

# Playing to Learn: A Literature Review on the Digital Game Based Learning approaches for Programming Education, and its applicability in Sri Lanka.

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**Abstract**— Game making and game playing as means of learning is a popular research topic as it offers enhancements in skills development in student centered strategy. This has been experimented within junior high schools, high schools, universities as E-Learning strategies and supplementary approach with different subject modules including programming, science, mathematics, computer science. This paper reviews the varied applications of Game based learning as a supplementary teaching technique in schools, universities for programming education. The study focuses on student-driven digital game making over a systematic review of the global contributions on related topics published since 2010. The review begins with a rationale for GBL adoption in pedagogy. This is followed by analysis of different GBL models, the effectiveness of GBL in programming and other subjects together with a prospective of GBL based education in Sri Lanka, a South Asian country.

**Index Terms**— Game-Based Learning, eLearning, Games, Motivation for learning, programming education, computer programming

## 1 INTRODUCTION

Numerous studies argue that students view computer programming as a purely technical activity rather than a set of combined problem-solving skills [1]. Hence, most of students studying the preparatory computer programming are likely to cultivate a shallow knowledge and consequently fail to construct problem solving approaches using the basic programming constructs.

One of the approaches suggested to facilitate the instruction and education of preparatory computer programming is the practice of video game technologies in an educational game context (also referred to as "serious games"). The foundation for approach is that games are appealing and motivational, inspiring students to acquire programming constructs in an enjoyable and potentially acquainted environment, and will then be able to transfer their learning outcomes from that environment into learning introductory computer programming with a programming language.

Moreover, curricula that used serious games to specialize in learning programming have found positive effects on students as well as on learning outcomes [1].

Researchers [2] have examined the impact of playing games on students' cognitive behavior. The researchers McClurg and Chaille [3] carried out a research with samples of fifth, seventh and ninth grade students which indicated a growth in their mental rotational ability 6 weeks past of game play. This research was replicated with a sample of Grade 5 students in another study [4].

This research showed a significant increase in spatial ability after three sessions of playing a game that required spatial skills.

It was significantly noted that students who were ineffective in school felt that game-based learning makes complex sciences seem like reachable. That a significant proportion of study participants who had participated in video game tournaments reporting development of positive skills compared to those who had not played, have been shown in several studies.

Educational games support several aspects of learning. In educational games, learners are encouraged to apply their knowledge into real life situations which sometimes requires combining of knowledge gained in several areas. Also, the outcome of each decision made in the game establishes their prior knowledge. Research has found that GBL helps players to improve their social skills such as collaborative working skills. One of the key concepts in GBL is intrinsic motivation. Intrinsic motivation refers to motivation that comes from inside an individual rather than from any external or outside rewards, such as money or grades.

An intrinsically motivated person will work on a solution to a problem because the challenge of finding a solution provides a sense of pleasure [2].

## 2 EFFECTIVENESS OF GAME BASED LEARNING IN LEARNING PROGRAMMING AND OTHER SUBJECTS

### 2.1 Impact on educational effectiveness and student motivation

A study [5] evaluated the learning effectiveness and motivational appeal of a computer game targeted at the learning of computer memory concepts taught within the Greek high school. Furthermore, the study investigated potential gender

differences in the game's learning effectiveness and motivational appeal.

The study concluded that educational computer games can be exploited as learning environments within high school CS courses for they can considerably improve both knowledge of the embedded subject matter and student enjoyment, engagement and interest in the learning process.

Regarding gender issues, despite the fact that the boys of the sample exhibited significantly greater involvement with, liking of and experience in computer gaming outside school as well as significantly greater initial knowledge of the embedded subject matter, and greater interaction among them during the intervention, the learning gains that boys and girls achieved through the use of the game did not differ significantly. DGBL can be equally effective and motivational for boys and girls.

It should also be noted that, the improvements that they suggested to the game revealed that they are particularly demanding mainly regarding game multimedia and plot, which denotes that students expect to find in the educational games that they use within school the elements that they encounter in the games that they play outside school.

An educational computer game should, thus, bear the features of the multimedia-rich, adventurous games that students experience outside school in order to meet students' expectations, to retain their interest and to be exploitable within long-term educational interventions [5].

## 2.2 Play IT: A GBL approach for programming

This study [6] has demonstrated the effective use of GBL as a teaching and learning activity. Students felt confident about practicing the use of programming constructs in a game scenario and were eager to help others in understanding the game strategy. In applied fields of study such as ICT, the inclusion of gaming elements with traditional teaching practices will bring about more active learning. This will be beneficial for tutors as well as students because games could enable students to grasp technology-based applications quickly in a more enjoyable learning environment. The study has used game-based learning approach alongside current teaching methods to engage students and bring about active learning for one subject module in an introductory ICT course.

