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Gamification in Science Learning to Improve Student Literacy

Nur Annisaa Septiani[a], Rosita Putri Rahmi Haerani[b*], Erna Suhartini[c]

[a] Primary School Teacher Education, Faculty of Teacher Training and Education, Mulawarman University, Indonesia
[b] Primary School Teacher Education, Faculty of Teacher Training and Education, Mulawarman University, Indonesia
[c] Primary School Teacher Education, Faculty of Teacher Training and Education, Mulawarman University, Indonesia

[*]Corresponding author: Jl. Kuaro, Gn. Kelua, Kec. Samarinda Ulu, Kota Samarinda, Kalimantan Timur, 75119, Indonesia. E-mail addresses: rosita.putri.rahmi@fkip.unmul.ac.id

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abstract

This research is based on students' low science literacy skills based on the results of research conducted by the Program for International Student Assessment (PISA) in 2022. This study aims to determine the effectiveness of educational game-based science learning on students' science literacy. This educational game development uses the Research and development method with the ADDIE development model (analysis, design, development, implementation, evaluation), producing an educational game that can be accessed without an application. Data is collected by providing feasibility instruments, observation sheets, test questions, and questionnaires. This educational game has been assessed for feasibility by 2 material experts, with a score of 90% in the very feasible category, and 2 media experts, 88% in the very feasible category. The feasibility test was also conducted through a small-scale trial of 96% very feasible category. The student feasibility assessment on a large-scale trial with 28 respondents obtained a value of 94% in the very feasible category, and a feasibility assessment from the teacher was obtained in the 98% very feasible category. The n-gain test results showed an increase of 0.573 with a moderate category. Using this educational game in learning can improve students' science literacy.

1. Introduction

The Program for International Student Assessment (PISA) conducted a study in 2022 and showed that Indonesia was ranked 67 out of 81 countries (OECD, 2023). This research shows that the understanding of science literacy in Indonesia is still not good. Science literacy is very influential in the development of education and the economy in a country (Fortus et al., 2022). Science learning is important in creating students who can think critically, logically, creatively, innovatively, and globally competitive (Sari & Amini, 2020). Science literacy can also improve students' thinking, creativity, and ability to understand scientific problems, explain scientific phenomena, draw conclusions based on evidence, and strengthen their character as individuals who care about themselves, society, and the environment (Noor, 2020; Stylos et al., 2023).

This increase in science literacy can be done by utilizing current technological developments. Educators can use technology as a tool in learning or as a facilitator to convey material to students (Nurillahwaty, 2021). Using technology as a learning tool can also provide students with a fun and varied experience (Purnamasari & Hanifah, 2021). One form of using technology in the learning

process is game-shaped media, commonly referred to as educational games. Educational games are games made for learning about specific topics and help in learning while playing (Kalaka et al., 2023). Educational games can contain material in the form of audio, text, images, and animation to expand concepts and improve player skills (Purnomo, 2020; Wibawanto, 2020). Educational games are designed with educational purposes that not only entertain users but are expected to increase knowledge insights related to certain materials and encourage students' interest in learning through playing and learning based on games (Rinaldi et al., 2023; Najuah et al., 2022).

