



DEVELOPMENT OF ANDROID-BASED EDUCATIONAL GAME MEDIA ON EARTH AND THE SOLAR SYSTEM TO IMPROVE GRADE VII STUDENTS' LEARNING

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Abstract

This research aims to develop Android-based educational game media on Earth and Solar System materials to improve the learning outcomes of grade VII students at MTsN 1 Kediri City. The background of this research is the lack of use of interesting and interactive learning media so that student learning outcomes are still low or have not reached the Learning Goal Achievement Criteria (KKTP). The method used is Research and Development (R&D) with a Four-D (4D) model which includes Define, Design, Develop, and Disseminate stages. Data was obtained through expert validation as well as students' Pretest and Posttest results, then analyzed using feasibility and effectiveness tests (normality, homogeneity, paired sample t-test, and N-gain tests). The results of the study showed that the developed media was very feasible with a percentage of assessment of material experts of 88.7%, media experts of 94.3%, and question experts of 90%. The effectiveness test showed an increase in learning outcomes with a sig. (2-tailed) value of $0.000 < 0.05$ and an N-gain value of 0.5888 in the medium category. Thus, Android-based educational game media is declared feasible and effective enough to improve student learning outcomes.

Keywords: educational game media, Android, learning outcomes, Earth and Solar system

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INTRODUCTION

The development of information technology opens up great opportunities in learning innovation. However, its use in schools is still not optimal because learning tends to use conventional media such as textbooks and lectures. In fact, based on the Multimedia Learning Theory proposed by Richard E. Mayer (2009), students will learn more effectively when information is presented through a combination of text, images, and interactive elements. In addition, the high ownership of smartphones in Indonesia shows that digital devices have the potential to be used as a flexible and accessible learning medium.

Based on a survey by the Ministry of Communication and Information of the Republic of Indonesia in 2017, as many as 66.3% of the Indonesian population already owns a smartphone and Java Island is the region with the most users at 86.60% (Kominfo, 2017). This condition can be used by teachers by developing learning multimedia that can be accessed anytime and anywhere through smartphones so that the learning process becomes more efficient. In addition, multimedia is an effective learning medium in supporting student understanding.

The results of the pre-research at MTsN 1 Kediri City showed that some grade VII students had difficulties in understanding the material of the Earth and the Solar System. This material is abstract because it discusses celestial bodies and astronomical phenomena that cannot be observed directly. The material of the Earth and the Solar System has unique and complex characteristics, as it contains abstract concepts regarding celestial bodies and astronomical phenomena that cannot be observed directly by students. This spatial and temporal limitation necessitates dynamic visualization media to transform abstract orbits into concrete representations, thereby mitigating conceptual misunderstandings and bridging the gap in students' cognitive achievement. Learning that still relies on textbooks and presentation slides causes low student involvement, even around 30% of students have not reached the Learning Objective Completeness Criteria (KKTP). The material of the Earth and the solar system itself contains abstract concepts about celestial bodies and astronomical phenomena that cannot be observed directly, so students need learning media that can help visualization. This condition shows the need for learning media innovations that are able to help visualize concepts while increasing student motivation and learning outcomes.

One alternative that can be used is an Android-based educational game. These media allow for the interactive presentation of material through animations, simulations, and challenges

that encourage active student engagement. In line with cognitive learning theory, the learning process will be more effective when students are mentally involved in understanding information, processing it, and relating it to the knowledge they already have (Yanti, 2024). *Educational games* meet these needs because they provide visual stimulus, challenges, and interactions that help students build a deeper understanding. As such, students need learning experiences that encourage attention, processing, and understanding, rather than simply passively accepting explanations. Research shows that educational *games* are effective in improving student motivation and learning outcomes (Lamada et al., 2022).

