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Procedia - Social and Behavioral Sciences 191 (2015) 487 – 494

Procedia
Social and Behavioral Sciences

WCES 2014

Comparison Between Serious Games and Learning Version of Existing Games

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Abstract

In recent years, there has been a growing interest in computer games that support learning and teaching. In particular, Serious Games and learning version of existing games were pointed out in many works that they succeeded in improving student motivation, increase students' desire to learn and make learning more enjoyable. However, a little of works have examined the impact of these types of learning games on students' level of knowledge and students' satisfaction. Thereafter, this work study the impact of Serious Games and learning version of existing computer games on the level of knowledge and satisfaction of students. Furthermore, this work conducts a comparative effectiveness studies between these two types of learning games. The comparison reveals the effectiveness of serious games in improving students' level of knowledge and the convergence of the two types of learning games in terms of students' satisfactions.

Selection and peer-review under responsibility of the Organizing Committee of WCES 2014

Keywords: Serious Games, Learning version of existing games, Level of knowledge, TAM;

1. Introduction

In recent years, there has been a growing interest in computer games that support learning and teaching. A number of factors led to this interest including the availability of easy tools and technologies for creating learning games and the desire to move from traditional education methods. All these factors aim to solve the problems of Game Generation (Simpson, 2005; Prensky, 2004) in school. This new generation is those students who are raised in the digital world and are native speakers of the digital language of computers, video games and the Internet. They spend a significant amount of time on playing computer games, have the skills to maneuver and problem-solve

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Selection and peer-review under responsibility of the Organizing Committee of WCES 2014
doi:10.1016/j.sbspro.2015.04.380

within it and they are accustomed to high level of motivation and engagement. Many of these students in school today are at risk for failure. This is due to the fact that students of this generation are disengaged, bored, suffering from a bad attitude and they aren't challenged in traditional classroom. They find that traditional learning is a very complex task that requires a lot of effort from them and it is so incredibly boring that they don't want to do it (Olga, Pavel, Alexander& Alexey, 2009). Consequently, they need a lot of motivation to cope with it. Therefore, using computer games in school can clearly consume the attention of students and increase their motivation and engagement. All these factors may stimulate learning. In particular, using Serious Games and learning version of existing computer games was pointed out in many works (Zualkernan, 2006; Zualkernan&Parmar, 2004; Roslina, Rasimah, Hasiah&Azizah, 2011; Mathieu, Patrice & Jean-Pierre, 2010) that they have succeeded in improving student motivation, increase students' desire to learn, make learning more enjoyable, and lead students to complete more difficult work.However, a little of works have examined the impact of these types of learning games on level of knowledge and satisfaction of students. Thereafter, this work study the impact of Serious Games and learning version of existing computer games on the students' level of knowledge and students' satisfaction. Furthermore, this work conducts a comparative effectiveness studies between these two types of learning games. The comparison reveals the effectiveness of serious games in improving students' level of knowledge and the convergence of the two types of learning games in terms of students' satisfactions.The paper is structured as follows: Section 2 contextualizes the contribution by reporting related works. Section 3 presents the implementation of two learning games generators. Section 4 describes the experimentation and discusses the results. Lastly, conclusions are drawn and directions for future work are presented.

