

Online Programming Course Based on Gamification for First-Year Informatics Students

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ABSTRACT

Programming is an essential skill in the field of computer science. Even though many students despise programming, they are unable to abandon it. Students' interest wanes during their first year, as programming is required for first-semester syllabuses. Indeed, there is a widespread issue with students' incapacity to comprehend and apply abstract programming concepts. As a result, the purpose of this study is to create a gamified online learning platform for an online programming course. The media were created using the ADDIE methodology. The developed media will then be examined on a media and material aspects. Additionally, the students' perceptions of their desire for learning were elicited. According to the results, the students enjoy and are more interested in learning programming than in a classical way.

Keywords— gamified, online training, learning motivation, programming course

1 Introduction

Programming is an essential skill for informatics students. Even though most students struggle with programming, they cannot avoid it. Since programming language is a requirement for first semester syllabi, students' enthusiasm wanes during their first year. The common issue is students' inability to grasp an abstract programming concept and turn it into a coding program [1]. Disappointment sets in when one realizes that one lacks the necessary skills to create a sound computer program and is unfamiliar with its underlying structure. There is a lack of involvement and a high dropout rate, and the anxiety persists in the following programming courses.

The monotonous learning activities cause a lack of motivation and make the students not interested in the learning [2], [3]. Therefore, to solve the problems, an attractive way to teach the programming course includes learning platforms, material resources, and learning strategies is required [4]–[6]. Several related studies already discuss the relation of those learning environments to the programming course. The first study discusses the use of Scratch, a web-based visual programming language, as an educational tool for programming. The study describes that the interface of Scratch is attractive. However, it is not easy to understand the interface for the tasks constructed with nested programming concepts [7]. Moreover, the complex tasks need too many motion blocks, which causes a higher cognitive load. Therefore, the task should be planned and divided in a sequence from easy to complex. Another study examines the effects of code.org as an online platform on reflective thinking skills towards problem-solving skills. The study shows the insignificant result or slight improvement related to the programming course. Since the use of code.org was enjoyable, the students faced some difficulties in giving appropriate directional commands due to the lack of direction [8].

Hence, there is still room to develop the ideal platform for learning programming. The platform must be easy to use, have motivating factors, be fun, attractive, self-progress monitoring, and embedded learning materials. As an option, a gamified-based can be an ideal online learning platform for a programming course. Gamified is a process that uses game thinking and mechanics to bind users and solves problems [9]–[12]

Gamified uses the game elements and game design techniques in a non-gaming context. The game elements are like points, badges, levels, narratives, and so on, but the core of the gamification develops today to build motivation [1], [13], [14]. Gamification in education strives to make learning more engaging and appealing

to a broad audience, and it transcends standard learning approaches, which are frequently tedious. The use of game components in education makes sense because games and training share some characteristics. In games, players act to achieve a specified goal despite impediments. A learning target is a goal that must be attained through specific learning activities or interactions with educational content. Tracking players' progress in games is critical because their results determine following actions and maneuvers. Tracking student development is critical in education to attain learning goals. The knowledge and skills of students determine their learning path. Collaboration in education is key to effective active learning implementation. Unlike training games, they are highly competitive. Instead than focusing on student rivalry, the learning process should create abilities for collaboration, teamwork, and accountability for group performance.

Based on the problem, the authors conducted a system development named NEMU. It is a visual programming environment using gamified to increase learning motivation in programming courses. The application of gamification is expected to facilitate students in understanding the material and add a competitive spirit in learning programming [15]. NEMU has unique features such as a competitive leaderboard and students' motivational badges [16]. Specifically, as a gamified online training course for programming. In this study, students' motivation was also evaluated to determine the impact of implementing NEMU.

2 Method

This study adopts the ADDIE model as a research and development method. The model consists of five stages: analyze, design, develop, implement, and evaluate, illustrated in Figure 1. At the first stage, we identified a problem and requirements to determine the cause of performance gaps of the students in the learning process. This stage was performed through class observation, a survey on students, and interviews with lecturers. In this case, the subjects are the students of Educational Informatics, Universitas Negeri Malang, Indonesia.

