Animated Game-Based Learning of Data Structures In Professional Education

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Summary

Teaching and learning are one of the major issues during this pandemic (COVID-19). Since the pandemic started, there are many changes in teaching and learning styles as everything related to studies started online. Game-Based Learning has got remarkable importance in the educational system and pedagogy as an effective way of increasing student inspiration and engagement. In this field, most of the work has been carried out in digital games. This research uses an Animated Game-Based Learning design in enhancing student engagement and perception of learning. In teaching Computer Science (CS) concepts in higher education, to enhance the pedagogy activities in CS concepts, more specifically the concepts of "Data Structures (DS)" i.e., Array, Stack, and Queue concepts are focused. This study aims to observe the difference in students' learning with the use of different learning methods i.e., the traditional learning (TL) method and the Animated Game-Based Learning (AGBL) Method. The experimental results show that learning DS concepts has been improved by the AGBL method as compared to the TL method.

Keywords:
Animated Game-Based Learning, Game-Based Learning, Data Structures

1. Introduction

Teaching and learning in the higher education sector were done traditionally till a few decades back. Teaching during this period was generally founded on a kind of "teacher-directed pedagogical practices" [6]. Now, in today's educational field, the strategy and instrument utilized aren't just completely reliant upon the traditional strategies and instruments, yet additionally by utilizing numerous other innovations to make the learning system more significant, intriguing, and compelling for the students [5]. The methodology of learning through genuine gameplay was recommended the students alongside having a great time can learn with better adequacy [4, 11]. The students need to be able to adapt to a dynamic environment surrounded by new technologies. As technology is being evolved and keeps changing with time

so the study of Computer Science has become so tough it is not that easy to learn and understand the strong concepts of Computer Science so essential computer literacy is not sufficient to stay competitive in the current workforce and have the fundamental capabilities for the 21st century. Game-based learning (GBL) enables new forms of teaching that transform the learning experience through simulated (real-world) tasks and knowledge [2]. GBL (through digital games) in education can be effective and engaging because knowledge is built through the student's activity and interaction with the environment in a non-stop and dynamic cycle because of outer upgrades [3].

This paper analyses the students' learning and determines which learning method is better for students. Animated games is the focus of this research because Animations have more attraction than other kinds of games. They are more colorful and the person who plays an animated game or watches an animated video can easily understand the context. Now, students are more intrigued by digital games, and these days, home gaming has turned into a popular pastime. The games have become more complex and interest has grown in developing the use of digital games for education. This interest in games depends on the perception that youngsters become completely submerged in the games and can play them for quite a long time. The youngsters are energetic and persuaded to gain ground. Secondary education teachers might want to see this energy in their students' learning since research shows that students' inspiration to take in diminishes when they progress from essential to secondary education so that is why we decided to go towards digital games and more specifically towards to Animation as discussed earlier.

The primary goal of this research is to comprehend the assessment of the students towards the ease of use and adequacy of the AGBL (Animated Game-Based Learning) application. The secondary goal is to measure the enhancement in students that either students' concepts of Array, Stack, and Queue become stronger or there is no difference. First, we will conduct the quiz and have a

result set for multiple students. That result is analyzed with some mathematical formulas like Mean, and Standard Deviation and checks whether the students get passed or failed. Similarly, each question is analyzed that how many students can solve the question. The first quiz is basic into three parts. The first part is of Array, the second part is Queue and the third part is consisting of Stack. Each portion is analyzed and measured by the statistics. We have calculated the Mean, Standard Deviation, and percentage of passing students, and these statistics are calculated specifically for the Array, Stack, and Queue, in the end, calculated the overall quiz Mean Standard Deviation and Percentage.

Game-based learning has received [1] significant consideration in instructive teaching methods as a viable way of inspiration and commitment. Most of the work in this space has been focused on computerized games or games including innovation. We focus on the utilization of traditional game plans in improving students' view of learning by showing software engineering and computer science concepts in higher education. Likewise, as a feature of interdisciplinary exertion, we examine the exchange between game-based learning in advanced education and disciplinary societies. A precise literature review [2] gives proposals on the best way to survey and assess students' learning experience (i.e., execution, accomplishments, results) utilizing 3DVWs. By far most of the models upgraded students' commitment and interest, influencing their achievements positively. This study tells [3] that in teaching, the use of virtual and augmented reality has been on the rise. Game-based learning is one of the approaches that have received growing interest. The game was intended to develop competency skills in primary school learners (8-10 years). Research has commanded [4] public notice for proposing that playing video and PC games has the constructive outcome of upgrading students' specific considerations. The development of the utilization [5] of interchanges innovation has prompted the interesting development in driving the capability of games and PC games in the present-day education period. This research expects to notice the distinction in students' inspiration in math inclining the utilization of various learning techniques such as traditional learning strategy and GBL.