Using educational games as a learning tool can increase students' activeness in solving problems, making decisions, and completing thinking tasks, which will encourage the development of students' thinking skills (Haerani & Suhartini, 2023). Educational games can be made using one of the innovative platforms available, namely genially (Castillo-Cuesta, 2022). Genially is a web-based (online) platform that users can use to create all kinds of audio-visual and interactive content quickly, easily, and cost-effectively (Rahayu et al., 2023). Genially allows educators to develop media by adding text, quizzes, images, videos, animations, and even creating buttons that can direct learners to other pages so that learning materials become more diverse and interesting (Septianingsih et al., 2023; Muñoz Román & Vélez Loor, 2024; Santos & Lepiani, 2023). Genially, it can create beautiful and interesting interactive stories through posters, content, infographics, and games (Azizah et al., 2021). Educational games can provide new experiences, such as happiness and excitement in the learning process (Wibawanto, 2020). Another study revealed that games can improve the quality of student learning, both at school and outside of school (Daniyarova et al., 2022). Other research also revealed that educational games can improve students' science literacy (Susilowati & Saputra, 2022). Research conducted by Mokshein et al. (2023) states that applying games in learning can improve students' science literacy and facilitate understanding of the material. Other research also shows that combining games and learning materials can stimulate students' science literacy skills with a very high category (Putera & Hadi, 2024). Research on the development of genially-based educational games has indeed been done, but research on the development of genially-based educational games to improve students' science literacy has never been done. In addition, research on developing educational games to improve science literacy conducted in elementary schools is still tiny. This research is development research conducted to improve students' science literacy by utilizing educational games in classroom learning. The resulting educational game allows students to learn the material through writing, pictures, or learning videos. The educational game also contains reasons if the questions answered by students are wrong. This research can inform other researchers that educational games can improve students' science literacy.

2. Method

This research is a type of development research (Research and Development). Development research is a method to create new products and test their effectiveness (Sohilait, 2020). The stages of development research involve analyzing the findings of the product being developed (needs analysis), as well as the product development process based on the needs analysis, then passing the product revision stage to several experts and conducting product trials involving several research subjects to test and measure the feasibility of the product that has been made (Sudikan et al., 2023).

The development model used in this research is the ADDIE development model. The stages contained in the ADDIE model consist of five stages: (1) Analysis: Researchers analyze the needs of educational games that students want. (2) Design: Researchers create a storyboard as a reference in developing educational games. (3) Development: Researchers developed educational games using genial and validated media experts and material experts. (4) Implementation: Researchers conducted small-scale and large-scale trials. (5) Evaluate researchers made improvements based on suggestions and input from media and material validators (Rayanto & Sugianti, 2020). The stages of developing the ADDIE model are shown in Figure 1.

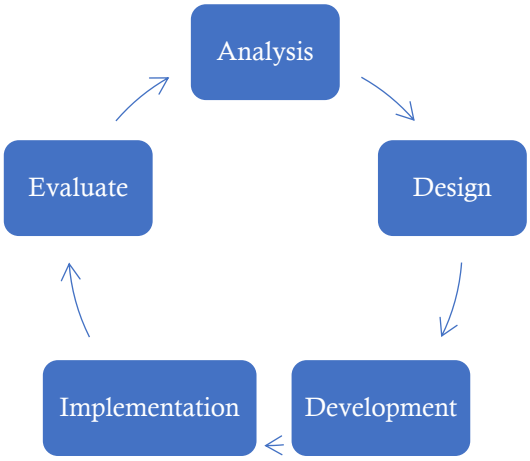

Figure 1. Stages of the ADDIE model

This study involved 29 students and 1 homeroom teacher. Data were collected through observation, interviews, questionnaires, and tests. This study used observation to observe the use of educational games in learning. The aspects observed in this study are learning aspects and learner responses. Interviews in this study were conducted to better understand students' science literacy levels and teachers' needs for educational games in supporting the learning process. The aspects interviewed include aspects of science literacy, aspects of learning media, and aspects of teacher needs for educational games. Questionnaires in this study were used to measure the validity of educational games by media experts and material experts, student and teacher responses. The media expert validity questionnaire consists of aspects of media design and use, while the material expert validity questionnaire consists of aspects of learning materials and content. The test in this study was used to evaluate students' science literacy skills before and after using educational games in learning. This science literacy test consists of 10 multiple choice questions divided into 3 levels in the educational game. Each level has different science literacy indicators. The science literacy indicators contained in the educational game explain scientific phenomena, evaluate and design scientific investigations, and interpret data and scientific evidence. The science literacy test questions were adopted from research (Meldani, 2020).