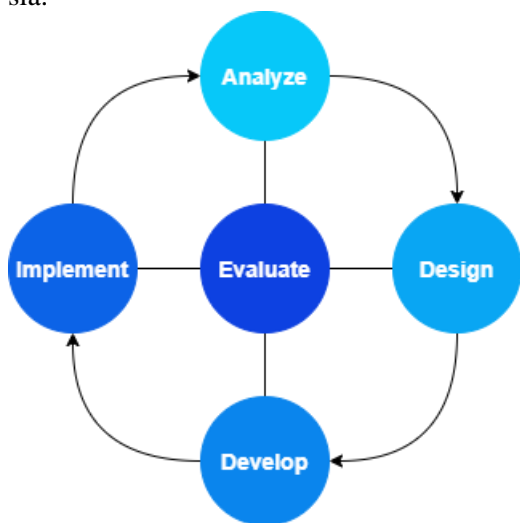


Fig. 1. ADDIE Model

Afterward, the design stage was performed based on the collected data from the previous stage. The analysis stage determines that alternative learning media is needed to assist the learning activities. In this stage, several things have to be designed, including material preparation, gamification implementation, learning media flow design, and learning media interface design.

Next, we start to create the media at the development stage based on the previous design stage. This stage aims to produce the learning media for the programming course. The media named NEMU, is the gamified-based visual programming environment. The development starts with creating material content and questions that will be implemented in the learning media, then encodes the program according to the completed wireframe design.

Furthermore, at the implementation stage, the beta-version media will be tested individually by media and material experts to focus on deficiencies that can be corrected and improved. Some aspects that need to be

tested include the media and material content. From the first test, the experts will provide some constructive feedback as a basis for the evaluation stage. Then, the media was tested on informatics students divided into two groups, small groups consisting of 15 students and large groups consisting of 30 students. The test was done by giving the website access address of the learning media and using the questionnaire to collect the data.

At the last stage, the evaluation has done according to the previous trial stage. The suggestions are obtained and used as a basis of the evaluation. The obtained data are quantitative data and qualitative to evaluate the learning media feasibility. Quantitative data is obtained from the questionnaire results, while qualitative data are from interviews and open-ended questions related to the media. Moreover, the student's perception of learning motivation was also discovered. The questionnaire comprises of questions that can represent students' learning motivation by using the media

3 Result and Discussion

The developed media can be accessed at <https://nemu-domjudge.herokuapp.com/>. The media consist of two main features, learning and competition feature. In the learning feature, there is a progress bar that will show the percentage of completed progress. The level and experience point (xp) will update automatically and be shown on the dashboard page.

true maka looping akan terus berlanjut. Perbedaan antara while dan do while yaitu Perulangan do/while akan mengecek kondisi di belakang (sesudah mengulang), sedangkan while akan mencek kondisi di depan atau awal (sbelum mengulang).

Contoh penulisan do while :

```
do {  
  
    Blok Pernyataan;  
  
}  
  
while(kondisi);
```

Perhatikan contoh penggunaan do while pada video berikut ini :

