

The Effectiveness of Circle Adventure Educational Game in Enhancing Student's Problem-Solving Skills on Circle Topics among Grade XI

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Abstract

The development of game-based mathematics learning media serves as a strategic means of improving problem-solving skills among grade XI students in learning circle concepts. This research aims to produce RPG Maker MV-based learning media that is valid, practical, and effective in improving problem-solving for class XI circle material. This research uses a development method with the ADDIE model, which consists of five stages, namely Analysis, Planning, Development, Implementation, and Evaluation. There are 2 (two) tests carried out, namely through formative evaluation with research success criteria, post-test and pre-test scores based on the N-Gain Test with the completeness criterion $g \geq 30$, and the Learning Goal Achievement Criteria with the completeness criterion $X > 40$. Based on the media use effectiveness test, an N-Gain result of 0.60 was obtained with the medium category, and the results of the Learning Goal Achievement Criteria with a percentage of 97.22% with the complete category, based on a limited trial of 39 students of SMA Negeri 1 Singaraja.

Keywords: Problem-Solving, Educational Games, RPG Maker MV.

Abstrak

Pengembangan media pembelajaran matematika berbasis game edukasi menjadi upaya strategis dalam meningkatkan kemampuan pemecahan masalah siswa kelas XI pada materi lingkaran. Penelitian ini bertujuan untuk menghasilkan media pembelajaran berbasis RPG Maker MV yang valid, praktis dan efektif dalam meningkatkan pemecahan masalah terhadap materi lingkaran kelas XI. Penelitian ini menggunakan metode pengembangan dengan model ADDIE yang terdiri atas lima tahap, yaitu Analisis, Perencanaan, Pengembangan, Implementasi, dan Evaluasi. Terdapat 2 (dua) pengujian yang dilakukan yakni melalui evaluasi formatif dengan kriteria keberhasilan penelitian nilai post-test dan pre-test berdasarkan pengujian Uji N-Gain dengan kriteria ketuntasan $g \geq 30$ dan Kriteria Ketercapaian Tujuan Pembelajaran dengan kriteria ketuntasan $X > 40$. Berdasarkan uji efektivitas penggunaan media diperoleh hasil N-Gain sebesar 0,60 dengan kategori sedang dan hasil Kriteria Ketercapaian Tujuan Pembelajaran dengan persentase sebesar 97,22% dengan kategori tuntas berdasarkan uji coba terbatas pada 39 siswa SMA Negeri 1 Singaraja.

Kata kunci: Pemecahan Masalah, Game Edukasi, RPG Maker MV.

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INTRODUCTION

Education functions to form a dignified character, behavior, and civilization of the nation in order to develop the abilities of students and educate the life of a democratic and responsible state (Asyafiq, 2016). Especially in mathematics learning, education has an important role in forming mindsets and solving problems. Mathematics is a lesson that teaches the reasoning process, shapes students' character and thinking patterns, and builds attitudes based on facts (Riswari et al., 2023). In learning mathematics, there are several abilities that students must possess, as stated in the *National Council of Teachers of Mathematics (NCTM)*, which stipulates that "to achieve content standards, students must have five main abilities in mathematics, namely problem-solving skills, reasoning, communication, pattern or relationship tracing, and representation." Categorization of characteristics

in problem-solving will provide teachers with information about how students approach and solve problems (Pramayudi et al., 2020).

The way teachers teach mathematics can also be one of the causes of students' low levels of activity and critical thinking skills in problem-solving. Problem-solving skills are a potential that exists in students, therefore that they can solve problems and apply them in daily life (Suryani et al., 2020). Students can use various problem-solving strategies to solve math problems, such as using pictures, recalculations, using formulas, and diagrams (Parwati & Suharta, 2020). In the learning process, the role of teachers is crucial in triggering students' creativity, in guiding and categorizing all characteristics of students' strategies to find solutions to various problems. There are still teachers who teach only in conventional ways without the involvement of learning media assistance (Anitasari & Utami, 2022). This shows that learning in schools does not include the development of problem-solving skills through the provision of questions that are included in the problem-solving category. As a result, students have not had the opportunity to hone their problem-solving skills (Aziza, 2019).

