PAPER • OPEN ACCESS

Gamification design to improve student motivation on learning object-oriented programming

To cite this article: D P Y Ardiana and L H Loekito 2020 *J. Phys.: Conf. Ser.* **1516** 012041

View the article online for updates and enhancements.

Gamification design to improve student motivation on learning object-oriented programming

D P Y Ardiana[1] and L H Loekito[2]

[1]Dept. of Computer Science, STMIK STIKOM Indonesia, Denpasar, Bali, Indonesia
[2]Dept. of Computer Science Undiksha, Singaraja, Bali, Indonesia

Email: [1]dewayudhi@stiki-indonesia.ac.id,[2]lucianahendrika7@gmail.com

Abstract. Object-Oriented Programming (OOP) is a skill that must be mastered by students to survive in information technology industry competition. The problem that occurs during OOP learning is that some students are not motivated during the class because of a passive learning style and the lack of understanding from previous programming classes. Based on these problems, this study aims to design gamification to increase student's involvement and motivation in OOP learning. Gamification provides an element of pleasure obtained in the game so that it stimulates the activeness and creativity of students. This research applied the Marczewski Gamification Framework. To find out student's motivation in learning OOP, the Hexad Gamification Questionnaire test was used. The test results showed that 43% of students have the type of achiever. The game mechanics used in this gamification design are for achiever types of users such as levels, challenges and achievements with game elements such as points, badges and trophies. The results showed that the Marczewski Gamification Framework has been implemented in gamification design according to the functional needs of users. This research contributes to the use of gamification in increasing student motivation in learning OOP programming.

1. Introduction

Object-Oriented Programming (OOP) is one of the most critical subjects in computer science schools. OOP applied object-oriented paradigm in a programming language. The object-oriented paradigm is a set of thinking method that creates an abstract model from the physical world. OOP implements real-world entities like object, class, data hiding (encapsulation), inheritance, polymorphism, abstraction in a programing language [1]. Generally, OOP has four advantages, namely 1) modularity that gives the easiest way to troubleshooting; 2) Reuse of code; 3) Flexibility; 4) the most natural and pragmatic approach that makes it useful problem-solving [2].

OOP is widely used in software engineering process design nowadays. It is because OOP provides three software engineering goals, such as reusability, extensibility, and flexibility [3]. Since OOP is supported by most common programming languages like JAVA, C++, PHP, Python, and Ruby, this subject became popular. Because it is widely used and is very popular, understanding the concept of OOP is very important for students so they can compete in the IT industry.

Teaching OOP is not as easy as expected. Students are not only required to write program code in OOP language but also to understand the object-oriented paradigm. One of the difficulties encountered by teachers in teaching OOP is unmotivated students in learning. It is because of student's passive learning style and the impact of a lack of understanding from the previous programming class.

Since it is essential to keep students motivated to achieve the learning goal, this research aims to solve the problem of unmotivated students in learning OOP by using Gamification concept. Gamification is a method that adopts game elements into a context that none related to a game with purpose attract user attention and motivation [4]. Game elements as the basis of gamification have proven effective for stimulating active mind, creativity, creative thinking, and at the same time, bringing joy and fun [5]. Gamification also can improve active learning [6]. Gamification can change passive learning style into active learning. The gamification method is considered an effective solution to learning OOP because this can make learning more attractive and joyful so students can be more motivated to achieve learning targets.

The application of gamification method does not solely lie at adding game elements into the learning context. So many considerations must be taken to implement gamification effectively, such as defining the purposed learning target, deploying appropriate game mechanics, and understanding the target audience [7]. This study designed gamification using the gamification framework to make good gamification in learning OOP as context learning and drive students' motivation.

