

Digital Game Based Learning in Computer Science Education

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ABSTRACT: This paper aims to propose the importance of Digital Game Based Learning approach for adoption in CS education system. Digital games provide a suitable platform to learn by playing coding games, as they motivate students to actively participate and interact with the game's activities. Educational games seem to be more apt for being used in computer programming education, since their provision of attractive graphical environments, interesting scenarios and high interactivity motivate students to learn concepts through achieving goals within an environment they are already familiar with. Game based learning describes an approach to teaching, where students explore relevant aspect of games in a learning context designed by teachers. In this paper a recommendation has also been made which incorporates game based learning in the current curriculum to propose improved standards in the field of Computer Science education and competitive programming.

Keywords: Digital Game Based Learning; CS education system and Educational Games.

INTRODUCTION: Over recent years there has been growing interest in the idea that Computer games can be used to engage challenge and motivate learners. This interest has recently translated into practice within the classroom. Students engagements with and exposure to digital cultures and technologies have important implications for teaching and learning. Computer games inspire self-reliance in addition to self-determination when it comes to the learner's ability to create progress in an incrementally challenging staged natural environment. Games creates innovative thinking abilities, provides diversity in teaching methods and often act as learning trigger inducing discussion on learning concepts amongst students following game play.

Studies have depicted that some subdomains of Computer Science education, such as Computer programming, face significant problems like lack of motivation, complex programming methods etc. that hinder the efficient teaching and learning process. Thus, there is an increasing need for adopting technologies that can handle these problems, incorporating the new knowledge and adopting new learning strategies to provide efficient and effective computer programming education ^[1].

Most of the research work shows that the learning process is highly enhanced when this kind of approach is used in Computer Science teaching, not only because of the motivation they produce, but also

because high end results can be easily generated with relatively little effort. In fact, both interactive and game tools are growing in importance for supporting Computer Science learning, since they are capable of covering many of the typical topics included in the curriculum: Linear Algebra, Artificial Intelligence, Computer Graphics, Network, Real Time Simulations, Human Computer Interaction, Software Engineering, among other important topics ^[2].

RELATED WORK: Studies conducted in the field of Computer Science discovered that games promote learning and decrease the time of teaching for a large number of subjects and with pupils of different age. A study by Marina Papastergiou ^[3], suggests that within high school CS, educational computer games can be exploited as effective and motivational learning environments, regardless of students' gender. Essential game characteristics that contribute to this engagement are challenge, fantasy and curiosity. The motivation of games could be combined with curricular contents. The study was conducted in a secondary school on a sample of 88 pupils, 47 in group A, who used computer games in learning, and 41 in control group B without computer games. The research analysis indicated that teaching with computer games was more efficient in promoting pupils' knowledge, i.e. these pupils were more motivated for work when compared to teaching without computer games.

In their study Kebritcki and Hirumi [4] looked into the effects of computer games on pupils' achievements and motivation for learning. They also examined the effects of prior knowledge, computer skills has on achievements and motivation. The results indicated a significant improvement of achievements of pupils who played computer games both in ordinary classrooms and computer labs. Prior knowledge, skills did not have a significant role in achievements or motivation.

A study presented in the book 'Digital Game Based Learning' by Mark Prensky [5] reveals that by the time today's average teenager in America enter the companies as workers a conservative estimate can be made that they would have watched over twenty thousand hours of television, played over ten thousand hours of video games. So these changed times also call for a change in the methods of teaching being employed to make these minds learn.

In group games, players can learn collaboratively with other students. Students can also be motivated by the competitive nature of games. Programming courses offer a natural environment for games related programming tasks. Wallace et al. [6], describes four different approaches to use games in education:

- Students learn by implementing games.
- Students learn by writing programs that implement a critical aspect of the game.
- Students learn by writing programs that act as a player in an existing game.
- Students learn by playing educational games.

