



Gamification: Role Playing Game-Based Learning Media to Improve Mathematics Learning Activities

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Abstract: Low interest in learning mathematics among high school students is a common problem. Along with technological advances in the current era, the learning approach needs to be focused on the visual aspect in order to captivate students' interest. Teachers are faced with the demand to not only be professional, but also utilize technological innovations in the learning process. Monotonous and less creative mathematics learning often makes students feel bored and unenthusiastic. Gamification is one strategy that can be used to increase interest in learning mathematics. The concept of gamification blends video game elements into learning methods. This research aims to develop gamification-based mathematics learning media to encourage student learning interest. This research was carried out at SMA Muhammadiyah 1 Klaten consisting of 20 students with material Three Variable Linear Equation System. This research uses research and development (R&D) methods with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. The results showed that the gamification-based mathematics learning media developed was feasible and very good for use in mathematics learning. Material experts provide assessment scores with an average percentage of 88% with the category very worthy of use, media experts provide assessment scores with an average percentage of 78% with the category very worthy of use, and student interest in learning media of 3.5 with the criteria "Very Interested". Therefore, gamification developed in this study is considered a feasible and very effective solution in improving mathematics learning.

Keywords: Gamification, Role Playing Game, Learning Media, Mathematics Learning

1 Introduction

Learning is a process of interaction between two or more people, which can occur between students and students, students with educators, or students with learning resources (Gumartifa et al., 2023; Jannah et al., n.d.; Zakiy et al., 2018). This interaction can be observed from the learning process that takes place (Adi Nurcahyo & Nugroho Arif Sudibyo, 2020). The development of technology has changed the way we learn (Awaludin et al., 2022; Maghfiroh et al., 2023). Nowadays, visual learning can interest students because it is more interesting and easy to understand. In practice, classroom learning often focuses on understanding theory, but emphasizes less on the application of theory in everyday life (Darmawan & Suparman, 2019; Firdausy et al., 2019; Nurrita, 2018). This causes students not to understand the material in depth, especially in mathematics learning.

Mathematics learning is less varied and usually monotonous, sometimes making students feel bored and unenthusiastic. Moreover, there are math teachers who still use blackboards to explain the material (Ishartono et al., 2018). Thus causing many students to be sleepy during learning, not concentrating, crowded alone, and lack of concentration which causes students to not be able to absorb well the material taught (Masykur et al., 2017). Mathematics is one of the most important subjects at all levels of education (Murtiyasa & Hayuningtyas, 2020). These subjects play an important role in the development of critical thinking, problem-solving, and reasoning skills. Mathematics is generally synonymous with numbers and formulas, so it is considered difficult by students (Ishartono et al., 2022). And mathematics is often associated with strict teachers as well as discipline (Supriyanto, 2014).

In the 21st century or what is often called the digital era, teachers are increasingly required to be more active, critical, innovative, creative, and collaborative towards the development of technological times so that they are able to keep up with current teaching trends (Akrim, 2018). The development of technology requires teachers to improve their competence, including in terms of learning (Malik, 2018). Therefore, the ability of teachers in the digital era must be more updated in the use of technology than their students (Sharma, 2017). For this reason, teachers must be able to utilize the availability of technological information in adding insight and skills in designing and providing creative and varied methods, so that students' interest in learning can increase. One of the strategies that can attract students' interest in learning mathematics is by implementing innovative, technology-based and multimedia mathematics learning strategies (Sadriani et al., 2023).

The results of interviews conducted with students of SMA Muhammadiyah 1 Klaten found that students spend their free time to playing games (Hermita et al., 2021; Sulistyanto et al., 2023). This is because students are interested in the game. However, excessive

interest in games can cause students to become disinterested in learning, especially math learning. Student achievement can also have an effect on their learning interests (Ishartono & Sufahani, 2019). Interest is a combination of desire and will that can develop if there is motivation (TAMPUBOLON, 1991). To restore students' interest in learning, teachers must be able to innovate with learning media to improve the quality of learning. Learning media will provide an understanding that encourages and helps students in understanding the material during the learning and teaching process (Yudianto & Murtiyasa, 2021). One innovation that is also suitable for encouraging student interest in learning is gamification in learning.

