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Developing Android-Based Educational Games to Improve Students' Literacy in Whole Number

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ABSTRACT

(During the learning process, the use of media and teaching materials, as well as non-routine questions, can help students improve their understanding and literacy in mathematics. One of them is game-based media designed or created to stimulate thinking skills to improve concentration and problem-solving, with attractive features such as audio, text, images, and moving animations, utilizing only links and tools on each individual's Android phone. This is also in line with the use of technology-based media in learning as formulated by the Ministry of Education and Culture through the Merdeka Curriculum. This research aims to produce valid and practical educational math game materials in the form of an Android-based game and to describe students' responses after using the game. The subjects of this research are 33 seventh-grade students from SMP SRIJAYA Palembang. The research method used is Development Research, with the model applied in the learning process being the Plomp model, which consists of 2 stages: preliminary research and prototyping. The data collection techniques are questionnaires, observations, interviews, and tests. The questionnaire is used to assess the validity and practicality of the teaching materials. Observation is used to measure learning effectiveness, while tests are used to measure students' mathematical literacy. The data analysis technique used in this research is descriptive, both quantitative descriptive and qualitative descriptive. Based on the results of the data analysis, it was found that the developed Android-based game is categorized as valid when viewed from the aspects of content, construct, language, and ICT. In addition, the Android-based game has also been categorized as practical when viewed from the aspects of ease of use, attractiveness, challenge, and its applicability in mathematics learning

ABSTRAK

. Selama proses pembelajaran, penggunaan media dan bahan ajar, serta soal-soal non-rutin, dapat membantu siswa meningkatkan pemahaman dan literasi matematika mereka. Salah satunya adalah media berbasis game yang dirancang atau dibuat untuk merangsang daya pikir untuk meningkatkan konsentrasi dan memecahkan masalah, dengan fitur yang menarik berupa audio, teks, gambar, dan animasi bergerak dengan hanya memanfaat link dan tool pada hp android masing-masing. Hal ini juga sejalan dengan pembelajaran pemanfaatan berbasis media teknologi yang dirumuskan oleh kemendikbud melalui Kurikulum Merdeka. Tujuan penelitian ini adalah untuk menghasilkan bahan ajar matematika berbentuk game edukasi berbasis android yang valid dan praktis serta mendeskripsikan respon siswa setelah menggunakan game tersebut. Subjek penelitian ini 33 orang siswa

kelas VII SMP SRIJAYA Palembang. Metode penelitian ini adalah Development Research, model yang digunakan dalam pembelajaran adalah model Plomp yang terdiri dari 2 tahap, yaitu preliminary research, dan prototyping. Teknik pengumpulan data yang digunakan adalah angket, observasi, wawancara, dan tes. Angket digunakan untuk menilai kevalidan dan kepraktisan bahan ajar. Observasi digunakan untuk mengukur keefektifan pembelajaran, sedangkan tes digunakan untuk mengukur literasi matematika siswa . Teknik analisis data yang digunakan dalam penelitian ini adalah deskriptif, baik deskriptif kuantitatif maupun deskriptif kualitatif. Berdasarkan hasil analisis data diperoleh bahwa game berbasis android yang dikembangkan telah terkategori valid jika ditinjau dari aspek konten, konstruk, bahasa, dan ICT. Selain itu game berbasis android tersebut juga telah terkategori praktis jika ditinjau dari aspek kemudahan penggunaan, menarik, menantang dan dapat digunakan dalam pembelajaran matematika.