2. Related Works

2.1. Serious Games

Serious Games are defined as digital games that educate, train, and inform. These games are designed for a primary purpose other than entertainment, enjoyment or fun. The initial intention of serious games is to combine the serious aspects (learning, instruction, etc) with the playing aspect of digital games (game) (Sorensen & Meyer, 2007).As an example of Serious Games used for educational purposes, we cite Ecotoons2 (Rosa, Ana, ladys& Antonio, 2002). The main goal of this game is to help and motivate children to construct knowledge about mathematical concepts and improve their mathematical reasoning. The educational goals involved in the game are related to mathematical concepts and operations such as counting, adding, subtracting, and so on.Prime Climb (Cristina & Heather, 2009) is designed to help 6th and 7th grade students practice number factorization. Prime Climb consists of series of mountains. Each mountain is divided into hexes labeled with numbers. Two players must collaborate to climb these mountains. Each player can only move to a number that does not share any common factor with the partner's number. If a wrong number is chosen, the climber falls and swings from the rope until the player select a correct number. E-Adventure (Pablo, Pilar, Iván, José&Baltasar, 2007) is a point and click adventure games in which learner can learn by the interaction with objects, consultation of in-game books and conversations with other characters. The <e-Adventure> engine includes mechanisms that can monitor the learner's activity and then provide adaptation and assessment. PlayPhysics(Karla, Paul, Tom, Julieta& Luis, 2011) is a Role Playing Game in which the learner plays the role of an astronaut on a mission. The main goal is to save the mentor. To achieve the main goals, the learner has to overcome challenges applying principles and concepts of Physics. The hands-on OS game (Fong-Ling, Rong-Chang& Sheng-Chin, 2009) is designed to introduce learners the common problems associated with the operating system of the computer. The main goal of this game is to enhance the proficiency of the learner in certain skills related to computer's operating system. The balance game (Irene, Saul, &Anup, 2009) is developed with the purpose of guiding the student to understand the moment's concept. The object represented in the game is bar lying on a wheel that acts as the pivot for the system. Two boxes at the sides of the bar represent two forces acting on the beam. The learner has to balance and control the movement of the bar by changing the force acting on one side of the beam.

2.2. Learning version of existing Games

Researchers have demonstrated the effectiveness of learning version of existing games in many domains. So, modify an existing game and make it suitable to support educational activities is a common issue of many researches. As an example of learning versions of existing games, we cite: Learning version of Tetris (Zualkernan, 2006). It is used for teaching precedence relationship between activities. The classical game of Tetris consists of a sequence of geometric figures called Tetriminos falling down at various rates. The objective of the game is to manipulate these Tetriminos, by moving each one sideways and rotating it by 90 degree units, with the aim of creating a horizontal line of ten blocks without gaps. When such a line is created, it disappears. The learning version of Tetris was created by mapping the geometric constraints to the precedence relationships between activities. A player who is able to match these precedence constraints achieves a high-score. A learning version of snake (Zualkernan, 2006) is used for determining the precedence relationship between activities. The game of snake consists of a snake that gets progressively longer and faster (and hence difficult to maneuver) as it eats various bits of "food" that appear. The learning version for this game was created by mapping the "eating" activity to the precedence relation and the length of the snake. A player who is familiar with the precedence relationship will, in fact, achieve a higher score.A learning version of Space Invaders (Zualkernan, 2006) is used for determining the precedence relationship between activities. The classical game of Space Invaders consists of a number of alien ships coming down from the sky. The objective of the game is to shoot them down. A learning version of this game is formulated by mapping the precedence relation to the sequence in which the activities (in this case alien ships) are targeted. The activities have to be targeted in the right sequence of precedence to achieve a high score.Crossword Games (Roslina et al., 2011) is used for teaching introduction to programming language. In fact, a crossword is a word puzzle that takes the form of a square or a rectangular grid. The goal is to fill the squares with letters, forming words or phrases, by solving clues which lead to the answers. In this learning version, the clues are questions about programming language. Shooting Games (Roslina, et al., 2011) is used for teaching introduction to programming language too. In the traditional version of this game, players use a gun and attempt to shoot down pigeons. In the learning version, players have to answer to questions about programming language by shoot down the correct answers.Prog&Play(Mathieu et al., 2010) is used to strengthen student learning in C++ programming. It is a modification of an existing game called "Kernel Panic". In this game, the player gives orders to his units to perform operations (move, jump, etc). Traditionally, these instructions are given using the mouse by clicking on a map. In the learning version of this game, players have to give this type of instruction with a program.

