Gamification in Learning Programming Language

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ABSTRACT

In this study we present an approach for using gamification elements to increase students’ engagement and motivation in learning Programming Language. Programming Language is one of the toughest subjects for Computer Science students with large number of students who drop out of the course, hence finding new ways is very significant in order to get them engage and motivate. Gamification has been recently implemented in many areas from business to education. Gamification is defined as the use of game elements in a non-game context in increasing students’ engagement and motivation particularly in learning Programming language. In this paper, we focus on investigation suitable game elements to be implemented in this learning by referring to previous studies. The finding of this study propose the use of game elements and feedback characteristic that will increase students engagement and motivation in learning Programming Language the will be further apply in providing gamification framework in future study.

Keywords: Gamification; Game elements; Feedback; Programming language, Engagement, Motivation

INTRODUCTION

Technology is rapidly evolving and changing the way things get done across industries. 21st century has been tremendously impact the educational industry at a global level (Costley, 2014). The fast development in technology has led to diminishing of importance of geographical areas, culture, economics, politics and education barriers. In education, knowledge that has been greatly imparted by educators towards learners by using various technologies has shown a significance success (Rincon-flores, Gallardo, Maria, & Fuente, 2018). This suggest that educators have to continuously innovate their teaching strategies by creatively integrate various teaching tools to enable more dynamic classroom (Ministry of Education Malaysia (MoE), 2015). This has taken shape in experiments with namely flipped classrooms, simulation, mobile learning and gamification as well as a heavy focus on collaboration. Technology will also promote different ways of learning by making learning more fun and enjoyable (Khalid & Wong, 2017). This enables educators to integrate many IT tools in teaching same things but in new ways. Millennia students are the generations that come with skills and are more attractive to technology (Sebastian Deterding, Dixon, Khaled, & Nacke, 2011b). Majority of students are too dependent to their teachers in receiving information. Such dependence suppresses students’ creativity hence many of them never get to know their ability. In serious cases, students are not allowed to interrupt until teacher finish delivering lecture. This will hinder students interest and motivation in learning, at the same time students might be forgotten what to be asked. Moreover, Traditional classroom encourage rote learning by forcing students to memorize repeatedly and ignoring the importance element of learning which is stimulating senses or mind (Li, Qi, Wang, & Wang, 2014). The most important is, when technology is changing rapidly, same goes to education too, this indicate that the process of teaching and learning is dynamically change parallel with the technology too (Calvo, 2015).

One example of teaching tools is digital game. Games comprise of serious games, Game Based Learning and gamification. The popularity of digital games has been increased over the last few years (Mekler, Brülhmann, Tuch, & Opwis, 2017). One of them is gamification has been recognized as one of the most significant ideas in teaching and learning strategy. It had been said that gamification has long been practiced in business industry for promoting their product by giving loyalty points and rewards. Recently, gamification has been significant in education (Khaleel,
Ashrafi, Siti, Tengku, & Ismail, 2016) and has been widely used in many areas such as health, business and social networks (Seaborn & Fels, 2015). There are many definitions in the literature. Gamification is defined as a process of applying game mechanics to different context of situation (Graft, 2011). A popular and common definition of gamification is "the use of game design elements in non-game contexts" (S Deterding et al., 2011). Gamification is implementing by adding the elements of games such as points, leader board and achievement. These elements is inserting into tasks or activities that are usually difficult and boring and thereby make them more engaging and compelling. Other researcher defined gamification as the process of making activities in non-game environment to become more game-like by infusing game design elements (Sailer, Hense, Mayr, & Mandl, 2017). The purpose of gamification is to engage and motivate students in performing tasks given by their instructors. According to Topîrceanu (2017) gamification increases engagement, students are able to receive immediate feedback from the application itself. Moreover, gamification increase learning retention, they are more loyal and spending more time in learning because it is enjoyable, thus increasing their productivity. Topîrceanu (2017) in his research stated that approximately 80% of students agree that they would be efficient if their institution implement game-like activities in their learning. This is evident that millennia students are tend to use game-like tool in their learning as they has been exposed to this scenario at young age, thus, proven that integrating learning with game-like pedagogy is very significant. Hence, this paper suggests the appropriate game elements that are suitable in gamification of learning programing language. The suitability is based on literature review from previous research and the results are the game elements that have been group into categories. The paper is arranged in the following way. The first part explained the difficulties and challenges in learning programming that is gathered from prior research. Second part explaining concept related gamification and various types of game elements. Finally, the suitable game elements for learning Programming Learning are described.

