
A Review of Gamification for Learning Programming Language

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Abstract

Introduction: Gamification has been utilised in programming education to enhance student learning outcomes, such as raised motivation, engagement, and retention. This literature study intends to investigate the existing state of knowledge on the application of gamification in programming language learning. This literature review was carried out using online sources like Google Scholar, the ACM Digital Library, and IEEE Xplore. The search terms used were "Gamification," "programming education," and "programming languages." The study is focusing on the use of gamification in the study of programming languages. This review consists of extraction information from 21 chosen article. The results of the study show that gamification can significantly improve the learning experience for students studying programming languages by boosting motivation and engagement, enhancing conceptual understanding, and improving learning outcomes and programming skills. Finally, we can conclude from this study that gamification helps programming learning by generating an exciting and stimulating environment that boosts retention and enjoyment, but it should be utilised in conjunction with traditional ways. Where the gamification content and technique should be linked with the Learning Objectives. Furthermore, we believe that a continuous comparative study of student performance from traditional methods and new approaches such as gamification, along with continuous improvement, is necessary to ensure that the new approach always provides positive changes and not the other way around.

Keywords: Gamification; Programming Language; Education

I. INTRODUCTION

In recent years, gamification of programming language learning has grown in popularity. Gamification is the use of game design concepts and mechanics in situations other than games, such education, to increase motivation and engagement. According to Sharma, Bhagat, Huang, & Chen [1], gamification has been utilised in programming education to enhance student learning outcomes, such as raised motivation, engagement, and retention. This literature study intends to investigate the existing state of knowledge on the application of gamification in programming language learning.

Nowadays, programming subjects are very necessary and are offered not only at the higher education level but have also been introduced at the school level. Programming languages are essential

tools for computer programming, software development, and web development. Learning programming languages aids in the growth of a person's creativity, critical thinking, and problem-solving abilities[1]. With such a high need for software developers and programmers, it is also a useful talent in the present work market. According to Brinda & Kramer [2], Java Programming is used comprehensively not only in software development but also implemented at the university and high school level.

This programming course is not only a component of the curriculum that needs to be implemented in the field of Information Technology, but it is also a course that needs to be offered in fields of study such as engineering, science, and mathematics at the higher education level [3]. They also said that this course is difficult, complex, and categorized among the 7 big

challenges in computing education[4]. Students are having trouble in understanding the basic concepts of programming structure and how to develop a program to solve a problem. This statement also supports the opinion mentioned by Szydłowska et al. [5] where students who are attempting to study programming encounter a wide range of issues that touch on numerous different professions. Nearly every feature of the area is represented by obstacles and challenges faced along the journey.

Therefore, this study aims to research the current literature using gamification in learning programming. To achieve the objective of this study, the following Research Questions (RQ) need to be answered:

RQ 1: What are the popular key elements of gamification in learning programming languages?

RQ 2: What are the benefits of using gamification in learning programming languages?

RQ 3: What are the best practices for implementing gamification in learning programming languages?

This paper is organized as follows: Section II: Literature Review that describes the fundamental of gamification and the previous related work, followed by Section III: Research Methodology, Section IV: Review that answer all the Research Questions, Section V: Discussion and Section VI: Conclusion.

II. LITERATURE REVIEW

A. Gamification in Learning Programming Languages

Gamification is the application of gaming mechanics to non-game environments, such as education. To inspire and enthrall students, it integrates gaming aspects like points, badges, and leaderboards. Gamification has been demonstrated to boost student motivation, engagement, and retention, improving learning outcomes. Elshiekh & Butgerit [6] also mentioned the same meaning, in a non-game context, gamification refers to the application of game thinking, game components, gaming techniques, game methodology, and game framework to motivate users, address problems, improve user experience, and promote desirable behaviours. To make the learning process more interesting, interactive, and fun, gamification is used when teaching programming languages. It can be

used in a variety of learning contexts, including tutorials, quizzes, coding challenges, and projects.

Fotaris et al. [7] informed that since it has been explored since the 1980s, gamification is not a novel concept. The focus of the study is on what draws people to video games and how these elements might be used in education to increase student motivation and engagement. Furthermore, there was a study in 2000s described the impact of game play on cognitive development, identified 36 learning principles found in video games, and acknowledged potential benefits of video games in learning such as the value of immediate feedback, self-regulated learning, information on demand, etc.

