Game Based Learning vs. Gamification From the Higher Education Students' Perspective

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Abstract— The term Edutainment, has been fabricated by combing the two words "Education" and "Entertainment", and as this term expresses, this concept provides educational entertainment or entertainment-education. That means this let the student to learn subject matters with entertainment, so that the students get attracted to learning rather than getting used to learning through the teacher centered learning concept. Under this novel concept called "Edutainment" there comes a couple of new ways of teaching like Game Based Learning and Gamification. These concepts can be applied to enhance the learning procedure of students in various age levels.

This paper gives you an analysis of Game Based Learning vs. Gamification in higher education from Computer Science students' perspective.

Keywords; GBL, Game Based Learning, Gamification, Edutainment, Sorting Algorithms

I. INTRODUCTION

Today, it is found that the old teacher centered teaching mechanism is no longer beneficial to the students because of some reasons. Some of the reasons are as follows, the students will not be able to think out of the box because they tend to cram what the teacher says and the other thing is that the students will not be able to do some kind of practical assessments under the old mechanism, where edutainment gives the opportunity to do some practical exercises and to acquire experience by using some software. For example some of the chemical reactions which we cannot perform in the class rooms, can be shown with the aid of a computer.

In old teaching mechanism the students focus only on the exams rather than trying to understand the underlying concepts of the subject matters. So there arises a need to let the students to learn in their own ways, rather than focusing on the exams without understanding the subject matters. In order to give opportunities for the students to learn by experience, the researchers have been persuaded to create virtual learning environments. This concept is called "Edutainment" and most of the time they use Game Based learning and Gamification applications. Because it is a well known fact that, learning by experience is more efficient than learning by studying. The students get the opportunity to make observations depending on the experiments in an imaginary world through such approaches, rather than studying the theory and imagining what would happen. This innovative education paradigm called "Game based learning" helps the students of various age levels to enhance their learning process. No matter it is primary, secondary or higher education, we can apply this concept for any educational system to enhance it.

Nowadays various types of computer games such as action games, adventure and role playing games, strategy games, simulation games etc. are available. There are various kinds of online games that can be used to improve the subject knowledge of the students. Such games are not only limited to Computer Science subjects, but also to subjects related to psychology, youth, media and cultural studies. In addition to these games, there are some particular games especially for kids to improve their mathematical knowledge, awareness of the spellings, team playing, and strategy planning as well [8].

There are various types of simulations to teach some practical subjects. For example, we can show the simulations that have been implemented to give the training to military staffs [9]. By using such games, the soldiers can get an idea as to how they could face unexpected sudden attacks from the enemies. Likewise it is better to give a game to be played by the students relevant to their subject matters, before their teacher starts that lesson. Hence the students can ascertain the basic idea of the lesson and it would be a great help for them to understand the theory very clearly.

In addition to the Game Based Learning concept, now there is another concept called "Gamification". This means the usage of gaming rules to non-gaming environments. Here the basic thing is the offering of some kind of rewards to the students to motivate them. For example when someone has scored marks above a particular level, we can give them a sticker, ribbon etc. to indicate that he has been able to pass a particular level in a particular subject domain.

When it comes to the Tertiary education, there are subject matters that are difficult to understand. In Computer Science stream, Sorting Algorithms is considered as an important section and somewhat difficult to understand. The main objective of this research is to analyze the two concepts called Game Based Learning and Gamification with Computer Science students' perspective.

The rest of the paper is structured as follows. First, a brief literature review on the related work in this area is presented. Next, the design and the implementation of this research are outlined. After that the evaluation of the presented object and finally, the paper will be winded up with a brief discussion.

II. RELATED WORK

There are projects that have been carried out in "Game Based Learning" area. Some of those projects are described under this section.

Pivec M. et al [1] have introduced a game platform where different instructors can introduce different knowledge and contexts to apply game-based learning for their particular topics and specific goals.

They have followed these steps to create a successful game-based learning platform.