Learning media in the form of Android-based educational games has the potential to create a more fun and flexible learning atmosphere. *Educational games* allow students to learn independently as needed and can be accessed anytime and anywhere via smartphones. In addition, the interactive element in *the game* is able to increase students' motivation to learn, which has an impact on increasing activeness and understanding of concepts more deeply, so that learning becomes more effective and meaningful (Pratama & Haryanto, 2018).

Based on these gaps, this study aims to develop Android-based educational game media on Earth and Solar System materials and test its feasibility and effectiveness in improving the learning outcomes of grade VII MTsN 1 students in Kediri City.

METHOD

The type of research used is research and development or known as *Research and Development (R&D)*. The research design applied in this *Research and Development (R&D)* research uses the 4-D (*Four D*) model developed by Sivasailam Thiagarajan (1974). The development of 4-D models consists of 4 stages, namely, Define, Design, Development, and Disseminate. Here are the steps to develop a 4-D model.

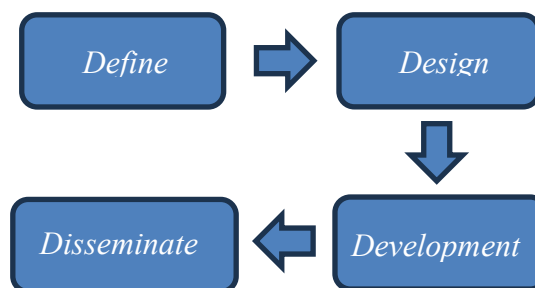


Figure 1. Stages of 4D model

The *Define stage* includes needs analysis, student characteristics analysis, analysis of learning concepts and tasks, and formulation of learning objectives. The *Design stage* includes the preparation of a criterion reference test (*Pretest-Posttest*), selection of Android-based educational game media, format determination, and initial product design. The *Development stage* is carried out through expert validation (material experts, media experts, and question experts) as well as development trials to obtain input and product revisions. The *Disseminate stage* is carried out by introducing the media to teachers and students through socialization and short training on the use of the application. This study employs a pre-experimental approach using the One-Group Pretest-Posttest Design. In this particular design, an external control group is omitted; instead, the subjects are measured twice (before and after the

treatment), meaning that the experimental group successfully serves as its own statistical control baseline to evaluate the absolute impact of the developed media.

Research Design

The trial design in this development study uses an experimental method with the *One Group Pretest-Posttest Design* model. In this design, there is only one group of students without a comparison group. Measurements are taken twice, namely before and after the treatment is given. The treatment in question is a learning activity using Android-based educational game media developed by researchers. Through this design, each student functions as a comparison for himself so that the researcher can see the changes in learning outcomes that occur after the use of the media.

Table 1. One-group pretest posttest design

Pretest	Treatment	Posttest
O ₁	X	O ₂

(Sugiyono, 2013)

Note:

O₁ = pretest before treatment is given

X = Treatment was given to the experimental group by applying Android-based educational game media as a learning medium in the learning process.

O₂ = final test (*posttest*) after treatment is administered

Research Objectives

The target of the research was 32 students of MTsN 1 Kediri City class VII-D. The research was conducted on January 19-30, 2026.

Data Collection Techniques

a. Observation

Observation is an effective method in obtaining data by paying direct attention and recording every relevant event. This technique is one of the choices in data collection because it has a fairly strong methodological strength (Hasanah, 2017). This technique utilizes preliminary data obtained through direct observation during learning activities to find out the actual conditions related to the use of *Android-based educational game media*.

b. Interview

Interviews were conducted with educators and students at MTsN 1 Kediri City to identify various problems that arise in the learning process, especially in grade VII.

c. Validation

The data collection technique in this study was carried out through an assessment by experts using a media assessment sheet. This technique is used to obtain data on the level of feasibility of developing Android-based educational game media that fosters caring and responsible characters. The data collection process involves several validators,

namely material experts, media experts, and *experts in pretest and posttest questions*.