The use of information technology in the teaching and learning process is important for interactive learning media that can help students understand the material (Kahar et al., 2021). One of the technologies that can be used to create interactive learning media is *RPG Maker MV*. Although it was originally designed for game development, it also has great potential for education. The use of *RPG Maker MV* in learning offers a variety of benefits. In general, educational games are games that are designed or made to stimulate thinking power, including increasing concentration (Najuah et al., 2022).

Previous research by Fathia and Kamilia, entitled "*Analysis of the Influence of Scientific Games on Changes in the States of Matter among Elementary School Students,*" shows that learning that combining game elements can improve memory while stimulating students' critical and creative thinking skills towards the material taught (Fathia & Kamilia, 2024). The use of games as a medium in learning activities can help the subject matter presented to be easier to understand and remember. In line with research by Scholastics Weni Febriani et al. entitled "*Mathematics Education Games Assisted by RPG Maker MV Flat Building Materials Against Mathematical Problem Solving Skills,*" stated that the effectiveness of mathematics education games assisted by RPG Maker MV flat building materials on the mathematical problem-solving ability of 7th-grade students of Junior High School 6 Kayan Hilir reached the effective criteria (Febriani et al., 2023). This research is the author's original work; it has differences and novelties from previous research. There are differences between this study and previous studies in the material discussed. The supporting study discussed the material of solid shapes, while the researcher discussed the material of circles. Furthermore, the research subjects also have differences, namely, the 11th-grade high school students used by the researcher and the supporting study used 7th-grade students.

This study aims to produce a valid, practical, and effective RPG Maker MV-based learning media in enhancing students' problem-solving skills on circle topics among grade XI, considering that

many students experience difficulties in circle material. The implementation of learning activities in the classroom still uses conventional methods by giving lectures and practice questions. The use of media can be said to be quite minimal, this is due to the lack of time and the wide scope of circle material that needs to be learned in just 1 (one) semester. The lack of students' creative thinking skills requires a new innovation that is able to support learning activities so that they can run more effectively without having to reduce the material or meaning of the learning to be delivered. Therefore, developing an educational game using RPG Maker MV is crucial to support effective mathematics learning.

METHOD

The research used a Research and Development (R&D) method with ADDIE model. According to Sugiyono this method used to produce a certain and test the effectiveness product (Sugiyono, 2016). Furthermore, Borg and Gall in Kartika's "explained that the process of educational research and development involves both the creation and validation of educational products" (Kartika et al., 2020). This study produced an educational game developed with RPG Maker MV that supports the learning of circle material at the senior high school level, meeting the criteria of validity, practicality, and effectiveness. The educational game developed in this study is considered valid, as it meets the feasibility aspects of content, language, presentation, and graphics. The study was conducted from January to July 2025 at SMA Negeri 1 Singaraja, involving Grade XI students during the second semester of the 2024/2025 academic year.

The research procedure consists of 5 stages, namely *Analysis, Design, Development, Implementation, and Evaluation*. The analysis stage is carried out not only to analyze teaching materials, it's also to analyze the competencies contained in the teaching materials. The several stages of analysis are: 1) Curriculum Analysis to help examine the subject matter developed in accordance with curriculum standards and meet learning needs. 2) Student Analysis to analyze student characteristics to find out individual behavior during the learning process and determine the skill levels of various students. 3) Material analysis to identify important materials and concepts that must be mastered by students, this stage of material analysis is carried out by conducting observations in class XI of SMA Negeri 1 Singaraja. 4) Analysis of Past Media to find out the learning media used by the previous teacher when teaching circle material. Furthermore, validation will be carried out using the analysis of the validation sheet that has been assessed by expert experts using calculations according to Febriandi with the following mechanism (Febriandi et al., 2019):