Gamification is a video game concept adapted into learning methods ("Gamification and the Future of Education," 2005; Takdir, 2017a). The concept aims to arouse user interest in learning. In gamification systems, program designers strive to display innovative learning that is interesting and not boring (Nicholson, 2015). An example of innovative learning used in gamification methods is using videos or animations that are combined and matched with learning materials in schools. Because it is adapted from a game, of course, there are game elements embedded in this method (Jackson, 2016).

Points are the first element of the game when playing the game, we will find the term XP (experience points). In games, points are usually earned when the user has completed a certain activity or task. The second element of the game is the use of levels. The level system is also applied in the gamification method. When playing a game, level is usually used as a term for level or difficulty. So the higher the level means the higher the level of difficulty that must be faced. The third element of the game is the use of Badges or digital badges (Hakulinen et al., 2013). Badges are an element that makes the game even more fun. If the player successfully completes a challenge or reaches a certain level, the player will earn Badges (Alomari et al., 2019). Badges in the gamification method are generally in the form of trophies, ribbons or other symbols that describe the gamification system provider institution. The last element is the leaderboard. The leaderboard lists the names of players who have succeeded in various achievements set in the game, both by level and the success of in-game challenges. (Rahardja et al., 2018).

These gamification elements can be applied to RPG (Role-Playing Game) game-based applications (Yusof & Alas, 2021). Role-Playing Game is a game in a fictional world where the player plays the role of a character (Feriatna, 2017). Players are responsible for portraying these roles in a narrative, either by doing acting, through a structured decision-making process, or character development. The actions taken while acting out the role can be said to be right or wrong depending on the formal system of rules and guidelines. Various studies have been conducted, one of the innovations applied in the learning process to encourage student interest is learning gamification (Basuki & Hidayati, 2019a; Permata & Kristanto, 2020a; Takdir, 2017b). Learning gamification was researched by Muhammad Destiny in 2017 with "KePoMath Go" Adopted from the Pokemon Go game (Takdir, 2017b). In this KePoMath Go learning gamification design, using a barcode system to play it. The results of the study show that gamification of learning can increase student learning

motivation. This can be seen from the increase in student interest in mathematics lessons, such as students who look forward to math class hours, ask for an increase in the number of practice questions, and feel that mathematics learning feels short. This shows that gamification can increase student motivation.

Further research on gamification was conducted by Clara Ayu and Yosep in 2020 with the Quizizz and Kahoot applications to increase students' interest in learning (Permata & Kristanto, 2020b). They tried to continue the research conducted by Basuki and Hidayati in 2019 because the research was not carried out on mathematics learning (Basuki & Hidayati, 2019b). One of the private high schools in Banguntapan, Yogyakarta was used as a place for the research with a total of 18 students of Class XI Science and XI Social Science. The potential of these learning tools in increasing student interest in learning is made possible by the gamification strategy in Quizizz and Kahoot online quizzes. Other research also states that according to most teachers and administrators agree that the use of Quizizz and Kahoot is interesting and interactive enough to be applied in learning to students (Abdillah et al., 2022).

Because previous research mostly used quiz games like Kahoot and Quizizz which were basically question quizzes and apps like KePoMath Go that used barcodes, researchers tried with other games that included elements of gamification. The game used in the creation of gamification researchers is RPG Maker MV. The advantage of this game with other games is that there is a story narrative that can be made at will by the creator and students can choose characters in this RPG Maker MV game such as choosing gender and can also give names to these characters. In addition, in RPG Maker MV, it is suitable for conceptualizing the story. The material selection of the Three Variable Linear Equation System material is based on the difficulties encountered by students in interviews, especially related to the substitution method. Students often experience confusion in arranging variables in story problems, substituting variables, and understanding the concept of a System of Three-Variable Linear Equations. From these problems, researchers are interested in developing Role Playing Game-based learning media to improve student learning activities in mathematics learning.

