \((-SI-1 + SI-2 + SI-3 + SI-4 + SI-5 - SI-6)\)

### 4.3. Outcome Findings

Following each week’s lecture, an assignment was given to the students to measure the academic outcome against the expected learning objectives.

#### 4.3.1. Learning Outcomes

During our observation period, 7 CS assignments and 6 ITR assignments were collected and graded. A total of 11 students from CS and 7 students from ITR submitted their assignments each week. This led to a total of 119 graded assignments.

Though Figure 4 showed that learning outcomes by the students from the CS class (mean=89.7, std=22.5) appeared to be higher than those from ITR class (mean=85.0, std=18.5), a t-test in SPSS showed that such differences are not significant \((t(117)=1.15, p>.05)\). The weekly comparison through an independent t-test of two classes showed a significant difference for week 6 only \((t(16)=2.52, p<.05)\).

Our interview with the instructor revealed that in general the CS class assignments were more complex and more difficult than those for the ITR class, due to the increased complexity of course work associated with CS. This might explain why CS students with a high level of social interactions did not show significantly better assignment grades.

#### 4.3.2. Unanticipated Learning Outcomes

There were two spontaneous events that happened toward the end of the semester that display unanticipated learning outcomes. In both events students assimilated and synthesized information from a few previous lessons to create and program interactive objects in a novel way that demonstrated their mastery of a few diverse programming topics.

**Figure 5: Ejection Seat Case**

The first event (Figure 5) was the creation of a virtual ejection seat. This seat was created using the in-world building tools and then a script was added. The script was designed to use a timer that would trigger a teleportation event after an avatar sat on the object in this case, a chair. The chair appeared with a text string above the chair that read “Reserved for the Professor”. In order for the students to program this ejection seat, they had to pull together bits and pieces of code they had learned in three previous lessons and then create the algorithm to bring these programming concepts together. The creation of this ejection chair was an unanticipated outcome of the lessons that covered the required programming concepts; however, it was a clear manifestation of student engagement within the course topics and learning activities. As can be discerned from this
narrative, the professor did sit on the chair during a lecture and was proudly transported by the students to a location some 4,000 meters in the air.

The second event was the creation of a replica avatar that accurately mirrored the look of the instructor avatar and spoke in the local chat as the instructor. This required knowledge of avatar modification techniques that were covered early in the semester. This clone avatar then needed to be able to enter text into the chat stream that would be identified with the professor’s name. In order to accomplish this, the student needed to draw upon his knowledge of a few programming concepts and techniques that were covered in previous lectures.

These activities demonstrate instances in which students aggregated the contents of several scripting lessons and applied that to an entirely new set of circumstances. Both events demonstrate creative synthesis of learned content. Clearly, both the ejection seat and clone avatar represent student ingenuity, creativity and ultimately, student engagement.

5. Discussion

The communication results reveal different communication dynamics in two classes. CS showed more active participation in both public chat room and private IM chat between the instructor and the students. Our social interaction data helped to explain such differences. Compared to ITR students, CS students demonstrated more social interaction with especially less negative engagement and less dependence on the instructor’s direction to respond in the chat. In another word, CS students were more socially engaged and interactive among themselves than ITR students. This was also supported by our observations of students’ self-organized outside-class activities. Prior to each class session, the CS students participated in student-initiated group play activity in SL that involved exhibiting new and unique avatar designs and their scripted behaviors. Completely initiated by the students, they altered their avatar appearances dramatically from one class to the next. They appeared as huge insects, icons from pop culture, and other characters. This creative play resulted from students’ immersion in the SL environment [7], as their avatar transformations were conducted outside of class time. The instructor, while not overtly encouraging this activity, endorsed it by expressing his own enjoyment. By contrast, only one student in the ITR class altered her avatar’s appearance. Beyond the initial creation of student avatars, participants in the ITR class exhibited few avatar modifications.

Our learning outcome results show interesting findings. The assignment grades didn’t reveal significant differences between two classes even though they showed different communication patterns and social interactions. However, unanticipated learning outcomes as demonstrated in the two extreme cases in the CS class not only supported our findings that the CS students were more engaged than ITR students, but also inspired us to reconsider the serious research question here. What are the best ways to measure learning outcomes in a virtual environment: structured learning (measured by assignment grades) or self explorative learning? How do we measure the enhanced value in learning in such a rich virtual environment? All these questions warrant further study.

This analysis has attempted to quantify input, transformation and output of two courses that take place in a virtual reality environment. System input consists of communication activities between instructor and students and between students and their peers. System transformation is the process participants activate when they interact with and are altered by their interpersonal collaborations. System output is evidence of student learning; positive student engagement feeds back into the transformation process. Students add to their intellectual capital which enhances absorption of new content. Negative student engagement is also fed back into the transformation process; both instructor and student are affected and the transformation process slows. Viewed across time, evolution moves these courses in different vectors, based on system feedback. Banathy’s modeling provides a viewpoint of courses in a virtual environment.

With increasing interest in using MUVEs for higher education, mainstream educators at colleges and universities are faced with delivering instruction in an unfamiliar environment. Until such time as specifications and guidelines are developed from empirical research, it is our intent to provide this system view of education in SL to help guide those efforts.

6. Conclusion and Future Work

We expected to find that communication and social interactions in Second Life are the key predictors for the outcome measures for learning in this MUVE. Our data partially confirmed our predictions. Over time, the CS course required less direct reference in slides and demonstrated more positive student engagement. As a condition of
dynamic interaction, greater student interaction leads to a greater degree of student-instructor interaction, and the reverse applies as well. Less engaged students require a greater amount of attention and facilitation. A virtual course offered to less-engaged students is essentially a double whammy. Less-engaged students are likely to do as well in a virtual course as they would have in a traditional course, but engaged students stand to reap greater satisfaction in virtual courses, given the increase in communicative activities.

The purpose of this study was to identify how communication and social interaction manifest in SL, as a measure of learning. Our results indicate that when analyzed from a viewpoint of input, transformation, and output, these variables are key indicators of student engagement. Communication is paramount to social interaction; however it is not nearly enough to be exchanging dialogue during a course. An evolving dialogue among course participants must be present for genuine learning to occur. Multi-user virtual environments support multiple communication channels and yet access is not enough. Instructor facilitation and student involvement are key ingredients necessary for a vibrant experience. Only when course participants are fully engaged, the affordances of virtual learning environments are fully exploited.

Several limitations to this study need to be acknowledged. First, the effect of the observer avatar appeared to have no effect on students; however, our study contained no control to measure this assumption. A second limitation is the lack of control for co-location, meaning students attended the virtual class from the same physical computer lab. Because students were scheduled for an on-campus class immediately after this SL course, they frequently gathered together in the lab for both courses. Other limitations arise from the subjective nature of the observations, and by restricting the study of these systems to one single virtual environment, Second Life.

In addition to questions raised above, implications for future study emerge. One area we identify is an increased instructor control of classroom management in a virtual environment. For an example, classroom management of student attention and distraction may be more easily managed by an increased instructor control of chat stream access and other attention-gaining devices.

7. References