3. Implementation

In order to compare the serious games with learning version of existing games, two generators of learning games have been implemented and used in this study. The first one is called Instruction Right Place Game Generator and it facilities to teachers the creation of many instances of Instruction Right Place Game (IRPG) (Khenissi, Essalmi, &Jemni, 2013a; Khenissi, Essalmi&Jemni, 2013c).An instance of IRPG game allows learners to benefit from the drag and drop technology to construct a program (from the programming language maple) in an amusing way. IRPG game is considered as serious game. In fact, it is designed, from the beginning, for educational purposes. Specifically, the main purpose of the IRPG game is to train learners how to solve problems of programming language Maple.The second generator is called Learning version of Pacman Game Generator and it facilities to teachers the creation of many instances of Learning version of Pacman Game (LPG) (Khenissi, Essalmi, &Jemni, 2013b; Khenissi et al., 2013c). Pacman Game is considered the immensely popular game and among the most famous games of all time. Concerning the Learning version of Pacman Game, it motivates learners to correctly answer the questions of the programming language Maple.

3.1. The Instruction Right Place Game Generator

Instruction Right Place Game Generator helps teachers to create easily instances of IRPG game. An instance of IRPG game allows learners to benefit from the drag and drop technology to construct a program (from the

programming language maple) in an amusing way. Figure 1 presents the interface of the IRPG game.

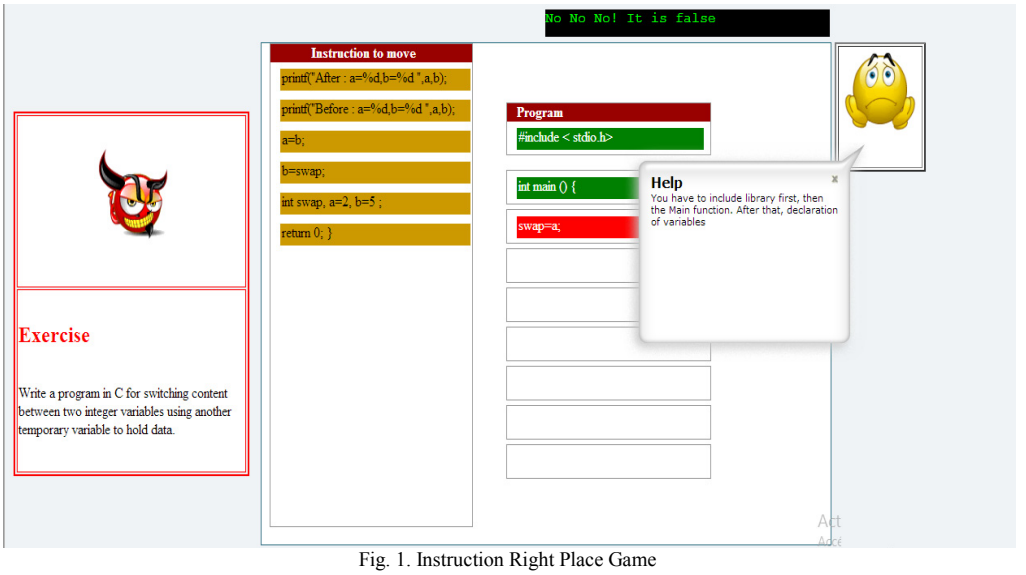

Fig. 1. Instruction Right Place Game

The learner begins the game by reading the statement of the exercise, and then reads the instructions of the program which are sorted in unordered way. Next, the learner tries to find a precedence relation between these instructions and find, for example, the first instruction and move it with the mouse into the first container. After that, the learner puts another instruction into another sub-container, until building the program. If the learner moves an instruction to non-appropriate sub-container, the color of the sub-container will be red, the devil avatar will be happy while the angel avatar will be angry and a help message is displayed. In this case, the learner may return the instruction in the middle container and move another instruction which could be appropriate. If the learner moves the instruction to appropriate sub-container, the color of the sub-container will be green, the angel avatar will be happy, the devil avatar will be angry, and a message is displayed informing that the answer is right. Once the learner has completed the construction of the program, a question (for evaluation) will be displayed, in order to test the learner's understanding of the program. After the response, a note / 20 will be displayed, taking into account the mistakes that the learner makes in the program.The Instruction Right Place Game Generator facilitates the construction of the IRPG games. In fact, teacher can create an instance of IRPG game in few minutes by following five easy steps. In the first step, the teacher should add the name of game in the title field, and then he/she can assign the game to a specific level (beginner, medium or advanced).In the second step, the teacher can write the questions (it can be the problem statement or an algorithm to solve), which will appear in the left container of learner interface. After that, in step three, the teacher writes instructions (answers to the problem or program instructions) in the correct order.In step four, the teacher can add an evaluation question (it is a question of understanding whether the student has understood the problem, and that is not answered arbitrarily). In the last step, teacher can add helps for students. Help is provided when the student makes a wrong answer. Finally, the teacher clicks on the save button for the creation of a new instance of IRPG game.