DIGITAL GAME ADOPTION STRATEGY: It can be observed from above mentioned studies that games play a vital role in enhancing the skills of students in every domain. Henceforth, a study was conducted where the participants were the students of Computer Science and Engineering Department of NIT Hamirpur. The current teaching learning methods adopted at NIT-H mainly focuses the theoretical approach, which does not sufficiently cover the subject concepts. The survey measured the effectiveness of present teaching methodologies, it included 131 students, which assured a decent sample size. Thus, the sample selection was justified and it made sure that the survey data reflected the true situation.

RESULT ANALYSIS: Based on the survey questionnaire, following results were obtained:

Fig.1 depicted that the control set had students who were fully aware of the digital games and a clear majority of learners today enjoy playing digital games. Fig. 2 revealed that there is a wide range of games that the students today enjoy; this can be kept in mind while designing games which may attract the young learner

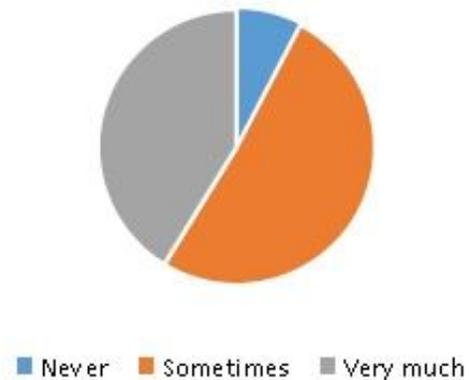


Figure 1. How often students like playing games?

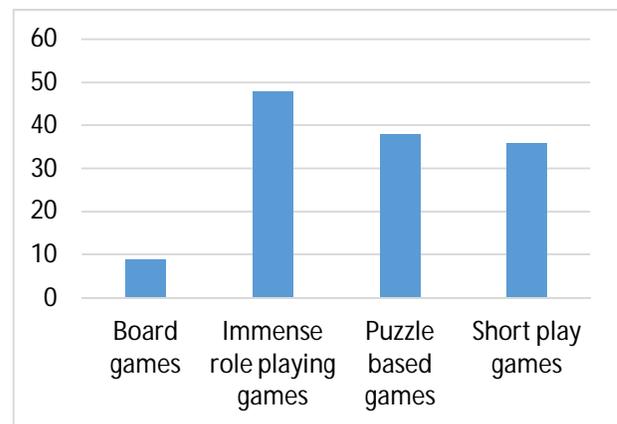


Figure 2. Type of games students like



Figure 3. Learn to code by playing games

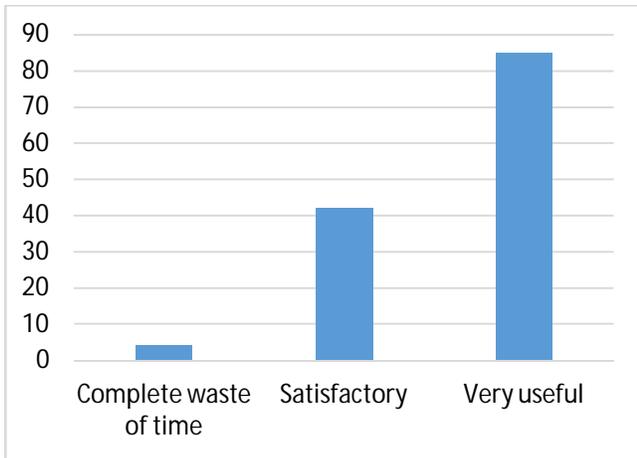


Figure 4. Opinion for coding websites

Fig.3 made clear that the majority students who undertook the survey are open to the idea of learning to code by playing a game, thus indicating that modifications must be introduced in the present approach to help the student's gain better understanding.

Fig.4 presented that the coding websites, another digital learning platforms have been found of utmost importance to improve the student's coding skills.