1. The assessment of instrument items conducted by expert validators uses a Likert scale.
2. The validity score is determined using the following formula:

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Description:

s : score by validator – the lowest score in the category used

n : number of validators

c : highest score in the category used

3. Matching the average validity with the validity criteria of the teaching material

The design stage is carried out after taking data from the analysis stage by designing products according to student needs, curriculum, student abilities, and facilities owned by students. The steps at this design stage start from determining software, hardware, creating a *storyboard*, compiling an outline of the material from the educational game, compiling the characteristics of the educational game, designing educational game components using *RPG Maker MV*, creating assessment instruments, and creating practice questions for students.

The development stage contains the performance of product design activities by developing a conceptual framework for the game. At the development stage, the conceptual framework is transformed into a ready-to-use product. At this stage, a validity test assessment will be carried out by the validator as the subject of the trial. The validity test was carried out using the *Learning Objects Review Instrument (LORI)* questionnaire, analyzed by calculating the average.

The implementation stage was carried out by testing the educational game through formative evaluation. First, test the product by means of *one-to-one evaluation* (Individual Trial) with 1 to 3 students by face directly with the researcher. The selection of the students in individual tests with medium, low, and high ability. Furthermore, a game practicality test was carried out using the *UEQ* indicator by calculating the average value. Second, the effectiveness test is considered effective if there is a difference in student learning outcomes both before and after using the educational game by calculating the score in the effectiveness test for students using the following formula:

$$Presentation (X) = \frac{Obtained\ Score}{Maximum\ Score} \times 100 \quad (2)$$

To determine the extent of the improvement in students' problem-solving skills taken from *pre-test and post-test scores*, it is carried out with the N-Gain test, which is to measure the effectiveness of learning in improving student learning outcomes (Sukarelawan et al., 2024) with category:

Table.1 N-Gain Category Score

Average N-Gain Score	Category
$0,70 \leq g \leq 1,00$	High
$0,30 \leq g < 0,70$	Moderate
$0,00 < g < 0,30$	Low
$g = 0,00$	No improvement
$-1,00 \leq g < 0,00$	Decrease

The *Learning Objectives Achievement Criteria (LOAC)* can also be used to determine whether students have successfully achieved the learning objectives, Teacher need to set criteria or indicators for the achievement of learning goals (Juhairiah, 2023) with the following categories:

Table. 2 Assessment Interval Categories by *LOAC*

Interval	Criteria	Intervention
0 – 40 %	Not yet Developed	Remedial in all areas
41 – 60 %	Begining to Develop	Remedial in spesific areas
61 – 80 %	Developing at Expected	No remedial needed
81 – 100 %	Highly Develop	Enrichment or more complex challenges needed

(Source: School Administration Data)

The evaluation stage is carried out to ensure that the educational games developed are in accordance with the objectives, namely to measure or assess learning products that include the validity of experts, user responses to educational games, and effectiveness in increasing student learning motivation. At this stage of evaluation, it is only carried out through formative evaluation with research success criteria through post-test and pre-test scores based on *N-Gain* testing which obtains a $g \geq 30$ value. In addition, the success of the research based on the *LOAC* if the results of the post-test score $X > 76$ are obtained.

RESULTS AND DISCUSSION

Research Results

The results of the research conducted at SMA Negeri 1 Singaraja involved 39 student respondents. This indicates the need for improvements in learning media to make it more effective in enhancing students' motivation, understanding, and problem-solving abilities related to circle material. Therefore, at the analysis stage, it is necessary to develop media that can support the mathematics learning process, particularly on the topic of circles. To meet this need, an educational game called *Circle Adventure*, developed using *RPG Maker MV*, was created to improve the problem-solving skills of grade XI students in circle material.

At the planning stage, this educational game is produced a storyboard which will then be developed into a valid learning medium. This media development uses several applications to support the creation process, namely *RPG Maker MV* as the main application in developing this media according to the flowchart and storyboard that has been created, and the *Canva* application to design the appearance of media and materials. In this educational game, there is a feature that can increase interaction between students and the subject matter, namely interactive conversations that support theoretical explanations. Students can take advantage of this feature to better understand the material on how to solve the given problems.



