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Improving Caribbean Undergraduates' Enjoyment, Engagement and Learning Using a 3D Role Playing Game

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Many students complain of being bored in traditional classrooms and yearn for the use of technology to enhance their learning. New media, such as video games, are engaging for many of these students therefore it is worthwhile to explore how these media can be effectively harnessed for learning. This paper presents the results of a study which investigated the use of a 3D role playing game (RPG) to teach Caribbean Undergraduates about the challenges of health management information systems (as a part of STEM training). At the end of the game playing activity, participants reported that they were fully engaged and enjoyed playing the 3D RPG. In addition, there were statistically significant differences in the pre- and post- test scores of the participants based on the cognitive levels examined. These results are important because there is a dearth of published research in the use of 3D RPGs in Caribbean classrooms.

Keywords: *Game-based learning, 3D role playing games, STEM, active learning, video games, learning tools*

Introduction

It appears that many students in traditional classrooms are bored (Herreid, 2006) which may be a contributing factor to their poor academic performance (Finn & Rock, 1997). Disengaged students often do not put in much effort, they tend to be distracted and exhibit signs of overall withdrawal from the lesson and class (Moreno & Mayer, 2000). Classrooms which are non-traditional use active learning techniques to improve students' enjoyment, engagement and learning. These active learning methodologies often utilise new media.

Many studies have reported improvements in students' enjoyment, engagement and learning through the use of new media to provide solutions to learning challenges. New media, such as video games, keeps younger demographics engaged and motivated for many hours a week (Prensky, 2003; Shaffer & Gee, 2005), therefore are potentially good active learning techniques for use inside and outside of the classroom (Van Eck, 2006; Watson, Mong & Harris, 2011). In addition, a combination of learning and game play has been shown to be effective in transferring knowledge and teaching skills (Noraddin & Kian, 2014).

In 2013, Spil Games released an industry report stating that over 1.2 billion people worldwide (out of an estimated population of 7.1 billion) played games (SpilGames, 2013). The report highlighted the fact that gaming has become a mainstream activity with all possible demographics being well represented in the gaming industry. This wide appeal of video games

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makes it important to study the different ways that they might be used to improve the enjoyment, engagement and learning of students.

This significant appeal of video games for entertainment also makes it important for designers of instructional technologies and educators to study the game designs and genres that can promote learning. It is useful to note that the positive impact of several game genres, such as Action, Adventure, Puzzle, Simulation, Virtual Reality and Role Playing Games (RPGs), has already been reported in the literature (Connolly, Boyle, MacArthur, Hainey & Boyle, 2012).

It is important to study 3D RPGs because "strategies of design that lead to engagement may include role-playing" (Dickey, 2006, p. 1) and "researchers such as Dickey (2006) have found that 3-D learning environments not only provide a narrative context for situating and contextualising learning, they also enable spatial relationships rather than linear ones" (Dondlinger, 2007, p. 23). These characteristics (engagement and learning) of RPGs potentially make them good learning tools, thus deserving of further study. Furthermore, RPGs are very popular and have been translated across different media, for example, from board games to digital games (Tychsen, 2006).

In the Caribbean context there has been an increased emphasis on STEM education since this is viewed as important for regional growth. Innovative ways therefore need to be explored to engage Caribbean students in STEM; one such method is the use of digital games, for example 3D RPGs.

Before embarking on this campaign, however, it is necessary to understand whether Caribbean learners are different in any way from their counterparts in developed countries. One obvious difference is their access to technology and their ability to use it, as a result of the digital divide. Earlier studies have shown that Caribbean students' ICT competencies do in fact differ, for example, in the use of some productivity tools from students in other developed countries (Walcott, Garner-O'Neale & Depradine, 2013; Walcott & Rolle, 2014).

The study presented in this paper investigates the use of a 3D RPG to teach undergraduates about the challenges of health management information systems. This study is important because it examines the use of a 3D RPG as a part of STEM training in the Caribbean where limited research on this topic has been reported.

Literature Review

Teaching and learning can be a challenging activity for educators, especially when students are not directly motivated by a lot of the material that they have to learn (Prensky, 2003). The traditional view of teaching which focused simply on information transfer through books, notes and lectures (Ruben, 1999), for example, is no longer having the desired effect and educators are increasingly challenged to find methods that engage and motivate students (Legault, Green-Demers, & Pelletier, 2006). This review will examine the need for active learning in traditional classrooms and discuss how video games have been used in this regard with a specific focus on RPGs.

