



GAME BASED LEARNING AS AN E-LEARNING STRATEGY IN PROGRAMMING EDUCATION FOR SCHOOL CHILDREN

W.B.P.N.Herath¹, T.C.Irugalbandara², M.S.D.Fernando³

Co-Author : 1, Department of Computing, Rajarata University of Sri Lanka, Mihinthale, Sri Lanka

Authors: 2, Department of Computing, Rajarata University of Sri Lanka, Mihinthale, Sri Lanka , 3, Department of Computer Science and Engineering, University of Moratuwa, Sri Lanka

KeyWords

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ABSTRACT

Learning the syntax and understanding the basic concepts have been identified as the most difficult aspects in the learning of computer programming. The Digital Game Based Learning approach has gained successful outcomes at several studies related to programming and other subjects. Yet, with the examination minded competitive classrooms, lack of computer facilities and deficient time for practical sessions, studying the best way of executing Game Based Learning approach in Sri Lankan context for programming education was necessary. Thus, this study was conducted to evaluate the efficacy and motivational attractiveness of computer game play for learning programming principles within Sri Lankan school context. This study demonstrates a Game Based Learning approach exploited as an E-learning environment to motivate and engage students in learning and enhancing programming skills. Primary data was collected from subject evaluation questionnaires, interviews with students and teachers involved in programming, game developers and through study of game artifacts. An educational game mapped with the basic programming concepts was implemented. In the game, the students were guided to find simple solutions by playing a game. The core study was conducted as illustrative case studies of sampled ICT students of 3 schools. The students' performance was recorded and observed before and after the application of Game Based Learning approach. Summative evaluation of the results suggests that Educational Games can be exploited as an effective and motivational learning environment. The recommendation is to blend the Game Based Learning approach as a supplementary learning and teaching material to the conventional instructional designs in programming education.

Introduction

Games that encompass educational objectives and subject matter are believed to bear the potential to render learning of academic subjects more learner-centered, easier, more enjoyable, more interesting, and, therefore more effective [1].

As certain researchers point out, games are comprised of potentially powerful learning environments for a number of reasons. They can support multi-sensory, active, experiential, problem-based learning; they provide immediate feedback enabling players to test hypotheses and learn from their actions; they encompass opportunities for self-assessment through the mechanisms of scoring and reaching different levels; game playing can also favor the development of various skills, such as critical thinking and problem-solving skills.

With all these the fact that game design methods and techniques should inform the design of educational software to be used in schools is increasingly gaining acceptance within the educational technology research community.

When paying attention to the programming education, one of the more difficult aspects in the learning of programming is to learn syntax and to understand coding concepts. To learn to program also requires to be able to see the big picture and to develop a deeper understanding of structures and programming techniques which usually comes over time after hours in of coding and seldom immediately[2] [3].

It was evident in our preliminary study and the review of literature that, in the traditional classroom students often are fed with information and with a risk of cognitive overload. This study suggests a solution and discusses how programming might be taught in online environment with a strategy that combines game-based learning with traditional pedagogy.

Game based Learning is a category of Gameplay that has defined learning outcomes. This is designed to balance subject matter with gameplay and the ability of the player to retain and apply said subject matter to the real world [4]. In this approach, the learning comes from playing games and promoting critical thinking and problem-solving skills. Game-based learning can be accomplished through digital or non-digital games, and may include simulations that allow students to experience learning firsthand.

Literature review

Numerous studies argue that students view computer programming as a purely technical activity rather than a set of combined problem solving skills .Therefore, the majority of students who are learning introductory computer programming tend to develop superficial knowledge and fail to create problem solving strategies through using programming constructs [5].

One strategy proposed to facilitate the teaching and learning of introductory computer programming is the use of video game technologies in an educational game context. The rationale for this is that games are engaging and motivational, students will be encouraged to learn programming constructs in an entertaining and potentially familiar 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 [5].

Researchers have examined the impact of playing games on students' cognitive behavior. McClurg and Chaille research showed a significant increase in spatial ability after three sessions of playing a game that required spatial skills. The study has shown 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 [6].

In educational games, learners are encouraged to apply their knowledge into real life situations which sometimes requires combining of knowledge gained in several areas. Research has found that GBL helps players to improve their social skills such as collaborative working skills while being intrinsically motivated [6].

A study by Marina Papastergiou evaluated the learning effectiveness and motivational appeal of a computer game targeted at the learning of computer memory concepts 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. The learning gains that boys and girls achieved through the use of the game did not differ significantly [7].

