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GAMIFICATION IN PROGRAMMING LANGUAGE LEARNING: A REVIEW AND PATHWAY

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ABSTRACT

For the past several years, many gamification applications have been introduced and implemented for programming language learning. However, existing gamification applications are still lacking in terms of gamification specialization in learning specific programming languages. This concept paper presents a gamification literature review in programming language learning. Findings suggest that more gamification applications should be developed in the future especially for learning specific website development programming languages as gamification has proven to be one of the creative approaches in enhancing student's motivation and learning engagement. This concept paper review classifies existing gamification application and offers valuable insight and pathways of programming language learning gamified solutions. Our future research direction is to work on a case study of integrated gamification application in digital learning platform based on Microsoft Teams, and how those gamification elements could improve student's engagement and enjoyment in learning

Key words: programming, gamification, learning, website

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1. INTRODUCTION

Gamification can be portrayed as the gaming application metaphors to real life tasks to advance motivation, influence behavior, and to enrich engagement. In other words, it is a term used to depict application of games in other non-gaming field. Applications scope from training and education to innovation, self-management, marketing, well-being and many more [1]. As education is an area in which improved motivation and enhanced engagement are certainly needed, not surprisingly it is also an area of various gamification attempts [2].

Learning website design programming is difficult and can be considered challenging for certain people. For this reason, numerous techniques were suggested including games as one of the learning approaches [3]. Gamification, however, deals with game design elements as a whole new set of opportunities to enable the students to be more involved and engaged, such as well-defined goals with a variety of methods to approach them, system of challenges and achievements [4].

Programming is one of the compulsory subjects in Malaysia's higher education institution especially for computer science and information technology students. Moreover, basic programming languages have been adopted and taught in Malaysia's high school in order to equip the students with advanced knowledge of programming [5]. From the previous study [6], teachers and students prefer other learning methods such as referring to textbook and online sources. The finding in this study is also supported with inspired approaches in using gamifications as the main feature to enhance a student's motivation and engagement in learning programming.

Hence, in this concept paper, we reviewed several literatures related to website design learning through gamification approaches. Different approaches have been proposed to support the gamification development and usage. Accordingly, we present this work as an attempt to characterize the state-of-the-art gamification approach in programming language learning. The rest of this article is organized as follow: Section 2 presents our main content, reviewing literature of gamification approaches in learning programming languages. Section 3 is a discussion of the literature findings, and section 4 presents future work for gamification in website design and development learning. Finally, we provide conclusion and the perspectives of this work.

2. LITERATURE REVIEW

A gamification idea brings together numerous experts and disciplines such as psychologists, game designers, computer engineers, and others. Our research study is emphasizing on gamification review, which is aimed for supporting their learning in programming language. In other words, our concern is to review related work in gamification implementation in any programming language learning in general, and more specifically in programming language that is related to website development such as Hypertext Markup Language (HTML), JavaScript, Cascading Style Sheet (CSS), Java and so forth.

Computer programming course can be difficult and student dropout rates tend to be high due to inadequate time for learning and lack of motivation. According to [7], the utmost common problem faced by the students who are learning programming languages is during the practical session, which would require them to practice and refine their programming abilities. Hence,

they proposed a framework of gamification that consists of game components and programming language learning requirements. Lecturers and students have verified the framework and the results shown are promising. The gamification framework proposed to solve two main problems in learning programming language, which are demotivation of students and lack of learning interest in programming subjects.

The gamification success in education is tied to its potential to involve students in learning activities as engagement has been demonstrated as certainly associated with results of student achievement [3]. Thus, Maria-Blanca *et. al* [8] has evaluated the learning engagement and effectiveness appeal of a gamified learning activity aimed at the C programming language learning. Positive effects have been shown on the student's engagement toward the gamified learning activities and an adequate improvement in learning outcomes. Collecting badges have been identified as the most successful mechanism to promote engagement in the study. However, the study shows several limitations in which the study examined short-term memorizing of C programming language knowledge and the study merely involved students who are not familiar with a gamified learning activity before.

Another related study of gamification-based and computer education field is by Jakub and Pawel [9]. They recommended a novel design of an e-learning platform, which focused on programming education for groups of students. The platform structure consists of five sections, namely Course Management, Account Management, Forum, Training Area and Competition Area. The objectives are similar to other gamification works as well, which is to increase learning of students' engagement. Other than engagement and motivation, this platform encourages the students to participate in various activities such as coding exercises, tutoring and learning from instructional materials.