B. Previous Studies and Research

Several studies related to gamification in learning programming languages have been reviewed. A study by Dea Pratama & Putra Kusuma [8] has been conducted to a group of Computer Science students who take Procedural Programming subject. The purpose of the study is to improve online learning on the material of teaching and learning. A gamification framework namely Octalysis has been created that includes several of gamification elements.

While Sharma, Bhagat, Huang, & Chen [1] use Game-based Learning (GBL) with Augmented Reality (AR) to teach basic programming. A study of 27 persons from various professions such as design, engineering, humanities, and management found that the GBL approach through AR produced better outcomes in learning fundamental programming even when the students were not from a technical background.

According to Palaniappan & M. Noor [9], a research that conducted to a group of 29 undergraduate students Year 2 that learning basic programming language has been done by using a gamification experience questionnaire before and after learning basic programming with gamification approach. The result shows that gamification used in online learning environment can give a motivating factor that encourages students to pursue independent study.

While in Kazimoglu [10]'s paper, this researcher created an ad hoc game called Programme Your Robot, which was specifically designed to teach programming language. The study included 190 students from the University of Greenwich's Computer Programming course. The

primary goal of this research is to determine the association between game play and students' confidence in learning programming languages. This Game-Play is intended to cover numerous major parts of the programming curriculum, including programming sequence, methods, decision making, and loops.

Other than that, Rodrigues et al. [11] carried out an experimental study, in order to better understand how gamification functions and how context-related factors affect intervention length and learners' familiarity with programming. The study has been conducted to 19 undergraduate students from an Algorithms class participated in a six-week study that examined how much they learned, how intrinsically motivated they were, and how many quizzes they passed.

A study about the method of teaching computer programming also has been done by Bjursten et al. [12] in Sweden among the pupils in primary school. Most Swedish teachers lack formal education or have minimal experience with computer programming. The purpose of the study is to investigate the pedagogical techniques instructors employ when instructing computer programming. The findings reveal that teachers employ eight educational techniques, including three new technique such as do-it-yourself, gamification, and progression that have been developed inductively.

An article addresses the integration of gamification components using experience points, interactive content, local teams, and global teams in an Object-Oriented Programming (OOP) course. The study was carried out by Jusas et al. [13] in the autumn of 2020, and it was contrasted with the two years before it that weren't gamified. While the mean grade increased by a statistically negligible amount, 7% fewer students had to retake the OOP course because of the gamified course than the year before. Additionally, the gamified course led to a noticeably lower percentage of students who needed a second try to pass the final exam.

III. RESEARCH METHODOLOGY

Online resources like Google Scholar, the ACM Digital Library, and IEEE Xplore were used to perform this literature review. "Gamification," "programming education," and "programming languages" were the search terms chosen. Studies the paper written in English, most recently published between 2019 and 2023, however there are also papers published before 2019 to support this paper

writing. Other than that, the paper cited are focusing on the use of gamification in programming language learning met the inclusion requirements. This review comprised a total of 21 studies.

IV. REVIEW

A. Key Elements of Gamification in Learning Programming Languages

Gamification in programming language learning is largely based on the incorporation of game mechanics like points, badges, and leaderboards. The feedback and sensation of progress that these game components give students encourages them to keep learning. Saleem et al. [14] pointed out that points, leaderboards, badges, and levels are the most prevalent gamification components utilised in e-learning and have a significant impact on students. Erlangga et al. [15] has used several gamification components such as a dashboard page that includes student profiles, number of courses attended, subject matter completed, level archived, and points earned. Apart from that, practice questions are also provided for students to complete and can be repeated a maximum of 3 times and the questions are displayed randomly. Leaderboards are also provided to display student names, positions, and student level achievements.

Furthermore, Md Noor et al. [16] by including a score, leaderboard, rules, and badges in the Computer Programming course, the gamification method did aid to increase student engagement throughout online learning. Dea Pratama & Putra Kusuma [8] has identified several types of gamification elements that can be used in the subject of Procedural Programming from 7 reviewed research papers such as quest, point, level, badge, challenge, leaderboard, reward, onboarding, engagement loop, hint, avatar, friending, progress bar, stage, countdown, storyline, and award.