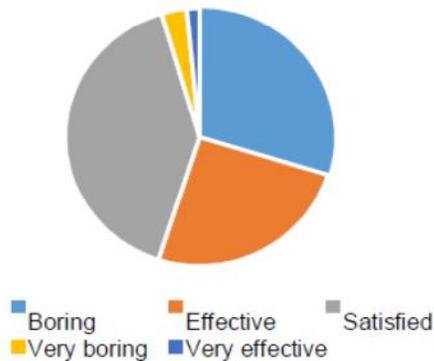


Figure 5. Response to current teaching techniques

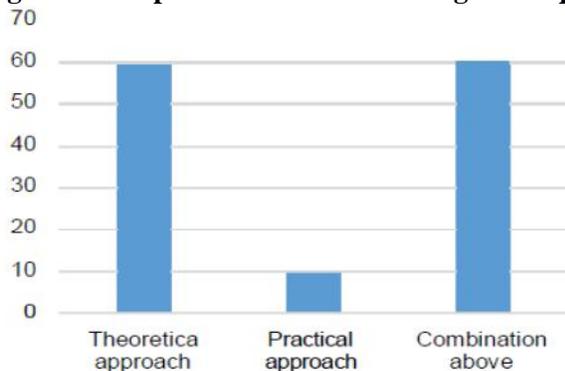


Figure 6. Current teaching trends

The Figures 5 and 6 shown above depicted that though most of the students today are satisfied with the current teaching techniques being used at NIT Hamirpur which mainly focuses on theoretical approach but a large segment find these techniques relatively boring and less effective. Yet another segment feels that a combination of both theoretical and practical approach is being employed, either way the future techniques must outsmart the present teaching methods being employed.



Figure 7. Response to e-learning

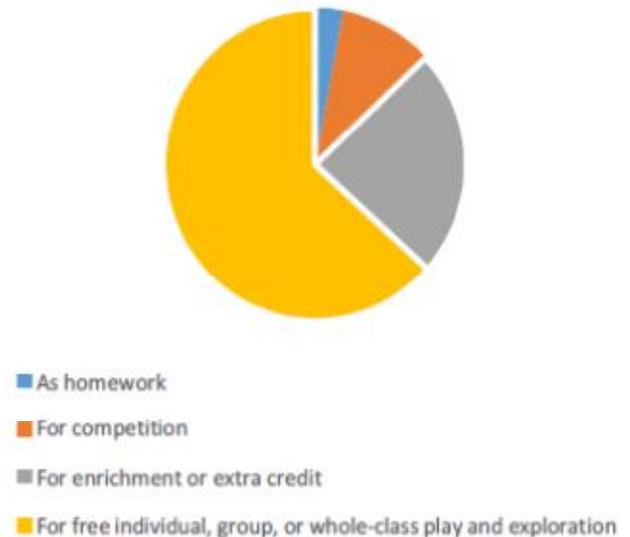


Figure 8. Integrating games into teaching and learning

From Fig.3.7 it was observed that the students are mostly satisfied with the current teaching techniques but are interested to learn through practical means and are in favour of e-learning, so more focus should be placed on the transition between the current teaching methods and dgital based learning. The response in Fig. 3.8 reveals that integration of the games should

be done in such a manner that the students are given a chance to explore using these games which provides a conducive atmosphere for learning.

DISCUSSION: Responses recorded from Computer Science students show that the coding platforms play a vital role in brushing the programming skills to meet the challenging coding environment. This study describes how visual hooks and props can be used to engage students or how programming can be taught through the medium of a game.

The present learning generation has been brought up in an environment which is very different from the one which the previous generations have experienced. This shift calls for a change in the teaching methodologies being employed today. Digital game based learning is an interesting approach which creates an environment conducive for learning. The survey reveals that the majority of students are open to the introduction of game based learning in the curriculum. Also, the participants feel that introduction of this will lead to an increased interest in the curriculum.

RECOMMENDATIONS: Digital game based learning in the field of Computer Science can be attained with the help of a coding game which aims to provide functionalities that help students to learn computer programming elements and teachers to organize their courses efficiently. The game must be designed in such a way that it targets various aspects of teaching-learning process and should have cross-platform compatibility upon deployment.

Objective: The game should support multiple learner models that can be assessed according to each student's specific performances and profiles. These models can be built in accordance to the pedagogical goals the teachers set while they are constructing the game's world and depending on the educational materials to be taught as well as the activities / steps that the students have to go through. Teachers can study their student's behaviours and correspondingly adapt the game's scenario, materials, activities, goals and desired outcomes.