3.2. Learning version of Pacman Game Generator

Learning version of Pacman Game Generator helps teachers to create easily instances of LPG game. LPG game motivates learners to correctly answer the questions of the programming language Maple.In the traditional version of Pacman Game, the player controls Pacman through a maze, eating pac-dots. When all dots are eaten, Pacman is taken to the next stage. In addition, there are four enemies roam the maze, trying to catch Pacman. If an enemy touches Pacman, a life is lost. Near the corners of the maze are four dots known as power pellets that provide Pac-

man with the temporary ability to eat the enemies. When all lives have been lost, the game ends. Concerning the Learning version of Pacman Game, it aims to motivate learners to correctly answer the questions of the programming languages. The interface of the LPG game is present in Figure 2.

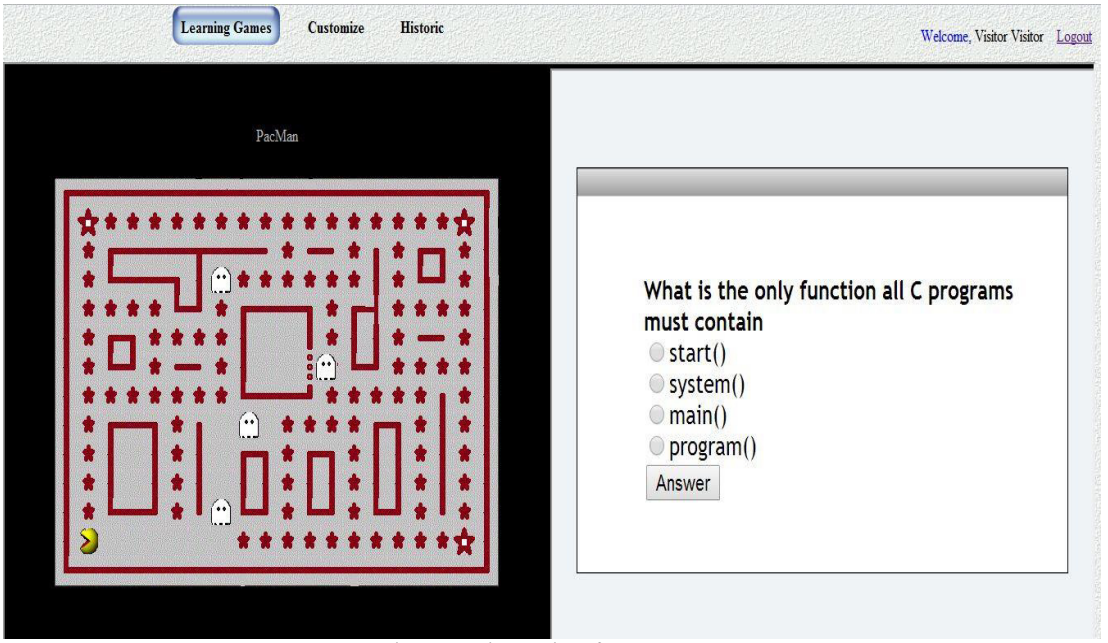

Fig. 2. Learning version of Pacman game

In the LPG, when Pacman eats a power star, the learner has to respond to a question (about the programming language) in order to continue the game having a 'reverse' role (Pacman can move freely and eat the enemy for a short period). Before continuing the game, the learner's score of his/her answer to the question will be displayed. Furthermore, the incorrect responses and the correct answer will be displayed. Also a link to a course that can help the learner is shown. In this case, the learner can click on this link and read the course. Finally, if the learner's score is greater than the average, the learner will get the bonus and there Pacman can move freely and eat the enemy for a short time, otherwise the learner will not get this bonus and he/she can continue by clicking on the button "continue". The game ends when Pacman eats all dots or players lost all lifes. In that event, a score /20 is displayed. Else when he/she failed to finish the game, the attempts have expired, a score / 20 is calculated and displayed with an invitation to play again.Learning version of Pacman Game Generator facilitates the construction of the LPG games. Similarly to IRPG Generator, teacher can create an instance of LPG game in few minutes by following only four steps.In the first step in which the teacher should add the name of game in the title field, and then he/she can assign the game to a specific level (beginner, medium or advanced).In second step, the teacher can choose the number of questions that will appear when Pacman eats the power star number 1. Then, a new interface will be displayed where the teacher can enter the questions and answers. This step will be repeated at each power star. Several options are available for the teacher, for example he/she can add a help to each question or limit the number of power stars. Last of all, the teacher click on the save button for the generation of a new learning game.

4. Experimentation and Discussion

The experiment was carried out in a tertiary school in Tunisia (ISSAT Gabes), during November 2011 and January, November 2012. This experiment involved students of the first grade of the tertiary school. Students are divided into two sub-groups (Group 1 and Group 2).The first group (Group 1) includes 84 students that will use many instances of IRPG game to learn and solve problems of the programming language Maple. On the other hand,