Figure.1 Cover Page Display Development Results

In the development of the Circle Adventure educational game, users will be presented with 2 (two) learning options, namely, the first is to access the material first which is then continued with exploration, while the second option is that the user is directed directly to the exploration site. To access the material, the user needs to choose the first option. The content of the material is made to resemble a book that contains explanations of the material both in writing and through videos, sample questions, and practice questions as shown in the following image:



Figure. 2 Exercise page

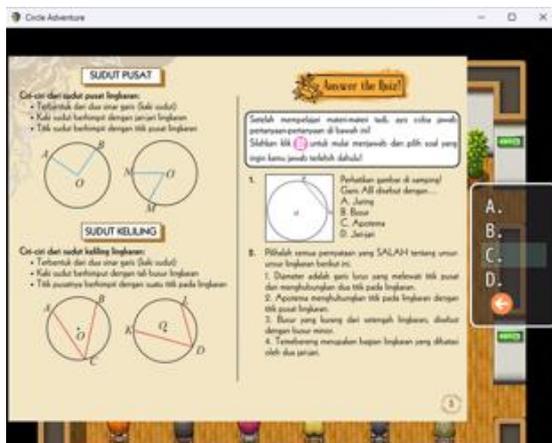


Figure. 3 Exercise page

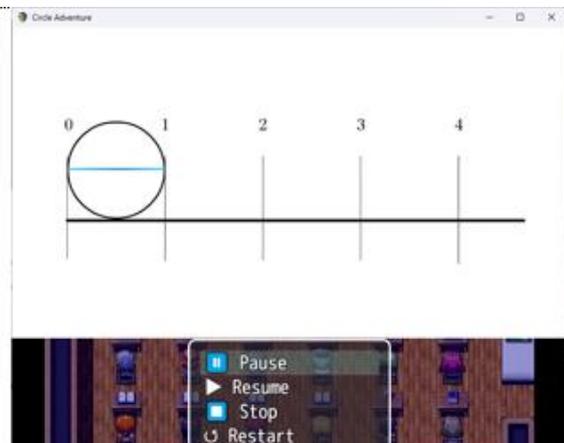


Figure 4. Material Video Page

Before proceeding to the trial stage on the learning media of the *Circle Adventure educational game* based on *RPG Maker MV*, a validity and feasibility test was conducted to determine whether the developed educational game prototype was suitable to proceed to the trial stage. The results of the validity of the material are focused on providing an assessment of the learning objectives and the quality of the content of the material.

Table. 3 Results of Material Validity by Experts

Total Value		Average
Expert 1	Expert 2	
47	50	48,5
Average Score		4,85
Criteria		Very High

The material assessment conducted by the two experts shows that the average score is 4.85 with a very high category. In the process of material validity, experts also provide comments and suggestions. The validity of the media based on the results of the expert assessment of *RPG Maker MV* educational games indicating that is highly suitable for use.

Table. 4 Media Validity Results by Experts

Total Value		Average
Expert 1	Expert 2	
30	38	36
Average Score		4,5
Criteria		Very High

Based on these results, the *Circle Adventure* educational game as a learning medium was considered feasible to advance to the trial stage of development. Which refers to *One to One Evaluation*, a test of the practicality and effectiveness of learning media.

