

Game Based Learning Creating a Triangle of Success: Play, Interact and Learn

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Abstract

As teachers tend to use new technologies to engage students in the learning process, game-based learning can offer a powerful approach for learning and skills development. This study examines how the integration of 3D-Online Multi-Players Role-Playing Educational Serious Games (3D-OMPRPESGs) would enhance students' learning performance.

Multiple game sessions are conducted for three times and promising results are obtained. This study found that the more students play the 3D-OMPRPESGs, the higher perception of social interaction they will experience and the better learning performance they will achieve. Additionally, students who did not play any session of the game experienced the lowest perception of social interaction and performed the worst.

Keywords: Collaborative Virtual Environment, role-playing game, serious games.

1. Introduction

The education system at the 21th century should reflect and meet the need of the 21th century generation. There is a noticeable increase in teachers' motivations to implement educational computer games as supplemental learning tools because the new generation of students can master a wide range of digital equipment such as computers, cell phone, PDAs and digital cameras, which in turn affects their learning styles. As an educator, it is easy to see that students today perform differently than in the past. Therefore there is a need to move from a teacher-centric lectures based environment to a student-centered interactive learning environment.

In order to meet the emerging changes, games-based learning teaching methodology can be applied in modern classroom. Game-based learning focuses on integrating the power of computer games to capture the attention and engage students in the learning process to help them in developing new knowledge and skills. In general, educational computer games are designed to teach about

certain subject, expand concepts, reinforce development, understand a historical event or culture, or assist in learning a skill [18]. In particular, serious games are educational games "that do not have entertainment, enjoyment, or fun as their primary purpose" [10, p.21]. Game-based learning, namely, "Serious games" are expected to be the next era of technology-mediated learning [3]. The implementation of serious games in immersive collaborative virtual environments is a leading-edge technology that positively affects students' learning process.

The presented study is considered to be among the few experimental studies that highlighted and examined the integration of serious games technology in the learning process. In order to enrich the research in this field and to address the emerging educational needs, experimental research studies are significantly required to test how 3D-OMPRPESGs either support or inhibit interaction and learning. Therefore, we conducted a study that measures the effectiveness of using 3D-OMPRPESGs in teaching British literature in an interactive virtual classroom context. Specifically, we examined how the frequency of playing educational games would enhance students' perceptions of social interaction and their learning performance. We used quantitative research methods to answer the following three questions:

- Q1. Does the number of times of playing the 3D-OMPRPSEs influence students' perceptions of social interaction?
- Q2. Does the number of times of playing the 3D-MPRPSGs affect students' learning performance?
- Q3. Is there any relationship between students' perceptions of social interaction and their learning performance?

The significance of the conducted study relies on:

- i. Conducting a real world learning task based on serious game technology.
- ii. Employing quantitative analytical research methods to identify relationships and critical factors affecting student social interaction and

learning performance during the learning process in online courses.

- iii. Providing useful research findings to those who are interested in integrating 3D-ORPSGs in online courses.

This paper is organized into six sections. Section 2 presents an overview about serious games, role-playing games, and effect of serious games on education systems. Sections 3 and 4 describe the experiment methodology and obtained results. Section 5 analyzes the obtained results. Section 6 concludes the paper.

2. Related Work

2.1. Game-Based Learning “Serious Games”

Game-based learning (GBL), namely, Serious Game refers to different kind of software applications that use games for learning or educational purposes. GBL deals with applications that have defined learning outcomes. Generally they are designed in order to balance the subject matter with the game play and the ability of the player to retain and apply the covered subject matter to the real world [13]. According to [22], a serious game is “a mental contest, played with a computer in accordance with specific rules that uses entertainment for government or corporate training, education, health, public policy, and strategic communication objectives”.

In order to produce effective serious games, the founders of the initiatives of Education Arcade and Serious Games suggested that the development of serious games should be a collaborative task among subject matter experts, educators, and commercial game developers in order to combine video game design with constructivist learning methods for non-entertainment purposes [10].