An educational computer game should, 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 [7].

Another study, Play IT, has demonstrated that in applied fields of study such as ICT, the inclusion of gaming elements with traditional teaching practices will bring about more active learning [8]. The authors believe that traditional classroom teaching cannot be replaced since teachers play both an educator and a mentoring role and the addition of GBL to development of pedagogical activities will enhance the teaching and learning experience [8].

In another study [9], a collaborative game-based learning environment was developed by integrating a grid-based Mindtool originating from a knowledge engineering method. It improved the learning performances of students from both the aspects of cognition and affection by gaining benefits from both the Mindtool and the digital game [9].

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 [11].

A study by H.Perera, K.P.Hewagamage, T.A. Weerasinghe focused on the applicability of Game Based Learning as a supplementary learning approach for learning mathematics in Sri Lanka. 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 more attention has to be given to find out the sustainability of the students' interest [6].

The digital game based learning approach has had successful outcomes at several studies attached with Programming and other subjects. The influence of gender, demographics, literacy level and prior experiences in gaming have been proved to have no significance in those findings. Yet, with the examination minded competitive classrooms, lack of computer facilities and deficient time for practical sessions, the need for studying the best way of executing Game Based Learning approach in Sri Lankan context for programming education was not answered.

Concept Design and Methodology

Interviews were conducted with the experienced ICT teachers of several schools with the aim of identifying the teaching and learning techniques currently executed at classrooms, to identify learning challenges faced by students in grasping the programming principles. Interview findings revealed the teachers' perceptions of the difficulties and challenges faced by students and suggestions to mitigate those.

In delivering the programming content the teachers found that the majority of students have difficulties in:

- Transferring theoretical knowledge to practical exercise,
- Lack of interest in course contents,
- Understanding conceptual topics due to lack of analytical and logical skills.
- Making the connection between the syntax they memorized and the functional application of the code they are trying to write.

The ICT teachers' opinions and suggestions likewise affirmed the practice of Game Based Learning to encourage participation and bring about active learning through simulations of problem based scenarios using some e-learning environment.

The students answered that they find the fundamental components of programming hard, Such as sequential logic flow, if-then-else, loops, functions and recursions; and thus these mentioned concepts were covered in the set of games implemented for the GBL experiment. A set of educational Games were implemented and integrated as a web application called "CodeLab" to discover the effectiveness of GBL in T&L environments.

recursion and conditional flows. The CodeLab consists of 6 Games with each having ten levels with gradually increasing complexity.

Five of the developed games are for individual playing while the last is a designed to be played by two where the concept of collaboration is executed.

Apart from the built in games in CodeLab the capability of creating new games and tasks was also added to the project as to be used by the teachers.

The open source Blockly toolbox with the workspace was utilized here with added functionality of saving the current work for future restoration.

The students of the selected sample were allowed to study the basic programming module with the ICT teachers first and their competency was evaluated with a quiz. The CodeLab game was then played by the whole sample of 30 students.

The students were told to play the CodeLab levels in a specific order to achieve gradual understanding of programming constructs.

The game play design had steps, levels designed to gradually introduce the complexity of the programming constructs.

Below snapshots (Fig.2., Fig.3.) are from the Web based GBL model developed in this study.

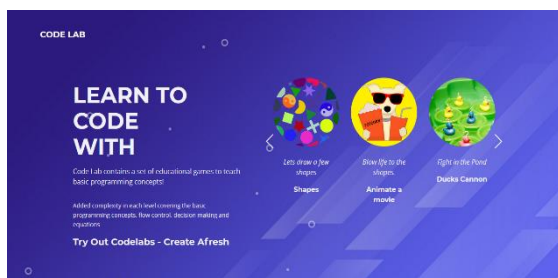


Figure 2: Codelab Homepage



Figure 3 :Gaming Workspace and feedback

Subject-related questions were included in the feedback form to assess their learning after playing the game. Feedback was collected in two different ways: before the gameplay and after the game.

In the first stage, the students were asked to fill a feedback form immediately after the game play. Since the game was conducted in a classroom environment, the whole population sample of 30 responses were obtained in stage one. Both qualitative and quantitative data were collected from the survey.

Qualitative data included open-ended questions to capture student opinion in their own words. Quantitative data was collected using a Likert scale questionnaire. Questions were mostly aimed at understanding student perceptions of fun elements in the game, and whether they found the game difficult, or whether concepts on loops, conditionals or recursion were clear after the game had been played, whether they are willing to play the game again.