• Determine Pedagogical Approach (how you believe learning takes place)
• Situate the Task in a Model World
• Elaborate Details
• Incorporate Underlying Pedagogical Support
• Map Learning Activities to Interface Actions
• Map Learning Concepts to Interface Objects

It can be classified as a role-play game, that fosters participation in problem solving, effective communication, teamwork, project management, as well as other soft skills such as responsibility, creativity, micro-entrepreneurship, corporate culture, etc. The game is based on constructivist learning approach and collaborative learning. It should be able to be used in regular face-to-face or online classes.

Their game themes (i.e. assignments and subjects to be discussed) are defined by the teacher. Play time can fluctuate from few days to few weeks and it depends on the difficulty of the theme and basic skills of the students. In the game, basic stages can be distinguished as follows: team work and team preparation time, general discussion, student feedback, discussion of the game in the seminar.

Kirriemuir J et al [2] have done a survey on how and why online games are used as an integrated part of formal classroom learning. They have presented a number of examples of the use of such games, and have tried to determine likely trends in their use in such an environment. They have found that an increasing number of schools are using computer and video games in variety of situations, many of which are imaginative, or support the learning process within a range of other tools and resources. However, on the negative side, they have pointed out that there is a lack of games being used for relevant subject-based learning and the schools provide games for recreation or as rewards for good behavior (thus recognizing that children like to play them), but fail to use them for learning-oriented purposes even where this potential is recognized.

Garris R. et al [3] have developed a game called BOTTOM GUN which is a game-based submarine periscope trainer for the U.S. Navy. BOTTOM GUN was developed to enhance submarine technical skills and to examine the effects of the game-based training approach on student motivation. It has been designed to provide an entertaining way to practice making estimates of critical visual variables, including angle-on-the-bow (AOB) (i.e., angle at which the observed ship is visually presented to the periscope observer) and divisions (the number of tick marks on the periscope reticle representing the height of the targeted ship from its waterline to its highest visible point).

In addition to this BOTTOM GUN game there are number of games for Air Force, Army, Marines, Navy and joint forces. These games have been developed by the Department of Defense games developers' community.

Connolly T M et al [4] have explored the use of interactive visualization and computer games to provide a web-based collaborative learning environment to supplement traditional methods of teaching database analysis and design.

They have illustrated the influences of the online games-based collaborative learning environment that they have developed to teach database analysis.

The following three main components have formed their learning environment.

The online learning units/topics introduce the concepts to be explored; these units are structured in a hierarchical manner allowing students to 'drill down' to obtain further details. Topics are hyperlinked to allow non-sequential browsing.

The visualizations enhance learning by providing animated walkthroughs of specific examples (e.g. construction of an ER diagram or the process of normalization).

The simulation game provides a real-world simulated environment within which to apply skills and techniques.

Finally they have come to a conclusion that there was a higher rate of the number of students who faced online exam got the highest marks when compared with the students who had a written paper exam.

Connolly T M et al [5] have described a computer game to teach Software Engineering concepts. Here, the whole life cycle of the software development has been animated. In this system the responsible person for each and every phase in the software development life cycle should take the correct decisions to carry out the project. The team members have to do the project better than the other teams, because the teacher gives the marks for all the projects.

III. DESIGN

Here we describe two situations where we have used gamification techniques and game based learning for Data Structures and Algorithms course module comes under Computer Science stream.

Our intention is to get to know what sorts of learning materials are expected by the tertiary students, i.e. whether they are more towards to gaming components or to the gamified materials which let them to grab the underlying theory at a glance without any unnecessary decorations.

Here we compared a simple game [13], which has been implemented to give the idea of sorting algorithms with a gamified material which gives the idea of each and every sorting algorithm along with an animation according to the pseudo code and this has a simple quiz after each and every sorting algorithm.

This is the methodology of our comparison. We selected group of 60 students who are not familiar with the Algorithms and who had been able to score a grade higher than an "A" for Mathematics course, so that we can make an assumption that all the students are in the same level of knowledge. First we divided them into two groups and again we divided both groups into two sub groups.

First Group:

Sub Group 1.1: gave the Gaming Component to learn Bubble Sort

Sub Group 1.2: gave the gamified material to learn Bucket Sort

Second Group:

Sub Group 2.1: gave the Gaming Component to learn Bucket Sort

Sub Group 2.2: gave the gamified material to learn Bubble Sort

At the end of the practice, the students were given a quiz and we analyzed the performance of the students belong to the two sets mentioned before.

