

# How Interactive is your Virtual World?

## Examining Student Engagement on Virtual Learning Activities

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**Abstract**—This paper is part of our ongoing research on the ways interaction affects student immersion within a virtual world and, consequently, student engagement with the educational activities that take place within it when a hybrid learning method is used. We confirm and further enhance our hypothesis investigating student feelings and thoughts about the interaction taking place within a virtual world when that is used in higher education. Specifically, 111 university students, both at undergraduate and postgraduate level, who used our “in-house” OpenSim virtual world for roughly 8 weeks, were asked to indicate their opinion and feelings about the virtual world and the various kinds of interaction they had. The results of this study validated our initial hypothesis that interaction plays a crucial role in student engagement, underlying that the nature and the design of the educational activities substantially affects student engagement.

**Keywords**—OpenSim, Virtual World, Virtual Learning, Interaction, Engagement.

### I. INTRODUCTION

One of the most overwhelming achievements of the technological evolution in the past decades (early '80s) lies in the field of virtual reality [1]. Virtual worlds were initially introduced as computer-aided 3D artificial environments, remotely or locally accessible to individual people and capable of simultaneously hosting their actions and interactions [2]. Even though their initial purpose was to provide an alternative for leisure (computer games) [1], within the last decade virtual worlds have massively progressed and serve various purposes such as socialisation, recreation, exploration, collaboration and education [3] [4]. This is attributed to the unique features of virtual worlds, like Second Life (<http://secondlife.com/>) or OpenSimulator ([http://opensimulator.org/wiki/Main\\_Page](http://opensimulator.org/wiki/Main_Page)), as they allow users to modify, design, and control the virtual environment [5].

Several studies have been conducted with the focus being on the use of virtual worlds in education [2] [4] [6] [7]. Researchers and educators [5] [8] agree that the 3D element, the use of avatars (users' virtual representations), the manipulation and development of environmental content, the embodied / real time communication (verbal/non-verbal) and the interaction, are some of the core features which turn virtual worlds into appropriate for learning activities. In [9], the author claims that the next generation of learners will be

“learning in technology” whilst, other researchers [4] [10] agree with this statement and also add that virtual worlds allow learners to “learn by experiencing” the subject. The aforementioned claims are based on Vygotsky's [11] constructivist theory according to which learners construct their knowledge in virtual worlds by experiencing it as active participants [7].

A wide range of traditional learning styles has been identified and employed within virtual worlds under different learning approaches [12] [13] [14] [15]. This is attributed, to some extent, to the wide and complex network of interaction which can be developed within virtual worlds [6]. Even though the importance of interaction upon learning activities has attracted the interest of researchers and educators, as shown from the related literature [16] [17] [18], very few attempts have been made to develop and introduce frameworks and taxonomies for the evaluation of the educational activities [13] [19].

In an attempt to fill this gap, de Freitas et al. [16] and Childs [17] presented and assessed their framework for the evaluation of the learning affordances of virtual worlds. After assessing their own framework, they concluded that even though studying virtual worlds as a distance learning tool can be a sound method to extract some results, there is still need for further investigation with regard to the use of virtual worlds in hybrid-learning approaches (students' virtual and physical simultaneous co-presence) [18]. Likewise, Bronack, Rield and Tashner [13] developed their social constructivist framework and evaluated it using distance education environments with some quite encouraging conclusions.

Virtual worlds are, indeed, a great example of a tool to support distance education, but several approaches have also been made to utilise virtual worlds as a supplementary material to traditional learning. Camilleri and de Freitas [15] used a hybrid-learning approach to investigate and understand the level of engagement of learners with virtual worlds. The conclusions drawn from their experiments highlighted some of the benefits that student engagement has (e.g., development of working presence, increased collaboration and enthusiasm for learning). They also suggested that further research should be conducted in order to better understand how student engagement can be achieved and measured, as this is a key-factor to design successful educational activities within virtual worlds. The link between engagement and learning is believed to be

interaction, as described by Childs [17] (e.g., interacting with the world, interacting with others, interacting with the avatar, finding and searching).