In [10], the proposed work concern on computer engineering students. The fundamental work is the gamification use for both technical and creative understanding, as well as an additional teaching and learning research assessment by focus groups of general public. The concept necessitates the students to discover lesson by gamifying the technical content themselves. This approach of learner-generated game-based learning consents the students to combine a strong mastery of technical domain understanding with innovative, hands-on application. Overall, the outcomes from this initiative of teaching indicate that project based on game may be used to improve the understanding of both creative problem solving and technical domain knowledge.

Gamification achieves better users engagement with greater frequency of use of the Virtual Learning Environment (VLE), larger views of lessons of video and a greater amount of complete tasks, as in [11]. The VLE is proposed for teaching online programming as well as digital games competition and allowed several gamification techniques, namely ranking, challenges, progress and scoreboard. The study claimed that the VLE creates more competitive and friendly environment for students. However, the research work only covered the gamification in a specific VLE, which is the video lesson.

PeerSpace is a collaborative learning environment that based on online social network for Computer Science students in which the application integrates a Web 2.0 suite for student communications on course-related topics [12]. Gamification features have been added to attract and engage students in the collaborative learning. The preliminary results are promising and the students have become more active in social activities in PeerSpace and positively responded to the new game mechanics. Nevertheless, the research still requires a longer observation period as to fully comprehend the gamification features impact.

Another research work on programming gamification was done by [13]. The gamification approach is used as a support tool for distributed and concurrent subjects for lecturers of undergraduate computer science students. The results indicate that the computer programming class became more exciting, and the same goes to the lecturers' explanations. Additionally,

students also reported that they could understand the topics better and hands-on application of the fundamentals through the game. The approach developed evidences of effectiveness in working with games to learn computer programming and improvement of lesson quality in terms of better understanding of the concepts taught.

As computer programming teaching and assessment are considered challenging and frequently unsuccessful especially for weaker students, Panagiotis *et. al* [14] proposed a gamified and problem-based learning approach in learning Python programming course. The approach used an instructor feedback combination, scored quizzes in real time sequence and live coding to provide a fully interactive learning practice. The outcomes were encouraging in terms of final grades, attendance and downloading of course material. However, they still need to work on long-term factors as the results shown only focusing on short-term factors due to new technology introduction and learning techniques.

In [15], a gamification platform called ClassCraft has been proposed and analyzed. The proposed study provided an empirical case study, which presents the comparison of high school students' performance and motivation in learning programming while using gamification approach. The findings show significant results that group of students using the gamified platform were more inspired and obtained good results. Nevertheless, the study might need to include more comprehensive study on a bigger sample with a longer time period.

Another related work is using gamification in online course to teach Python programming language [16]. The proposed study argued that their education approach able to solve many online learning issues such as lack of interactivity, motivation and isolation. The approaches were using gamification mechanics like badges, scores and leaderboard. However, the proposed study only focusing on learning Python programming language.

Additionally, Kumar and Khurana [17] claimed that using technology such as gamification could increase learning interest. They also argued game output must be fun and consist of learning element. The technique introduced is collecting badges in learning programming concepts. Badge is one of game mechanics, which motivated students to work harder. Still, the study might need to investigate specific learning programming languages such as HTML, JavaScript or CSS instead of focusing on general programming languages.

Table 1 Gamification Programming Course Review

Authors/Year	Gamification Course
Firas Layth et. al , 2017 [7]	General Programming
Maria-Blanca et. al, 2014 [8]	C Programming
Jakub & Pawel, 2013 [9]	General Programming
Emily et. al, 2016 [10]	Java Programming
Murilo Rocha et. al, 2016 [11]	General Programming
Cen Li et. al , 2013 [12]	General Programming
Rodrigo & Felipe, 2015 [13]	General Programming
Panagiotis et. al, 2016 [14]	Python Programming
M. Schatten, 2019 [15]	C/Game Programming
M. Krause et. al, 2015 [16]	Python Programming
B. Kumar, 2012 [17]	General Programming
J. Maiga et.al, 2019 [18]	Java Programming

Most students who are beginner in learning programming languages struggles to understand the fundamental of Java in Object Oriented Programming (OOP). Thus, Jaouja *et. al* [18] has proposed a review study on gamification for learning and teaching programming in Java especially to early students. The finding indicates that gamification is proven to improve student's motivation and engagement in the learning process. However, more gamification components should be analyzed in detail in the future study.

To summarize the literature review, we classified the results in Table 1 below. However, reviewed in this report is still incomplete plus additional systematic literature review will be conducted with more focus on numerous gamification concept and recent works.

3. DISCUSSION

All the studies above described that gamification has positive impact in programming language learning. The impact of gamification learning element can increase engagement and motivation among students, and they enjoyed doing their task [19]. The most common gamification elements used in the literature review were badges, points, leaderboards and ranking or level. Moreover, gamification can be an effective and attractive tool to improve students and teacher engagement in learning [19].