According to Faust and Paulson (1998) the majority of college faculty teach their classes using the traditional lecture format. These researchers believe that the traditional lecture format was an efficient method of presenting information, however they indicated that if used as the only mode of instruction then issues could arise for both educators and students. They noted that given the differences in learning styles amongst students, presenting information exclusively in one style, such as a lecture, is discriminating and disadvantageous to those people that may learn best using another style. Similarly, Noraddin and Kian (2014) noted that the traditional method

of teaching is recognised as generally not being able to accommodate the many different learning styles of a given set of students. Wilson and Korn (2007) added that if the aim of the teaching methodology is to foster critical thinking in students, then lecturing is not enough.

It is likely that the traditional lecture format will continue to be the main form of information transfer which may result in students passively taking in information that has already been processed by the lecturer and simply regurgitating it in examinations (McCarthy & Anderson, 2000). To overcome this challenge, McCarthy and Anderson (2000) suggested that there needs to be a balance between passive and active learning, in large classrooms, where the lecture format is the dominant mode of information delivery. So what is active learning? Faust and Paulson (1998) defined it as any learning activity that students engage in other than simply listening to the lecture; these include short writing exercises to more complex collaborative or cooperative exercises. As succinctly stated by Watson, Mong, and Harris (2011), students will not learn if they are unaware or asleep, but will learn if they are engaged. Engaged students are more motivated thus more driven to learn (Gee, 2003).

Jang, Reeve and Deci (2010) described two types of engagement, behavioural and self-reported. Behavioural engagement relates to what is observed during the task (for example, attention to the task, level of effort invested and persistence in facing difficulties) while self-reported engagement refers to what students were actually experiencing (such as positive feelings, determination to succeed, intentionally learning to master a skill or accomplish the task and deep information processing) (Jang, Reeve, & Deci, 2010).

The pursuit of the most appropriate strategies and actions to develop the educational systems in this new age, through active engagement of students, is therefore inevitable, and must be based on a firm comprehension of social and cultural perspectives "and of the new media that holds the key to potential educational reform" (De Aguilera & Méndiz, 2003, p. 5).

Games are informal, pedagogically-sound learning environments, providing a 'multi-sensorial' experience (Oblinger, 2004). It has been stated that they have the ability to facilitate the development of various skills including critical thinking and problem solving (Ebner & Holzinger, 2007; Papastergiou, 2009) since they are considered active, collaborative and technology-rich learning experiences (Bekebrede, Warmelink, & Mayer, 2011).

There are many different types of video game genres, each with the potential to foster specific skills and abilities related to learning and education. De Aguilera and Méndiz (2003) identify several of these along with their educational possibilities, including: (1) arcade and platform games which facilitate psychomotor development and spatial orientation; (2) sports and dynamic games which help to improve psychomotor coordination and provide stress relief; (3) puzzle and question games which assist in developing reasoning skills and improving logical thinking; (4) simulation games which foster the development of all intellectual capabilities; and (5) strategy and role playing games which stimulate internal motivation.

Young students find modern video games extremely engaging and motivating, keeping them focused on game play for hours at a time (Shaffer & Gee, 2005). In fact, it has been recognized that this engagement and interest in games continues as the person matures, given that many gamers do not give up this hobby (De Aguilera & Méndiz, 2003).

In a study conducted by Ruggiero (2013) with pre- and in-service teachers in the United States, it was found that teachers agreed that games should be used to augment the learning process and that their usage in the classroom is not a transitory trend but will increase in prevalence as classroom technologies catch up to mainstream entertainment (Ruggiero, 2013). Other studies have reported high levels of students' enjoyment, engagement and learning through

the use of new media, such as videogames (Crookall & Thorngate, 2009; Gremmen & Potters, 1997; Malone, 1981; McCarthy & Anderson, 2000; Sanford & Francis, 2006; Squire, 2005).

Games provide challenges, beauty, fantasy, fun and social recognition in a way that can motivate learning to a great many people (Annetta, 2008; Gee, 2003). With the advancements exhibited in technological applications, it has become possible to create very sophisticated digital games that combine rich multimedia and enable high levels of interactivity (Noraddin & Kian, 2014) that capture and keep the gamers' attention.

Although they might not be a single definition for RPGs, they usually comprise of: a game world (an imaginary world where the players play); a game master (who controls the game world); participants (players and game masters); characters (individuals in the game world); interactions (with the objects in the game world); and, a narrative (a sequence of events portrayed in the game world, in other words a story) (Hitchens & Drachen, 2008).

There are many different types of RPGs including: pen-and-paper/table-top (PnP), single player digital and massively multi-player online (MMORPG) (Hitchens & Drachen, 2008). PnPs, like Dungeons and Dragons, were the original form of RPGs and were played around a table by a group of people; single-player digital RPGs were derived from the table-top versions; and MMORPGs (a very popular genre), such as World of Warcraft, allow thousands of participants to play online (Hitchens & Drachen, 2008). 3D RPGs are essentially single-player digital RPGs with integrated third person (for example) 3D environments. In these RPGs the computer plays the role of game master.