2.1.1. Role-Playing Game

One of the well known types of serious games is a role-playing game where participants assume the roles of fictional characters and collaboratively create or follow stories [14]. A role-playing game has no winners or losers where participants decide on game actions based on their roles in the game. Every player repeatedly takes different roles and different positions. They try to be and act like the chosen character in every game [14]. The players often say that playing role-playing games makes one more tolerant. If one can put oneself in a position of somebody else, she/he can perhaps do it also in real life [14]. In our study, we decided to use this type of serious games.

2.2. Why Serious Games?

In general, games are effective not because of what they are, but because of what they embody and what learners are doing as they play a game [3]. There are many advantages that can be added by integrating serious games in the education system. These advantages are:

Motivation: serious games can motivate students to learn and to try out different roles. One of the key factors behind students’ success is motivating them to learn. Motivation can be sustained through feedback responses, reflection and active involvement in the learning process [1]

Authentic learning: serious games provide learners with a learning opportunity that takes place within a meaningful and authentic context. Learners can apply and demonstrate what they did learn in the same environment. In consequence, the learning output will not be only relevant but also applied and practiced within the learning context. Learning that occurs in meaningful and authentic context is more effective than learning that can be achieved outside of these contexts [3]

Interactive learning: the integration of serious game in the learning process can support teacher to create a social learning environment. Such environment promotes the teacher-student, student-student, and student-content interaction. Facilitation of collaboration and interaction provide learners with the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question conceptual frameworks, express their feelings, reflect about certain conflict situation, and become actively engaged in the learning process [8].

Active learning: students prefer to learn through being able to experiment and seeing what happens. The integration of serious games in education will inspire students to think, to go beyond the given information in order to explore and discover the correct information, and to build their own learning concepts [11].

Turn impossible to possible: Serious games enable students to complete tasks and experience situations which would otherwise be impossible and/or undesirable for cost, time, logistical and safety reasons [2]

2.3. Benefits of Serious Games

The integration of pedagogy, fun, and play in one educational tool add several benefits to the learning process. These benefits are:

- Encouraging learners who may lack interest or confidence [10]
- Enhancing Students’ self-esteem [15, 16].

- Reducing instruction time and instructor load
- Enhancing knowledge acquisition and retention [13,22]
- Supporting development of a number of various skills: strategic thinking, planning, communication, collaboration, group decision making, and negotiating skills [5,9]
- Encouraging greater academic, social and computer literacy skills [13]

2.4. Serious Games Development Technologies

Six dominant technologies drive the development of serious games [19]. These are 3D Engine, Accessible GUI, Physical Models, Artificial Intelligence, Networking, and Persistence. The 3D Engine is the most identifiable part of a game that is responsible for character details, vibrancy of colors, realistic explosions, all of which attract players to the game. Easily accessible and understandable GUIs make it possible for a broad audience to play the game without reading a manual. How characters run, jump, fall, move, shoot, and explode in a game is controlled by physics models that determine how real objects would perform these actions. The recent addition of physics engines treats the digital objects/assets in a game as if they have mass, weight, height, volume, joints, and stiffness. Artificial Intelligence techniques in a game allow the digital players/opponents in a game to perform actions that are similar to human actions and do so in a manner that appear realistic to the human player. Networking enables live players to connect via Internet with other players around the globe thus creating a networked virtual world. Persistence creates a gaming environment that exists before a player enters and after a player leaves simulating a real world environment and experience.