The research instruments used are media expert and material expert instruments adopted from research (Ruswandari & Yermiandhoko, 2021). Data analysis in this study uses a Likert scale (Sugiyono, 2020) with alternative answers with weights for each answer. Alternative answers are very feasible, have a weight of 5; feasible, weight 4; quite feasible, have a weight of 3; less feasible, have a weight of 2; and significantly less feasible, have a weight of 1. Analyze science literacy test data using the normalized-gain test (Sukarelawan et al., 2024).

3. Result and Discussion

The process of developing educational games is carried out based on the stages of the ADDIE development model consisting of 5 stages: Analysis, Design, Development, Implementation, and Evaluation (Rayanto & Sugianti, 2020). At the analysis stage, researchers conducted a needs analysis of the learning media needed by students and teachers. The needs analysis stage is the initial product development stage (Negara et al., 2019). Needs analysis is carried out to understand the needs of students for the product being developed (Tambunan, 2021). This needs analysis stage was carried out through interviews and questionnaires. Based on the data obtained, it can be seen that the teacher has never used educational games as media in teaching in class. Teachers only use simple media in the package book. The needs analysis conducted on 28 students also showed that students need educational games as a supporting medium in learning. Students also prefer learning materials in the form of games. The data from the needs analysis above shows that the current needs are educational games for students that contain learning materials, animated images,

interactive buttons, and challenges based on the learning material. The development research allows it to meet the needs of students in increasing their enthusiasm for learning and science literacy because this research collaborates with science literacy.

The next stage is the design stage or making a design. At this stage, the researcher makes an educational game design in the form of a storyboard that is tailored to the needs of students and teachers. The storyboard made is used as a reference in developing educational games. In addition to making designs, researchers also collect learning videos and images related to the material. This learning video becomes part of the educational game's material. The next stage is the development stage or the product development stage. Educational game development is carried out using the genial website. The development of this educational game refers to the storyboard that has been made at the design stage. Researchers added interesting animated images according to the needs of students. Researchers also added interactive buttons and learning videos. Educational games developed by researchers are integrated with aspects of science literacy competency. This competency aspect contains 3 indicators: explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and scientific evidence (Zuriyani, 2017). These indicators become part of the features of the educational game. The purpose of developing educational games integrated with science literacy is because science literacy is one of the basics besides reading, writing, and arithmetic (Rudolph, 2024). In addition, science literacy is important in creating excellence in science and technology (Xie et al., 2023). The visual appearance of the educational game developed by the researcher is shown in Figure 2.

