

# Enhancing Mastery of Eco-Pedagogy for Sub-Urban Children by Gamification on Problem Based Learning

Nova <sup>1,\*</sup>, Dedi Kuswandi <sup>1</sup>, Habib Syafi'udin <sup>1</sup>

<sup>1</sup> Faculty of Education, Universitas Negeri Malang, Malang, Indonesia

\*Corresponding author. Email: [galaxynova345@yahoo.com](mailto:galaxynova345@yahoo.com)

## ABSTRACT

Problem-based learning is a learning method often used for solving problems, where students can gather independent information and get real experience in the learning process. The problem of environmental damage that occurs in Kampung Kramat, Malang City, Indonesia, can be reduced by eco-pedagogy in early childhood, to internalize environmental care and awareness attitudes. The gamification approach was chosen to attract children's interest and participation in eco-pedagogy learning. Various game features in delivering eco-pedagogy with a problem-based learning model make the series of learning activities increasingly attractive to achieve learning goals. The method used was a quasi-experimental research with one-group pre-test-post-test design to see the effectiveness of the problem-based learning strategy with a gamification approach to the mastery of eco-pedagogy materials for children aged 4-7 years in Kampung Kramat Malang. The findings showed that the effectiveness of the application of this model increased the mastery of concepts in children up to 10.34% with a significance is 95%. This model subsequently influenced self-habituation and environmental care. This proves that problem-based learning with the gamification approach to eco-pedagogy for children 4-7 years was very effective.

**Keywords:** gamification, problem-based learning, eco-pedagogy, sub-urban, early childhood

## 1. INTRODUCTION

Instructional is an essential process to create changes in one's behavior, especially in solving current problems. Therefore, the choice of an instructional model is one key to the success of learning. One instructional model often used in problem-solving is Problem-Based Learning (PBL), which is not only a learning method but a way to learn [1]. This is a method that fosters learning and focuses on problem-solving and the application of knowledge in real-world settings [2], [3].

The origin of PBL have been explained by Boud and Feletti, was developed in the 1960s at McMaster medical schools to produce graduates who think critically and solve increasingly complex medical problems, but after 1980s- 1990s, the PBL approach was adopted in other medical school and then accepted in other disciplines [4]. PBL encourages learners for gaining critical thinking, independent responsibility for learning, knowledge acquisition, sharing information, effective time management, and better retention of information [5]. PBL is consisted of the utilization of the "real world" problems like a necessary context, for the pupils "to learn" critical thinking and the abilities of problems solving, to assimilate the essentials, and creates a

learning environment. Teacher as a coach for problem investigation, as learning facilitator and "advancing" towards superior levels of understanding [6].

One example of a problem highlighted is the problem of environmental damage. In 2015, plastic waste in Indonesia ranges from 187.2 million tons in the waters, the second-highest figure after China [7]. Most of Indonesia's rivers are heavily polluted, piped water management is unreliable. This is the best example of mismanaged water [8]. Throwing garbage into the river is considered normal in Indonesian suburban, even they think river as the most practical large bin. From this problem, environmental education is needed to teach how the natural environment functions and how humans can maintain a sustainable ecosystem [9]. One example of popular environmental education to be developed is through eco-pedagogy.

Eco-pedagogy was initially introduced by Paulo Freire to reveal the relationship between environmental and social problems in people's lives [10]. Eco-pedagogy also develops opportunities to critically analyze various environmental problems such as global warming, environmental damage, depletion of natural resources, and poverty [11]. Thus, eco-pedagogy is planned to foster environmental care by developing knowledge,

internalizing values, and habituating. Eco- pedagogy and problem-based learning have a shared purpose; solving problems.

Eco-pedagogy is important given as early as possible to emphasizes the main causes and effects of real-world environmental problems, then children will learn to critically understand how nature should be treated [12], allowing become socially responsible for the environment [13]. Children will start to build their knowledge through real experiences every day. Furthermore, delivering Eco- pedagogy should be considered early childhood characteristics. Students at a pre-operative level (only able to understand visually object) the beginnings of language, of the symbolic function, and therefore of thought, or representation [14]. Therefore, it is necessary to consider the right approach, such as learning through fun [15], in implementing a problem- based learning model in eco-pedagogy.