After that we compared the results of group 1.1 with group 2.2 and group 1.2 with group 2.1, so that we can get an idea about which has been able to give the idea correctly to the students i.e. whether it is the gamified material or the gaming component.

In addition to the quiz the students were given a questionnaire to gather their own ideas about the two learning components.

By analyzing the details we get from the questionnaires, we were able to get an idea about what the favorable medium of the students who are being engaged in higher education is.

We measured the average time they spent to learn the theory as well as the average time they took to finish the quiz. By analyzing these two durations we thought of measuring the effectiveness of these two mechanisms.

A. The Game Design

The gaming component is developed as an undergraduate project by Roderick Vella [13], and the intention of this game is to help the students to understand the fundamental principles of Bubble and Bucket Sorting algorithms. It is said that this game is based on the famous game 'Frogger', where the student has to collect boxes and sort them according their values by using sorting algorithms rules.

B. The Design of the Gamified component

This is to teach five of the sorting algorithms come under Data Structures and Algorithms course module.

Here we use the concept called Gamification, and we try to give the basic idea of the each and every sorting algorithm at a glance.

The following sorting algorithms have been implemented under this section.

- Bubble sort
- Selection sort
- Insertion sort
- Shell sort
- Merge sort
- Bucket sort

We allow the student to look at the pseudo code for a particular sorting algorithm. There, a given data set is being sorted and the part of the pseudo code is being highlighted according to the execution of the algorithm so that the student will be able to capture the fundamental idea for a particular sorting algorithm.

After the demonstrations for sorting algorithms, there are quizzes to be followed by the students and they will be able to get to know their standards. Based on the marks that the student has obtained, he will get a ribbon so that he can be satisfied with his knowledge.

IV. IMPLEMENTATION

A. The Game Implementation

As we have mentioned earlier, this game has been implemented by Vella R[13] and he says that this game has been developed using Microsoft XNA and can be installed freely on any PC that is running Windows. Figure1 and 2 are screenshots from this game and Figure 1 shows how the Bucket short happens and the Figure 2 shows how the Bubble sort happens.
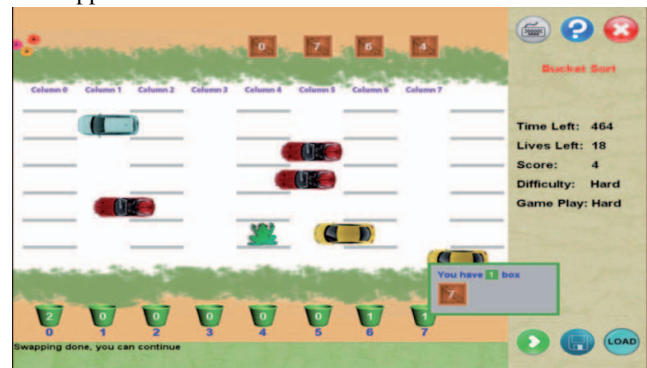
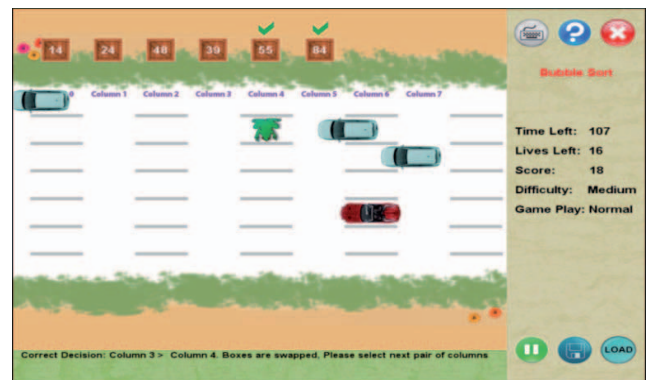

Figure 1.   Bucket Sort

Figure 2.   Bubble Sort

B. The Implementaionof the Gamified component

To implement this we used java applets [14] and online quiz generating tool called "ProProfs"[11]. After that we used "Reload Editor" [12] to create a SCORM object of the implementation in order to upload that in the moodle so that the students can access that.