the second group (Group 2) includes 93 students that will use many instances of LPG game to learn and answer questions about the programming language Maple.
The students of the both groups will use personal computers available in the computers rooms of the ISSAT Gabes for connecting to the web server delivering the learning games.

4.1. Impact on students' level of knowledge

Before using learning games, the students of both groups, were requested to work on a pre-test using paper and pencil. This pre-test was an ordinary classroom test in which every student had to answer questions by filling in a test paper. The student's note in the pre-test was compared to the student's notes in a post-test that was given to the students after the use of the instances of LPG games and instances of IRPG games respectively. The comparison of students' results in the pre-test and the post-test was used to draw conclusions about the most effective type of learning games.After having learned through the learning games, averages of students' scores in the pre-test and the post-test are calculated. Table 1 presents the average of students score in pre-test and post-test. In addition, it presents student's progress. The result shows that, before starting the experimentation, the level of knowledge of the students in the Group 2 is greater than the level of the students in the Group 1 (11.67 for Group 1 and for 12.60 the Group 2). However, after the experimentation, students of the Group 1 and Group 2 have similar levels of knowledge (16.31 for Group 1 and 16.53 for the Group 2).

Table 1.Averages of students' scores

	Group1	Group2
Pre-test	11.67	12.60
Post-test	16.31	16.53
Progress (Post-test - Pre-test)	4.64	3.93

Results of this experiment showed that students benefited from learning games which represents an amusing teaching way. Furthermore, this experiment showed that using the learning game has positive impact on students' levels of knowledge.In addition, Table 1 shows that students of Group 1 (that have used instances of IRPG game) made a progress of 4.64. However, students of Group 2 (that have used instances of LPG game) made a progress of 3.93. This observation shows that students' progress after using Serious Games is relatively greater than students' progress after using learning version of existing games.This difference in progress is due to approaches adopted by each one of these two types of learning games. On the first hand, Serious Games apply so-called chocolate-and-broccoli approach to gaming. In this approach, there is strong correlation between learning content and gaming experience. In fact, learning content is seamlessly integrated into the gaming experience. Therefore, students benefited from gaming that help them to make satisfactory progress.On the other hand, learning version of existing games applies so-called A-B-A-B approach to gaming. This approach starts by offering some engaging gaming content (A), then it switch to some learning content that students must get through in order to return to the game (B). Therefore, relation between learning content and gaming experience is not strongly linked. This approach tends to go wrong when students interested only in the play experience. This may affect on students' progress.