A *one-to-one evaluation* was conducted on 3 (three) students of 11th-grade at SMA N 1 Singaraja. The students, selected to represent low, medium, and high academic ability, experienced no difficulties during the evaluation process. The trial was conducted on each student individually. On the individual trial, students operating the media independently, students were given a questionnaire related to the response to the use of the educational game that had been developed. The questionnaire given to students is a questionnaire based on *LORI* which has an answer scale of 1 to 5 with the following results:

Table. 5 Result of One-To-One Evaluation Trial

No	One-To-One Evaluation Student	Average
1	CRW	4,375
2	IGDA	4
3	IBNMJU	3,875

The results of the *one-to-one evaluation* trial of three students with a high category had a percentage of 33.3% and a very high category of 66.7% with the following assessment distribution:

Table. 6 One-To-One Evaluation Distribution of Assessments

No	Interval	Criteria	One-To-One Evaluation Trial	
			Frequency	Percentage
1	$4,20 < \bar{X} \leq 5,00$	Very High	1	33,3%
2	$3,40 < \bar{X} \leq 4,20$	High	2	66,7%
3	$2,60 < \bar{X} \leq 3,40$	Moderate High	-	
4	$1,80 < \bar{X} \leq 2,60$	Low	-	
5	$1,00 \leq \bar{X} \leq 1,80$	Very Low	-	
Sum			3	100%

Students gave the positive responses that the educational games developed were very interesting, the media used was good, the material was complete, and with a new learning style through entertaining characters therefore for students the lessons became less boring and fun. Thus, this game is worth using to improve problem-solving skills during the learning process.

The practicality test of the *Circle Adventure* educational game was conducted using the *UEQ* questionnaire, administered to limited trial participants consisting of 36 students of 11th-grade B at SMA Negeri 1 Singaraja. The results were categorized as excellent, indicating that this learning media is highly practical, as shown below:

Table. 7 Results of the Practicality Questionnaire on Game

Aspects	Average	Category
<i>Attractivness</i>	2,474	<i>Excellent</i>
<i>Perspiciuity</i>	2,173	<i>Excellent</i>
<i>Efficiency</i>	2,423	<i>Excellent</i>
<i>Dependability</i>	2,519	<i>Excellent</i>
<i>Stimulation</i>	2,724	<i>Excellent</i>
<i>Novelty</i>	2,750	<i>Excellent</i>

The next trial stage was carried out to test the effectiveness of the learning media. The effectiveness test was conducted by administering pre-test and post-test assessments on problem-solving skills to 36 grade XI B students at SMA Negeri 1 Singaraja. Two types of tests were conducted to determine the level of the educational game's effectiveness, namely the N-Gain test and the Learning Objectives Achievement Criteria.

Table. 8 Results of the N-Gain Analysis on the Effectiveness of the Learning Media

Test Assessment	Score
Mean Score <i>Pre-Test</i>	48,56
Mean Score <i>Post-Test</i>	79,11
Mean Score N-Gain	0,60
Effectiveness Level Criteria	Moderate

The average test scores indicates an increase in the average score of 30.55 which has an impact on improving students' problem-solving skill's on the circle material, especially the outer common tangent and inner common tangent material. In addition, the average N-Gain score for students was 0.60, which is included in the criteria for moderate effectiveness. Hence, the developed RPG Maker

MV-based educational game is effective in improving the problem-solving abilities of circle material in grade XI students.

Table. 9 Effectiveness Test Results Based on LOAC

Subject	Total
Students Who Achieved the <i>LOAC</i>	25 students
Students Who Did Not Achieve the <i>LOAC</i>	11 students
Total	36 students
Percentage of Completeness	69,4%
Category of Completeness	Achieved

Based on the post-test, students are declared to have achieved mastery if their scores exceed 76%. Out of 36 students, 25 were categorized as having achieved mastery, which means that 69.4% of students met the mastery criteria. Therefore, the learning process can be considered effective and complete based on the post-test results, as the students have met the *LOAC*.