INTRODUCTION

Mathematical literacy is a person's ability to formulate, use, and interpret mathematics in various contexts of everyday life problems efficiently (Mboeik, 2023). Mathematical literacy skills can help a person apply mathematics to the daily world as a form of involvement in constructive and reflective community life (Lindawati, 2018). Literacy are the abilities, skills, and excellence in exploration, speculation, logical reasoning, and using various mathematical principles to solve problems (Chaniago & Awalludin, 2024). This mathematical literacy ability is very important and useful to be developed even better. Mathematical literacy can also be said to be a goal to be achieved after learning mathematics (Larasaty, Mustiani, & Pratini, 2018). Therefore, this capability needs to be developed and improved. Previous research related to mathematical literacy skills includes mathematical literacy using PMRI (Susanti, 2023). Analysis of students' mathematical literacy skills (Saputri, Sari, & Ayunda, 2021). Mathematical problem solving (Muslimah & Pujiastuti, 2020). The education system has changed to be more modern with the use of technology in the learning process (Frilia, Susanti, & Scristia, 2020). Educational games developed to support numeracy literacy skills (Adrillian, Nizaruddin, & Aini, 2023). Educational games as a learning medium for learning the smallest common multiples (Widyastuti, Izzah, & Kusuma, 2020). However, it is only limited to the ability to specialize in problems and is not optimal overall. Students who have a *field-dependent* cognitive style type show good mathematical literacy skills only on the indicator of formulating problems (Rahmasari, & Setyaningsih, 2023). Educational games can be used as a learning medium that can solve the current problems of online learning and help students understand the basic concepts of mathematics (Fahlevi, & Yuliani, 2021). With an android-based approach, it is hoped that students will be able to improve their mathematical literacy skills.

Each student has different reasoning, comprehension, and analysis skills. This is a focus on improving students' mathematical literacy skills so that they can be as much as possible according to the student's level and learning style. In the application of cognitive level problems, students' numeracy literacy skills are useful in analyzing information so that they can determine and apply problem-solving strategies. In reasoning problems, numeracy

literacy skills are important and are useful in addition to analyzing and using reasoning but can also increase students' accuracy and accuracy in solving problems (Fajri et al, 2022). Mathematical literacy is an important skill that supports an individual's ability to understand, analyze, and apply mathematical concepts in everyday life (Hasanuddin et al, 2023). Mathematical literacy ability is used in dealing with problems in daily life in real life. In mathematical literacy, there are four important parts, especially capturing ideas, handling problems, conveying, and implementing systems (Isnaniah et al, 2021). The application of media and learning models supports students' mathematical literacy skills during mathematics learning (Yenzi, Mujahidawati, & Novferma, 2023). The ability to analyse information can be done well if students have knowledge and experience related to the context of the problem (Septiati & Susanti, 2022).

One of the solutions to implementing character education in this technological era is to use *games*, which are useful not only for playing but also for learning both in character and as a learning medium (Rachmawati, Padmasari, & Firmansyah, 2022). Educational game-based media plays a role in determining the design, implementation, and validity (Arigunawan, Sukajaya, & Suryawan, 2020). The educational nature of this game is in the form of fun and interesting math learning. In this game, players can enjoy animation and can also increase their knowledge of counting by answering the questions in the game (Kalaka, Mustofa, & Dalai, 2023). Educational games as a practical and effective learning medium to be used in mathematics learning. To overcome the problem of low numeracy literacy in students and the limited electronic-based learning media with game-based methods (Gusteti et al, 2023). Utilizing game applications can contribute to mathematics literature by supporting the use of games in improving student's performance in mathematics (Haruna & Umar, 2021). **Therefore,** it is necessary to develop *android-based games* to improve students' mathematical literacy so that **the formulation of** this research problem is how the level of validity, practicality, and students' response to *android-based games.*

METHOD

This research method is D*evelopment Research,* with the category TKT-2 because it only produces development products in the form of game-based teaching materials, only produces development products in the form of android-based game teaching materials based on learning styles and then validates and tests the teaching material products on students, so that the type of research used is development research. In this study, the focus of the research is to produce development products in the form of game-based teaching materials. The game was developed using the Wordwall application. The research subjects are students of SMP Srijaya Palembang with different levels of ability. Students will be selected from two classes at random, from the two classes it will then be decided that one class is a one-to-one and small group trial class, while the other class will be prepared for the field test.