In this regard, the gamification approach can be a bright solution. Gamification was chosen to grab more attention from the children who are in the preoperative period. Preoperative children (< 7 years) are only able to understand objects that can be visually understood [16]. Gamification is still rising in popularity and has seen rapid adoption in business, marketing, corporate management, and wellness and ecology initiatives. In education, gamification mostly only discusses the elements and their application, not the effectiveness and proper evaluation system in the learning [17]. gamification is the process of applying in-game experience to increase motivation and exhibit behavior [18], [19]. In short, gamification is the process of thinking games and game mechanics in-game to involve users and solve problems, to strengthen motivation and critical-thinking skills [20].

This is a combination of content learning, literacy, and 21st-century learning skills in creating a learning environment [16]. The gamification features follow Abstracted reality, goals, rules, reward structures, conflict, competition, cooperation, time, feedback, levels, storytelling, player interest, aesthetics, replay or do over [21], [22]. While the most used elements are feedback, goals, badges, leader board, point system, and levels [23]. Thus, it is expected that these features can increase children's interest, involvement, and learning motivation effectively.

Gamification has always been an appealing topic to be discussed and explored. Until recently, several studies have investigated that early adopters of gamification are mostly Computer Science/IT teachers. Some teachers used to combine their class with software for supporting gamification implementation. The example is using Moodle [24], Blackboard 9 [25], and the online homework platform WeBWorK [26].

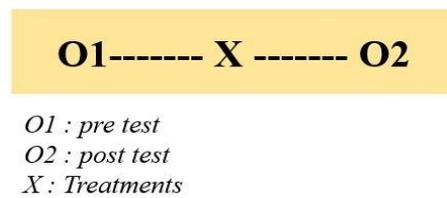
In 2014, Akpolat & Slany applies gamification through traditional learning with game features in the form of Badges and Leaderboard, without involving online support [27]. They were in 5 small groups of 10 members within 6 weeks. The result showed that the usage of game mechanics and game design seems to be effective in the area of teaching software development processes. Students did identify more with our classroom project and their output increased when applying game mechanics to the course.

Other research on gamification without an online course is also done by Iosup & Epema which we have designed a toolbox for course gamification, which adapts to different types of students via a set of mechanisms and dynamics [28]. They have Key features of our design include enabling various paths of advancement and fostering social interaction inside and outside the classroom for 450 students. This research found that gamification can help in many ways our students, from increasing passing rates and participation to high student satisfaction and heart-warming testimonials.

Research on gamification explicitly discusses eco-pedagogy has been developed by Syafi'udin and Nova (2019) in Kramat Village Malang for children aged 4-7 years resulting in an instructional design. This research is a continuation of the research to test the effectiveness of the application of problem-based learning with the gamification approach in the eco-pedagogy for children aged 4-7 years in Kramat Village, Malang.

**2. METHOD**

This was a quasi-experimental research with a one-group pre-test-post-test design. This research did not use a comparison class but only used the experimental class by giving pre-test and post-test. This type of research was chosen because the control group was impossible to obtain. The research subjects were first given a pre-test to find out their initial abilities. Then, they were given treatment in the form of eco-pedagogy about garbage with a problem-based learning strategy with gamification approach for children aged 4-7 years for several meetings. Then, they were given the final test (post-test) to determine the effectiveness of the problem-based learning strategy with a gamification approach to mastering eco-pedagogy material applied to children aged 4-7 years. Simply, the research design used can be described in Figure 1.



**Figure 1 One-Group Pre-Test-Post-Test Design**

This research was conducted in children aged 4-7 years in Kramat Village, Malang, a Brantas riverbank area in the Kasin public burial area, Sukun District, Malang City, Indonesia. Students at a pre-operative level are the beginnings of language, of the symbolic function, and therefore of thought, or representation [14]. They live in Kramat Village with populated around 450 people who worked as grave-digger and small merchants. There are 25 children aged 4-7 years. Kampung Kramat has been established as a thematic tourism village following Local Regulations Number 7 the year 2001 about the plan of Regional Spatial (RTRW) Malang 2001-2011 [29]. This a pre- prosperous village with low learning motivation and serious environmental problems (plastic waste on the river).