The second stage of data collection involved a quiz based on the programming principles, yet this carried questions more complex than the ones they faces before the game play.

Results and Discussion

Data in stage one was collected immediately after the classroom game activity, so student responses were not blurred with recollections from some past event. Accordingly, survey responses noted the present-day and present-time nuances of students who had just experienced a break-away from the traditional classroom teaching methods. Feedback of all 30 participants was collected through a survey. Responses indicate that overall all considered game based learning approach effective and helpful to learn programming concepts.

Overall, the whole class had completed higher levels in Basic and Recursion, but had achieved lower levels in Conditionals.

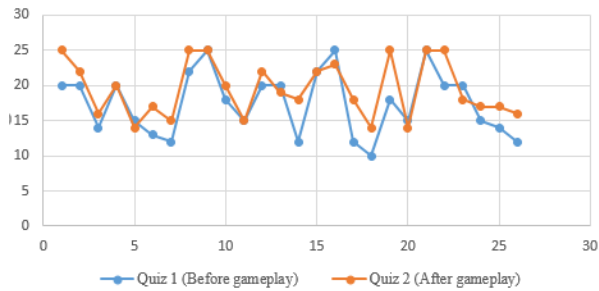
Largely, the students agreed that the game was effective in learning programming concepts and playing the game had brought clarity to some of the earlier taught concepts. There was also much agreement on including gaming elements in the curriculum, as these elements were considered relevant to what students had learnt in their previously taught modules.

However, a small percentage of the students (4%) found the game to have no effect in the understanding of programming basics. The general consensus about the impact of game based learning for understanding of programming constructs was overwhelmingly positive.

The purpose of programming related quiz collection after the game play was to capture student reflections on the game based learning strategy after completion of the study.

Two evaluation quizzes were conducted before and after the game play and were marked out of 25. The graph below (Fig.4) depicts the student scores in the pre and post quizzes.

Marks of students before and after the game play experience



Average marks of the pre-test = 17.6

Average marks of the post-test = 19.7.

Figure 4 : Student marks for the two inclass quizzes

Conclusion

This 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 set of educational games which covered the core subject areas of programming module. This was to encourage student interest by making the learning experience fun.

In the game, the blocks utilizes logical skills associated with programming constructs to solve tasks given. When the player applies correct programming logic rules, problem is solved gradually with each correct move.

In this way, the game gives instant feedback to the player for each correct move, which in turn motivates the player, who tries achieve all levels of the game while the game slowly increases in complexity.

The findings indicate that students enjoyed playing the game and indicated that games are effective in learning of some programming constructs (e.g., functions, procedures, conditionals and recursions). The game created a positive attitude towards studying programming for students. The more students found the game enjoyable, the more they considered it an effective way to learn programming (80%). Data showed that students' perceptions on how interesting they consider programming to be was strongly related to the proportion of their enjoyment in the game (63.3%). After playing the game, students felt gaming elements to be effective way to learn the programming concepts (80%).

However, the data showed no significant relationships between enjoyment and in the level of difficulty or in the level of understanding or in gender.

Findings suggest the more students understand a topic the more they think the game is effective and the topics are interesting. This finding supports using games which introduce course topics in an easy manner so that students are motivated to learn further.

Educational games thus encourage players to apply their logic and reasoning to challenging situations. Students were more likely to want to try out new thought-provoking moves in stricter game settings, which they may not have tried in a directed teaching and learning environment.

After completion of the diploma, we obtained two datasets. One dataset from the paper based survey, a retrospective view of how

students perceived the game based learning approach for their programming module.

The second dataset comprised all student results for their final assessment. While only one third of the students participated in the post completion paper survey, the open-ended nature of the questionnaire gives an insightful picture of how those students felt about having gaming elements in classroom teaching. Students rated the game as useful and fun-filled learning strategy. They could visualize programming constructs with animated movements made by the robot on a tiled walking area. The positive respondents to this survey show a high level of emotional engagement.

Other factors related to student's attributes such as self-study, attendance and interest may have contributed to higher success levels. Nonetheless, the overall findings indicate that GBL is a useful pedagogical approach, which may contribute to learning difficult concepts.

Future Work

The CodeLab games are developed to address several basic programming concepts the students have to learn and understand like programming flow control and program struttred. To be more efficient and useful the advanced programming concepts like data structures, database handling and fie handling have to be added, thus the game can be considered as a whole learning module.

Further, this study utilizes a sample of 30 students from three schools. If this scale can be widened and game design can be developed to address such, provide a more complete insight of the learning efficiency of the game can be provided.

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