2 Method

This research uses research and development methods or Research and Development. The model used is ADDIE (analysis, design, development, implementation and evaluation) (Branch, 2009a). This study involved tenth grade students of SMA Muhammadiyah 1 Klaten. The learners involved have an age between 15-17 years. The class X students involved do not have experience with gamification learning because the learning carried out has not applied the principle of gamification. Learning carried out by students uses group learning or discussion. Research and development is a step or process to develop a new product or complement an existing product and can be accounted (Sutama, 2019). The

ADDIE development model includes 5 stages, namely Analysis, Design, Development, Implement, and Evaluate. The data collection procedure was conducted through initial interviews with the students to understand their level of understanding of the material and their interest in mathematics learning. Additionally, observations were used during active learning sessions utilizing the developed gamification media. The data gathered from the initial interviews with the students to understand their level of understanding of the material and their interest in mathematics learning, as well as from observations during active learning sessions using the developed gamification media, were analyzed using the Statistical Package for the Social Sciences (SPSS) application for validity and reliability evaluation.

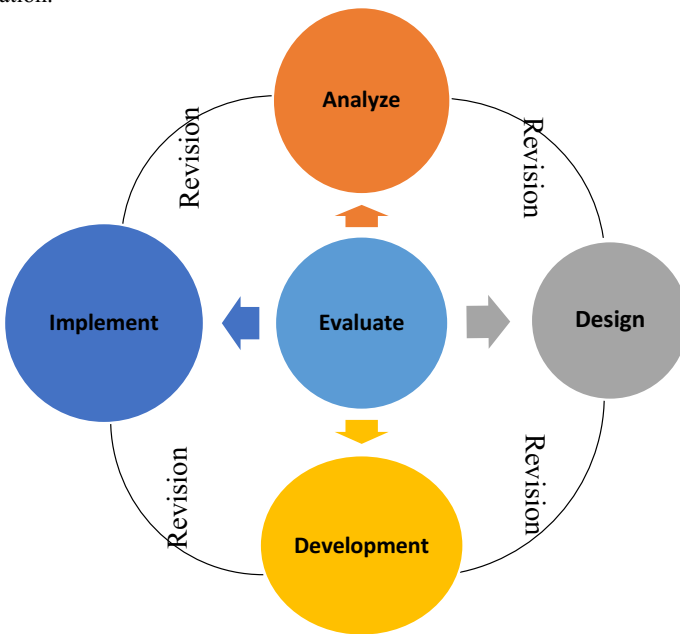


Fig. 1. ADDIE Development Model by Robert Maribe Branch (Branch, 2009b)

The ADDIE development steps allow researchers to re-revise the steps. The ADDIE development step begins with the analysis step, then continues with the design, development, implementation, then the final step is evaluation. The results of the evaluation process can then be improved at each step which makes it possible to get the best product results. The things that are reviewed in each step are as follows:

- **Analysis**, stages to determine the needs and availability of learning media that focus on the development of student education.
- **Design**, stages to create an initial design that covers various needs in product development.
- **Development**, this stage begins with the stage of producing or making learning media.
- **Implementation**, stages of conducting research using learning media on a large class scale.
- **Evaluation**, this stage is to determine whether the objectives of the learning media development are in accordance with the targets to be achieved.

This research was conducted at SMA Muhammadiyah 1 Klaten. The object of research is the trial of mathematics learning media. The game developed has quiz game content, materials and methods of the Three Variable Linear Equation System, examples of real-life story problems and explanations, and challenge questions. The test subjects in this study were teachers and grade X students of SMA Muhammadiyah 1 Klaten consisting of 20 students. In this study, data collection techniques were disseminated likert scale questionnaires and interviews. The instruments in this study include questionnaires and validation sheets. After collecting data, researchers check the degree of trust and validity with several data collection techniques used using the same method. This is done in order to obtain consistency, and completeness of research instruments so that they can be material for analysis of researchers in developing products according to needs and have values that are in accordance with what is expected.

The data analysis technique of expert validation results has 4 answers according to the content of the statement. Each answer choice has a different score. Expert validation assessment scores from each answer choice as shown in Table 1.

Table 1. Expert Validation Assessment Score

Criteria Answer Options	Score
Excellent	4
Good	3
Not good	2
Very Less good	1

The total assessment score in the data analysis above can be found by the formula proposed by Arikunto as follows (Arikunto, 1996):

$$P = \frac{\sum n_i}{N} \times 100\%$$

Description:

P = Assessment score percentage
 $\sum n_i$ = Scores obtained
N = Maximum score

Then grouped in expert validation assessment score criteria to determine the quality and feasibility level of gamification media on the Three Variable Linear Equation System material. Expert validation assessment score criteria as shown in Table 2.