Coding: Playground: A coding game named "Coding playground" can be brought to use in Computer Science education to provide a highly motivational and interesting virtual world for computer programming courses so as to make the teaching – learning process easier and more interesting.

Gameplay: The gameplay must be smooth followed by a step by step progression in levels. The basic idea of the game is to enhance the learning of the students which can be achieved by solving a problem as well as suggesting a problem.

The game consists of three primary launch options on the menu, namely -
Train yourself,
Assignment and
Challenges

The gaming discipline may consist of low to high level questions, involving the concepts from all the Computer Science subjects like C, C ++, Data Structure, ADA, Networks etc. which can also be made a regular part of the curriculum. Competitive puzzles can be added in the list of questions to make the students get familiar with the level of competitive programming.

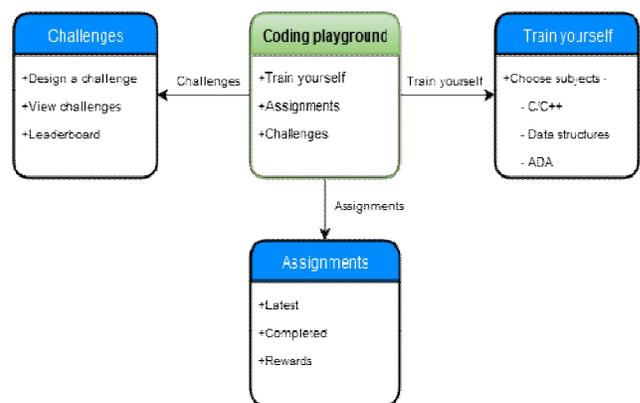


Figure 9. Flow diagram of Coding Playground

Interface and Level design: To bring a competitive spirit in the students, the game levels may range from beginner to the most advanced, which can be played individually or in groups. Strategic game rounds based on certain programming rules can be played and leader board can be used as an important information source to keep check on student's performance and for the evaluation of their ranks. The game will initially contain some predefined levels which are common to all and anyone can play. Other than these the teachers as well as the students can design the levels and can set the level difficulty accordingly. As a part of a regular curriculum teachers can add coding assignments for the students followed by completion deadlines and a reward system for those who complete well in time with better solutions.

Apart from this the students can themselves also design a level and publish it in the challenges section. Proposing a problem and creating a solution for it will be an added benefit to the learning process. Both, problem devising as well as problem solving skills of an individual will be enhanced in such a gaming environment.

The interface of the game should be user friendly and easy to adapt. The splash screen should be built in such a way that it has all the options defined properly and easily understood. The controls of the game should readily accessible and a control guide should also be provided that helps the users to understand how the controls work.

CONCLUSION: This paper mainly focused the importance of game based learning in the CS curriculum. Aim was to assess and propose improvement in the field of coding and learning so as to meet the challenging coding environments today. It's evident that using advanced techniques involving the idea of using games to teach coding will help increase the level of coding and Computer Science education. The survey conducted in this paper compared the credibility of theoretical learning approach to that of practical learning approach. It was observed that game based learning act as a good alternative over regular lab assignments and rote learning. Through competitions and coding challenges, students tend to develop interest and therefore, are expected to learn more quickly and think more creatively. Hence, digital game based learning should be incorporated in our education system as it offers unique structure to compliment traditional strategies, infusing teaching with energy, spark innovative thinking and provide diversity in teaching methods.

FUTURE WORK: Although, the game Coding Playground has been discussed which aims at improving teaching and learning process involved in coding subjects, most of the work needs to be done in the field of development of this educational game. Multiple aspects like technology and domain are to be taken into consideration. Concepts involved in game design - learning objective, pedagogy, graphical environment, user, activities, scenarios, learning outcomes and other adequate features that form a progressive computer programming game needs to be taken into account. The game should be designed with cross-platform

compatibility, which will ensure a good number of users, a web based application as well as a mobile application should be the primary targets.

There is a scope for designing the laboratory curriculum which goes hand in hand with the theoretical courses. Also, the gaming environment should be updated with the changing laboratory and theoretical courses, periodical gaming challenges should be introduced for the students for extra credits.

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