2. Literature Review

2.1. Gamification
Gamification is mostly described as "the use of game design element in non-games context" [8]. Game elements used on another purpose, not just for entertainment. The term "gamification" was firstly used in 2008 by Brett Terrill, but the terms began wide adoption in 2010 [9]. Gamification has been used commonly in various fields like marketing, healthcare, and education. Huang and Soman simplified the application of gamification into five steps [10]:

- The first step is understanding the target audience and the contexts. A good understanding of the audience became a factor in determining the success of the educational program. These steps need a good understanding of the audience and contexts that surround the education program. A good understanding will help in designing a program that empowers the student to achieve the learning target.
- The second step is defining the learning objective. The instructor needs to set up a learning objective that the students achieve at the end of the learning program. This objective includes general instructional goals, specific learning goals, and behavioral goals.
- The third step is structuring the experience. Stage and milestone are tools for the instructor to sequence knowledge and quantify what students will achieve at the end of the stage.
- The fourth step is Identifying Resources. After judge which stages can be gamified, the instructor must identify track mechanisms, currency, level, rules, and feedback that will be applied.
- The fifth step is applying gamification elements. In these steps, the instructor applied game mechanics to the learning program.

2.2. Marczewski Gamification Framework
Marczewski has proposed two parts of the gamification development process. The first part is a set of questions to yourself as a consideration in deciding to use gamification or not. The second part is a list of things to remember about gamification and should never forget [11].
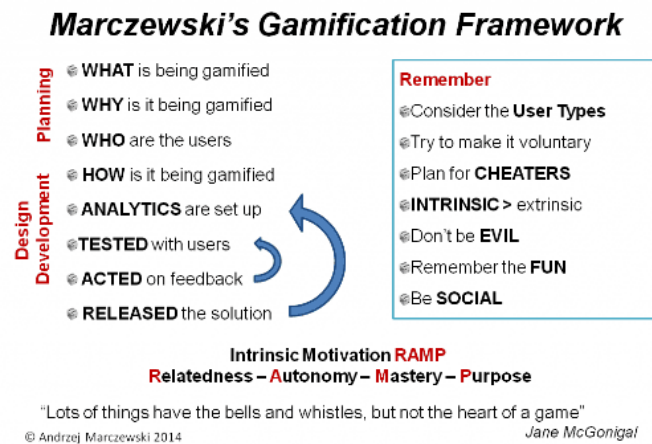
Figure 1. Marczewski's Gamification Framework [12].

2.3. Gamification User Type Hexad

Marczewski has proposed six types of users based on what motivated them. The motivational factor can be either intrinsic or extrinsic [13]. There are four basic intrinsic types; Socialiser, Free Spirit, Achiever, and Purpose. They motivated by Relatedness, Autonomy, Mastery, and Purpose (RAMP). The other two are Player and Disruptor. The Player(extrinsic) user type motivated by reward and The Disruptor driven by change [14].
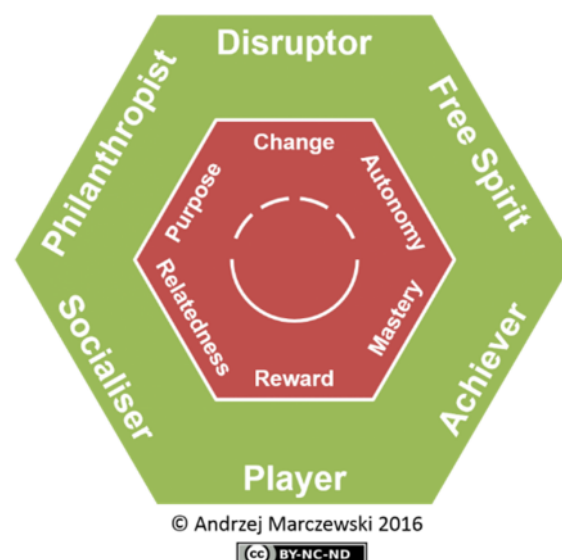

Figure 2. Marczewski's User Type Hexad [14].

3. Research Method

This study aims to design gamification for OOP learning using the Marczewski Gamification Framework method. There were two phases in this study, the planning phase and design development phase. The planning phase began with three questions that underlie the design of gamification.

- What activity is going to gamify?
- Why is it gamified?
- Who are the users?