Table 2. Expert Validation Assessment Criteria

Eligibility Criteria	Quality Score
Very Worth Using	$75\% < P \leq 100\%$
Eligible for Use	$50\% < P \leq 75\%$
Less Eligible to Use	$25\% < P \leq 50\%$
Very Less Worth Using	$0\% < P \leq 25\%$

While the data analysis technique of the response questionnaire results has 4 answer choices according to the content of the question. Each answer has a different score that indicates the level of interest of the product to the user. The scoring score of each answer choice is as shown in the Table 3.

Table 3. Assessment Score Answer Choices

Interest Answer Options	Score
Very agree	4
Agree	3
Disagree less	2
Very Disagree	1

The collected data will then be analyzed and the total assessment score will be sought using the formula proposed by Rully Anggraini as follows (Anggraini & Putra, 2016):

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{N}$$
 With: $x_i = \frac{Score\ Total}{Maximum\ Scores} \times 4$

Description:
 $\bar{x}$ = Final average
 x_i = Operational Test Scores of Each Student's Questionnaire
N = The number of students who filled out the questionnaire

In converting product interest scores, score criteria for interest tests are used in Table 4.

Table 4. Score criteria for Interest Tests

Interest Criteria	Quality Score
Very interested	$3,26 < \bar{x} \leq 4,00$
Interested	$2,51 < \bar{x} \leq 3,26$
Less interested	$1,76 < \bar{x} \leq 2,51$
Very Less Interested	$1 < \bar{x} \leq 1,76$

3 Result and Discussion

3.1 Result

Research and Development stages with the ADDIE model are used for the development of this learning media. ADDIE includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The five stages are carried out systematically in the development of this learning media. As the ADDIE model is defined in this developed mathematics learning media, the following is an explanation of these stages.

3.2 Analysis Stage

The needs analysis stage is the basis for making a medium. Needs analysis is carried out to obtain supporting data for media development produced in accordance with the needs of media users. Analysis of student needs was conducted by interviews with grade X students of SMA Muhammadiyah 1 Klaten. The interview results are as follows: 1) lack of interest in student learning, 2) students have difficulty understanding the substitution method. 3) students still feel confused when doing story problems related to the Three Variable Linear Equation System. 4) teachers have not utilized mathematics learning media, especially in the Three Variable Linear Equation System material. Based on the results of observations made in this needs analysis phase, information can be obtained that teachers still use learning methods that are less desirable and preferred by students due to lack of teaching materials such as educational game-based learning media.

3.3 Design Stage

This media was developed with the premise of wanting to create mathematics learning media that make students educated, can be used in the classroom and outside the classroom

to be more effective, efficient and increase student interest in learning. The material in the media is designed according to the needs of teachers in teaching Three Variable Linear Equation System material and is taken from various sources such as grade X high school mathematics textbooks. The subject matter of the Three Variable Linear Equation System is taken from the Mathematics Book published by the Ministry of Education and Culture Revised Edition in 2017 for high school / vocational school class X odd semester. The material in this learning media is in the form of Three Variable Linear Equation System material, sample questions and quizzes. The learning media material that will be loaded can be made using the help of RPG Maker MV and Geogebra application software.

3.4 Development Stage

At this stage, researchers began to create mathematics learning media in the form of gamification learning media by taking the material of the Three Variable Linear Equation System. The material in the media is obtained from several sources such as grade X high school math textbooks. The process of creating media uses software (software) which includes Windows 10, RPG Maker MV and Geogebra. After the development tools are prepared, then researchers choose image templates, places, characters, plugins, and searches on the internet, making it easier for researchers when designing designs such as backgrounds, characters, and other media design needs. After the design has been completed in RPG Maker MV, researchers put material in the form of images into each place of the script. Here's what the media looks like.



(a) translate teks on figure 2 (a) SPLTV ADVENTURES

(b) translate teks on figure 2 (b) type on the keyboard on the laptop. Click ENTER when finished. -or- Click the arrow keys on your keyboard to switch on-screen keyboard modes. Click ESC to change the laptop's default keyboard mode.

Fig. 2. (a) Main menu; (b) The gender choice of the character being played.