Rankin, Gold and Gooch (2006) described the use of Ever Quest 2 to teach vocabulary to English as a second Language (ESL) students. The four participants that finished the study were required to complete a pre-game questionnaire which queried their computer literacy and comfort levels playing video games. These participants played the 3D RPG for four hours a week, for four weeks. From the post-tests conducted it was noted that the participants were able to accurately define 35 percent or more of the words that they were introduced to once and 55 percent or more for the words that were introduced to more than five times. In addition, the confidence levels in reading, writing and conversation increased for those participants that were not beginner ESL students.

Levy (2011) described a 3D RPG for teaching history and literacy to 5^{th} grade students. The purpose of the game was to solve a mystery about a knight's armour in a medieval town. Participants were given about 45 minutes to play the game. A pre-/post-test was used which asked the students to write down the names of the pieces of armour. The post-test showed that learning occurred. Although students felt that the 3D RPG was fun, they believed that there was too much talking in the game since audio clues would loop if participants were in close proximity to the given objects.

Chen (2015), in a study of 362 undergraduates, reported significant differences in pre- and post-test scores of English learning for EFL (English as a foreign language) students. The test examined students at several cognitive levels based on Bloom's taxonomy. Not only were there significant increases in test scores, but participants also believed that the virtual learning environment was advantageous and meaningful to them.

Vasileiou and Paraskeva (2010) used a 3D virtual environment implemented in second life to teach role playing to fifteen primary and secondary school teachers. Within this 3D environment they were taught how to role play and then engaged in role playing performances. The results, derived from interviews, indicated that many of the participants found the

experience exciting, fun, liberating and engaging, especially during role playing performances. In addition, more than half of the participants believed that they had learnt how to role play.

Finally, Balicer (2007) surmised that RPGs such as "World of Warcraft" could be used to model and study infectious diseases with a view to creating public health policies. Using an outbreak of a serious epidemic in World of Warcraft" as an example, Balicer (2007) described a potential strategy for testing hypotheses of infectious disease dissemination.

The 3D RPGs discussed resulted in improved participants' enjoyment (Levy, 2011; Vasileiou & Paraskeva, 2010), engagement (Vasileiou & Paraskeva, 2010) and learning (Levy, 2011; Rankin, Gold & Gooch, 2006; Vasileiou & Paraskeva, 2010) at different cognitive levels (Chen, 2015). Although most of these studies used pre- and post-tests, they did not employ control groups. Additionally, the time period for the treatment varied from 45 minutes to about 16 hours. Finally, as realised by Levy (2011), care must be taken to achieve the right balance of audio narration since too much or too little might affect the participants' engagement.

Only a few studies appear to have been conducted in the Caribbean which used virtual worlds for teaching and learning (Depradine, 2007; Mohammed & Mohan, 2011). Depradine (2007) used a role playing virtual world to teach students the art of creating secure, web-based systems in the Java programming language; interacting in the virtual world resulted in the exploring of issues, such as, ethics, teamwork, leadership, strategy and software planning. Alternatively, Mohammed and Mohan (2011) used culture (language and customs) in a 2D digital game-based learning environment to improve undergraduates' attitudes towards introductory computer programming courses. In this game, students were required to detect and correct errors in programme code during game play.

In conclusion, active learning strategies can be used to engage students who are bored in traditional lecture-style classrooms. These strategies, which include the use of video games, can be used to engage and motivate students while they learn. The research literature on the use of 3D RPGs discusses the teaching of: English to ESL, EFL and 5th grade students; as well as, role playing to primary and secondary school teachers. Additionally, it discusses a proposal for the use of 3D RPGs to model and study infectious diseases. The outcomes of these studies begin to demonstrate that 3D RPGs can improve enjoyment, engagement and learning. It has also been shown that there is a dearth of research studies on the use of 3D RPGs in Caribbean classrooms. It is within this specialised area of research that this paper will be based. It is expected that similar learning outcomes may be achieved in Caribbean classrooms despite the digital divide.

Statement of the problem

Students are often not engaged during classroom instruction and do not enjoy traditional learning activities such as the reading of research papers. As a result, the desired learning outcomes are not always achieved.

Purpose

The purpose of this study was to determine whether a 3D RPG could be used to increase students' enjoyment and engagement, while improving their learning.

Research questions

The research questions explored in this study were as follows:

1. Were there any significant differences in the undergraduates' overall test scores or their test scores at the cognitive levels examined, before and after playing the 3D RPG?
2. Do undergraduates perceive that the 3D RPG increased their enjoyment, engagement and learning?

In the remainder of the paper the academic literature on the use of video games for learning will be discussed; the context of the study and the methodology will be described; and finally the results, discussion, conclusions and future work will be presented.