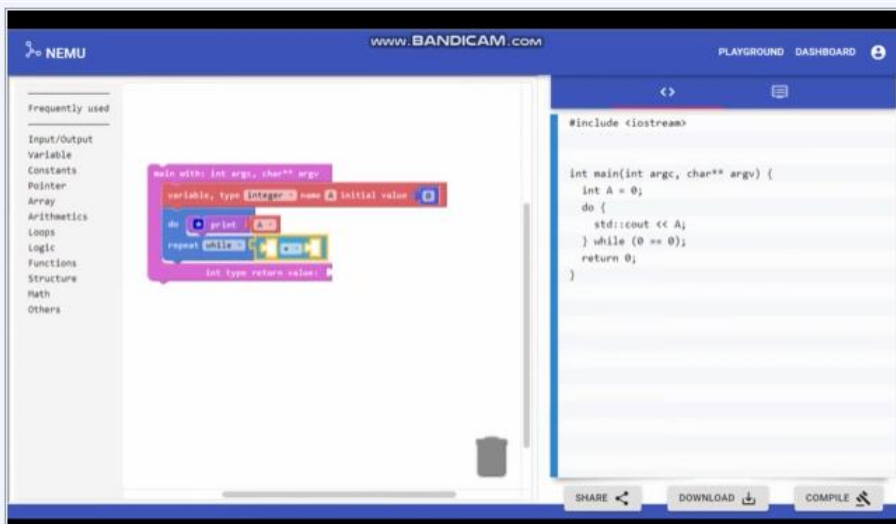


Fig. 2. Learning Details Page

A learning page provides information about the completed learning percentage, content material, and incomplete materials. NEMU's learning media materials are programming courses with intermediate and upper difficulty levels, i.e., iterations, arrays, functions, recursive functions, sorting, and searching. In addition, the learning details page provides detailed information on the selected material. This page consists of discussion and video implementation of code using the visual editor which presents in Figure 1.

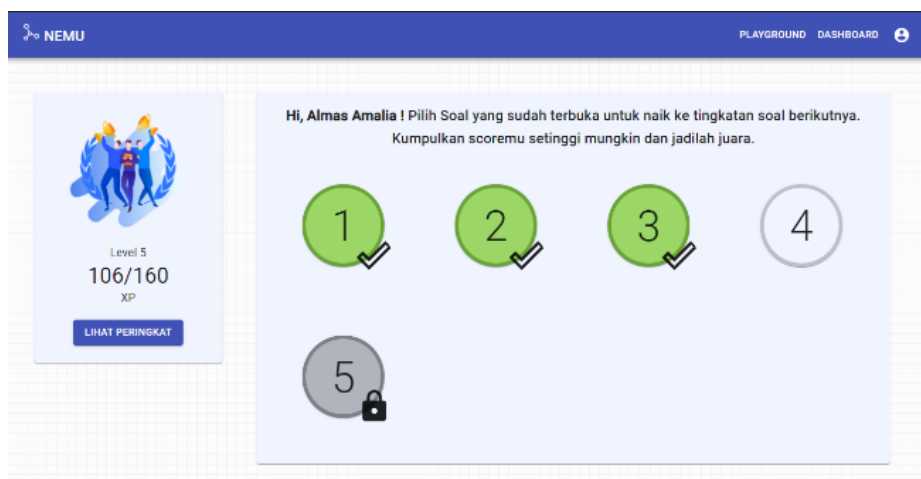


Fig. 3. Competition Page

As seen in Figure 2, the competition page provides challenges from the easy level to the difficult one. Each level has a quiz to complete as the requirement for the next stage in the media scenario. The students need to solve each challenge to hone the student's programming ability. On this competitive page, students compete with each other to become number one on the leaderboard. Points are calculated based on accuracy in solving problems and processing time. Then, points will be accumulated and presented on the leaderboard page. This page also presents the specific badges which represent the completed challenges.

Furthermore, the competitive leaderboard and students' motivational badges aim to increase students' interest and motivation to learn programming [17]. After the user completes the challenges, a page contains the player's learning success score and feedback. Feedback in the form of praise or words of motivation for users is also displayed so that students can be more enthusiastic about learning.