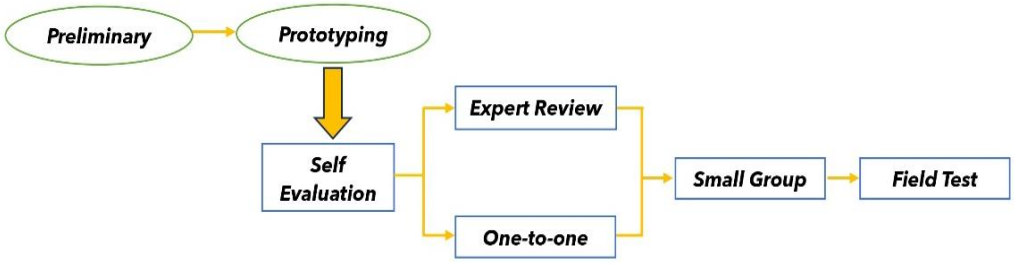

Figure 1. The Research Procedure

In Figure 1, the research procedure consists of two stages, namely preliminary and prototyping. The preliminary stage will produce differentiated theories, concepts, and designs of teaching materials. The prototyping stage consists of five stages, namely: self-evaluation, expert review, one-to-one, small group, and field test.

Validation sheets, questionnaires, observations, interviews, and documentation are data collection techniques carried out in this study. The validation sheet is used as a reference in the expert review stage. This study uses a learning style questionnaire, namely the Likert scale questionnaire. This questionnaire was given to students before the one-to-one, small group, and field test stages. Then the results of the questionnaire are used as material to determine the type of student learning style. Observation, documentation, and interviews were carried out during one-to-one, small-group, and field test activities. Observations were made to see student behaviors during the learning process. As proof of activities, it can be taken with documentation. In the field test, students are directed to open a word wall-based game that has been prepared by the teacher. At the end of the learning activity, students are given a questionnaire to see the students' responses to the game used. The responses include usefulness, ease of use, ease of learning numbers, and satisfaction.

All data can be analyzed in a qualitative descriptive manner starting with examining the data, reducing the data, and presenting the data in the form of a narrative. The data from the validation sheet results were analyzed by paying attention to suggestions and comments from validators. The questionnaire result data is analyzed descriptively by summing the scores obtained by students, and then looking for which score is the highest. From the highest score, various types of student learning styles are obtained. All supporting data such as observations, interviews, and documentation will be triangulated. Then it is analyzed and reduced qualitatively as a reinforcement of the findings of this study.

RESULTS AND DISCUSSION

3.1 Description of Android-based Game Development

As written in the introduction, one of the objectives of this research is to produce Android-based games that are valid and practical and can be used to improve the literacy skills of junior high school students. The application used to develop Android-based games is *Word Wall,* and because it focuses on numeracy literacy skills, the material chosen is Number. The stages of this research are in line with Tesmer (2003) where the stages generally consist of only 2 stages, namely the *preliminary* and stages *formative evaluation*.

3.2 Preliminary

The *preliminary stage* consists of two more stages, namely: the analysis stage and the design stage. At the analysis stage, an analysis of student characteristics, an analysis of student needs, and a curriculum analysis are carried out.

1. Analysis stage

a. Analysis of Student Characteristics and Needs

Characteristics and student analysis are carried out to obtain an overview of the student's background. Student characteristics include learning styles, thinking habits, and cognitive levels. The characteristics of the students were obtained from the results of the initial assessment in non-cognitive form that had been carried out by the mathematics teacher. Data on the characteristics of the students was obtained from secondary data from SMP Srijaya Negara. The results of the analysis of student characteristics will be used to

synchronize aspects of learning styles, thinking habits, and cognitive levels with the Android-based game to be developed. Table 1 is the data from the analysis of student characteristics.