Discussion

Problem-solving ability refers to a person's skill in addressing a given problem, including how they plan, take action, and evaluate the process to reach a solution (Sagge & Segura, 2023). The development of digital technology encourages educational transformation, which is through interactive and easily accessible educational games (Mardani et al., 2025). An educational game is a game developed from the purpose of learning which is not only used as entertainment however the game can increase knowledge (Novia et al., 2020). *RPG Maker MV* is a game for players to play a role to knit a story, players have a characteristic found in the characters in the game. The use of characters that guide students through interactive conversations makes learning more enjoyable and easier to understand the material (Hartawan et al., 2024). This educational game media is specifically designed to be played by single players with the aim that players can focus more on discovering and strengthening their own concepts so that they can understand and apply them in various situations (Arigunawan et al., 2020). Students' problem-solving skills improve through exposure to problems that require systematic approaches. In geometry learning, this also entails following a gradual and organized learning process (Pujawan et al., 2020). A good learning media should consider elements of readability, attractiveness, and interactivity in order to enhance students' motivation and understanding.

The validation results from material and media experts reinforced the confidence that the developed educational game met the standards of content quality and media quality. Therefore, the developed Circle Adventure educational game was considered very valid and suitable to be tested in the learning process. This finding is in line with the research conducted by Skolastika Weni Febriani et al., which showed that the educational game was declared valid with an average validity index percentage of 92.86%, categorized as *very valid* (Febriani et al., 2023).

The practicality aspect is measured through UEQ which is developed to assess the user experience of a product based on the dimensions of attractiveness, clarity, efficiency, precision, stimulation, and novelty (Schrepp, M., Hinderks, A., & Thomaschewski, 2017). The results of the

assessment show that the *Circle Adventure* educational game based on *RPG Maker MV* obtained the excellent category. In line with research from Andriyani & Buliali, which stated that the learning media developed was declared suitable to use based on the results of validation with a good category score (Andriyani & Buliali, 2021). In addition, the assessment of student responses indicated scores in the *very good* category. Therefore, this RPG-based learning media was considered suitable for supporting the development of students' problem-solving skills.

The effectiveness of the *Circle Adventure* educational game based on *RPG Maker MV* was evaluated using two references, namely the *N-Gain* and *LOAC*. The results of the *N-Gain* analysis showed an average score of 0.61, which falls into the medium category which means that this learning media is able to provide a significant improvement in students' problem-solving skills. Therefore, the use of this educational game is proven to help students in understanding the concept of circle material. The results of the assessment based on the *LOAC* showed that 97.43% of students were declared complete in learning.

This high percentage of completeness indicates that the *Circle Adventure* educational game based on *RPG Maker MV* has succeeded in creating a more meaningful learning experience for students. The effectiveness of this media is also supported by the element of interactivity and active involvement of students while using games. The *RPG Maker MV*-based *Circle Adventure* educational game provides a space for students to experience the process in a fun learning atmosphere. "This research is in line with Rasyid's study, which showed that the results of the research included the implementation and effectiveness of applying *RPG Maker MV*-based mobile learning applications in Ecosystem learning, the improvement of students' critical thinking skills (Rasyid et al., 2020). The research by Skolastika Weni Febriani et al. also revealed that the *RPG Maker MV*-based mathematics educational game on plane figure materials was effective in improving the mathematical problem-solving skills which met the effectiveness criteria" (Febriani et al., 2023).

CONCLUSION

Circle Adventure as an educational game based on *RPG Maker MV* with circle material for grade XI presents visuals, animations, and storylines that make students more interested and active in learning. By exploring the game world, interacting with NPCs, and finding solutions through direct experience in the game, students are helped in solving problems. The results of the material validity test and the media validity test used the LORI system with very high or valid score categories. The validity of the material obtained of 4.85 with a very high category, while the validity of the media obtained of 4.5, which means that it is very suitable to use. The results of the practicality test were obtained through the UEQ system involving 36 students of grade XI B at SMA Negeri 1 Singaraja as respondents received excellent score in several aspect, including Attraction (2,474), Clarity (2,173), Efficiency (2,423), Accuracy (2,519), Stimulation (2,724) and Novelty (2,750), therefore, the developed educational game was considered practical. The effectiveness test results of the Circle

Adventure educational game based on RPG Maker MV can be categorized as having a moderate level of effectiveness based on the *N-Gain* score, and are considered complete according to the post-test results of students who achieved the *Learning Objectives Achievement Criteria (LOAC)*.

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