PROGRAMMING LANGUAGE AND THE CHALLENGES

Computer Programming is one of the core courses offered for Computer Science major in foundation program or bachelor degree program. This course act as a core course that give exposure of programming skills to first year students in degree program or students in foundation year. It is one of the courses that posses with high level of difficulties and challenges faced by majority of the students, especially in understanding the basic concept of the course (Ding, 2019). Understanding logic of the coding and syntax is very crucial. Failure to understand logic will slow down student’s progress in writing coding when developing project. Furthermore, students have to be creative in solving the problems that require problem solving skill and higher order thinking skills. Writing computer programs is a basic piece of software engineering educational modules, yet usually problematic. The high drop out and disappointment rates in basic programming courses are all inclusive issue that roused numerous researchers to propose systems and tools to encourage students. Albeit a portion of these tools have been accounted for to have a beneficial outcome in students learning, the issue still remains for the most part unsolved. There are a few reasons for this learning issue. Possibly the most critical is the absence of critical thinking that many students show. They do not know how to program, since they do not know how to make algorithm, for the most part because of their absence of general critical thinking capacities (Gomes & Mendes, 2014). Furthermore, classroom methodologies are still focusing on theory of language syntax that do not magnify programming skill (Ding, 2019). Other factor that contribute to difficulty in learning programming is lack of engagement in learning. Students have to engage and participate either in class or online. Students refuse to participate because of low motivation. The frustration of not being able to master the syllabus will definitely leads to low engagement participation, and fears that other programming courses will be affected (Rahmat et al., 2012; Jenkins, 2002). Students should have high motivation in order to engage in learning. Instructor has to be creative and dynamic in pedagogy when teaching programming language. Teaching programming language is hard and demanding due to the nature of the course that is abstract and complex that involves concept and logic that require strong mathematical capability (Olsson, Mozuelius, & Collin, 2015; Lahtinen & Ala-mutka, 2005). Furthermore, despite many solutions have been suggested in previous years, certainly this issue is still prevalent among students who take programming language in first year (Astin, 1984). Alhammad & Moreno (2018) conducted research on gamification in software engineering found that by infusing gamification in programming language is mostly significance in improving student engagement, however only smaller extend when it comes to improving knowledge. In another research by Azmi, Ahmad, Iahad, & Yusof (2017), reported that implementation of gamification have positive impact in the context of developing required skills for the course. Five lecturers from Malaysia’s public university has been interviewed in their qualitative studies. However, it has been claimed in the research that integrating gamification programming learning is rather new and they suggested a proper design required to fulfil the programming concept and theory (Azmi et al., 2017). Despite all the weaknesses, gamification can still be infused in programming courses as a potential technique that could be able to increase student engagement and motivation.
i. Low Motivation

The previous study found out that many students have a very low of motivation to study programming. Heckhausen (1977) in his research elaborated the meaning of achievement motivation. According to him achievement motivation is the propensity of a person to boost proficiency in the domain of quality standards as a guideline, the standard is (1) task related standard of excellence, able to perform tasks excellently, (2) self-related standard of excellence, differentiate of self-achievement, (3) other related standard of excellence, comparing with the achievement of others (Weiner, Heckhausen, & Meyer, 1972). Overall, achievement motivation allow user to make comparison of self-achievement with others. Other previous research has also indicated that students are lack of motivation. They lack of motivation because there is a bad association connected with programming that spread among students (Gomes & Mendes, 2007). Furthermore, programming course has been labelled as extremely difficult course. Students perceive the course as a very hard and aspiring to this reputation, it is less likely for them to being motivated to learn the course. Students with low intrinsic motivation is likely to fail in this course (Ng & Bereiter, 2011). According to Gomes students’ motivation is low because teaching is not personalized. It is attractive to have a teacher constantly accessible to permit more customized student supervision. Quick input amid critical thinking and point by point clarification of less comprehended perspectives could most likely help numerous students. In any case, as a general rule it is difficult to give this kind of help because of time limitations and common course sizes (Gomes & Mendes, 2007)