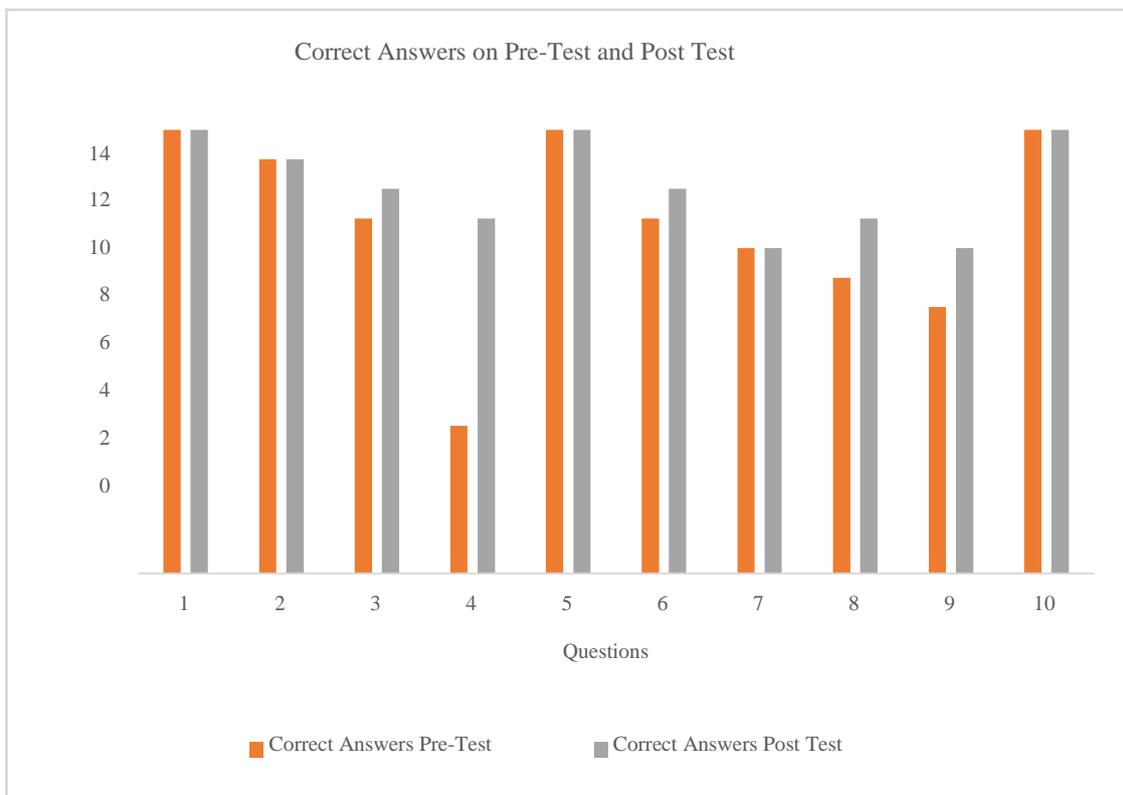
The material provided was eco-pedagogy about garbage and how to maintain the environment and rivers from the garbage. One class was used as an object as well as the control group (before the introduction of the test treatment) and the experimental group (after the test treatment has been introduced). The data obtained before the treatment (test results and other data) served as the data from the control group while the data collected after treatment included the data from the experimental group. During the eco-pedagogy treatment process with the material about garbage, an assessment and qualitative data collection were carried out through two sections questionnaire (pre-test and post-test) consist of cognitive domain C1 (remembering), C2 (understanding), C3

(applying), C4 (analyzing) and C5 (evaluating) to determine student’s mastery concept [30]. Research also using direct observation of student behavior and interviews with parents as additional data.

The analysis steps carried out include determining the average score of the pre-test and post-test, carrying out the normality and homogeneity tests, and then testing the hypothesis through the T-test using SPSS ver. 21. In this research, the researcher investigated the effectiveness of using the problem-based lingering model with a gamification approach to promoting a garbage-free environment in eco-pedagogy. The expected results of eco- pedagogy about garbage are cognitive understanding, behavior change, and self-habituation to dispose of garbage in its place.