Learning and practising programming languages can be motivated by incentives and rewards like virtual goods, awards, and recognition. These incentives and rewards provide students a feeling of accomplishment and success. However, none of the papers that have been examined use certificates as a form of student incentive.

B. Benefits of Using Gamification in Learning Programming Languages

Gamification's beneficial effects on programming education were confirmed by research done by Zhan et al. [17]. Gamification, followed by thinking skills, had the biggest impact on students' motivation and academic success. Gamification, nevertheless, had just a minor impact on raising students' cognitive burden. Maryono et al. [18] mentioned the following seven primary benefits are categorised as the strengths of gamification implementation: Learning will be more engaging, concepts will be better understood, students' motivation will increase, learning outcomes will be better, students' engagement in learning and programming skills will improve, and students' desire for learning materials will be satisfied.

Additionally, Siti Rosminah & Ahmad Zamzuri [3] claimed that gamification can increase students' involvement with online learning in the Computer Programming course. Students appear to be convinced and pay more attention to the e-learning resources to comprehend the course material while attempting to pass the quiz and gain badges. It's interesting to note that using gamification strategies in the classroom has an impact on lecturers as well as students because lecturers will be more creative when developing gamification techniques. This shown that gamification is highly effective in enhancing student learning outcomes and does more than just raise student achievement; it also satisfies their needs.

According to Kazimoglu [10], this researcher assesses not just student performance on programming languages but also students' social levels, such as confidence, teamwork, and decision-making confidence. When students' perceptions of the difficulty level of learning a programming language improve, their confidence grows.

C. Best Practices for Implementing Gamification in Learning Programming Languages

In a study conducted by Zsigmond et. al [19], to determine what a good set of achievements in gamification is not an easy way. It must consider the goals, obstacles, and problems of the course as well as the goals of the students. Clarifying the requirement for achievement and driving a clear knowledge of what must be done to acquire the appropriate badge are both crucial criteria in judging achievement.

The creation of a framework with 4 actions by Winanti et al. [20], such as 1) Participant

identification to identify all actors participating in the teaching-learning process, was done to guarantee that gamification applied to the subject was appropriate. 2) Goal identification identifies the primary goal of gamification in education and prioritises it based on how it is expected to affect learning outcomes and student learning satisfaction. 3) The implementation seeks to leverage various gaming elements required to increase student engagement and participation in the delivery of learning resources. 4) Learning evaluation to assess learning efficacy in terms of success, enjoyment, and playability.

Before implement gamification in the programming subject, Kazimoglu [10], Elmunsyah et al. [21] mentioned that a learning objective is a goal that needs to be met through learning activities or interactions with educational content. To achieve learning objectives, it is crucial to monitor student development. Student knowledge and abilities determine their learning path. Collaboration in the classroom is essential for implementing active learning successfully.

Kazimoglu [10] suggests that additional studies should focus on cognitive skills in CT rather than just programming expertise through code syntax and appropriate programming practises. Problem solving, algorithm construction, debugging, simulation, and socialisation are examples of cognitive abilities.

V. DISCUSSION

This study review indicates that gamification can be a useful strategy to raise student motivation, engagement, and retention in learning programming languages. Gamification elements should, however, be properly created and put into use to match the students' requirements and learning goals. To completely comprehend how gamification affects student learning outcomes and to determine the best gamification techniques for various learner types and learning outcomes, more study is required.

According to this study, gamification can have a big impact on how motivated students are to learn and how successful they are in school. It can enhance learning experiences, enhance conceptual understanding, boost motivation and enjoyment, and enhance learning outcomes and programming abilities. Gamification can also boost online student engagement and meet their demands for motivation, enjoyment, and learning satisfaction.

The objectives, challenges, and issues of the course as well as the objectives of the students should be considered while gamifying the learning of programming languages. It's also important to know exactly what needs to be done to get the right badge. Gamification can be used to promote student engagement and learning by making a framework containing participant identification, goal identification, implementation, and learning evaluation.

VI. CONCLUSION




As a result of the study review, gamification can be a useful tactic for increasing student motivation, engagement, and retention in the study of programming languages. However, it is

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