The above studies constitute a rather small example of the existing literature about interaction and engagement within virtual worlds. However, most of them are focusing either on distance education or, when a hybrid-learning approach is used, on the inner side of the virtual world disregarding the interaction occurring within the physical classroom. Specifically, a very limited –almost nonexistent– number of studies exist about the interaction occurring within the physical classroom, while a hybrid-learning approach is utilised [20] [21], or as a combination of the interaction occurring both within the virtual world and the physical classroom at the same time. This gap in the existing literature has been identified and suggested for empirical investigation and evaluation by several researchers [12] [16] [19] [20] [21].

We believe that interaction related to the use of the virtual world when occurring within the physical classroom affects student engagement with the virtual world. Therefore, we focus our ongoing research to that direction aiming to define, understand and map the way interaction (in-world and in-class) affects student engagement (positively or negatively).

Our initial attempt to identify and categorise the structural elements of learner engagement was made by Christopoulos and Conrad [22]. Based on that study, the conclusions that immersion and engagement are not inherent features of a virtual world were drawn and triggered further research that resulted in our previous attempt to investigate this subject [23]. That study allowed us to develop a taxonomy which mapped and described how interaction can be defined and understood in relation to learner engagement. In this research, we validate and further enhance our taxonomy aiming to generalise our findings on the kinds of interaction that affect student engagement.

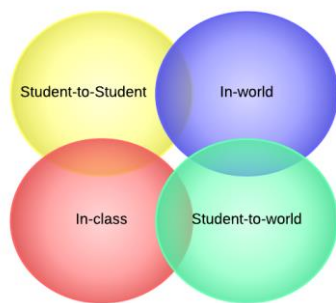


Figure 1. The four dimensions of interaction.

For clarification purposes, Figure 1 illustrates the four dimensions of interaction and the conjunctions that they may form. The term student-to-student interaction includes any kind of interactivity between students, either that may take place in the virtual world through avatars (e.g., chatting, emoticons, gestures, etc.), or in the physical classroom between the physically co-located students (e.g. talking,

commenting, exchanging ideas, sharing thoughts etc.) On the other hand, student-to-world interaction seen from the in-world perspective includes all the possible interactions a user can have with the 3D content of a virtual world (e.g. building, scripting, using 3D objects, exploring etc.), whilst, seen from the in-class perspective, includes the use of the virtual world's technology per se. All kinds of the investigated interaction are analysed under this point of view in this paper.

The paper is structured as follows. First we provide a general overview of virtual worlds and the theoretical framework from which our main hypothesis is derived. We contextualise it within existing work with regard to higher education in virtual worlds, interaction and its effects on student engagement. In Section II, we briefly describe the situation in which the study has been conducted, and the research method followed to investigate this subject. In Section III, the reader can find the analysis of the findings in detail, while Section IV highlights and summarises the most important dimensions of interaction and its impact on student engagement. Finally, Section V concludes the paper.

## II. MATERIALS AND METHODS

### A. Description of the Context of the Survey

The examined practical sessions took place from February until June 2014 with a cohort of undergraduate and a cohort of postgraduate students, both of which were using a virtual world in the context of similar units. The institutionally hosted OpenSim virtual world of the University of Bedfordshire was used as an innovative tool for students to deal with, in the concept of working and collaborating in groups with task division, similar to circumstances taking place in companies. Each group had to choose an emerging technology subject, run a research about it, create a virtual show case for its promotion, and document all the aspects of their work. During these practical sessions students were simultaneously co-present in the physical classroom and in the virtual world. The questionnaires were distributed to the students after the completion of the course.

### B. Survey

The use of surveys as a research method in studies related to education has several advantages. Surveys are considered to be one of the most sufficient methods to gather opinions of a large-scale sample. They are used to reveal participants' feelings, thoughts and beliefs about the subject under investigation, and also to justify their actions and behaviors. Furthermore, they allow researchers to draw accurate conclusions and make generalisations through the statistical analysis of the collected data. Finally, they are thought to be participant friendly, since participants are used to answering surveys with multiple-choice answers based on the Likert scale methodology [24].

### C. Structure and Sample

The survey consisted of thirty (30) statements on a five-point Likert scale (Strongly Agree to Strongly Disagree) and was divided in two parts: the first part (14 statements)

examined students’ interaction with the content of the virtual world in the context of the practical sessions, and the second part (16 statements) examined students’ interaction with other users of the virtual world in the context of the practical sessions.