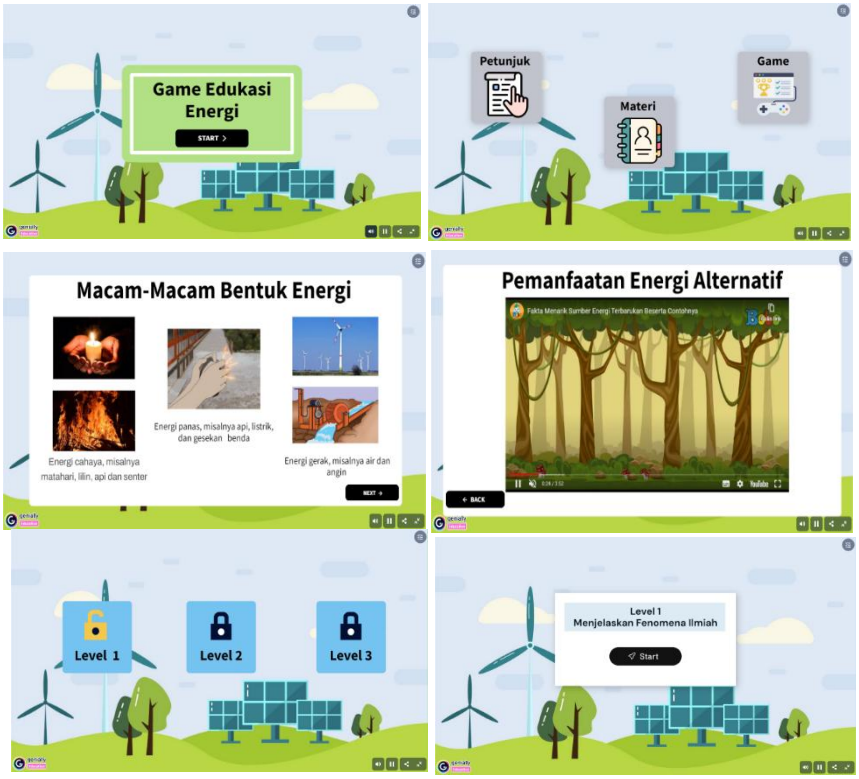

Figure 2. Educational game display

The finished educational game product is then evaluated by conducting validation by experts so that it can be accounted for (Okpatrioka, 2023). Media experts and material experts carry out the feasibility assessment of educational games. Aspects of media expert feasibility assessment are aspects of media design and media use. The results of media expert validation obtained 84.66%, which is a very feasible category. Some suggestions given by media experts are adding reasons for the students' answers to the questions being correct, adding the developer's identity in educational games, and clarifying the questions in educational games. Furthermore, the validation of the

material expert with the assessment aspects consists of aspects of learning material and content aspects. The results of the material expert validation obtained a percentage of 90%, which is a very feasible category. Material experts suggest adding learning objectives based on learning outcomes, materials, and images supporting learning materials. The validation results of media and material experts are shown in Table 1 and Table 2.

Table 1. Media expert validation result

No	Assessment Aspect	Score	Maximum Score	Percentage (%)	Average (%)	Category
1	Media Design	79	90	87.7	84.66	Very
2	Usage	48	60	80.0		Feasible

Table 2. Material expert validation result

No	Assessment Aspect	Score	Maximum Score	Percentage (%)	Average (%)	Category
1	Learning Materials	52	60	86.6	90.00	Very
2	Content	38	40	95.0		Feasible

The fourth stage is the implementation of educational games. Before conducting small-scale and large-scale trials, researchers conducted pretests for students. Pretest measures and test subjects before treatment (Sukarelawan et al., 2024). Pretests determine students' initial ability to learn science literacy before using educational games. The pretest questions given to students are science literacy-based questions. After conducting the pretest, researchers conducted a small-scale trial involving 3 students. A small-scale trial was carried out to determine the fluency of the interactive buttons in the educational game. The response results from the small-scale trial were 96% with a very feasible category. The subsequent trial was a large-scale trial. Large-scale trials were conducted on class teachers. The results obtained from the trial by the class teacher were 98%, with a very feasible category. The validation results obtained from class teacher responses are shown in Table 3.

Table 3. Teacher response validation results

No	Statement	Score	Maximum Score	Percentage (%)
1	Accuracy of color selection for learning media	5	5	100
2	The harmony of the color of the text with the background color (background) of the educational game	5	5	100
3	The accuracy of choosing the type and size of the font so that it is clear to read	5	5	100
4	The accuracy of the selection of educational game backsound	5	5	100
5	Educational games are easy to use	5	5	100
6	Educational games are easy to access using a smartphone	5	5	100
7	Educational games attract the attention of students	5	5	100
8	The material is clearly organized and directed	5	5	100
9	Energy material is easier to understand using educational games	5	5	100
10	The language used in educational games is easy to understand	4	5	80
	Average			98.0
	Category			Very Feasible

The large-scale trial was then conducted on 28 learners. This large-scale trial will also be a post-test for students. A post-test is an activity to test again to determine students' level of understanding after being given treatment (Magdalena et al., 2021). After using the educational game, students were given the same questionnaire as in the small-scale trial. This questionnaire is used to observe students' responses to educational games made by researchers. The results of the large-scale trial obtained a percentage of 94%, which is a very feasible category. Statement 6, I only obtained a

score of 126 because several students had difficulty using the interactive buttons in the educational game. This is because the network quality owned by students is less stable. The validation results obtained from student responses are shown in Table 4.