In addition, data collection techniques are also carried out through tests in the form of *pretest* and *posttest*. The *pretest* is given before the use of learning media to determine the initial ability of students, while the *posttest* is given after the use of media to determine the improvement of learning outcomes. Data from *pretest* and *posttest* were used to analyze the effectiveness of Android-based educational game media in improving learning outcomes and fostering students' caring and responsible character.

Data Collection Techniques

a. Feasibility Data Analysis

The data collected is in the form of assessment scores as well as comments and suggestions from validators. Therefore, the analysis is carried out through two techniques, namely score analysis and descriptive analysis. Score analysis was carried out by calculating the value of the questionnaire using the validity criteria formula, then the results were compared with the validity category table. Meanwhile, descriptive analysis is obtained from comments and suggestions given by material experts and media experts as a basis for product revisions. The validation questionnaire instrument uses the Likert scale which is then converted according to the scoring rules in Table 2 .

Table 2. Eligibility assessment score

Yes	Categories	Score
1	Strongly agree	5
2	Agree	4
3	Enough	3
4	Disagree	2
5	Strongly disagree	1

(Erianti et al, 2023)

The results of data analysis obtained from expert validators are used to determine the percentage of feasibility of learning media. The

media is declared feasible if the percentage obtained reaches $\geq 60\%$. The percentage is then interpreted based on the Table 3.

Table 3. Instrument eligibility criteria

Percentage (%)	Criteria
0% - 20%	Very unworthy
21% - 40%	Unworthy
41% - 60%	Quite worthy
61% - 80%	Worthy
81 - 100%	Very worthy

(Iis Ernawati, 2017)

b. Effectiveness Data Analysis

1) Normality Test

Normality tests are carried out to ensure that the data on each variable has a normal distribution. The guidelines for decision-making are presented as follows:

- Significance value < 0.05 , abnormal data distribution.
- Significance value > 0.05 , normal data distribution.

2) Homogeneity Test

The homogeneity test is one of the statistical tests used to find out whether two or more groups of sample data come from a population that has the same variance.

3) Paired sample t-test

Tests are used when the data distribution is normal. The statistical t-test aims to find out if there is an average difference between two samples taken at random from the same population.

4) N-gain test

This test was carried out to see an increase in learning effectiveness through the comparison of pretest and posttest scores.

homogeneity test, Paired Sample t-test, and the Normalized Gain (N-gain) calculation.

1. *Android-based Educational Game Media Development Process*

The significant increase in students' posttest scores strongly reinforces Mayer's Cognitive Theory of Multimedia Learning, which posits that working memory capacity expands when information is channeled through coordinated visual and verbal pathways simultaneously. The interactive adventure mechanics within the game successfully transformed passive instruction into active mental processing, thereby fostering deeper cognitive retention. The development of Android-based educational game media on Earth and Solar System materials is carried out using a 4-D model proposed by Sivasailam Thiagarajan which consists of four stages, namely *define*, *design*, *development*, and *disseminate*.

a. Define Stage

This stage aims to identify learning needs and problems. Based on the results of observations and interviews at MTsN 1 Kediri City, it was found that science learning is still dominated by conventional methods such as textbooks and PowerPoint presentations. Students have difficulty understanding abstract concepts on Earth and Solar System matter, especially related to rotation, revolution, and characteristics of celestial bodies.

The analysis of the characteristics of the students showed that the research subjects were 32 students in grade VII D MTsN 1 Kediri City with an age range of 12–13 years. Based on the results of observations and interviews, students' academic abilities are heterogeneous, where some students

RESULTS AND DISCUSSION

To provide a rigorous and detailed data analysis, the quantitative metrics obtained from the field trials were systematically evaluated using comprehensive statistical operations via IBM SPSS Statistics, which thoroughly includes the Shapiro-Wilk normality test, Levene's variance

are able to understand the material quickly, while others require explanations and supporting media.