Gamification design influenced the outcome of the approach [20]. However, poor design of gamification could lead to discouragement and reduced the learning motivation among students and thus, the lesson will not be no longer fun eventually. The gamification impact is determined on the context as well as how the user utilizes the gamification application. Based on the study, good design of gamification also includes feedback, story line and progression. Moreover, the result of gamification also varies among different group of students, namely tech-savvy student and non tech-savvy student [19]. The difference between those students is their attitude. Non tech-savvy group of students are commonly influenced by utility and availability. They also show excitement in using the technology compare to the tech-savvy students. The main reason is because tech-savvy group are closer to the technology and they can define the difficulties in using the gamification application. Nevertheless, non tech-savvy group of students have a clear achievement in the gamification application.

On top of that, the reviews indicate most of the gamification application is focusing on general programming languages. Several works emphasized on C programming, Java programming and Python programming. The specification of lesson could benefit the students in term of mastery of skills and specialization [13]. They would have better focus and learning tools as the programming language is concentrating to only one programming language or a few related programming languages to a certain application development. For instance, gamification application or tools that emphasize on programming languages of front-end website development such as HTML, CSS and JavaScript.

4. FUTURE WORK

To date, the learning technology utilization has become new style of teaching. The reviews surveyed gamification especially in programming language learning and majority described that gamification has positive impact to the students. Implementation of gamification in learning can engage and encourage students in learning programming language through a fun approach, and eventually improve their performance effectively.

Thus, from this concept paper, a gamification platform for learning website design programming language will be implemented and evaluated for validation purpose. The learning platform will be based on Microsoft Teams as the application is suitable to be used at both workplace and education institution. Microsoft Teams is an integrated platform that combines video meetings, real-time chat, storage of file (including files collaboration) and various

applications integration. The application integration consists of various types of application including corporate, education, sales, social fun and programmer or developer. The future study will involve identifying the gamification elements that can be adopted from the available integrated applications in Microsoft Teams, and analyzing the approach effectiveness through a group case study of students in our university. The aim is to observe the utilization of appropriate learning activities and gamification elements in terms of students' active engagement, specifically in learning programming languages related to web development. Figure 1 depicts several applications that are integrated with Microsoft Teams.

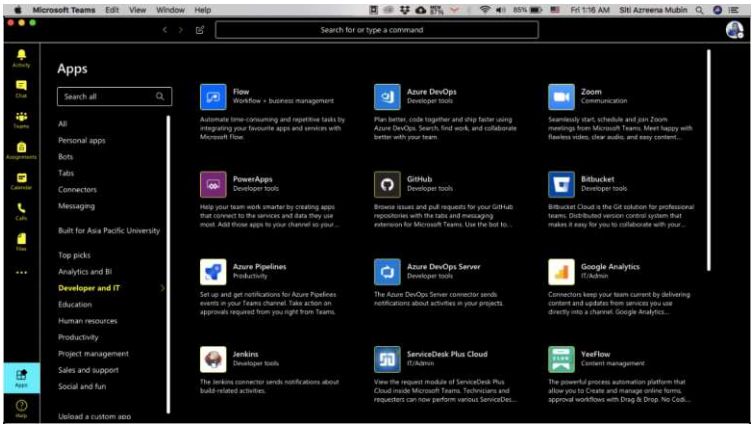

Figure 1 Microsoft Teams Integrated Applications

Our main focus of programming languages are HTML, CSS and JavaScript, which are the main scripting languages used to develop front-end web design nowadays. The findings will be used in creating our new gamification application that benefits students and educators in terms of students' engagement and enjoyment in learning programming languages associated with front-end web development.

5. CONCLUSION

In this concept paper, a review of programming language learning gamification has been conducted and it was found out that most of the gamification applications have been commonly developed in general programming language. The purpose of the review was to classify the difference, similarities, and to discover the gamification impact in motivating the students in learning programming language. Only few research works have been identified focusing on specific programming language such as C programming, Python and Java programming. In the review, reports indicate that gamification is extremely efficient in creating student's engagement and fun in learning certain subjects or courses. To conclude, for further research, a systematic literature review of gamification frameworks in learning programming should be analyzed. From that point, a case study using Microsoft Teams with current integrated gamification applications will be studied and the outcomes will lead to a development of gamification application in learning front-end website programming language. University students will be involved as to measure the gamification approach effectiveness in enhancing their knowledge and practical abilities. The present gamification approaches have proven using the right approach. However, those approaches do not focus on specific skills of programming language related to certain applications for web design and development.

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