Table 4. Large-Scale trial results

No	Statement	Score	Maximum Score	Percentage (%)
1	The colors in the educational game are clear	134	140	95.7
2	The color of the text is clear	134	140	95.7
3	The size of the text is straightforward to read	138	140	98.5
4	The voice in the educational game sounds clear	132	140	94.2
5	Educational games is easy to use	130	140	92.8
6	The buttons on the educational game work well	126	140	88.5
7	Educational games are exciting	134	140	95.7
8	The material in the educational game is clear	134	140	95.7
9	Energy material is easier to understand using educational games	126	140	88.5
10	Learning becomes fun by using educational games	132	140	94.2
	Average			94.0
	Category			Very Feasible

After the researchers had conducted the pretest and posttest, they conducted the N-Gain test using the scores obtained by students during the pretest and posttest. The N-gain test measures the effectiveness of learning in improving learning outcomes (Oktavia et al., 2019). This study used the N-Gain test of the one-group pretest-posttest design model. In this model, students who are subjected to pretest and posttest come from the same class. Data processing using SPSS obtained the following results, as shown in Table 5.

Table 5. N-Gain test results

Average	Standard Deviation	Minimum Value	Maximum Value
0.5731	0.20652	0.20	1.00

Based on Table 5, the data from the N-Gain test results on students' scientific literacy obtained an average value of 0.5731 with a standard deviation of 0.20652, a minimum value of 0.20, and a maximum value of 1.00. The N-Gain test results above show that the increase in students' science literacy falls into the moderate category. There are several causes of students' scientific literacy only experiencing a moderate increase, namely students working on posttest questions in a hurry so that the text in educational games is not read. This is in line with research conducted by (Putri et al., 2018), which shows that the higher the students' reading ability, the higher the students' science literacy. The low ability to read and interpret students' reading is also an obstacle to learning science, thus causing low science literacy (Suparya et al., 2022).

The next stage is the evaluation stage. Researchers conduct evaluations by revising or improving educational games based on suggestions and input from experts in material and media. Some of the revisions made by researchers are adding the developer's identity in educational games, adding learning objectives and learning materials, and adding reasons when the answer chosen by students is correct. Researchers carry out this stage to perfect the educational game developed to be suitable for use in learning.

The results of the products developed by researchers have advantages and disadvantages. The advantage of this genially-based educational game is that it has not been widely used in learning so that it can be a reference for teachers and students. This educational game can also improve students' science literacy. This is in line with research conducted by (Annisa & Hujjatusnaini, 2022), which shows that students' science skills have increased after using educational games. In

addition, using games as a tool in learning also encourages independent learning because educational games can be accessed anytime and anywhere (Rintaningrum, 2023).

Research conducted by Pereira et al. (2021) shows that using games in learning can increase student activeness in solving problems. In addition, student involvement in the game, which the researcher applied, motivates students to understand science. The research involved online games that students can access using devices anytime. Another study conducted by Oleksiivna (2020) also showed that the gamification method in education is very effective because when this gamification method is used, the information learned by students becomes easier to understand. The gamification method also allows students to do a lot of trial and error so that their abilities are getting better. Gamification can also increase student interest and make learning new material more manageable.

4. Conclusion

Based on the results of the research and discussion that has been done, it can be concluded that the use of genially-based educational games in science learning is efficacious in improving students' science literacy. The educational games used have been integrated with science literacy indicators. The response to the application of educational games in science learning is very good because it can help students understand the material using educational games. The disadvantage of this genially-based educational game is that it still depends on the internet connection. If the internet connection is not good, then the interactive buttons contained in the educational game cannot be used. Future researchers are expected to utilize other features contained in genially to develop other educational games.

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