Methodology

This study was conducted at The University of the West Indies, Cave Hill Campus which is a regional university comprising three main campuses. The smallest of the three campuses is in Barbados and offers programmes in Science and Technology, the Social Sciences, Humanities and Education, Law and Medicine. In the Faculty of Science and Technology, both a BSc. in Information Technology and a BSc. in Computer Science were offered at the time of the study. Several computer laboratories were available for use by students in the Faculty, including the laboratory used for the study which was outfitted with approximately 40 computers running the Windows 7 operating system. The RPG was preloaded on these computers.

Population and sample

Data were collected from a sample of 30 students reading either a second-year, software engineering course or a third-year information systems course. The software engineering course was compulsory for all students completing the BSc. Information Technology and BSc. Computer Science programmes. This sample represented just over 40 percent of the overall population of the courses. In the sample, 21 participants were male and 9 females. Twenty-four out of the thirty participants were thirty years old or under, with six between ages 16 and 20; thirteen between the ages 21 and 25; five between the ages 26 and 30; three between the ages 31 and 35; two between the ages 36 and 40; and, one between the ages 41 and 45.

Data Collection

Data were collected during a two-hour laboratory session. In the first 15 minutes, a pre-test was distributed, completed and collected. Participants then played a 3D RPG for 30 minutes. During this time the researchers took photographs and observed the activities of the participants. After the game activity a post-test was administered (for 15 minutes). The pre- and post-tests were the same twelve question instrument (as per the guidelines published by ITECH (2008, p.1)). A group interview was conducted with the participants immediately after the post-test to solicit feedback about the students' experiences during the activity. In addition, some participants provided additional feedback via course journal reflections.

Research instrument

Bloom's Revised Taxonomy (Krathwohl, 2002) identifies six categories (as verb forms) that can be used to define cognitive objectives. These six categories are: remembering, understanding, applying, analysing, evaluating and creating. The categories analysing, evaluating and creating relate to higher-order thinking and are therefore more desirable during learning experiences.

The developed test (pre/post) comprised twelve MCQ questions based on the health management information system (HMIS) described in a research paper by Smith, Madon, Anifalaje, Lazarro-Malecela, and Michael (2007). Eight of these questions related to the Remembering category, while the remaining four related to the Analysing category (Table 1).

Table 1

The Cognitive Levels Evaluated in the 12 Question Pre- /Post-test.

Bloom's Revised Taxonomy Category	***Questions***
Remembering: Recall or retrieve previous learned information.	1, 2, 3, 5, 6, 7, 8, 9
Analysing: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	4, 10, 11, 12

Two examples of the MCQ questions used, one drawn from the Remembering category (question 2) and one from Analysing (question 10) are:

Question 2. What is the overall opinion suggested about the HMIS according to initial surface reports?

A. The data contained in the HMIS provided a useful means of accurately measuring the disease levels.
B. Despite minor flaws, there was nothing intrinsically wrong with the concept of the system itself.
C. The HMIS in its current form was a useful tool and easy to use.
D. The HMIS project was a complete disaster.

Question 10. Do you think a bottom-up approach would have had an impact on the success of the HMIS?

A. Yes – it would likely have been more successful as it would have involved the users and incorporated their requirements, processes and perspectives.
B. Yes – it would likely have been more unsuccessful because it would have become more complicated to incorporate everyone's perspective and requirement.
C. No – it would not have made a difference because involving the users would not have had an impact.
D. No – it would not have made a difference because the process is too complex.

In the group interview, participants were asked to provide feedback about the game including issues found, whether the game was fun and if they perceived that learning occurred or what prevented learning from occurring.

Data Analysis

Both descriptive and inferential statistics were used in the analysis of the data collected from the pre- and post-tests. The number of correct responses, for each question in the pre- /post-test,

based on the cognitive levels examined, was calculated using frequencies. To determine whether statistically significant differences existed in the pre- and post- tests, at the different cognitive levels, paired sample T-tests were employed. SPSS 19 was used for the data analysis. Common themes were also identified and reported from the journal reflections submitted and the responses from the group interview.

The 3D RPG game

The 3D role playing game used in the study was based on the information contained in a case study presented by Smith et al. (2007) which discussed the failed implementation of an HMIS in Tanzania. In the paper, a number of stories were presented, highlighting different issues associated with the implementation, such as corruption and undermining authority.

A series of non-playable characters (NPCs) and interactive objects were introduced in order to provide information to the player. A summary of the information provided by each NPC and outlined in Walcott and Corbin Babb (2014) is as follows:

- Senior Member, Ministry of Health. Indicated that the HMIS data were not trustworthy;
- Rural Medical Aid. Described their responsibilities and duties;
- Assistant Clerical Officer. Indicated that their authority was undermined by Rural Medical Aids;
- District Medical Officer. Described the roles and responsibilities of agencies in the Health sector;
- District Health Worker. Indicated how complex the data collection process was;
- Village Health Worker. Described the complexity of the flow of information in the health care facilities;
- Soldier A. Highlighted corruption issues;
- Soldier B. Described how some doctors bribed community leaders to maintain their positions;
- Desk A. Contained an extract of a report describing a successful district; and,
- Desk B. Identified some of the problems associated with the HMIS.