ii. Lack of Engagement

In Malaysia, teacher still practising traditional method in teaching, which is teacher-centered, no freedom in teaching and learning and also exam oriented (Chuazairy, 2013). Furthermore, lecturers were found to be using an unattractive and mundane approach. Extensive use of slides with one way communication lessons has added more student tiredness. As a result student feel neglected to participate in class. Participation and engagement in class is very important, student who does not participate and engage in class will somehow drag the attention from the learning. Hence, engagement in class will stimulate thinking. Previous study reported that teachers’ strategies on teaching programming do not cater for all students’ learning style. The environment of learning does not adapt to specific scenario of learning based on student preferential learning style. Many teaching materials and strategies come with the same format to all activities and do not consider students’ characteristics. As a result, students are reluctant to participate and interact in the lesson activity, this will dysfunction the process of learning (Sleeman, 1986). To increase student engagement, new teaching method must be introduced by teacher. Based on previous research, gamification has been integrated into teacher’s teaching method. However some of the previous researchers have questioned on the effectiveness of the gamification in increasing student’s engagement that will somehow increase their achievement. The investment of students amid the educating and learning process in a PC helped synergistic learning condition can likewise be a standard for the level of cooperation and association of students amid the learning procedure (Fischer & Dillenbourg, 2007).

iii. Achievement

Several studies investigating gamification have been carried out on achievement that has positives implication. Hew, Huang, Chu, & Chiu, (2016) conducted a research of the implication of game mechanics on student cognitive and behavioural engagements in an Asian university by implementing two experiments studies. Hew et al., (2016) found that the implementation of game mechanics has contribute positive impact towards students in motivating them in completing difficult task. However, there are no significance difference has been reported on memorizing factual knowledge (Hew et al., 2016). Similarly, Kyewski & Krämer (2017) found that badges (one of the elements in gamification) did not contribute impact on grades or quiz results. This view is also supported by Attali & Arieli-Attali, (2015) who write that no effect found of the point manipulation towards correctness of the responses. However, gamification does increase the speed of responses. This study has been conducted to examine the effects of points (one of the elements in gamification) on performance in mathematics concepts. This can be concluded that the use of gamification produce various results with different context of application.
BASIC CONCEPT AND GAME ELEMENTS IN GAMIFICATION

Gamification is the process of applying gaming dynamics, mechanics and framework into non-game environment. This statement implies that application is designed by adapting game-like components, however the application itself has a functional non-game purpose (Kasurinen & Knutas, 2018). This is meant that normal activities will be injected with game elements to make learning more fun and enjoyable. In conclusion, gamification is defined as “the use of design (rather than game-based technology or other game-related practices) elements (rather than fully developed games) characteristic for games (rather than play or playfulness) in non-game contexts (regardless of specific usage intentions, contexts, or implementation media)” (Sebastian Deterding et al., 2011a, p.5). Gamification in education is not entirely new. In the 1980s, Malone (1980; 1981; 1982) has investigated on what makes the game fun and how these factors can be used in learning. Gamification allows user to score and record of achievements, be rewarded and get medals based on the points system (Gomes, 2016). In the context of education, gamification allows students to receive immediate feedback and acknowledgment on their performance and completion at anywhere and anytime (Karl, 2012). Moreover, gamification offer greater improvement in student engagement and level of motivation (Simões, Redondo, & Vilas, 2013a). The integration of Gamification inside and outside the classroom can assists student in learning programming. Computer programming is one of the toughest courses offered in foundation program in Higher Learning Institution in Malaysia. Students from different programs such as those who are majoring in Engineering or Computer Science have to enroll in this course as the compulsory course regardless of their experience and background. Many students feel that traditional approaches of learning computer programming are dull and mundane (Fisher & Margolis, 2002; Ashcraft, Mclain, & Eger, 2016). To teach this course for those with limited knowledge and exposure in computer programming can be a challenging task. For young generation particularly those in Z generation, game is not strange to them and they are actively engaged in digital game environment (Ván Eck, 2006), hence this gamification offers a potentially remarkable approach in increasing student interest, motivation and engagement in learning computer programming.