2.5. Developing Serious Games

Serious game design and development is a team sport requiring players with different skills. When designing and developing serious games, the development team brings four elements into a finished product – story, art, software developer, and learning [3, 22]. Design and development roles are distributed as follows:

- The *game design team* crafts the story that provides the entertainment component of the game.
- The *art team* is responsible for the game’s look and feel using content creation and distribution tools such as Adobe Flash, Director, and Shockwave Player.
- The *software team* uses programming languages, APIs and libraries (for 2D/3D graphics, input, sound effects, video, music, and sound effects) [4], and game engines [2] and tools to develop code to implement all requirements related to technical or

programmatic issues of the game. A list of commercial and open source 3D Game and Graphics Engines can be accessed from the Web site <http://www.devmaster.net/engines/> [move to reference section]

In addition to story, art, and software, serious games use pedagogy to impart knowledge or skill. The addition of pedagogy makes these games serious. Pedagogy includes activities that educate or instruct players in a specific subject. The development team must include instructional scientists, learning designers, and subject matter experts to address and incorporate pedagogy in the game. Therefore, learning designers are key factor to the success of a serious game. Hannah [6] describes an object-oriented game development framework or model that programmers can use to create computer games.

2.5.1. Second Life

Second Life is an Internet-based 3-D CVE where we developed “*The Village of Belknap*” game. Linden Labs, the creator of Second Life, defines it as a “3-D online persistent space totally created and evolved by its users” [17]. In Second Life, students navigate, interact, and view the world through their personal avatars. One of the main advantages of Second Life is allowing students to change the appearance of the avatar in any way they want. Students communicate via typed chat, voice chat, and pre-recorded animations such as dancing, crying, and typing.

3. Methodology

The study is conducted at The University of Louisville and included a total of 35 students. At the beginning of the semester, the instructor presented to the students the idea of participating in a 3D-O MPRPESG. The game was developed in Second Life on an island called *The Ville*. In accordance with the instructor, we scheduled an optional online orientation meeting at *The Ville* in order to help students to learn how to navigate the island and how to create their avatars. After the orientation of 35 students, 27 students volunteered to participate in the game and 8 students chose not to play the game. Students were 16 (45%) males and 19 (55%) females ranging in age from 18 to 23 years. They were of mixed age, gender and educational backgrounds. Participants were drawn from English 301, “British Literature” course. Among the 27 students, 6 students played one session of the game, 10 students played two sessions of the game, and 11 students played all three sessions of the game. The randomization of the sampling process helped the researchers to avoid threats to the internal validity of the results.

3.1 Experimental Design

In order to answer the research questions, *Kruskal Wallis nonparametric test*, and *Pearson Correlation test* were used to analyze the collected quantitative data of students' final exam test scores, perceptions' of social interaction, and the relationship between students' final exam test score and their perceptions of their social interaction.

The *dependent variables* were students' learning performance and students' perceptions of social interaction. The *independent variable* was the frequency of playing the 3D-OMPRPESG. The frequency of playing the game (f) is measured across four different groups of students as follows:

- Group 1 (f=0):
 - this included students who decided not to play the game
- Group 2 (f=1):
 - this included the students who played one session of the game
- Group 3 (f=2):
 - this included the students who played two sessions of the game
- Group 4 (f=3):
 - this included the students who played three sessions of the game

3.2 Instruments

In order to answer the *first question*, the Relational Communication Questionnaire (RCQ) was used. The questionnaire was developed by Burgoon and Hale in 1987. The questionnaire was used to collect quantitative data regarding students' perception of the quality of social interaction. The RCQ addresses several factors including the immediacy/affection, similarity/depth, receptivity/trust, composure, formality, dominance, and equality. The RCQ questionnaire consists of 19 items with a five-point Likert scale with response options ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire yields a total score that ranges from 19 to 95 with a higher score indicating a better perception of the quality of social interaction. The overall internal consistency reliability of the questionnaire is $\alpha = .70$. Alpha ranged from a low of $.52$ equality factor to a high of $.81$ for the immediacy/ affection factor. In order to answer the second research question, students in the two groups were assigned a 25-points short quiz at the end of the covered learning unit. The quiz consisted of 25 multiple choice questions.

In order to answer *the second question* and measure students' learning performance, students were assigned a final exam consisting of 50 multiple choice questions

and 10 short answer open-ended questions at the end of the semester. The final exam was worth 100 points.

Then in order to answer *the third question*, the scores for social interaction of the RCQ and the scores of students' final exam were analyzed to examine the relationship between the perception of social interaction and the students' learning performance by using Pearson's correlation test.