The planning phase was aimed to determine the learning objectives, defined type of users, and the limits of the gamification system. The next step was the design development phase that aims how is it

being gamified. The design development consisted of two processes, define intrinsic user motivation and define feedback & Game Mechanics. To define the intrinsic user motivation of students, this study used the Hexad Gamification Questionnaire as a test. The results of the test were used to determine the most dominant type of user among the six types of users according to Marczewski. After knowing the type of user motivation, the next process of designing gamification was determining the feedback that will be received by the user and game mechanics that will be used on the gamification. The phase of this research can be seen in figure 3.
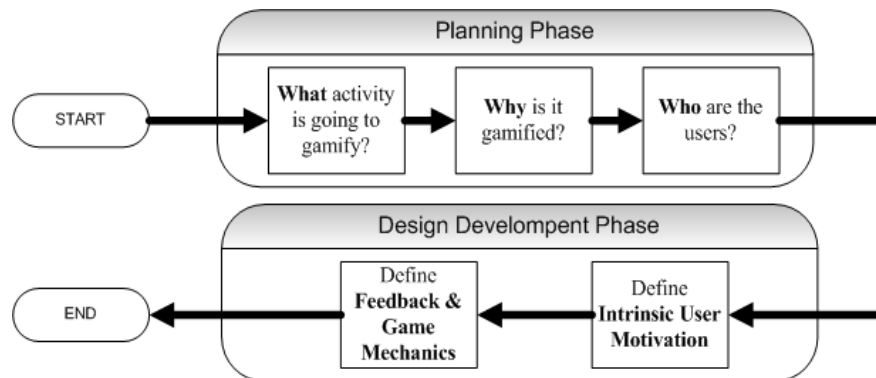

Figure 3. Phase of Research.

4. Result and Discussion

This gamification design for OOP learning using the Marczewski Gamification Framework consists of two-phase: Planning and Design Development.

4.1. The Planning Phase

Table 1. Planning Phase Questions and Answers.

No	Question	Answer
1	**What** activity is going to gamify?	The activity that will be gamified is Object-oriented programming. The contents of the material to be used are classes and objects, encapsulation, inheritance, polymorphism, and data abstraction.
2	**Why** is it gamified?	The difficulties encountered by teachers in teaching OOP is unmotivated students in learning. It's because of student passive learning style and the impact of a lack of understanding from the previous programming class. This study will apply gamification as a solution to these problems, so students become motivated to learn OPP.
3	**Who** are the users?	There are three user types: the admin in charge of managing the web system, the teacher in charge of correcting project assignments and giving badges, and students who take part in OOP learning.

4.2. The Design Development Phase

This phase applied two of Marczewski Gamification Framework's design elements: motivation to determine user type and game mechanics that will be used according to user type.

To determine the type of user of gamification, this study used Hexad Gamification Questions on 30 students who are studying OOP. Hexad Gamification Questionnaire used a Likert scale consisting of 7 points 1 = "Strongly disagree" to 7 = "Strongly agree [15]." The answers from students were analyzed to find the type of user that is most numerous in the class.
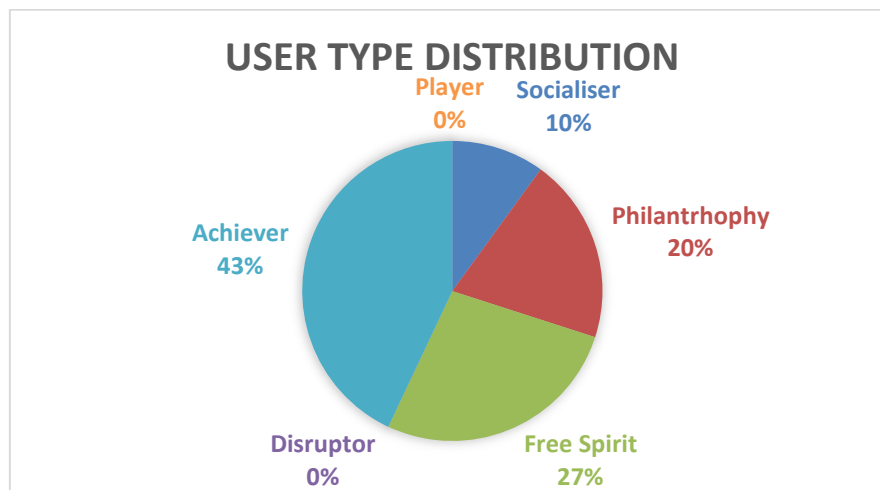

Figure 4. User Type Distribution.