Among the students who participated, forty-seven (47) were undergraduates and sixty-four (64) postgraduates. More than 4/5 of the participants were male (91), while less than 1/5 were female (20). More than half of the participants (59.45%) were aged 18-25 years old, several were 26-35 years old (38.75%), only two were 36-45 years old, and none was older than the age of 45.

III. RESULTS AND DISCUSSION

Student-to-world interaction had slightly more positive results than student-to-student interaction, and at the same time statements regarding student-to-student interaction gathered more neutral and negative responses than those regarding student-to-world interaction.

The majority of the participants agreed to all the statements provided, while in all cases the total of positive responses (“Strongly Agree” and “Agree”) was higher than the total of negative responses (“Strongly Disagree” and “Disagree”). Moreover, participants responded neutrally (“Neither Agree nor Disagree”) very frequently. However, the number of statements that gathered considerably more negative responses was not negligent either. It is worth mentioning that in several statements the sum of negative responses is higher than the amount of neutral responses (see Tables I and II).

TABLE I. THE FINDINGS OF THE QUESTIONNAIRE REGARDING STUDENT FEELINGS ABOUT THEIR INTERACTION WITH THE WORLD.

	Interacting with the content of the virtual world in the context of the practical sessions...				
	Strongly Agree	Agree	Neither A. nor D.	Disagree	Strongly Disagree
1	17.11%	43.24%	22.52%	5.40%	11.73%
2	12.61%	36.93%	20.72%	17.11%	12.63%
3	23.42%	33.33%	18.91%	13.51%	10.83%
4	16.21%	43.24%	18.91%	11.74%	9.90%
5	21.64%	39.63%	15.31%	11.71%	11.71%
6	18.94%	37.83%	19.81%	12.61%	10.81%
7	22.52%	42.34%	16.21%	9.00%	9.90%
8	25.25%	45.04%	17.11%	3.60%	9.00%
9	21.65%	41.44%	17.11%	9.90%	9.90%
10	21.62%	38.73%	18.04%	11.71%	9.90%
11	19.81%	33.33%	24.35%	12.61%	9.90%
12	18.01%	38.73%	24.32%	10.84%	8.10%
13	17.11%	39.64%	17.14%	16.21%	9.90%
14	11.71%	34.23%	28.82%	13.51%	11.73%

TABLE II. THE FINDINGS OF THE QUESTIONNAIRE REGARDING STUDENT FEELINGS ABOUT THE INTERACTION WITH THEIR FELLOW-STUDENTS.

	Interacting with other users of the virtual world in the context of the practical sessions...				
	Strongly Agree	Agree	Neither A. nor D.	Disagree	Strongly Disagree
15	15.31%	43.24%	17.11%	12.63%	11.71%
16	16.21%	38.73%	12.61%	17.14%	15.31%
17	17.11%	39.65%	20.72%	11.71%	10.81%
18	15.31%	37.83%	17.11%	15.34%	14.41%
19	16.21%	40.54%	15.31%	16.21%	11.73%
20	16.24	38.73	21.62%	13.51%	9.90%
21	16.24%	40.54%	19.81%	13.51%	9.90%
22	18.04%	36.93%	19.81%	12.61%	12.61%
23	17.14%	33.33%	27.92%	11.71%	9.90%
24	15.32%	42.34%	20.72%	10.81%	10.81%
25	25.23	33.33%	23.44%	6.30%	11.71%
26	16.21%	41.44%	18.93%	11.71%	11.71%
27	18.91%	36.93%	24.32%	9.00%	10.81%
28	19.81%	38.73%	21.62%	8.10%	11.71%
29	17.11%	32.43%	24.32%	14.41%	11.71%
30	18.91%	31.53%	30.63%	7.20%	11.71%

What follows is the analysis of the answers to the statements, some of which are examined in pairs so that a direct comparison is possible. In each pair, the first statement is about Interacting with the content of the virtual world in the context of the practical sessions, while the second one deals with Interacting with other users of the virtual world in the context of the practical sessions.