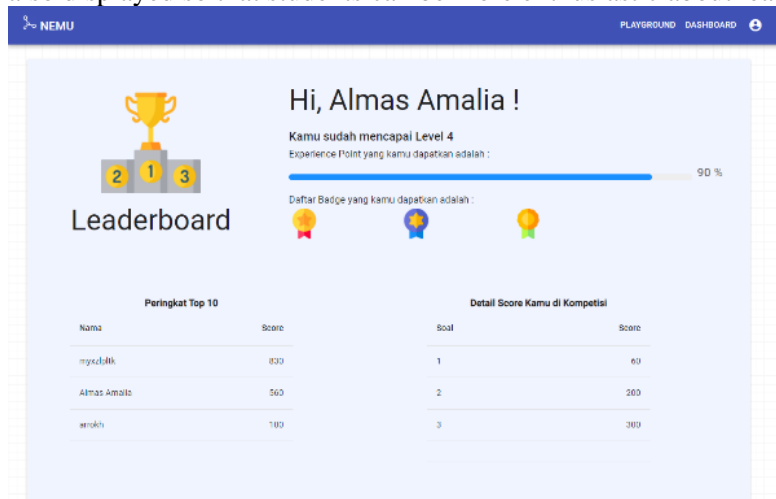


Fig. 4. Leaderboard Page

Furthermore, based on the individual test by media and material experts, the learning media is classified as valid and can be used for the field test. The aspects of media that were evaluated included software engineering, learning design, and visual communication. At the same time, the material aspect that was evaluated included Content, Language, and presentation. However, there are some feedback and suggestions obtained from the evaluation. The training is required before using the media due to the many features. Therefore, it is also equipped with a manual book for the user. In addition, the presentation of NEMU can be simplified to make it easier to use.

Besides the media evaluation, the student's perception of learning motivation on using the NEMU was also discovered by distributing a questionnaire. Table 1 presents the motivational indicator that was discovered on

the students. Based on the result, students feel that they have a strong motivation in learning programming using NEMU as an assisted media. They feel more enjoyable while using NEMU than classical learning. Following previous research, a successful effort can increase students' learning motivation [9], [13], [18]. According to the design, feedback is also displayed as more enthusiastic about achieving the learning objectives [17].

Table 1. Motivational Indicator

Indicators	Test B	Criteria
Learning Persistence	89,33 %	Strong Motivation
Persistence in Problem Solving	92,33 %	Strong Motivation
Interest and Attention in learning	89,83 %	Strong Motivation
Learning Achievement	92,92 %	Strong Motivation
Self-learning	90 %	Strong Motivation
Willingness to learn	89,17 %	Strong Motivation
Average	90,6 %	Strong Motivation

Several related studies support the result of this research. The web digital game-based learning system using WebGL technology and HTML5 was developed to help students learn Unity programming. The result shows that the system successfully motivates students, as well as strengthens their ability in self-regulation, and increases their learning self-efficacy [19].

Another study was done by using gamification for Supporting an Introductory programming course. The game has insignificant effects on the curriculum or in class assessments. Therefore, this unintended pedagogical value can only be extracted through careful consideration and clear direction in the classroom. However, the teacher's role and the game's appropriation are important [20].

Students' performance on their graduation projects significantly improved by enhancing the course curriculum with real-life game development projects in Scratch. Several technologies can help students perform better in introducing computer programming courses, affecting their performance in projects, such as game-based learning [21].

During this time, it can be said that the learning material can assist an online learning activity. Remote learning, attractiveness, comfort, and accessibility are some of the advantages of using online material [22], [23]. But there are a few things to keep in mind when embarking on an online education journey. It is because each level of education, each student, and each course has a unique characteristic. As a result of these considerations, an appropriate learning design can be determined. The following are a few examples of different types of learning design: blended, collaborative, mobile, and even a video game [24]. Gamification is potential to be used to create an educational tool for students in learning programming.

4 Conclusion

NEMU learning media has been developed through several stages and evaluations. Based on the result, it can be concluded that the learning media can be the potential platform to assist programming courses. Also, it can increase the students' motivation by the game-based and competitive features. Although the study achieved a convincing result, there are some considerations for future works. It requires implementing the learning media for a longer period to discover that impact on students' learning achievement. It is also important to discover which learning approaches or strategies are suitable for using this media. Furthermore, a future study should explore and develop this learning media so that it can be adapted and used in many courses.

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