### 3. RESULT

This research was carried out in Kampung Kramat, Malang City for 6 meetings in a month. This research was conducted on informal class education for all children aged 4-7 years in Kramat Village Malang, comprising of 15 children. To see the effectiveness of the design developed, this research applied a quasi-experimental method with one- group pre-test/post-test design, without using a comparison class. The research was also supplemented by the data from field observations during the treatment and interviews with the children's parents. The findings of this research are shown in Figure 2 and Figure 3.



**Figure 2 Correct Answers on Pre-test and Post-test**

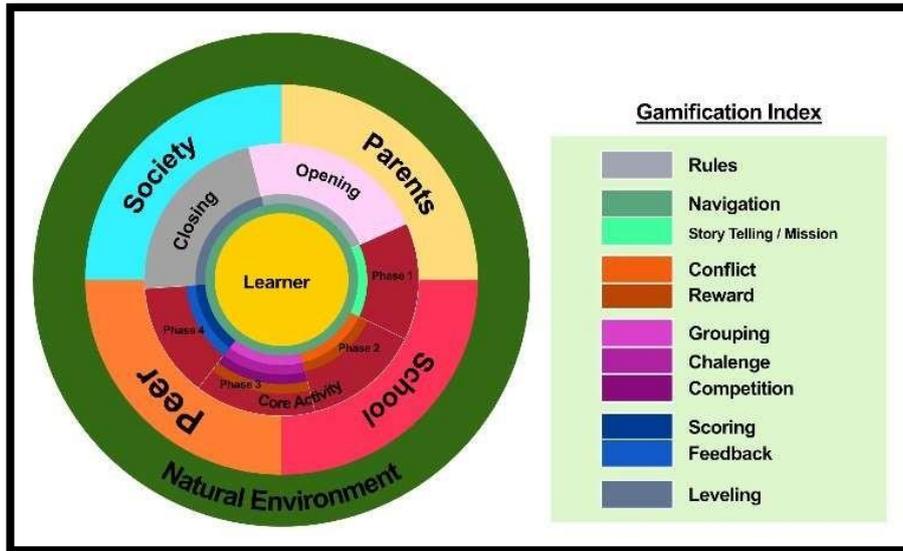


Figure 3 Instructional Design on Syafi'udin and Nova research

The pre-test results (before treatment) of children on the eco-pedagogy material showed an average score of 78.6667 from 10 questions asked to children. The questions given contained basic knowledge of garbage, river hygiene, and awareness of garbage disposal. In the highest scores in the pre-test are on the answers to questions number 1, 5, and 10 of 100%. The questions are related to "clean" standards and the selection of clean houses and rivers. The lowest score is in question number 4, which is only 33% of children who choose the right answer about a place for garbage disposal. However, the correct answer question number 4 in the post-test increased to 80%. Overall, the problem-based learning strategy with gamification increase scores up to 10.34% to mastery eco-pedagogy material for children aged 4-7 years.

The calculation results of the correlation between the pre-test and post-test using SPSS ver. 25. The pre-test average score is 78.66667, which increases to 87.3333 in the post-test in Table 1. The correlation between the pre-test and post-test is strong (0.60 - 0.799 = strong correlation), which supports the value of 0.708 in Table 2. Meanwhile, the value of the t table from the data is 2.14479 while the value of the t-test is 6.5. This means that the value of the t-test is greater than the value of the t table, so the treatment given has a significant influence of 95% shown in Table 3.

Table 1 Paired Samples Statistics

Pair 1	Paired Samples Statistics			
	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	78.6667	15	6.39940	1.65232
Post-test	87.3333	15	7.03732	1.81703

Table 2 Paired Samples Correlations

Pair 1	Paired Samples Statistics			
	Pre-test and Post-test	N	Correlation	Sig.
		15	.708	.003

Table 3 Paired Samples Correlations

Paired Samples Test						
Mean	Std. Deviation	Std. error Mean	95% Confidence Interval of the Difference		t	Sig. 2-tailed
-8.66667	5.16398	1.33333	-11.52638	-5.80695	-6.500	.000
						14

#### 4. DISCUSSION

From the above explanation, it shows that the use of the problem-based learning strategy with the gamification approach in eco-pedagogy in Kampung Kramat Malang for children aged 4-7 years is the right solution. The learning design developed by Syafi'udin and Nova (2019) is revealed in Figure 3. Learners are in the center of the circle to receive the eco-pedagogy material. The next layer is the syntax of the problem-based learning as a strategy used in delivering the material through three stages, namely opening, core activity, and closing.