Table 1. Student Characteristics

Learning Style	Habits of Thinking			Level Cognitive			
	Right Brain	Left Brain	Total	High	Medium	Low	Total
Visual	2	19	21	3	18	0	21
Auditorium	1	7	8	1	5	2	8
Kinesthetics	1	3	4	1	2	1	4
Total	4	29	33	5	23	6	33

Based on Table 1, it was found that the majority of students in the seventh grade at SMP Srijaya Negara have a visual learning style. This indicates that the students are suitable for being given learning materials that contain a lot of images. Besides that, the researcher also interviewed a grade VII mathematics teacher at Srijaya Negara Junior High School to collect information related to student needs. The interview questions began by exploring teachers' learning process in the classroom, both related to learning models, learning resources, and learning media, including whether teachers have ever used Android-based games for teaching activities or evaluations. The results of the interview concluded that the teacher rarely learns using ICT, apart from the limitations of school facilities and infrastructure, the teacher also revealed that the teacher's knowledge of Android-based game development is still low. Another cause is that some students come from financially disadvantaged backgrounds, so many students do not have cell phones or cannot afford to buy quotas to access the internet.

b. Curriculum and Material Analysis

Curriculum and material analysis is used to find out what curriculum is used in school and what materials can be used to measure numeracy literacy of junior high school students in grade VII. Based on a survey in the classroom and interviews with the mathematics teacher, information was obtained that SMP Srijaya Negara has used the Independent Curriculum. Based on the results of the analysis of the material contained in the Independent Curriculum, it was obtained that the number element is very suitable for measuring students' numeracy literacy.

Table 2 Scope of Material

Topic	Scope of Materials
Integers	1. Summing of Whole Numbers 2. Integer Reduction
Rational Number	1. comparison of two numbers 2. Common fractions 3. Decimal Fractions 4. Fraction of Percent 5. Fractional Summing 6. Fractional Reduction
Social Arithmetic	1. Profit 2. Lose out

Topic	Scope of Materials
	3. Discount 4. Net 5. Tare 6. Rabat

Based on Table 2, especially for grade VII, there is integer material, rational numbers, and social arithmetic contained in number elements. The three materials will be used as the main content to develop the numeracy literacy skills of Srijaya Negara Junior High School students using Android-based games. Based on Table 2, the material on rational numbers and social arithmetic is more extensive than that on integers. This affects the formulation of questions that will be displayed in the game. On the game, at least one question for each topic in Table 2.

2. Design Stage

The second stage of the preliminary is the design stage. At this stage, researchers design Android-based games. Android-based Game Design is made in three different types of games. Apart from the fact that there are three materials to be learned and understood, one of the other aspects is that the duration of each game is generally not long. The various games used can also have an impact on student motivation and enthusiasm. At this stage, the researcher designs the material content material that will be displayed and at the same time designs what type of game will be developed as a product for Android-based games. The design results are drawn from the design of the material, the type of game used, and the storyboard design.

a. Material design

The material used in Android-based games is adopted and modified from various books, AKM questions, ANBK questions, PISA questions, and other sources. Number elements are grouped into three materials: integers, rational numbers, and social arithmetic. The material is packaged in the form of questions on Android-based games. These questions aim to train students' literacy and numeracy skills.

b. Game Type Selection

This Android-based game is developed from the Word Wall application, which displays many templates that can be used as an Android-based game. Based on the results of the analysis of the interactive, interesting, challenging, and possible aspects of mathematics learning, the researcher chose three types of games that can be used: airplane games, balloon-train games, and maze games. These three games have different levels of difficulty.

c. Storyboard Design

All the results of the material design and subsequent questions are combined with the game that has been selected. Before being presented in the Word wall application, the researcher made the concept in the form of a Storyboard. Here are pictures of the initial draft.