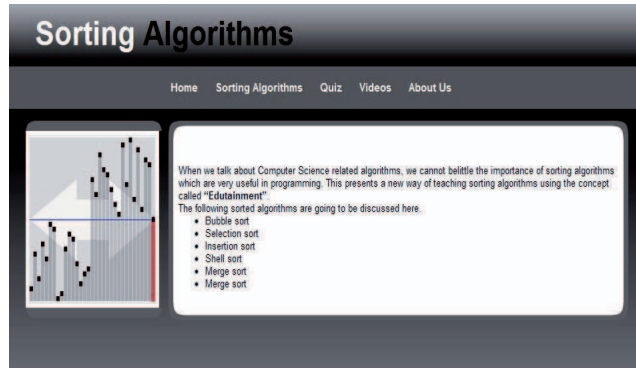A screen shot from the SCORM object that has been implemented is shown in the Figure 3.

Figure 3.   Sorting Algorithms SCORM object

Here are more screen shots from the SCORM object to illustrate the steps of this gamified component.

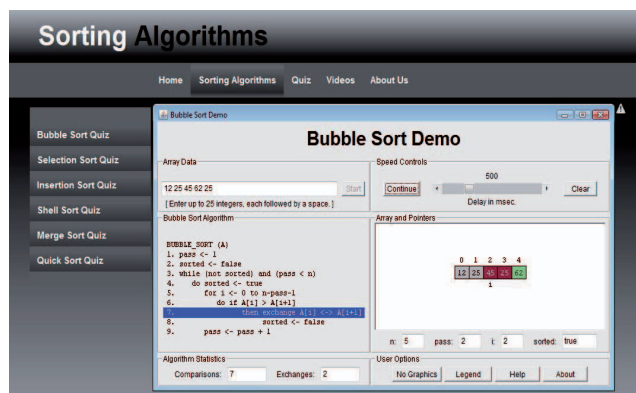Figure 4.   Sorting Algorithms page of the SCORM object

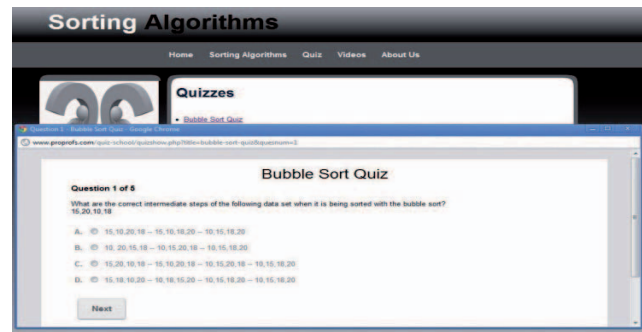Figure 5.   Bubble Sort demonstration

Figure 6.   Quiz page for Bubble Sort

V.   EVALUATION

The intention of this evaluation was to gather the ideas of the students about the Game based learning and the gamified learning as well as to get to know which medium really helps the students to grab the idea of the underlying theory. As these components are made for the students who are following their tertiary education, we have to have an idea about their desires, and what they expect from this GBL concept.

First we thought of evaluating the marks of the two groups which we have mentioned earlier in the design section, so that we can compare the marks of them.