On the start page in figure 2(a), the background design should be made as attractive as possible so that students are interested and interested in trying the game. The setting of mountains, countryside, and rivers was taken because the theme of the game is a child character living in the countryside. There are New Game, Continue, and Options buttons. "New Game" to start the game, "Continue" to resume previously saved games, and "Options" for in-game settings. After the student/player presses the "New Game" button, the student can change the player character in the game such as gender and name for the player as shown in figure 2(b).



Translate teks on figure 3: "Because your father's age is 4 times than Akbar's age, So 4 times 15. So how old is your father?" and the Instruction: "to change the number, click the arrow on the keyboard. up arrows to increase numbers, down arrows to decrease numbers. right and left arrows to shift the numbers".

Fig. 3. One of the Level 1 Questions

In the first level in figure 3, students are given an initial mission containing the material One Variable Linear Equation System first. Players must help the younger character do the homework assignment given by his teacher. The question contains the difficulty level of question C1 (Remembering) and must be answered correctly by the student/player. It is expected that students / players can remember basic concepts in linear equation systems such as moving segments, dividing both segments, what are variables, what are constants, and what are coefficients.



Translate text on figure 4(a): The monster said: “Hey Akbar! Before you go to school, Face my challenge first! Surely you will fail! Bwahahahaha!”.

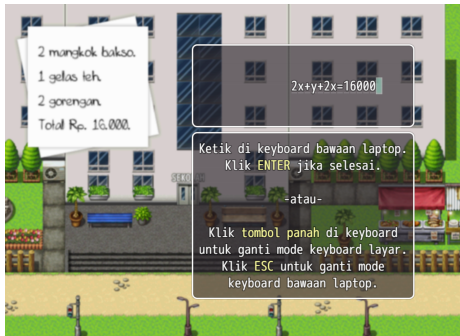


Translate question text to figure 4(b): “From the above examples, Which is a system of linear equations of TWO variables?”

(b)

Fig. 4. Level 2; (a) Monsters challenge players to answer questions; (b) One of the Level 2 questions.

Furthermore, for level 2 as in figure 4, students / players are given material on Two Variable Linear Equation Systems. There is a snippet of material to recall the material System of Two Variable Linear Equations. The mission in level 2 is that students / players must fight evil monsters as shown in picture 4(a) by answering the questions given as in picture 4 (b). The question contains the difficulty level of the C2 (Comprehension) question and must be answered correctly by the student/player. It is expected that students / players can explain and categorize a system of equations.



Translate teks on figure 5(a): “2 bowl of boxing, 1 cup tea, 2 fries, Total price: Rp. 16,000”.

(a)



Translate teks on figure 5(b): “SYSTEM OF THREE VARIABLE LINEAR EQUATIONS”, In the command section under the heading: “Write the values of x, y, and z that are known in the problem into the following boxes. Determine the solution set from: ... (box filled with known numbers in the problem)”, then in the method section: “Click and hold the box button below to see how-to and answers.”, in the button section: “Working Steps”.

(b)

Fig. 5. Level 3; (a) One of the level 3 questions; (b) Learning simulations associated with Geogebra web links

Then at level 3, students / players are given material on the Three Variable Linear Equation System. There is a choice of core competencies, basic competencies, learning objectives, and material discussion. There is also a Geogebra-based simulation connected to a web browser such as figure 5(b) so that students can explore for themselves how to solve the problem of the Three Variable Linear Equation System given. The mission that must be completed by students / players is one of them must find several buckets containing how to solve the given problem. The bucket must be found in order so that students are expected to be able to sequence in solving problems with the Three Variable Linear Equation System.



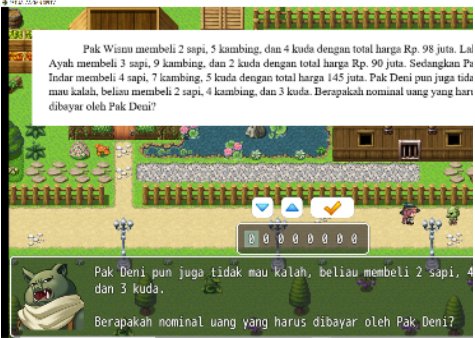
Translate teks on figure 6(a): “I bought 7 kg of red apples, 1 kg of carrots, and 1 bread for a total of Rp. 47,888. You buy 1 kg of Red Apple, 2 kg of Carrots, and 1 Bread for a total of Rp. 43,088. Syifa bought 3 kg of red apples, 2 kg of wartel, and 1 bread for a total of Rp. 71,000. The equation is like in the picture above.”