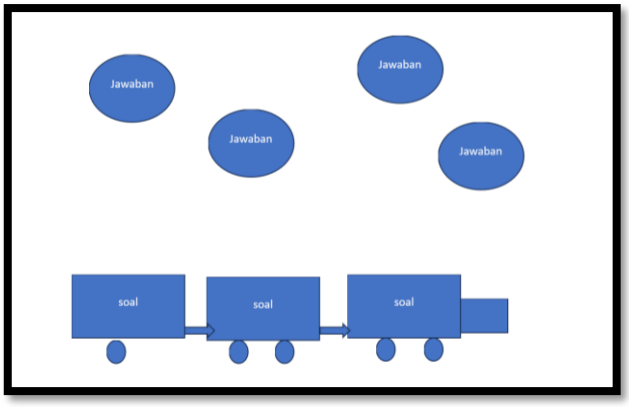

Figure 2. The Storyboard Design

In Figure 2, it can be seen that the storyboard has a picture of a train and a balloon above it. On each carriage, a question is written, and on the balloon, a balloon question is also written. The plan for the game later is that there will be several questions and several correct answers that correspond to those questions.

d. Early Design of Android-based games

After obtaining an overview of what will be displayed in the game. Furthermore, the results of the Storyboard are outlined in the Word wall application. The following is an initial design image of an Android-based game that has been created in the Word wall application. The games can be accessed at https://wordwall.net/play/76359/911/897.

Table 3. Results of Android-Based Game Design

Design Results	Description
	The problem presented at Level 1 consists of one question. It can be seen in the picture next to it that the locomotive only carries one car. The questions presented are categorized as easy.
	The problems presented at Level 2 consist of two questions. The questions presented are categorized as moderate. It can be seen in the picture next to it that the locomotive pulled two cars.

Design Results	Description
	The problems presented at Level 3 consist of three questions. The questions presented are categorized as moderate. It can be seen in the picture next to it that the locomotive pulled three cars.
	When students have completed the game, the score obtained by the students will be visible.

In Table 3, several screenshots of the developed game can be seen. It is also seen that the game is developed into several levels. the higher the level, the higher the difficulty level. The results of the game will appear in the form of a score that shows how many questions the students can answer and how quickly they can answer them.

4.1.2.1 Step Formative Evaluation

The formative evaluation stage is divided into four more stages, namely: self-evaluation, expert review and one-to-one, small group, and field test.

1. *Self-Evaluation*

At this stage, the researcher conducted his assessment of *Android-based games* that had been developed previously. The researcher carried out this self-assessment activity by involving the supervisor. From the results of self-evaluation, it was obtained that the duration of the game played by the students was too fast. In this game, students are not only required to solve problems, but each problem takes a special time to solve.

2. *Expert Review*

At this stage, the researcher carried out expert validation with 3 validators. The validator consists of three mathematics education lecturers. The first validator is a lecturer in Mathematics Education at UNSRI. The second validator is a lecturer in Mathematics Education at UIN Raden Fatah Palembang. The third validator is a lecturer in mathematics education at Syahyakirti University Palembang. The validation stage is carried out to obtain information about the theoretical level of validity of the Android-based game that has been developed. The validity of this android-based game is reviewed from three aspects: content, construction, language, and ICT. The four aspects are packaged in a questionnaire consisting of 29 questions. The following are the results of validator validation.

Table 4. Validator Validation Results

Aspects	Indicator	Percentage
Content	The material/questions presented in the Android-based game are by Phase D of the Independent Curriculum	86,7 %
	The material/questions presented in the Android-based game are on the learning objectives that have been set	86,7 %
	The material/questions in the Android-based game are arranged from easy to difficult	86,7 %
	Maps/materials in Android-based games present the correct facts, concepts, or principles	73,3 %
Construction	The suitability of the situation presented in the android-based game with the Characteristics of Phase D students	86,7 %
	Accuracy and consistency of font types used in Android-based games	93,3 %
	The situations presented in the Android-based game are interesting and challenging for students to work on	86,7 %
	Layout settings in Android-based games have been presented consistently	86,7 %
	The use of font types and sizes in Android-based games has been presented consistently	80 %
ICT	Visual illustrations of good images/animations on Android-based games are interesting	93,3 %
	The illustrations and animations presented in *the Android-based game* motivate students to learn and work on it	80 %
	The colors and design of the *android based game* are attractive	86,7 %
	Background music on Android-based games is audible	93,3 %
	Letters and numbers on Android-based games can be read clearly	93,3 %
Language	The sentences used in Android-based games are effective and easy to understand	73,3 %
	The terms used in Android-based games are by the field of Mathematics Education.	73,3 %
	The word used in Android-based games is by the PUEBI rules	66,7 %
	The language used in Android-based games is communicative, standard, and interesting	73,3 %
	The language used in the Game is unambiguous and does not have double meanings	80 %