Points, level and leaderboards are the example of game elements that commonly related to gamification (Seaborn & Fels, 2015). There are many games element besides the above mentioned which includes badges and avatar. The elements differentiate gamification from serious games (Sebastian Deterding, Dixon, Khaled, & Nacke, 2011c). Gamification refers to the use of definite game elements embedded in real situation. On the other hand, serious games is a game design used for purposes other than mere entertainment (Sebastian Deterding et al., 2011). According to Sebastian Deterding et al., (2011) game design elements can be defined as the games features or characteristic of games that normally exist in many games and this definition is relevant to the definition of the game. On the aspect of design it contrast game design elements with game-based technologies. The fundamental technologies of the game include technological characteristic such as game engines, whereas the gamification’s definition refers specified to a design process (Sebastian Deterding et al., 2011). While the term non-game context is very general, no specific areas of gamification application, and thus leaves the definition open for potential utilization circumstances (Sebastian Deterding et al., 2011). There are many elements in gamification. Some of the most common elements are points, levels and leaderboards, when recognized as informational, it may offer feelings of mastery and thus increasing motivation and promote performance gains (Mekler et al., 2017). Nevertheless, participants performance did not reflect their intrinsic motivation, this findings suggest that this game elements effectively only from performing performance quantity. (Mekler et al., 2017). Gamification can be a strong learning tool to address motivational problems; however, this gamification tool must be well designed addressing subject syllabus and are develop upon well-established implementation model. In other words, the overall process of performing gamification plays a significant role. Because points, level and leaderboards have close connection with digital games, they are now become the popular elements of gamifications (Hamari, Koivisto, & Sarsa, 2014). Futhermore, these game elements are readily significant to various non-game contexts. These three elements work as informational performance feedback and hence play an important part of digital games’ motivational aspect (Przybylski, Rigby, & Ryan, 2010). This agreed by Przybylski, Rigby and Ryan, (2010) that points, level and leaderboard are among the popular games elements that are integrated with performance feedback (Przybylski et al., 2010). They form a clear relationship between user actions and their achievement (Carl Gutwin, Jared Cechanowicz, Brianna Brownwell, & Larry Goodfellow, 2013). (Wang, Li, Feng, Jiang, & Liu, 2012) Furthermore levels and leaderboard have clear performance goals for users to aspire to, which has been related to further achievement attains (Jung, Schneider, & Valacich, 2010) . Among scholars, there is a general consensus on the most basic and concrete elements include badges, points and leaderboard which can be used to trigger particulars behaviour among users and respond to their psychological needs (e.g., Werbach & Hunter, 2012). (Huang & Hew, 2018). In research performed by Sailer et al (2017) indicate that several games elements that graphs positively affect competence need satisfaction are leaderboards, badges and performance. Meanwhile game elements of teammates, avatars and meaningful stories affect social experience relatedness. Simões, Redondos and Villa (2013) in
their research described gamification as the application of game elements known as game mechanics and game-thinking to be used in non-game scenarios. When game mechanics and game thinking are adapted into teaching and learning, only suitable game elements are extracted, hence learning will be more fun and enjoyable. Students will be more motivated and engaged into learning because they learn while playing, thus increasing their interest in the course. It is necessary here to clarify exactly what is meant by game mechanics, in the literature the term tends to be used to refer to mechanism to gamify activities (Simões, Redondo, & Vilas, 2013). Mechanism is referring to procedures and incentives. As game mechanics are the procedures and rewards of the game, intended to stimulate player’s emotions, game elements are the inspirations prompting those feelings (Simões et al., 2013).

CONCLUSION

Based on the findings from the literature, it can be concluded that games elements that are significant and commonly use are points, badges and leaderboard. These elements will be integrated in teaching programming language using gamification to increase students’ motivation, engagement and has potential in increasing academic achievement. Identifying suitable elements is very important in designing the tools of gamification so that students will be able to follow the lesson. A proper design is needed to ensure the effectiveness of gamification in elevate student’s engagement in learning programming language. In the future, researchers will conducted pre-test and post-test in accessing its viability, inspiration with the ease of use of learning application by infusing those elements.

REFERENCES


Chuzairy. (2013). Modul pengajaran kimia berdasarkan model inkluir-kreativiti chuzairy bin hari universiti teknologi malaysia.


Deterding, S., Sicart, M., Nacke, L., … K. O.-


79–83.
Computers in Human Behavior, 29(2), 345–353. https://doi.org/10.1016/j.chb.2012.06.007