The traditional teaching-learning [6] measure which centers on educator-coordinated academic practices" has its innate disadvantages. Game-based learning (GBL) is a compelling asset that can help educators in drawing in students having a wide assortment of learning styles. This paper intends to present [7] an overview of a mobile game-based learning application, BaghLearn, that develops skills in programming and algorithmic knowledge by playing a traditional world-based game. This study exhibits the idea of integrating learning with the contextual mobile game as an effective approach to understanding the impact of games on the psychological accomplishments of students in figuring education. Game-based historical learning [8] means to give manners by which the innovation, intelligence, or social shows of PC gaming can help manage the cost of the social comprehension of oneself, of the past, or of others with outlooks very changed to our own.

The game Sorceress [9] of Seasons was created to show major ideas of python programming to middle school students. The goal was to increase enthusiasm in the Science, Technology, Engineering, and Mathematics (STEM) fields, especially for middle school female students. A Game-based learning (GBL) approach was used to increase interest in STEM for girls. The motivation behind [10] this exploration is to plan an applied model and foster an execution as proof of the idea of game-based learning (GBL) to support linguistic abilities procurement. Arabic games for learning Arabic are simplistic and will in general spin around a similar paltry thought. Value is absent in the show as far as illustrations, movement, shadings, and voice-over.

This study contains [11] the research, plan, and advancement of a digitalized game-based learning (DGBL) module that incorporated academic components of energy and transportation innovation guidelines. An example game model on energy productivity in transportation was made by the specialist and surveyed by a board of topic specialists. In an address to students [12] at TechBoston Academy, public technology and college prep school in Massachusetts, ExEx-USresident Obama declared, "I'm calling for investments in educational technology that will help create...educational software that is as compelling as the best video game.

2. Methodology

Data structure and algorithm is a significant course in software engineering/data technology programs applied in practically all courses of programming. Lack of strong concepts of data structures like an array, queue, and stack cause failure in student's academic performance throughout their studies, and if somehow students get passed and got their final degree or certificate then they face difficulties when they apply for the jobs and sits on the interview sear Infront of the interviewer. In almost every interview, at least one question on the topic of data structures is always asked. And without a good skill set in data structures, it gets difficult for the students to get passed in the interview and get the job. And if somehow students get passed in the interview, they will be less effective and inefficient employees (developers) for the company. Animated Game-Based Learning of data structures could be acquiring energy as it brought about expanded inspiration, commitment, and learning results.

If the viability of game-based learning could be blocked if inappropriate learning techniques are utilized. Informative framework in game-based learning as question prompts have been discovered to be simply the best method to platform learn in Computer Based Learning. Hence, game-based learning of stack information structure utilizing

Question prompts were planned, created, and tried dependent on an embraced model to assist students with understanding the calculations of stack's embed and erase activities for cluster execution with ongoing interaction that could make significant learning. A pre-game and post-game test were led to analyze student's exhibitions on the subject. The methodology usually followed by TL and AGBL is shown in Figure 1 and Figure 2 respectively.
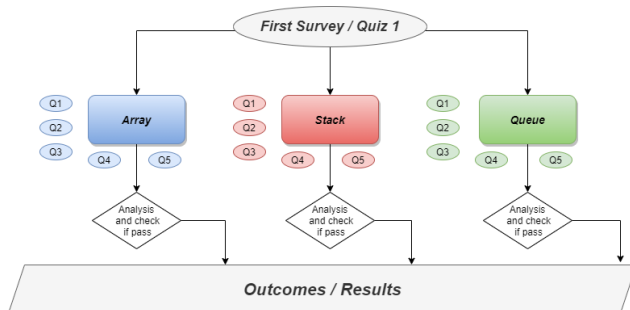