The hexad results show that the type of user that most students have is Achiever. Based on these results, this gamification design will use a user type Achiever who motivated by mastery. The Achiever user type wants to gain knowledge, learn a new skill to improve themselves, and challenges to overcome. This user has game mechanics such as levels, challenges, achievements, leaderboards, and competitions [16]. This study used three achiever game mechanics: level, challenges, and achievements.

This Gamification has five levels. To determine the level of gamification is based on the five materials contained in OOP learning. Level 1 is class and object, level 2 is encapsulation, level 3 is an inheritance, level 4 is polymorphism, and level 5 is data abstraction. Each level has three steps that must be passed by students to be able to continue to the next step. The first step is a puzzle, the second step is a quiz, and the final step is the project task. If students can complete the first and second steps, they will have points. If the student can complete the final step, they can get badges.

The first challenge that students must face is level 1. If students have not completed level 1, then they cannot proceed to level 2. They can continue to the next level if they get badges after completing the final project for each level. To get trophies, students must complete the middle test and final test. To get to that level, students must collect the required badges.

The achievements of this gamification are points, badges, and trophies. The point can achieve from complete every step on the level. To get badges, every level must be completed. The badges contained in this gamification can be seen in table 2. The design of badges based on five element panca maha butha from Balinese culture. The main reason is to introduce and popularize Balinese culture. There are five elements in panca maha butha: akasa, perthiwi, teja, apah, and bayu. Many Balinese believe these five elements construct the universe and the human body.

Table 2. Badges.

No	Badges	How to Achieve
1	Akasa	If complete level 1
2	Perthiwi	Required Akasa Badges and complete level 2.
3	Teja	Required Perthiwi Badges and complete level 3
4	Apah	Required Teja Badges and complete level 4
5	Bayu	Required Apah Badges and complete level 5

Table 3 shows trophies contained in this gamification design and how to achieve them.

Table 3. Trophies.

No	Trophies	How to Achieve
1		Required two badges and complete middle test
2		Required all badges and complete final test

Game rules are needed in gamification to establish the rules that will apply and produce something that is measured. Games rules determine the limits of the game and know the conditions when winning or losing. Figure 4 shows the game rules of the designed gamification. In the game rules, there are rules for leveling up, awarding points, awarding badges and trophies.
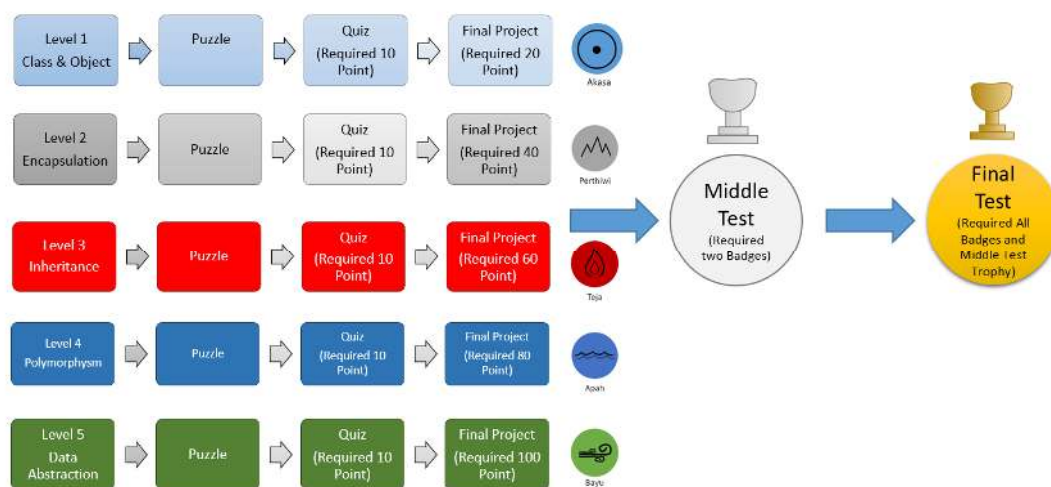
Figure 5. Games Rules.