The study identified an educational game (Light Bot 2.0) which covered the core subject areas of a level 5 programming module. This was to encourage student interest by 4 making the learning experience fun. In the game, an animated robot utilizes logical skills associated with programming constructs to light up blue tiles as the robot moves from one place to another.

The authors [6] believe that traditional classroom teaching cannot be replaced since teachers play both an educator and a mentoring role; the addition of GBL to development of pedagogical activities will enhance the teaching and learning experience.

## 2.3 A collaborative game-based learning approach

Learning collaboratively not only enables students to learn the spirit of respecting others, but also facilitates their learning performance. Through the process of collaboration and brainstorming in a collaborative learning group, students are able to efficiently receive a large amount of information, which is helpful to them in generating new ideas for completing learning tasks. Consequently, researchers have indicated that attention should be paid not only to the use of new technological solutions, but also to collaborative learning methods in order to develop students' skills for their future careers [7].

The students in the experimental group learned with the collaborative educational computer game with the repertory grid approach; that is, they played the role-playing game in the mode of three or four students as a team to complete the learning tasks embedded in the story of the game as well as having to complete the repertory grid for organizing the learning content.

In this study [7], a collaborative game-based learning environment was developed by integrating a grid-based Mindtool originating from a knowledge engineering method, which is quite different from most studies, that aimed to provide more interesting learning environments for students to acquire knowledge, or those that mainly employ digital games as an approach for promoting students' learning motivation. Instead, this study aims to improve the learning performances of students from both the aspects of cognition (e.g., learning achievement) and affection (e.g., learning motivation and attitudes) by gaining benefits from both the Mindtool and the digital game.

## 2.4 SPITKOM GBL for Computer Science

Students with a low scholastic background very often have negative learning experiences. They have little or no confidence in their skills and abilities and only limited motivation to learn. Traditional education has little prospect to bring them back into education. The study [8] thus tested the applicability of Game based learning approaches to meet the target group's needs.

Directed their study at the learners (17-25) who are very leastly educated, opinion wise varied have very poor command in the language, mutual communication and in comprehension and memorization. They were not willing to participate actively in learning activities, had a very little competence in using computer as an information tool.

The final results of the study suggest that Multiplayer Browser Games (which usually contain construction and management features) could appeal to the target group. The absence of high degree of guidance and instruction in the game had let many players to have difficulties dealing with a complex game system. Many players were overwhelmed by too many variables and options as well as they were confused as their inputs were not followed by immediate feedback. Thus, it can be assumed that the target group's mastery of construction and management games presupposes a well-structured game environment,

high level of stimuli and immediate feedback to game play actions [8].

### **3 E-LEARNING AND GAME BASED LEARNING APPROACHES IN SRI LANKA**

Although various efforts made to improve teacher development, school infrastructure and develop a relevant curriculum, the goal of 'excellence' appears to be still elusive. Among the quality issues highlighted consistently are shortcomings in curriculum and teaching-learning, which lead to examination domination, rote learning, and children being ill-equipped to face demands of life and the world of work or the opportunity to develop creativity [9].

The subject contents taught in schools are mostly a fragmental collection of facts, techniques and theorems that bear little relation to each other. Moreover, these topics are taught as if they have no connection in real life. This theoretical approach to teaching has led many students to perceive subjects like Mathematics as unpleasant and difficult subjects to learn [9].

A study [2] focused on the applicability of Game Based Learning as a supplementary learning approach for learning mathematics. They selected Foundation of Information Technology's Mathematics curriculum, a distance-learning program that operates in e-Learning mode.

This study concluded that over 80% of the students were keen on a GBL for learning mathematics for it allowed them to learn while enjoying and a process that included an explanation of the practical uses of the theoretical concepts.

But the initial interest has decreased down after sometime. Therefore, even though it is agreed on the fact that GBL is a preferable learning approach for learning mathematics, more attention has to be given to find out the sustainability of the students' interest.

## **4 GAME BASED LEARNING MODELS**

### **4.1 Problem-Based gaming (PBG) Model**

This model is based on the premise of Problem-Based Learning. It is supported the experiential learning theory. The model defines learning as a perennial method through direct expertise within the game world and a mirrored image on this expertise. The model highlights reflective thinking and conjointly makes it clear that reflection might present itself in isolation or with collaboration with others. As per [10] the feedback that the recreation provides from a player's actions ought to support reflective thinking and data construction by focusing a player's attention to relevant data from the training purpose of read. This can be solely possible if the feedback (a sort of scaffold) is ZPD-specific (The zone of proximal development, typically abbreviated as ZPD, is that the distinction between what a learner

will do while not facilitate, and what they cannot do.). Minimal significance on scaffolding that isn't enough to tag the framework appropriate for the dependent learner [11].