Fig. 1. Traditional Learning approach

Figure 1 is showing the procedure of traditional learning that how students actually get learned and how the pedagogical activities are being followed currently the teacher comes and teaches on board. Some teachers use real-life examples to make the students understand but it's not enough because data structures have some complex concepts.
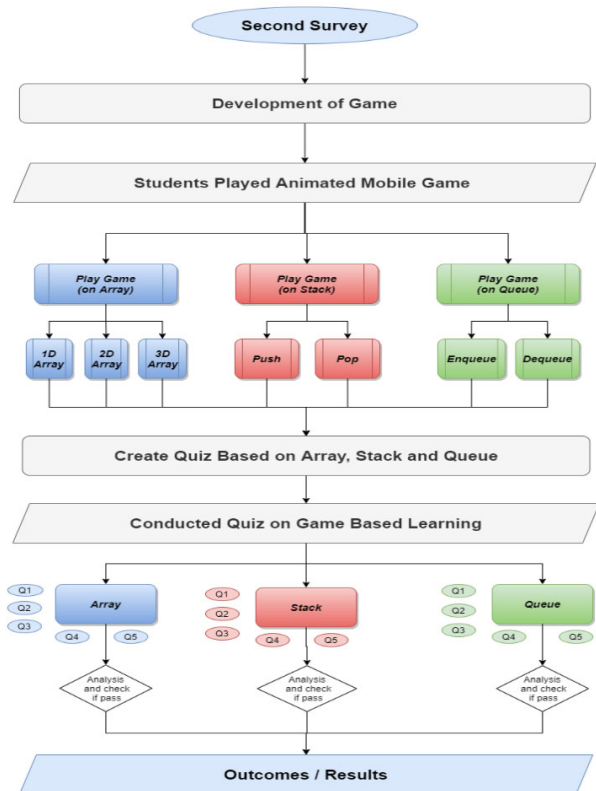

Fig. 2. Game-Based learning approach

Figure 2 is showing the flow of game-based learning which is used in this research. In Traditional Learning diagram, it showed that students were asked to attempt a quiz. But when we talk about game-based learning then students are supposed to play Animated Game which is based on stack, queue, and array. After then, students attempted a quiz.

3. Results and Discussions

First of all, students are tested with the quiz which was having three sections named Array, Stack, and Queue each section contained 5 questions so in total there were 15 questions. Once a good number of students responded and attempted the quiz then the outcome or dataset of the quiz was analyzed and calculated the overall percentage, mean, and all. After that, the process of game development started and designed the screens and game scenarios of Game. The game is an Android Mobile Application and students played that game on their smartphones. That game was helping students to understand the basic knowledge of Array (1D, 2D, and 3D), Queue, and Stack. Once, the students played the game then they were asked to attempt the quiz and that quiz was again having three sections named Array, Stack, and Queue each section

contained 5 questions so in total there were 15 questions. After attempting the quiz, students were asked to fill out a survey form related to game-based learning and traditional learning containing a total of 5 questions. The questions were as under:

1. In which Learning method, the concept becomes stronger and clear?

2. Which Lecture delivery method is so well formed and organized?

3. Which Lecture method is more interesting, more engaging, and more attractive?

4. In which Lecture method, students enjoy most while studying?

5. In which Lecture method, students help each other, communicate better, support each other and get more engaged and enjoy most while studying?

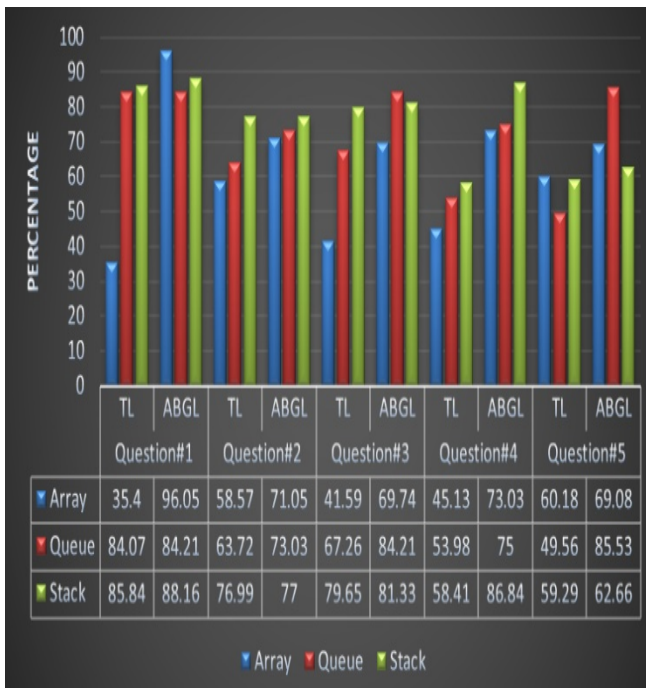|	TL	ABGL	TL	ABGL	TL	ABGL	TL	ABGL	TL	ABGL
	Question#1		Question#2		Question#3		Question#4		Question#5	
▼ Array	35.4	96.05	58.57	71.05	41.59	69.74	45.13	73.03	60.18	69.08
▼ Queue	84.07	84.21	63.72	73.03	67.26	84.21	53.98	75	49.56	85.53
▣ Stack	85.84	88.16	76.99	77	79.65	81.33	58.41	86.84	59.29	62.66