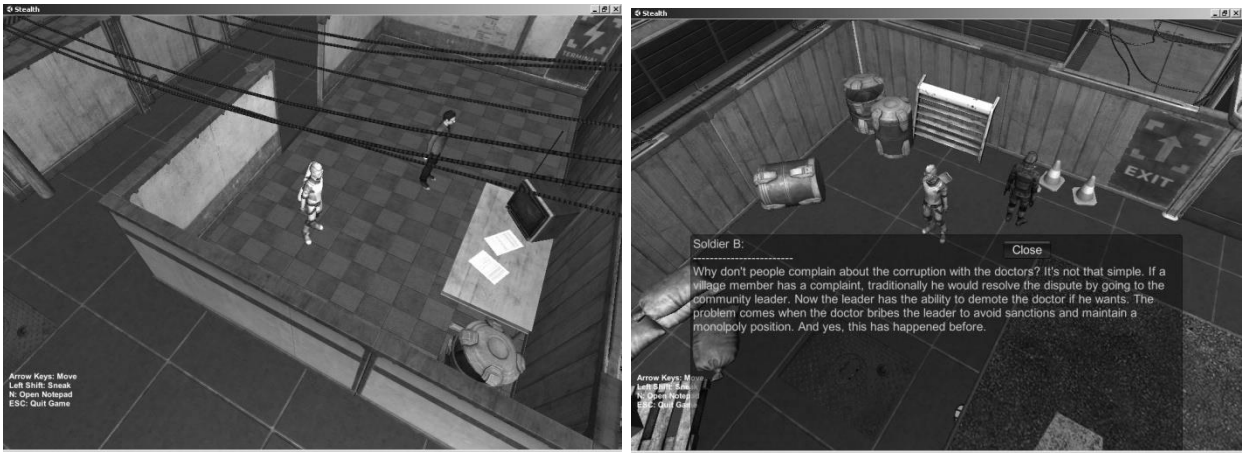
The player's objective was to find the key necessary to exit the level, a task only achieved when all the required information had been gathered.

The 3D role playing game was created using Unity3D, a gaming engine that incorporates the use of animations, audio, text capabilities and gaming objects for the creation of either 2D or 3D games. Within Unity3D, gaming objects can be controlled and manipulated through computer programming scripts (C# was used in this game). For this game, elements contained within a Unity game development tutorial were utilised, such as the playable character and the environment. Other features were added to the game including the NPCs, the interactive objects, and the text-based interactions with the game objects.

The case study (Smith et al., 2007) examined the issues associated with the failed implementation of an HMIS in Tanzania which was caused by a complicated hierarchical structure of data collection and reporting within the health care facilities, as well as the existence of corruption within the Health sector. Additionally, the case study highlighted a series of political, social and cultural issues that also negatively affected the implementation of the HMIS.

Within the case study, information was collated from identified interviewees, and this was translated into the game by the introduction of NPCs that assumed certain identified roles from the paper and interacted with the player to provide him/her with information (from the case

study). Each of the NPCs assumed one of the identified roles contained within the paper, except for two of the NPCs which were introduced to provide independently uncorroborated information received from anonymous sources. Additionally, interactive objects such as desks containing papers were used to provide information found in reports mentioned within the paper or relevant background information (Figure 1). The information obtained by the player from the NPCs and interactive objects needed to be used to retrieve the key and end the game.



(a) (b)

Figure 1. Screenshots of the 3D RPG: (a) The player (on the left) is about to interactive with an NPC and the desk which has important documents on it; (b) The player is interacting with a soldier.

Results

Research Question 1

Overall (for all the questions in the pre-/post-tests) there was an increase in average score from the pre-test (M=1.00, SD=1.62) to the post-test (M=3.43, SD=2.14) (Table 2).

Table 2

The mean scores for the pre- (TotalPRE) and post- (TotalPOST) tests.

Pre/Post Variable Pair	*Mean*	*N*	*Std. Deviation*	*Std. Error Mean*
TotalPRE	1.00	30	1.62	.30
TotalPOST	3.43	30	2.14	.39

This increase was significant at the 95 percent confidence level as evidenced by the paired samples T-Test ($p<0.000$) in Table 3.