5. Conclusion
Gamification of OOP learning can be designed using the Marczewski Gamification Framework. Problems of students who are unmotivated in learning OOP can be solved by knowing the user's motivation. Marczewski has proposed six types of users with what motivated them. This study used a Hexad Gamification Questionnaire to measure what motivated students in learning. The results obtained that most students have achiever user types. Based on these results, the gamification was designed with game mechanics levels, challenges and achievements according to the achiever user type.

References
[1]   GeeksforGeeks, "Object Oriented Programming (OOPs) Concept in Java." .

[2]   R. Half, "4 Benefits of Object-Oriented Programming | Robert Half." [Online]. Available: https://www.roberthalf.com/blog/salaries-and-skills/4-advantages-of-object-oriented-programming. [Accessed: 14-Nov-2019].

[3]   A. Urdhwareshe, "Object-Oriented Programming and its Concepts," *Int. J. Innov. Sci. Res.*, vol. **26**, no. 1, pp. 1–6, 2016.

[4]   F. F. Lubis, Y. Rosmansyah, and S. H. Supangkat, "Math Workout Series : Enhancing Learning Application with Gamification," in *International Conference on Information Technology Systems and Innovation (ICITSI)*, 2014, no. November, pp. 24–27.

[5]   S. Azmi, N. A. Iahad, and N. Ahmad, "Attracting Students ' Engagement in Programming Courses with Gamification," in *IEEE Conference on e-Learning, e-Management and e-Services (IC3e)*, 2016, pp. 112–115.

[6]   D. Hidayat, "The Implementation of Gamification System in Higher Education Teaching," *J. Game, Game Art, Gamification*, pp. 17–21, 2017.

[7]   A. Matallaoui, "Towards More Effective Gamification : Does Deploying Semiotics Help Design Better Perceivable Badges ?," *2018 4th Int. Conf. Comput. Technol. Appl.*, pp. 131–135, 2018.

[8]   F. Durin, R. Lee, A. Bade, C. K. On, and N. Hamzah, "Impact of Implementing Game Elements in Gamifying Educational Environment : A Study," in *J. Phys.: Conf. Ser. 1358 012064*, 2019, pp. 1–7.

[9]   M. H. Ohn, K. M. Ohn, U. D. Souza, S. Yusof, and Z. Ariffin, "Effectiveness of innovative gamified learning among undergraduate medical students," *J. Phys. Conf. Ser.*, vol. **1358**, p. 12060, 2019.

[10]   W. H. Huang and D. Soman, "A Practitioner's Guide To Gamification Of Education," *Univ. Toronto - Rotman Sch. Manag.*, 2013.

[11]   B. Šlibar, D. P. Vukovac, S. Lovrenčić, M. Šestak, and D. Androček, "Gamification in a Business Context : Theoretical Background *," in *Proceedings of the Central European Conference on Information and Intelligent Systems*, 2018, vol. **2014**, pp. 123–131.

[12]   J. Landsell and E. Hägglund, "Towards a Gamification Framework : Limitations and opportunities when gamifying business processes," 2016.

[13]   G. F. Tondello, R. R. Wehbe, L. Diamond, M. Busch, A. Marczewski, and L. E. Nacke, "The gamification user types Hexad scale," *CHI Play 2016 - Proc. 2016 Annu. Symp. Comput. Interact. Play*, pp. 229–243, 2016.

[14]   A. Marczewski, *Even ninja monkeys like to play : gamification, game thinking & motivational design*. Gamified UK, 2015.

[15]   L. Diamond, L. E. Nacke, G. F. Tondello, M. Tscheligi, and A. Marczewski, "The HEXAD Gamification User Types Questionnaire : Background and Development Process," no. October, 2015.

[16]   A. Marczewski, "Supporting Gamification User Types - Business 2 Community," 2013. [Online]. Available: https://www.business2community.com/tech-gadgets/supporting-gamification-user-types-0525675. [Accessed: 10-Nov-2019].