(a)



Translate teks on figure 6(b): “Guess what, so what's the total price? I just bought 3 kg of red apples, 2 kg of carrots, and 1 bread. Total price: Rp. 71,000. Then I ended up buying 2 kg of Red Apples, 3 kg of Carrots, and 1 Bread.

(b)



Translate questions on figure 6(c): “Mr. Vishnu bought 2 cows, 5 goats, and 4 horses for a total price of Rp. 98 million. Then Akbar's father bought 3 cows, 9 goats, and 2 horses for a total price of Rp. 90 million. Meanwhile, Pak Indar bought 4 cows, 7 goats, 5 horses for a total price of 145 million. Mr. Deni also did not want to lose, he bought 2 cows, 4 goats, and 3 horses. What is the nominal amount of money that must be paid by Mr. Deni?”



Menu to view player scores and save game progress. Features to make it easier for students to continue the game.

(c)

(d)

Fig. 6. Level 4 and 5; (a) Application of the concept of Three Variable Linear Equation Systems; (b) Level 4 question snippets; (c) Level 5 question snippets; (d) In-game Score and Save menus.

Level 4 and 5 in this game is the application of concepts in the Three Variable Linear Equation System material as shown in figure 6(a). There are questions that contain the difficulty level of questions C3 (Application) and C4 (Analysis) as in figures 6(b) and 6(c). It is hoped that students / players can analyze the application of the Three Variable Linear Equation System given. Seen in figure 6(d), this game is also given a player score menu and there is a save feature to save the progress that has been played. The menu can also be accessed via the "Esc" key on the keyboard.

3.5 Implementation

At this stage, learning media trials involve expert lecturers, teachers, and students. This stage uses expert and teacher questionnaire sheets to assess the level of validity of the learning media. The questionnaire is filled out after the learning media is downloaded. Then give the assessment on the questionnaire sheet which then the assessment is recorded by the researcher. Based on the calculation results of the validators' assessments, material experts provide assessment scores with an average percentage of 88% with the category very feasible to use, media experts provide assessment scores with an average percentage of 78% with categories very suitable for use so that they can be categorized as very good and have met valid qualifications and student interest in learning media of 3.5 with the criteria "Very Interested". In other words, the media developed in this study is considered Very Suitable for Use and very good for use in mathematics learning. Just like previous research, the development of gamification with RPG-based games in this study can encourage students' interest in learning.

3.6 Evaluation

At this stage, learning media is assessed by material experts and media experts to find out the existing disadvantages and advantages. If some deficiencies are found, the researcher will immediately revise them through the suggestions and responses given. In this game, there are drawbacks, namely the variables in the game only have x, y, and z. Whereas for other variables such as a, b, and c can also be used, so students do not only assume correctly variables with x, y, and z symbols.

3.7 Discussion

The results showed that the learning media developed had a percentage of assessment scores by material experts with an average of 88% which was included in the category of

very feasible to use. Media experts provide an average rating score percentage of 78% in the excellent category. As for the validity of learning media, it has met the valid qualifications for student interest, which is 3.5 or the criteria of great interest. This shows that learning media is feasible to be used in gamification-based learning. The integration of technology in Gamification can improve students' ability to solve HOTS problems. This is supported by Versoza's opinion (2021) stating that the use of mobile technology can increase higher order thinking skills.

The use of learning media can improve student achievement. They are more motivated to learn by using game media. Karamert (2021) also stated that the use of Gamification in learning can improve student achievement and attitudes in learning. Therefore, gamification-based learning media developed can be recommended to teachers for use in learning.

4 Conclusion

This research provides an illustration of the process of developing mathematics learning media which is outlined as a medium in the form of gamification of mathematics learning for grade X high school students with the subject of the Three Variable Linear Equation System. Based on the development of mathematics learning media for grade X high school students made using RPG Maker MV, the research conducted which included five stages of development with the ADDIE model, including Analysis, Design, Development, Implementation, and Evaluation, produced media in the form of games with exe format, the quality of media received a score by material and media experts by 83% with learning media being in Very good category and has met valid qualifications and student interest in learning media of 3.5 with the criteria "Very Interested". In other words, the media developed in this study is considered feasible and very good for use in mathematics learning.

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