Table 3

A *paired sample T-Test applied to the pre- (TotalPRE) and post- (TotalPOST) tests.*

Pre/Post Variable Pair	*Mean*	*Std. Dev.*	*Std. Error Mean*	*t*	*df*	*Sig.*
TotalPRE TotalPOST	-2.43	2.27	.41	-5.87	29	.000

The number of correct responses for the pre- and post-test questions in the Remembering and Analysing categories of Bloom's Revised Taxonomy are illustrated in Figures 2 and 3, respectively.

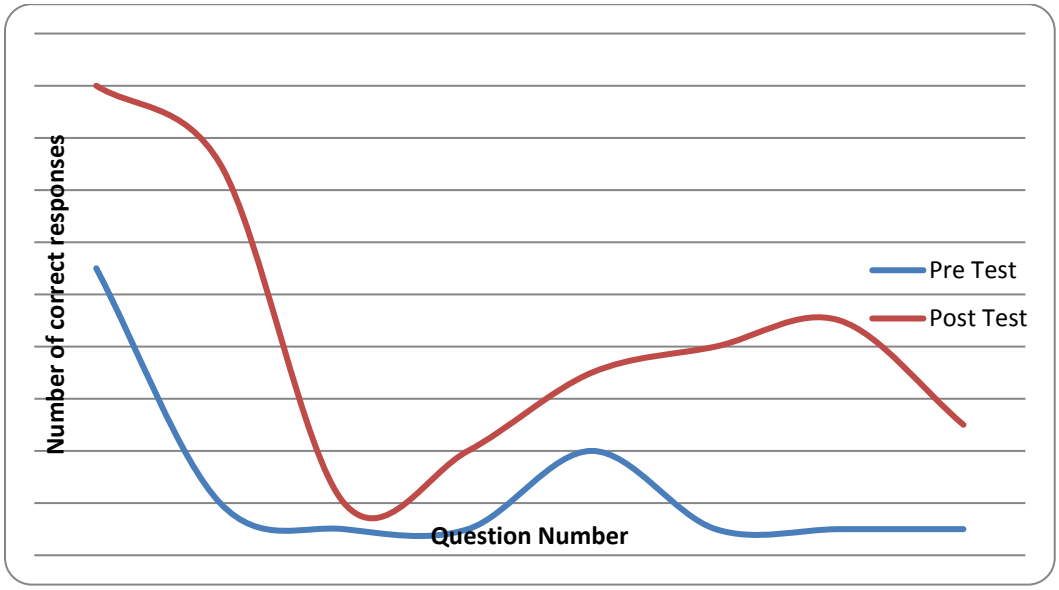


Figure 2. The number of correct responses for the eight questions in the Remembering category for the pre- and post-test.

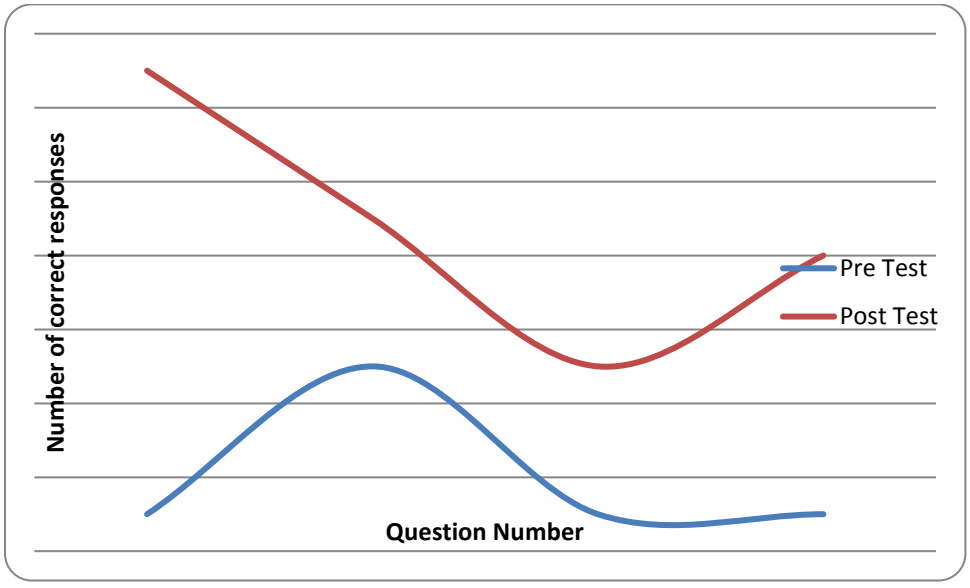


Figure 3. The number of correct responses for the four questions in the Analysing category for the pre- and post- tests.

There was an increase in scores from the pre-test to the post-test for both the Remembering (from M=.733 (SD=1.08) to M=2.27 (SD=1.31)) and Analysing (from M=.267 (SD=.69) to M=1.17 (SD=1.12)) categories (Table 4).