Statements 1 and 15 (...is a good reason for me to use a virtual world). The findings clearly demonstrate that participants used the virtual world for both kinds of interaction it offers. However, when thoroughly comparing the positive with the negative responses, we can see an indication that they would opt to use a virtual world slightly more for the interaction occurring with the world itself and less for the interaction occurring with others.

Statements 2 and 16 (...made me feel I am actually present in the virtual world). Because of the sporadic nature of these responses, no conclusion that students were truly immersed can be safely drawn. In fact, the number of the neutral as well as the negative responses was considerably high, too. However, the sum of the responses with positive values provides an indication that interaction can actually have a strong impact and important outcomes on students’ engagement and immersion. Nevertheless, the nature and the design of the activities play an important role and, therefore, clear and careful design for the enhancement of both kinds of interaction ought to be set as a priority.

Statements 3 and 17 (...made me “experience” the knowledge). As shown by these findings, both kinds of

interaction may have a significant impact on the experience of the learning material. However, the fact that the number of neutral and negative responses was not low raises concerns about the cases and the conditions when a virtual world can truly help students “live” the lesson and learn by doing and interacting.

*Statements 4 and 18 (...was real-time and that helped me have real-time awareness and feedback of the results of my work).* Even though responses demonstrated as more important for the students the advantages such as the real-time awareness of their work had, it became apparent that a significant number of students used the virtual world as a medium to host their meetings, provide feedback to other team members and fellow-students, and also discuss matters that were non-related to their project.

*Statements 5 and 19 (...made the learning material more attractive for me).* It seems that both student-to-student and student-to-world interaction can have a very positive impact on the attractiveness of the learning material accessed in the virtual world. Indeed, students used to enjoy working with their teammates in-world and to collaborate trying to perform their tasks.

*Statements 6 and 20 (...made me participate gladly in the practical sessions).* Indeed, for most of the participants the opportunities given to them to interact with this tool increased their willingness to participate and engage gladly with their assignment. However, taking into consideration the server’s data logs, it became apparent that the number of students who were using the virtual world initially was decreasing significantly over time. This explains, to some extent, the high percentages of the neutral and negative responses.

*Statement 7 (...was interesting since I had the opportunity to see my creations ‘alive’).* These results clearly demonstrate that the interactive 3D content of a virtual world and, even more so, the students’ opportunities to create and alter it according to their needs and preferences can be an interesting part of the use of a virtual world. Besides, coding in a virtual world differs dramatically from coding on a compiler and that is the element that makes a virtual world interesting to use.

*Statements 8 and 25 (...was fun).* The use of a virtual world to assist the learning process, to give students the feeling of actually participating in it, and, by extension, to make it more amusing and entertaining is something which was acknowledged by most of the participants. Indeed, not all the students learn the same way and this is where special attention should be given.

*Statements 9 and 26 (...made the practical session more attractive for me).* These findings clearly demonstrate that the use of the virtual world had a very positive impact on the attractiveness of the practical session. It is really interesting that the unique element of student interaction with the 3D content of the world that cannot be replaced by other features of the physical classroom contributed more, compared to student interaction with their classmates, on the attractiveness of the procedures that take place during the sessions. It is supposed that the innovative nature of this tool

was the main reason why students were attracted to it and the practical sessions, by extension.

*Statements 10 and 27 (...made learning easier for me compared to just studying).* A quite large portion of students agreed that this tool had a positive impact on their engagement and that they learned a lot of things along the way. Indeed, several educators and researchers have focused on the advantages of the so-called learning by doing. However, for a significant number of students it had no impact, and in several cases the results were not positive at all.

*Statement 11 (...pleased me a lot, especially when I was building and scripting).* These results, though encouraging, raise serious concerns about the use of virtual worlds in educational context. Despite the fact that most of the students considered building and scripting as a pleasant part of their student-to-world interaction, a noticeable number of others probably considered it as just one more educational activity with nothing special to offer, or others even disliked it maybe because of the difficulties they faced when using this new tool.

*Statement 12 (...pleased me a lot, especially when I was exploring and sightseeing).* Once again the sample showed that the students tended to have neutral feelings towards the chance they had to explore the content of the virtual world. Nevertheless, most of the students enjoyed that part of the in-world interaction. While students were exploring the virtual world, they also had the chance to see their classmates’ creations, use them, and get new ideas. Cross-studying the responses derived from this statement with the one from statement 11, we can understand that for some students using virtual objects existing in the virtual world might be more pleasant than creating their own artefacts from scratch.