We drew two graphs according to the marks that the students have obtained. Graph 1 has been drawn taking into account the results of the students who have done the quiz for Bubble Sort and Graph 2 for the students who have done the quiz for Bucket sort.
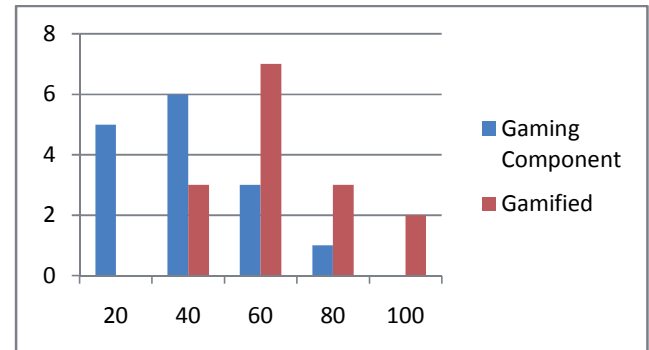
Graph 1. Marks for the "Bubble Sort" quiz
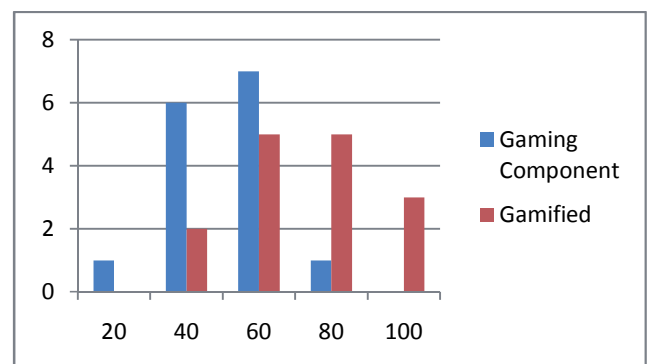
Graph 2. Marks for the "Bucket Sort" quiz

By looking at the two graphs it can be said that higher marks have been obtained by the students who have studied the gamified component.

Students from sub group 1.1 have scored 50.667% of average marks where sub group 1.2 has scored a 72% average mark. Students from sub group 2.1 have scored 40% of average marks where sub group 1.2 has scored a 65.333% average mark.

When we look at the average marks for both sub groups it can be said that, the students who followed the gamified component have been able to score a higher average than the other group.

We gave only five questions in the quiz and 3 of them were based on the underlying theory and the other 2 were based on the code. We analyzed the questions against marks and got to know that 33% of the students from group 1.1 and 2.1 were unable to answer the two questions based on the code. That means they were able to understand the underlying theory, but not the code.

The average time that they have spent to learn the theory are 40.5 mins and 20.667mins for sub group 1.1 and 1.2 respectively. And 48.667 mins and 26.333 mins were taken by the students from the sub groups 2.1 and 2.2 respectively.

By looking at the average times taken to grab the underlying theory of the both algorithms, it can be said that gamified component is the effective one for these students.

To get to know, what sort of learning materials are expected by the students, out of these two types, we distributed a questionnaire among the students who followed both course materials in the university. The questions we asked from them are shown in the table 1.

	Rating					
	1	2	3	4	5	Comments
1. Do you like to play this game?						
2. Can the "Game Based Learning" scenario enhance your motivation?						
3. Can the gaming phenomena be used in other complex topics in Computer Science?						
4. Which methodology do you suggest to teach the other subjects?						
• Gaming Component?						
• Gamified Component?						
5. Is this gaming environment appropriate for a learning environment?						
6. Does this provide an adequate learning environment?						
• Gaming Component?						
• Gamified Component?						
7. Which methodology do you prefer?						
• Gaming Component?						
• Gamified Component?						
8. Which methodology explains the underline theory clearly?						
• Gaming Component?						
• Gamified Component?						
9. Which one motivates you to refer repeatedly?						
• Gaming Component?						
• Gamified Component?						
10. Give an overall rating for the learning out come.						
• Gaming Component?						
• Gamified Component?						

Table 1. Questionnaire

VI. DISCUSIION

Based on these questions on the questionnaire, we made a hypothesis that the gamified components are preferred by the students who are having a tertiary education; in addition to that, they are capable of understanding the underlying theories easily with the gamified component. That means they want to grab the theory of particular subject matter immediately, rather than wasting their time to enjoy it with a simple game full of graphics.

According to a revised version of Bloom's taxonomy in 2001 we can simplify the learning process as follows.

- Before we can **understand** a concept we have to **remember** it
- Before we can **apply** the concept we must **understand** it
- Before we **analyze** it we must be able to **apply** it
- Before we can **evaluate** its impact we must have **analyzed** it
- Before we can **create** we must have **remembered, understood, applied, analyzed,** and **evaluated.**

By letting the students to use gamified learning materials, they will automatically follow the above learning processes.

But when they use game based learning materials, sometimes the students will not get the chance only to follow all the processes mentioned above.

Finally we came to a conclusion that "Gamified" type of teaching approach paves the way for the students to follow their tertiary education, even in difficult academic matters in an efficient way.

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