3.3. 3D-OMPRPESG Task and Scenario

Playing the 3D-OMPRPESG aims at helping students understand the course materials using a 3D-OMPRPESG called *The Village of Belnap* (Fig. 1 and Fig. 2).



Fig. 1 Snap shot of the Village of Belnap game



Fig. 2 Snap shot of the Village of Belnap game

By completing the game, students will be able to describe a fourteenth-century village and the roles of its residents, reflect attitudes appropriate to the social role of their characters, and make a historically appropriate argument about the assigned topic. This game consisted of three different sessions. Each session was linked to a certain learning topic.

Before starting each game session, students were asked to:

- Choose a village identity for their avatar. Choose some appropriate fourteenth-century clothing for their avatar;
- Update their profile to reflect their new fourteenth-century role.

During the game, students:

- Meet and chat with other villagers, click on the other avatars and read their fourteenth-century profiles, interact with the other characters in a way that is appropriate to the social role of their character in fourteenth-century English village culture.
- Create a note card. In order for them to learn how to create a note card, students should go to Bulletin Board and follow the directions. On their note card, they should describe their beliefs and points of view about the assigned topic. They should then post their note on the Bulletin Board.
- Go to the tavern at the top of the hill and sit down at a table; they discuss the assigned scenario. Everyone should contribute to the debate using arguments that reflect the various fourteenth-century attitudes toward justice, the social hierarchy, and the tensions of the times. The students should make an argument that their character would be likely to make.

At the end of the game, each group should come up with one shared decision.

3.4 Procedure

At the beginning of each learning unit that is linked to one of the game sessions, the instructor reminded the students of the date and time to play the game. She explained to them that the game will last for an hour. At the end of the semester all students took the same final exam as well as filling out the RCQ.

4. Experimental Results

4.1. Analyzing Results Using Descriptive Statistical

4.1.1. Analyzing Results For Q1

The researchers expected that the frequency of playing the 3D-OMPRPESG would enhance students' learning performance in the final exam as well as increasing their perceptions of social interaction.

Table 1 shows that students test scores' median value increases linearly. In other words, group 4 experienced higher perception of social interaction as compared with groups 1, 2 and group 3

Playing Game Frequency (f)	RCQ Questionnaire Score		
	Median Score	Min Score	Max Score
f=0	74	68	79
f=1	82.5	79	92
f=2	88.5	80	93
f=3	91	85	94

Table 1. Descriptive Data of the students' Perceptions of social interaction

4.1.2. Analyzing Results For Q2

Table2 shows that group 4 outperformed groups 1, 2 and group 3 on the final exam questions (MED_{no game} = 83, MED_{1 session} = 91, MED_{2 sessions} = 95, MED_{3 sessions} = 98). The results are consistent with our expectations.

Playing Game Frequency (f)	Final Exam Score		
	Median Score	Min Score	Max Score
f=0	83	81	86
f=1	91	89	93
f=2	95	93	98
f=3	98	96	100

Table 2. Descriptive Data of the students' learning performance

4.1.3. Analyzing Results For Q3

In this section, scores for social interaction of the RCQ and the scores of students' final exam were analyzed to examine the relationship between the perception of social interaction and the students' learning performance by using Pearson's correlation technique. The researcher hypothesized a significant positive correlation between the perception of social interaction and the students' learning performance.

The analytical results, reported in Table 3, confirmed authors hypothesis of having a significant strong positive correlation between the perception of social interaction and the learning performance: $r = 0.848$, $p = 0.000$.

Pearson Correlation	
Social Interaction	Learning Performance
Social Interaction	1
	0.848 ^(**)

Table 3. Pearson Correlation between Social Interaction and Learning Performance

Figure 3 demonstrates the linear relationship between students' perceptions of social interaction and their learning performance. Figure 3 illustrates that when the perception of social interaction tends to increase; the learning performance tends also to be improved and vice versa. The coefficient of determination (R^2_{XY}) was calculated to determine the proportion of variability in students' perceptions of social interaction can be predicted from students' learning performance ($R^2_{XY} = 0.72$). It was found that 72% of the variance in students' perceptions of social interaction is accounted for by learners' learning performance.