*Statement 13 (...pleased me a lot, especially when I was using the virtual objects I created).* According to the students’ answers, using their own artefacts can be a pleasant activity. However, when cross-studying the responses in this statement with those in statement 11, a question is posed: Why students enjoyed using their own virtual artefacts but did not enjoy creating them? The speculation that students were struggling with the technology and, thus, building was a painful and time-consuming procedure can be made.

*Statement 14 (...pleased me a lot, especially when I was using others’ virtual objects).* Since it was a group project and in order to show that they were actually a part of that group, students had, by default, to at least use their classmates’ objects in order to work on and complete their assignment. However, using them does not necessarily mean that it can offer any kind of pleasure. That can explain, to some extent, the high amount of neutral or even negative responses the participants gave. On the other hand, there were many students who found the whole process pleasant, as it allowed them to get ideas that could have helped them to develop or further enhance their own artefacts.

*Statement 21 (...made me more open and positive to collaborations).* It seems that collaboration is enhanced through the use of the virtual world. Given that students had to complete a collaborative project working in groups with

task division, the fact that most of them felt inspired to work harmonically with their teammates is really encouraging. However, the high counts of neutral and negative responses raise concerns regarding the ways collaboration can be aided through the use of a virtual world as a learning tool.

*Statement 22 (...made me learn what other users already knew).* Participants' replies to this and the following statement form a very clear view of peer-tutoring in virtual worlds. When students are interacting in a virtual world, they learn what their fellow-students already know, usually subconsciously and without being directly taught, while sharing their experiences and working together for a common goal.

*Statement 23 (...made me teach other users things I knew).* Most of the students were keen to provide support to others, initially related to the use of the virtual world regarding its tools and capabilities, and then more focused on their assignment. Considering statement 22 along with this statement, it can be postulated that the use of the virtual world had a positive effect on peer-tutoring and social learning.

*Statement 24 (...was interesting since I had the opportunity to chat with others about our projects).* An interesting form of interaction for most of the participants was talking about, commenting on, and exchanging ideas about their projects. It seems that the use of a virtual world encourages the use of this form of communication. Nevertheless, this kind of interaction had not been as interesting as for the rest of them. The fact that several students thought of it as not particularly interesting or not interesting at all can be attributed to the fact that they conceived it as nothing more than part of their project routine.

*Statement 28 (...pleased me a lot, especially when collaborating with others for a common goal).* Managing or working together with others to achieve common goals is always a tough process, taking into consideration the diverse personalities that people, and, by extension, students have. However, the high percentages of positive replies indicate that the use of the virtual world seemed to have a positive effect on that, helping students to overcome their difficulties and making them feel more confident. Nevertheless, there were several students who felt uncomfortable in the virtual world for several reasons, some of which have already been mentioned, and this had a negative impact on their collaboration with others. Therefore, it is very important to determine the factors that increase student collaboration and those who decrease it.

*Statement 29 (...pleased me a lot, especially when we were laughing with our mistakes).* Most of the students seemed to enjoy working in-world even when the results of their work had not been the expected ones. Building and scripting can be a very interesting form of in-world interaction for students, as already noticed through the responses in statement 7. On top of that, when students have the chance to share the results of their work, even the most uncommon, unexpected, and funny ones, with their class and team mates in a virtual space where 3D representations are the key element, even their mistakes can prove to be pleasant and enjoyable.

*Statement 30 (...pleased me a lot, especially when we were having breaks from our work).* Taking into consideration the data logs, it was revealed that several times students spent considerable time in-world wandering, chatting, and modifying their avatars. However, there were several students who kept a neutral position or even a negative one. Since this virtual world was introduced in the context of a university assignment, many students faced it as a medium to complete their assignment and not as a game-like environment. In addition, there were several students who either did not have spare time to spend in-world or could not find anything interesting enough for them to do other than complete their assignment.