Table 4

The mean scores for the pre- and post- tests in both the Remembering (RememberingPRE/RememberingPOST) and Analysing (AnalysingPRE/ AnalysingPOST) categories of Bloom's Revised Taxonomy.

Pairs	*Pre/Post Variables*	*Mean*	*N*	*Std. Deviation*	*Std. Error Mean*
Pair 1	RememberingPRE	.73	30	1.08	.20
	RememberingPOST	2.27	30	1.31	.24
Pair 2	AnalysingPRE	.27	30	.69	.13
	AnalysingPOST	1.17	30	1.12	.20

A paired sample T-Test at the 95 percent confidence level resulted in a statistically significant difference in the pre- and post-test for both the Remembering ($p<0.000$) and Analysing ($p<0.000$) categories of Bloom's Revised Taxonomy. This is illustrated in Table 5.

Table 5

A paired sample T-Test applied to the pre- and post-tests of the Remembering (RememberingPRE/RememberingPOST) and Analysing (AnalysingPRE/AnalysingPOST) categories of Bloom's Revised Taxonomy.

Pre/Post Variable Pair	*Mean*	*Std. Dev.*	*Std. Error Mean*	*t*	*df*	*Sig.*
RememberingPRE - RememberingPOST	-1.53	1.59	.29	-5.28	29	.000
AnalysingPRE - AnalysingPOST	-.90	1.09	.20	-4.51	29	.000

Research Question 2

Three broad themes emerged from the data collected (photographs, group interview and journal reflections); these were students' enjoyment, engagement and learning. The participants also voiced their opinions about the shortcomings of the activity. These results are presented in the following sections.

Student Enjoyment

The general observation by the researchers was that the students enjoyed playing the game; this was especially so when they first started playing. One female participant noted that it *"add[ed] a little fun to learning."* Oddly enough though, this same student believed that this type of game was better suited for secondary school rather than university students. A male student stated that he liked the session and thought that it was a *"great game."*

Many students commented on the creativity of the game and that it was an innovative way to teach the course materials. This helped to improve their overall enjoyment.

Student Engagement

During game play, it was observed that students remained focused on completing the tasks (Figure 4a), including overcoming the challenge created by the glitch in the game that did not

allow the game to end when all the relevant information was collected. This absorbed attention to the tasks involved remained, even after 20 minutes of game play, demonstrating the players' persistence in achieving the required goal despite difficulties encountered; this can be seen as evidence of behavioural engagement as described by Jang, Reeve and Deci (2010).

(a) (b)

Figure 4. (a) Participants engaged during game play; (b) Participant taking notes during game play.

Student Learning

The playing of the 3D RPG encouraged other forms of active learning, for example:

- Note taking. During game play several participants were taking notes using pen and paper to summarise the material found (Figure 4b); and,
- Collaboration. While playing the game participants were sharing strategies; tips and information; and, discussing who to talk to, in what order and where to go next.

Although some of the participants felt that the game was confusing due to the game objectives not being stated (reinforced) during game play (note the objectives of the activity/game were stated by the researchers before they started playing) they believed that this was an important learning experience. For example, a male student stated that *"... i [sic] would say for the most part it was confusing but still a key learning experience."* He felt that the game was *"unending,"* the result of a bug in the game that prevented the final door from opening when the player received the key; and suggested the use of different worlds for different topics.

Finally, a male student stated that the

> *"final highlight again [of the course] would have been the game played in the final lab which again wouldn't have been the norm in a regular classroom. Teaching methods used in this course has [sic] now given me insight to try other studying methods for other courses whereas rather than reading and writing i [sic] can try online quizzes or games to see how or if the study material will stick similar to this class. I may even try a movie as well!!"*

Shortcomings of the RPG

Participants also voiced their opinions about some of the shortcomings of the RPG. These included:

- The large amount of information that was presented to be read. Some students believed that there was too much text and decided to skim through it. One female student said that it *"felt like cramming for an exam."* Others suggested that voice clips should be used to reduce the amount of reading required;
- The lack of in-game objectives/instructions. Some participants thought that the lack of instructions made the game confusing; and,
- The game did not appear to end. As noted earlier this was due to a bug in the game software.

Discussion

To determine the level of engagement of the participants both a behavioural (objective) and self-reported (subjective) assessment (Jang, Reeve, & Deci, 2010) were performed. Observations of the participants while they played the RPG showed a high level of attention to the game and the tasks involved, including a persistence to complete the tasks and gather all required data despite encountering challenges. Additionally, participants expressed enthusiasm and positive attitudes toward the game and the use of the new medium for learning. These results speak encouragingly to the engagement of the participants using this new medium as a learning tool.