▼ Array   ▼ Queue   ▣ Stack

Fig. 3. Comparison between TL and AGBL

Fig. 3 shows comparative results of quizzes taken by students using traditional learning (TL) and animated game-based learning (AGBL). The results clearly show that the students have scored higher in AGBL than TL. The average score achieved via TL is 61.3% whereas it is 78.4% via AGBL. Therefore, the learning has improved up to 17% when AGBL compared to TL. Therefore, it can be concluded that animated game-based learning is better approach than traditional learning or learning through cards/images.
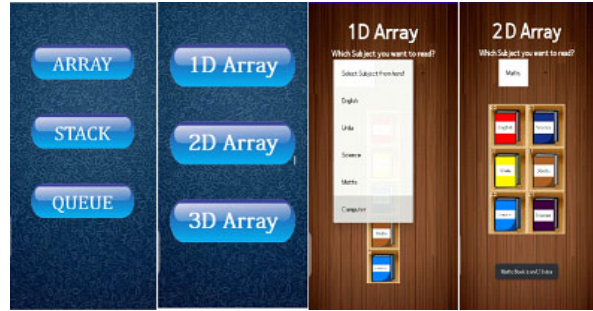

Fig. 4. AGBL application provides selection options for data structure concepts and specially for array concepts
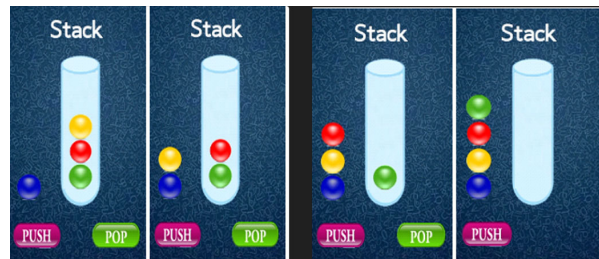

Fig. 5. AGBL application provides selection options for different stack operations
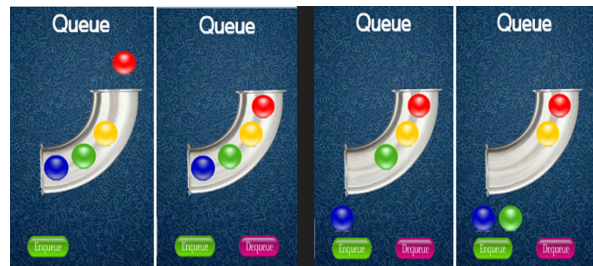

Fig. 6. AGBL application provides selection options for different queue operations

Fig. 4, fig.5 and fig. 6 show some of the screenshots taken from the mobile application developed in this research study for AGBL using different data structures. Users are provided different options to learn via the animated game. The interface initially provides the learners with 3 options i.e., Array, Stack, and Queue. The given interface is further linked to detailed screens related to each AGBL option.

Table 1 shows the comparison ✓ means the concept is covered and × means the concept is not covered:

TABLE 1. Data structure concepts are covered in the developed game.

Authors	Data Structure Concepts		
	Array	Stack	Queue
[13]	✔	×	×
[14]	×	✔	×
Our work	✔	✔	✔

4. Conclusion

The proposed work is a mobile-based game application. The game helps students to learn the basic knowledge of Array (1D, 2D, and 3D), queue, and stack. Once, students played the game then they were asked to attempt the quiz (Array, Stack, and Queue) After attempting the quiz, students were asked to fill out a survey form related to game-based learning and traditional learning. Those questions were basically about that what students think that which learning technique is better either game-based learning or traditional learning method. If a student is confused then the third option is there for students as "both". After a good number of students responded and attempted the quiz then the outcome or dataset of the quiz was analyzed and calculated the overall percentage, mean, and all.

Both Traditional Learning based quiz results and Game-Based Learning based quiz results were compared. The results proved that Game-Based Learning got a higher percentage of results in terms of percentage, mean and number of students getting passed etc. based on obtained analysis. It is concluded that the majority of students were in the favor of Game-based Learning. So, through the statistics it is proved while teaching Data Structure course, game-based learning technique is better than the traditional learning and not just through the statistics but through the survey and students' opinion, it is proved that Game-Based learning is a better option than traditional learning. The performance measure of the presented game may be improved by the inclusion of cameras for students to implement emotion recognition using available algorithms [15, 16, 17].

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