#### IV. REFLECTION OF THE SURVEY DATA

The data collected through this survey greatly validate our taxonomy. Even though student opinion about several aspects of the use of a virtual world on education is confirmed and enhanced, a number of other aspects is altered. This alteration can be attributed not only to students' different personalities, but also to the difference in the learning material, the learning approach, the design of the learning activity, and the difference in the ways the virtual world was used, as well as the purposes it was used for.

The general outcome, comparing the means of each couple of statements and the mean of each single statement, is that the impact that student-to-world interaction has on student feelings towards the use of a virtual world is slightly more positive than that of student-to-student interaction. Nevertheless, both kinds of interaction seem to enhance student engagement with learning activities, but this needs to be further investigated.

##### A. In-world interaction both with the world and among students

Both kinds of interaction that students performed in-world had equally positive results in their engagement with the learning material and in the educational activities. As students stated, both interacting with the content of the virtual world and with their classmates made them have a sense of presence in the virtual world mostly because these kinds of interaction made them spontaneously engage with the activities and focus on their in-world tasks. Besides, in-world student-to-student interaction and student-to-world interaction were rated as equally responsible factors that affect students' willingness to participate in the practical sessions. On top of that, all the complex network of interactions that students performed in-world allowed them to experience the learning material, and as a result their learning outcomes were enhanced.

##### B. In-world interaction with the content of the world

Participants named the student-to-world interaction as a particularly worthwhile reason to use a virtual world. This interaction was described as the main reason for both the learning material and the practical sessions to become more attractive for students. Students stated that building, scripting, exploring, sightseeing and interacting with the content of the virtual world using 3D objects were some of

their in-world actions that made the learning process pleasant for them. In addition to that, the fact that all student-to-world interaction was synchronous, and the fact that students could receive immediate feedback from the content of the world upon their actions was conducive to students' real-time awareness of the results of their work and actions, in general. That feature was characterised by students as particularly interesting, since it gave students the feeling of a "living" world that responded to their actions.

### C. In-world Interaction with fellow-students

The use of a virtual world as a tool in the practical sessions was deemed as particularly beneficial by the participants not only because of the student-to-world interaction they had the opportunity to perform, but because of the in-world student-to-student interaction, as well. The fact that students not only became open and positive to collaborations, but also enjoyed their collaborations in the virtual world is underlined. These kinds of interaction and collaboration encouraged peer-tutoring and peer-assisted learning, since participants mentioned that they both taught their classmates and were taught by them in the context of their in-world collaborations. Moreover, students stated that the fact that they had the chance to talk in-world with their classmates about their projects made the whole process more interesting for them. Students also evaluated as particularly helpful the fact that they could have immediate feedback on the course of their projects from their fellow-students. Even in cases when the results of their work had not been the expected ones, students still enjoyed the whole process, since their mistakes could be observed as funny reactions on the 3D representations. Finally, it seemed that having the chance to use the virtual world not only for educational reasons but also to spend some leisure time, made students enjoy the use of the virtual world and engage with it and with the project. However, the extent to which activities that are irrelevant to the educational project itself are conducive to student immersion in the virtual world and, by extension, conducive to the engagement within the project, is still to be investigated.

### V. LIMITATIONS OF THE STUDY

At this point we should note the limitations of this study and the factors that have potentially influenced the results, even though these influences were intended to be kept to a minimum. The participants of the survey were students of the University of Bedfordshire, which is where all the authors of this paper work. Despite the fact that the questionnaires were completely anonymous and participants were ensured that their participation in the survey would have absolutely no consequence on their academic progression, some of them were potentially forced by some biases to answer in certain ways, which could not have been avoided by the authors

### VI. CONCLUSIONS

The findings derived from this study validated our taxonomy and confirmed our initial hypothesis that both kinds of interaction have the potential to affect student engagement. The interaction that occurred between the students and the virtual world was shown to be more intense compared to the one that occurred among the students. However, student-to-student interaction was also affected by the one that occurred between the students and the world indirectly. Our hypothesis is enhanced compared to our previous one since it identified a need for careful planning of the educational activities, taking into consideration the wide and complex network of interactions that can be developed in order to achieve engagement. However, further research is deemed necessary in order to shed light on the design principles which educators should take into account when creating learning activities that involve the use of a virtual world with an aim to engage their student with their learning material.

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