In the core activity, there are five learning phases carried out with various kinds of gamification approaches (see gamification index). In learning activities, learners also get influence from the next layer (parents, school, peer friends, and society) in the form of habituation and example. At the outermost layer is the natural environment as the result of learning, which gives an influence on the knowledge and real attitudes of child behavior as reciprocity.

The learning design developed by Syafi'udin and Nova (2019) shows the importance of learning strategies and the environment around learners. The eco-pedagogy material is adapted to solve the problem of garbage in Kampung Kramat Malang City. Therefore, children get a lot of knowledge through real experiences around them, as evidenced by the increase in the overall average score of 78.6667 in the pre-test to 87.333 in the post-test (increasing up 10.34%). More specifically, the number of children who have increased knowledge about the type of garbage and how to dispose of it is also higher, from 33% of children who answered correctly (pre-test) to 80% (post-test).

The cognitive domain involves is remembering (C1), understanding (C2), applying (C3), analyzing (C4), and evaluating (C5). Students showed high improvements are categorized in the applying (C3) and analyzing (C4) domain. The analysis of the post-test also showed the problem-solving model contributes to students' concept mastery improvement. the problem-solving model was able to make students have a more comprehensive understanding. Another analysis is performed to investigate students' concept mastery improvement using the problem-solving model, such as previous research conducted by Aka, Aydogdu, and Guven in 2010 [31]. Problem-based learning will stimulate student participation cause it is concerned with guiding the learning process through viable solutions.

Another finding is the children become very active in collecting garbage around the house environment and river. They also like to throw garbage collected into the garbage bin, no longer to the river. The interview results with the learner's parents also showed good results. Children began to be more aware and care about the environment after learning the eco- pedagogy material. They were excited about getting used to throwing garbage in its place and warning others not to throw garbage into the river anymore. This finding certainly shows the achievement of the essence of eco-pedagogy, which is to involve the participation of early childhood to shape a better future for the environment [13].

The gamification approach used in instructional also shows a significant influence related to learning motivation and the development of children's knowledge. Student brain development is only able to understand objects visually so that gamification features can attract children's attention and help them understand the material presented [16]. In 2018, Dixit observed that 80% of students found the blending of gamification with traditional classroom teaching are appropriate and useful for the course. This increased students' interest in the class. It increases a student's engagement and attention span [32]. Likewise, this research shown all the children involved in the activity, showed general interest, for example, giving a 'star' reward of 100%, using the greeting button (navigation feature) of 86.67%, and using

'navigation', 'stop', 'next', and 'level' buttons of 93.33 %. Besides, a variety of activities based on real problems around the environment also showed very positive results. The children proved to be very happy to observe the river of 100%, collect the garbage of 86.67%, practice to dispose of garbage 86.67%, and listening to stories of 66.67%.

## 5. CONCLUSION

Finally, this research concluded that the problem-based learning strategy with an effective gamification approach was applied to improve the mastery of the eco-pedagogy material for children aged 4-7 years in Kramat Village, Malang City. The effectiveness of the application of this model reached 95% significance (influential), as seen from the increase in the post-test results compared to the pre-test results. The most significant increase in knowledge or mastery of the material (43%) is about the type of garbage and how to dispose, from 33% of children who answered correctly (pre-test) to 80% (post-test).

Overall, the student's improvement is 10.34% on average score. Another aspect that affects the mastery of the material is the level of children's interests, especially through the gamification features provided. The results indicate that the reward and navigation features (buttons) in all subjects provide interest for children of 100%. Other features in gamification also provide high interest for children which affects the mastery of the material, behavior change, and self- habituation. This proves that problem-based learning with the gamification approach to eco-pedagogy for children 4-7 years was very effective in the mastery of eco-pedagogy material for children aged 4-7 years in Kampung Kramat Malang.

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