In addition, most students have become accustomed to using smartphones and show a high interest in technology-based learning, especially media-based games, which are considered more interesting, less boring, and can increase learning motivation. In addition, concept analysis and the formulation of learning objectives were carried out so that the material presented in the Game was in accordance with the Basic Competencies and learning indicators of grade VII.

b. Design Stage

At this stage, the initial planning of the media is carried out. The activities carried out include the preparation of test instruments (pretest and posttest), the selection of Android-based media, and the design of game structures and flows. The game is designed to contain several main components, namely:

- 1) Main menu and instructions for use,
- 2) Presentation of material in the form of short text and animation,
- 3) Visualization feature of celestial body movement,
- 4) Practice interactive questions with an automated scoring and feedback system.

The display design pays attention to aspects of text readability, color combination, image clarity, and ease of navigation to suit the characteristics of junior high school/MTs students.

c. Development Stage

The development stage includes the process of making products as well as validation by experts. The initial product that has been developed is then validated by material experts, media experts, and question experts to assess the feasibility of appearance, and quality of evaluation instruments.

Table 4. Expert validation

Expert	Validator 1	Validator 2
Material expert	77,5%	100%
Media expert	93,3%	95,5%
Pretest posttest question expert	94%	86%

The validation results show that the media is in the category of worthy to very worthy. Revisions are carried out based on expert suggestions and comments so that the final product is ready to be tested.

d. Disseminate Stage

The dissemination activity was carried out through socialization and short training by explaining the concept, objectives, and benefits of Solar Adventure media in learning Earth and Solar System material in grade VII. In addition, technical guidance is provided regarding the installation and use of media, from scanning QR codes to running the Game. The training also includes an explanation of the available features, such as profile menus, instructions for use, materials, and game levels containing evaluations. Teachers and students are given the opportunity to try the media directly to understand the flow and function of each feature.

2. Effectiveness Test Results

a. Normality Test

Based on the data of the pretest and posttest results that have been obtained, then data analysis is carried out through a normality test. The normality test aims to find out whether the research data is normally distributed as one of the prerequisites in determining the statistical analysis technique to be used.

The basis for decision-making in the normality test refers to the significance value (Sig.). If the significance value < 0.05, then the data is declared not to be normally distributed. On the other hand, if the significance value > 0.05, then the data is declared to be normally distributed. The results of the normality test obtained in this study are presented as follows.

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.131	32	.174	.971	32	.525
Posttest	.146	32	.079	.944	32	.094

a. Lilliefors Significance Correction

Figure 1. Normality test

Based on the Table, the normality test in this study uses the Shapiro-Wilk test. Based on the test results, the pretest significance value was 0.525 and the posttest significance value was 0.094. Referring to the decision-making criteria, if the significance value is greater than 0.05 (> 0.05), then the data is declared to be normally distributed. Because the significance values of pretest (0.525) and posttest (0.094) are both greater than 0.05, it can be concluded that the pretest and posttest data in this study are normally distributed.

b. Homogeneity Test Results

The homogeneity test was performed to find out whether two data groups had the same variance or were homogeneous. In this study, which uses a one group pretest posttest design, a homogeneity test is used to ensure that the pretest and posttest data have the same variance.

		Levene Statistic	df1	df2	Sig.
Nilai	Based on Mean	1.150	1	62	.288
	Based on Median	1.216	1	62	.274
	Based on Median and with adjusted df	1.216	1	55.500	.275
	Based on trimmed mean	1.171	1	62	.283

Figure 2. Homogeneity test

Based on the results of the homogeneity test on the pretest and posttest values in the Based on Mean section, a significance value (Sig.) of 0.288 was obtained. The decision of the homogeneity test is determined by the criterion that if the significance value (Sig.) > 0.05, the data is declared homogeneous. Because the significance value obtained was $0.288 > 0.05$, it can be concluded that the data from the pretest and posttest results are homogeneous.

c. Paired Sample T-Test Results

After the data is declared to be normally distributed, the next step is to conduct a hypothesis test using a t-test (paired sample t-test). This test aims to find out whether or not there is a significant difference between students' learning outcomes before and after being treated in the form of the use of Android-based educational game media in learning.