4.2. Impact on students' satisfactions

In order to determine students' satisfaction when using the two types of learning games, we have adapted the Technology Acceptance Model (TAM) (Davis, 1989). TAM is among the most widely used model for the validation of the information systems. TAM postulated that usefulness and ease of use are the main factors to predict behavioural intention. Specifically, students of both groups were requested to answer to a questionnaire validated in the literature. An instance of the questionnaire is developed for determining the student satisfaction when using the game for learning. The questionnaire includes instances of the 4 items for Usefulness (U) and the 4 items for Ease Of Use (EOU). The questionnaire includes also instances of the 4 items for attitude toward using the system (ATT) and the 3 items for behavioural intention to use the system (INT). Beside each item of the questionnaire, 7 values on

Likert scale ranging from 1 for the total agreement to 7 representing the total disagreement.Averages and medians of the students' responses to the questionnaire are calculated. An average nears 1 expresses that, in average, the students are very satisfied when using the learning game. However, an average nears 7 expresses that, in average, students are very dissatisfied when using the learning games. Furthermore, a median such as 1 expresses that most students are very satisfied. Table 2 presents the averages and medians for the variables Usefulness (U), Ease Of Use (EOU), attitude toward using the learning game (ATT) and behavioural intention to use the learning game (INT).

Table 2.Averages and Medians of students' satisfaction

		U	EOU	ATT	INT
Average	Group 1	2.17	1.55	1.40	2.31
	Group 2	2.26	1.61	2.73	2.57
Median	Group 1	2	1	1	2
	Group 2	2	1	2	2

Table 2 shows that students are very satisfied when using the learning games. In fact, the averages for the variables U, EOU, ATT and INT are nears 1 and far from 7. For example, the average of the variable EOU is 1.55 for Group 1 and 1.61 for Group 2. Furthermore, the medians of the variables show that most students are very satisfied when using the games. For example, the median of the variable EOU is 1 for both groups.In addition, table 2 shows that students of Group 1 were satisfied more than students of Group 2. This difference strongly appears in the variable ATT. In fact, average of this variable is 1.40 for Group 1 and 2.73 for Group 2. In addition, the median of the same variable is 1 for Group1 and 2 for Group 2. This observation shows that students' attitude toward using learning version of existing games is low compared to students' attitude toward using Serious Games.This difference in satisfaction is due to the low tolerance from students of Group 2 to learning version of existing games. In fact, the act of playing is understood by them as a less serious activity. However, in Serious Games, learning content is integrated into the gaming experience. Furthermore, Serious Games are generally designed for a primary purpose other than pure entertainment. For that, students look at this type of learning games as serious activity.

5. Conclusion

This study sought to compare two different types of learning games which are Serious Games and learning version of existing games. In particular, this work examined the impact of these types of learning games on students' level of knowledge and students' satisfaction. The comparison reveals the effectiveness of serious games in improving students' level of knowledge and the convergence of the two types of learning games in terms of students' satisfactions.In addition, this work presents two learning games. The first one is called Instruction Right Place Game and it allows learners to benefit from the drag and drop technology to construct a program (from the programming language maple) in an amusing way. IRPG is considered as serious game. In fact, it is designed, from the beginning, for educational purposes. The second game is a Learning version of Pacman Game that motivates learners to correctly answer the questions of the programming language Maple.This study helps teachers to better understand and utilize learning games as a pedagogical tool. In addition, this study helps designers of learning games to understand the difference between these two types of learning games and remedy the deficiencies of each one. Furthermore, this study emphasizes on the importance of collaboration between teachers and designers to create effective learning games. Our future works generalize the comparative study by considering several kinds of serious games and several kinds of learning versions of existing games. In addition, we will study the appropriate types of learning games for modelling students' cognitive traits such as working memory capacity and inductive reasoning skill.

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