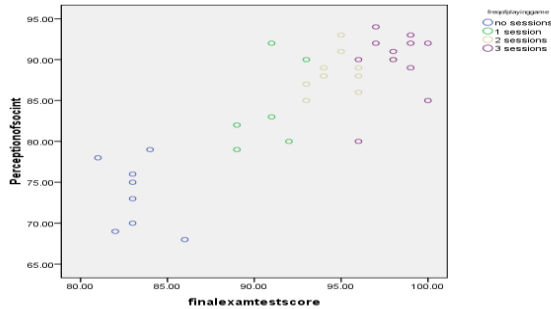


Figure 3. The relationship between Social interaction and learning performance

4.2. Analyzing Results Using Inferential Statistics

4.2.1 Analyzing Results For Q1

Since the use of serious games is still in its infancy stage, this study is considered to be a pilot study to test how the frequent use of 3D-MPRPSG can influence students' perceptions of social interaction as well as their learning performance. Due to the unpopularity of integrating educational serious games in the education system, the researchers were only able to work with a small sample size. The researchers therefore employed Kruskal Wallis nonparametric test to find out if there was a statistical significant difference among the four groups. An alpha level of .05 was used for the statistical test.

Table 4 indicated that the results are statistically significant at a 0.05 significance level. Descriptive results in table 2 along with the inferential results in table 4 indicated that there is a positive impact of the frequency of playing the 3D-OMPRPESG on students' perceptions of social interaction.

	Perception of Social Interaction
Chi-Square	21.13
Deg Of Freedom (Df)	3
Significance Level	0

Table 4. Inferential Data of Students' Learning Performance

4.2.2. Analyzing Results For Q2

Table 5 presents inferential analysis of students' learning performance. According to Table 5 the results are statistically significant at a significance level of 0.05. Together with the descriptive data in Table 1, the results indicate that the influence of the frequency of playing the 3D-OMPRPESG is varied widely across the four groups.

	Final Exam Test Score
Chi-Square	30.154
Deg Of Freedom (Df)	3
Significance Level	0

Table 5 Inferential Data of Students' Learning Performance

5. Discussion

The main purpose of this experiment was to examine if:

- The frequency of playing educational serious games influences students' perceptions of social interaction;
- The frequency of playing educational serious game influences students' learning performance
- There is a relationship between students' perceptions of social interaction and their learning performance.

For the first task, researchers manipulated the number of time of playing the game to examine if the frequent play of the game would promote social interaction among students. The results of this experiments confirmed that students who played three sessions of the game experienced the highest perceptions of social interaction and students who did not play any session experience the lowest perception of social interaction. Authors interpreted the obtained results based on actions took place in the game sessions as follows:

During the *first games session*, students familiarize themselves with the new learning tool, navigating the game environment, learn how to control their avatars as well as how to interaction with others' avatars. During the *second games session*, students start to get in a deeper discussion with their classmates. They start to exchange ideas, experiences, and point of views. In consequence, students experience the highest perception of social interaction during the third session of the game. During the third session, students are familiar with their team members, game environment, how to control their avatars, and how to interact with other avatars.

In addition, the gaming learning environment stimulated the conversation and encouraged students to go into a deep discussion and to exchange their points of view. The continuous interaction among students helped them to discover shared values and goals among them. This discovery supported the building of trust and shared understanding as well as a sense of community. This study proved the argument that the implementation of multi-players games can help students to maintain the sense of community and support them to create a motivating learning environment.