### **4.2 Game Object Model (GOM)**

The Game Object Model (GOM) tries to form rivalry between education dimensions and game components [12]. In GOM, academic games are thought of to comprises variety of elements (objects) delineate through abstract and concrete interfaces that represent the pedagogical/ theoretical and style components severally. The abstract to concrete interface in GOM represents a transition from conceptualization to realization.

In GOM, Game space Object includes visualization space Objects that drives psychological feature situation. The GOM has evolved, thus there's GOM version II. GOM version II establishes the requirement for collaboration within the learning method [1].

### **4.3 The 6 "I"s Model**

A Hierarchy of serious game components - identity, immersion, interactivity, increased complexity, informed teaching and instructional. This model functions as a hierarchy with identity because the basic foundational part [13].

This model is predicated on the artist viewpoint that students learn through determinative prior schema and ultimately constructing new data by connecting a replacement expertise to a previous expertise. The model conjointly introduces the thought of informed learning. Specifically, this entails embedding scaffolds (learning support) into a game style and distinctive to academic games, the thought of embedded assessments for academic learning outcomes [11].

## **5 SUMMARY**

The Digital Game based learning approach has had fortunate outcomes at many studies connected with Programming and alternative subjects. The influence of gender, demographics, skill seven level and previous experiences in play are proven to own no significance in those findings. Yet, with the examination minded competitive lecture rooms, lack of computer facilities and deficient time for sensible sessions, the requirement for learning the simplest approach of corporal punishment Game based Learning approach in Sri Lankan context for programming education isn't still answered.

## **REFERENCES**

- [1] C. Kazimoglu, M. Kiernan, L. Bacon and L. Mackinnon, "A Serious Game for Developing Computational Thinking and Learning Introductory Computer Programming", *Procedia - Social and Behavioral Sciences*, vol. 47, pp. 1991-1999, 2012. Available: 10.1016/j.sbspro.2012.06.938.
- [2] H. Perera, K. Hewagamage and T. Weerasinghe, "Game based learning as a supplementary approach in teaching mathematics", 2017 Seventeenth International Conference on Advances in ICT for Emerging Regions (ICTer), 2017. Available: 10.1109/ict.2017.8257799.

- [3] P.McClurg, C.Chaille," Computer games: environments for developing spatial cognition"Journal of educational computing research, 3(1), pp. 95-111, 1987
- [4] K. Subrahmanyam, P. Greenfield, R. Kraut and E. Gross, "The impact of computer use on children's and adolescents' development", Journal of Applied Developmental Psychology, vol. 22, no. 1, pp. 7-30, 2001. Available: 10.1016/s0193-3973(00)00063-0.
- [5] M. Papastergiou, "Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation", Computers & Education, vol. 52, no. 1, pp. 1-12, 2009. Available: 10.1016/j.compedu.2008.06.004.
- [6] A. Mathrani, S. Christian, A.Ponder-Sutton. "PlayIT: Game Based Learning Approach for Teaching Programming Concepts." Journal of Educational Technology & Society 19, no. 2 (2016): 5-17. <http://www.jstor.org/stable/jeductechsoci.19.2.5>.
- [7] H. Sung and G. Hwang, "A collaborative game-based learning approach to improving students' learning performance in science courses", Computers & Education, vol. 63, pp. 43-51, 2013. Available: 10.1016/j.compedu.2012.11.019.
- [8] B. Schmitz, A. Czuderna, R. Klemke and M. Specht, "Game Based Learning for Computer Science Education", Citeseerx.ist.psu.edu, 2011. [Online]. Available: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.846.6536&rep=rep1&type=pdf>.
- [9] C. Gunawardena, "Quality Issues in Secondary School Education in Sri Lanka", Hdl.handle.net, 2010. [Online]. Available: <http://hdl.handle.net/11599/2069>.
- [10] K. Kiili and H. Ketamo, "Exploring the Learning Mechanism in Educational Games", Journal of Computing and Information Technology, vol. 15, no. 4, p. 319, 2007. Available: 10.2498/cit.1001139.
- [11] C. Obikwelu, J. Read, G. Sim,"Children's Problem-Solving in Serious Games: The "Fine-Tuning System (FIS)" Elaborated". Electronic Journal of E-Learning, 2013.11(1), 49-60.
- [12] A. Amory, "Game object model version II: a theoretical framework for educational game development", Educational Technology Research and Development, vol. 55, no. 1, pp. 51-77, 2006. Available: 10.1007/s11423-006-9001-x.
- [13] L. Annetta, "The "Ts" Have It: A Framework for Serious Educational Game Design", Review of General Psychology, vol. 14, no. 2, pp. 105-113, 2010. Available: 10.1037/a0018985.

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