The novelty of the learning method captured the attention of the participants and despite the fact that everyone might not have liked playing video games, none of the participants indicated that they disliked the game or the genre. This supports the proposition made by Shaffer and Gee (2005) that young people are engaged by video games since the majority of the participants were 30 years old or under. The use of the 3D RPG sparked participants' interests causing them to become enthusiastic and engaged. It made some of the participants so excited that they indicated willingness to consider exploring the use of other active learning techniques, in future courses.

There was an increase in the number of correct responses during the post-test for every test question. Furthermore, the differences in the overall score and the scores at the remembering and analysing cognitive levels were statistically significant at the 95 percent confidence level (Tables 3 & 5). As a result of playing the RPG, students did not only exhibit an increase in basic remembering skills, but also critical thinking skills which concur with the findings of Ebner and Holzinger (2007). These results also correspond favourable with the findings of Chen (2015) who reported significant differences at the knowledge and analysis levels for participants learning English while using a virtual world.

Hagen (2015) introduced research papers into a Life Science course in a number of different ways in order to promote active learning. In the approaches employed students were required to read a research paper and then either: draw a diagram illustrating the mechanism of a disease, write a commentary, or complete an assessment. Just over 10 percent of the 250 students in the class liked the use of the research papers while less than one percent had a negative opinion about their use. Similarly, Yeong (2013) reported the results of a study that required participants to complete a practice assessment involving the reading of a scientific article and the answering of questions. In the actual assessment that followed, participants were required to read another scientific article and write a 1000 word essay. Generally these participants felt that the exercise was good but time consuming. Comparatively, all of the participants liked the 3D RPG in this study and no participant had a negative opinion about the game even though they reported the issues that they encountered.

Hagen (2015) also reported that the students felt that a stress-free learning environment was created during their study since they no longer had to memorise information, due to assessments being open book. Conversely, one of the female participants playing the 3D RPG noted that *"given the time we were allocated, getting the information and reading the information felt like cramming for an exam."* Clearly, unlike the participants in Hagen's (2015) study, the participants in the 3D RPG study did not have enough time to play the game. This helps to explain the lower than desired mean scores in the post-tests.

Yeong (2013) stated that 47 percent of the participants would prefer to listen to a lecture as compared to 27 percent who would prefer to read a research article. Despite this, several of the participants suggested that the exercise should be continued. Alternatively, participants playing the 3D RPG never indicated that they would prefer to engage in the reading of a research article exercise, rather they were more interested in using these same techniques in other courses.

3D RPGs provide great flexibility in the type of media that could be used during game play to improve learning, for example the use of movies in cut scenes. This opportunity for learning was particularly embraced by one of the male participants who said that he was even willing to try a movie to help him remember course content. A multi-sensory approach, for example, combining reading, audio and video, provides opportunities for facilitating a richer learning experience. The provision of different types of media is especially important since it will appeal to different learning styles. This was evident from the participants' feedback when they suggested using voice-overs to reduce the amount of text that needed to be read. This approach will ensure that there is no disadvantaging or discrimination against students with different learning styles as noted by Faust & Paulson (1998).

Despite the shortcomings of the game, significant learning took place. This augurs well for the use of RPGs in this and similar contexts. RPGs such as these could therefore be used outside of the classroom to complement existing resources thus freeing up valuable classroom time for other activities.

Limitations

Two main limitations of this study were that no control group was used and the sample was only drawn from two undergraduate Computer Science courses at a single Caribbean university. The issue of no control group was due to the fact that there were only 30 participants, therefore it was decided that they would all be placed in the treatment group.

Another limitation was related to the length of time participants had to interact with the 3D RPG. This was a result of the duration of the laboratory session, only two hours, and the fact that the experiment was run in the final laboratory session of the semester. Although this treatment period was short it was not unreasonable based on the literature (Levy, 2011).

Conclusion and Future Work

In this paper a 3D RPG was used to teach participants about HMIS. After engaging in the game, increases in the levels of lower and higher-order thinking of the participants as demonstrated by the statistically significant differences in the pre- and post-test scores were seen. In addition, students enjoyed the learning experienced and were engaged by it. Although several shortcomings of the RPG were identified by the students, they viewed it as an important learning experience.

When compared to the literature, it was found that participants had a positive attitude to both the reading of the article and the 3D RPG exercises. In addition, both groups indicated a

willingness to explore the use of these methods in the future. However, there was a high level of enthusiasm and persistence by the participants playing the RPG; and none of them indicated that they disliked the game or the genre. Finally, unlike the participants described in the literature who preferred to engage in the traditional lecture format, none of the participants who engaged in the RPG activity indicated that they would have preferred to engage in a research article reading activity. These results speak well for the use of 3D RPGs in this type of STEM training.

In the future, research in 3D RPGs should employ control groups to more effectively measure the effectiveness of this game genre. In addition, the impact of the use of 3D RPGs for different subject/topic areas should be investigated so that 3D RPG learning models can be created.

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