Based on the above mentioned results, researchers presented a 4-stages sequence diagram (OFIC) that represents the flow of social interaction in serious games. The four stages are summarized as follows:

- **Stage1: Observation**
 - During the orientation, students observe the teacher in order to learn how to use serious game. Also, they start to interact with the environment.
- **Stage 2: Familiarization and Experimentation**
 - In this stage, students spent most of time in familiarizing themselves with the game environment, their avatars, and others' avatars.
- **Stage 3: Interaction**
 - In this stage, students interacted with their colleagues in order to know each other.
- **Stage 4: Collaboration**
 - Finally, students were ready to collaborate in solving exchanges their knowledge to solve a real problem.

For the second task, the results revealed that the frequency of playing the games positively influenced students' learning performance because the frequent play of the game allowed students (i) to play different roles, (ii) to inhabit the 14th century atmosphere, (iii) to have several chances to exchange idea and information with their colleagues, and (iv) to be involved in different discussion and debates. All these factors facilitate their better understanding of the learning materials and a better performance in the final exam.

Additionally, serious games are effective tool in using storyline, characters, and humor to encourage students to immerse in the learning experience. This immersion will motivate students to practice what they learn, improve students' memory skills, and enhance students' understanding of complex and abstract concepts.

Therefore, students do not only remember what happened but also why it happened. Serious games can be introduced as a medium for embedding new knowledge that can then be immediately applied in real life.

For the third task, the relationship between students' perceptions of social interaction and their learning performance, the results indicated that more interaction with colleagues and course material the better the performance students achieve. The results indicated that students who did not play the game experienced the lowest perception of social interaction and at the same time have the lowest learning performance. On the other hand, students who played the three sessions of the game experienced the highest perception of social interaction and achieved the best learning performance. This confirms that there is a direct relationship between the amount of interaction between student and his/her colleagues as well as the amount of interaction between student and the course material. More interaction means better learning performance. The results of this study proved Gee's statement that playing MPRPESGs positively influenced students' learning performance.

Moreover, playing the game facilitated collaboration and communication among students, which in turn enhanced their learning performance. This study provided evidence regarding how playing the game helped students to understand and interact with the course materials in a different way. In addition, this experiment highlighted the issue that playing the game is not the only factor but the frequency or the number of times the game. This means that if the teacher will integrate as a teaching tool in his/her courses, they should allow and encourage the students to play it more than one time in order to achieve effective results.

The findings of this study suggest that 3D-OMPRPESG can be an effective educational tool in:

- (i) helping students to develop their strategic thinking, planning, communication, collaboration, group decision making, and negotiating skills; and
- (ii) helping students to have a better acquisition and retention rate.
- (iii) helping teachers to prepare students to meet the needs of the information society.
- (iv) helping educators, game designers and curriculum experts to work together in order to provide teachers with guidelines on how to integrate educational serious games in the teaching process. Also, they should design games that are flexible enough to support the different learning styles of students.
- (v) encouraging educators to be active participants during playing the game because they serve a

vital role in guiding students' focus and conversation.

Since this study is considered to be a pilot study and due to the small sample size, the results of this experiment will not be extrapolated until replicating the same experiment with a larger sample size.

6. Conclusion

Next Generation of our students didn't favor the passive, receptive tradition instruction and prefer to be active and being involved in the learning process. In addition, they enjoyed the integration of multimedia technology and the simulation of their multiple senses. Additionally, they prefer collaborative work as well as learning that can be accomplished in authentic, real world context and enhance their critical thinking and problem solving skills

People make a heavy use of games in informal learning. On the other hand, there is a minimum use of games in the formal education system. This study confirmed that serious games can be used to introduce a new topic in an interactive format. The integration of serious games can raise students' interest for the learning topic, to create a complex learning opportunity, to increase the motivation of students, and can facilitate another way of interaction and communication.

Also, the study indicated that the more students play serious game, the better understanding of learning concepts will be achieved, and higher perception of social interaction will be experienced. In addition, the study confirmed that there is a direct positive relationship between students' social interaction experience and their learning outcome. These findings can be a result of the nature of serious games, which engage students in an immersive rich visual learning environment. Such learning tools motivate students through involved them in a fun, challenging, and interactive learning environment.

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