The hypotheses in this study are formulated as follows:

H0 = There was no significant difference (0.05) between the results before and after the use of Android-based educational game media in learning.

H1 = There was a significant difference (0.05) between the results before and after the use of Android-based educational game media in learning.

	Paired Differences						t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
Pair1 Pretest- Posttest	-19.37500	6.31618	1.11691	-21.65295	-17.09705	-17.347	31	.000	

Figure 3. Uji paired sample t-test

Based on the results of the paired sample t-test, a significance value (2-tailed) of 0.000 was obtained. This value is smaller than the significance level of 0.05 ($0.000 < 0.05$), so it can be concluded that there is a significant difference between the

pretest and posttest scores. Thus, H₀ is rejected and H₁ is accepted.

d. N-gain Test Results

To determine the level of effectiveness of Android-based educational game media on Earth and Solar System materials in improving student learning outcomes, an analysis was carried out using N-gain calculations. N-gain measurement aims to see the extent of improvement in learning outcomes after students are given treatment.

The calculation of N-gain is carried out by comparing the pretest and posttest scores of students. The results of the N-gain calculation were obtained from 32 students who participated in this study, as presented in the Figure 4.

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain	32	.33	1.00	.5888	.18545
Valid N (listwise)	32				

Figure 4. N-gain test

Based on the Table, the average value of N-gain is 0.5888. Referring to the grouping criteria of the N-gain test, the value falls into the "moderate" category. Thus, it can be concluded that the Android-based educational game media on Earth and Solar System materials developed is effective in improving the learning outcomes of grade VII students.

These results show that the use of Android-based educational game media is able to provide an increase in students' understanding of the material learned. Therefore, this media can be used as an alternative learning media that supports the learning process to be more interactive, interesting, and helps students understand concepts more optimally.

Theoretically, the results of this study are in line with the Multimedia Learning Theory put forward by Richard E. Mayer which states that learning will be more effective when information is presented through a combination of text, images, and interactive elements. Educational games allow students to process information through visual and verbal channels simultaneously, thus strengthening the understanding of concepts. In addition, the element of challenge and direct feedback in the game also increases student motivation and involvement in the learning process. Thus, the development of Android-based educational game media is not only feasible in terms of content and appearance, but also proven to be effective in improving the learning outcomes of grade VII students on Earth and Solar System materials. The author must provide an explanation related to what is behind the results obtained, namely by making associations and/or comparisons. Association

means that the author must relate the results obtained to the theory. The comparison in question is that the author compares the results obtained with relevant previous research. In this section, it is very possible to have tables and figures.

CONCLUSION AND SUGGESTION

Conclusion

This research produces Android-based educational game media on Earth and Solar System materials to improve the learning outcomes of grade VII students and has been implemented at MTsN 1 Kediri City. Here are suggestions for further research:

- a. It is hoped that the media can be used by more schools as an alternative to science learning.
- b. Media can be used to support more engaging and interactive learning.
- c. The media developed is expected to be further refined by future researchers, both in terms of features, appearance, and materials, so that it becomes more varied and innovative.

Suggestion

Based on the results of research on the development of Android-based educational game media on Earth and Solar System materials, the researcher gave several suggestions as follows:

- a. The media that has been developed is expected to be used more widely by various schools as an alternative in science learning, especially to improve student learning outcomes.
- b. This media can be used by teachers as a means of supporting learning that is more interesting, interactive, and fun, so that it can increase students' motivation and activeness in the learning process.
- c. The development of this media still has limitations, so it is hoped that future researchers can improve the media in terms of features, appearance, and completeness of the material, so that it becomes more varied, innovative, and in accordance with technological developments and the needs of students.

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