Aspects	Indicator	Percentage
	The game uses sentences that are by the level of thinking of junior high school students	80 %
	Average	83 %

Based on Table 4, it can be seen that the average percentage of validity of Android-based games is 83%. Based on the validity criteria, it can be concluded that the Android-based games developed have been categorized as very valid. Safitri (2020), Arisandy et al (2021), and Zakyanto & Wintarti (2022) added that a game is categorized as valid if 75% of the total components in the game are also good. However, from the results of the validation, there are still several things and several aspects that need to be revised. Below is a table of comments, suggestions from experts, and the results of the revision.

Table 5. Comments and Suggestions with Revision

Comments/suggestions	Revision Decision
Some questions are still not appropriate so the questions need to be corrected	The question has been corrected according to the suggestion
There should be questions that contain illustrations or images	Picture questions have been added
Continuity in question writing	It has been fixed as suggested
It is necessary to pay attention to the layout and punctuation marks so as not to confuse when students answer	It has been fixed as suggested
Some questions are still not answered so the questions need to be corrected	Answer key has been fixed

3. One to one

Almost at the same time as the *expert review stage,* the researcher also tested *the android-based game* on 3 students in grade VII which aimed to see the validity empirically. As long as students use, access and play these Android-based games, researchers observe whether students have difficulties in playing and understanding the material or questions presented on *Android-based games*.

Figure 3. One-to-one

In addition to observing students' difficulties in working on Android-based games, the researcher also provided comment sheets and suggestions to students to get additional data. Below are the results of student observation of difficulties, comments, and suggestions related to *Android-based games*.

Table 6. One-to-one Student Difficulty

It	Student Difficulties	Revision Decision
1	Students are confused by the meaning of the questions in Android-based games	Fix the redaction of the question language
2.	Students are confused about finding the answers presented on the Android-based game because it is too fast	The duration of the time is set to be longer

4. Small Group

Prototype 2 is an Android-based game that has been categorized as valid. Prototype 2 is generated from one-to-one data and expert reviews that have been revised. After producing a valid Android-based game, the next step was to test the Android-based game on 6 students of Srijaya Negara Junior High School. The researcher selected 6 students with different backgrounds, reviewed different aspects of gender, learning style, cognitive level, and thinking habits, and then the 6 students were divided into 2 groups. This activity is called a small group. After completing the trial, the researcher shared a questionnaire that aimed to see the practicality of Android-based games. Table 7 below as the result of student questionnaire results.

Table 7. Results of the Practicality

Practicality Indicators	Percentage	Criterion
Android-based games are easy to use	80 %	Practical
Attractive Android-based game display	76,7 %	Practical
The images presented in the Android-based game are easy to understand	90 %	Very Practical
The animations presented in the Android-based game are interesting	93,3 %	Very Practical
The animations presented in the Android-based game can give me material knowledge about numbers	90 %	Very Practical
The typeface in the Android-based game makes it easier for me to read	76,7 %	Practical
The Android-based game is challenging to complete	80 %	Very Practical
The sentences in the Android-based game are easy to understand	86,7 %	Very Practical
Interesting games to use in math learning	73,3 %	Practical
I can use Android-based games independently or in groups	76,7 %	Practical
Present Installment	82,38 %	Practical

Based on Table 7, it can be seen their questionnaire contained 10 questions. From Table 7 the results of an average of 82.38% were obtained. According to Wildan et al (2023) and Mutmainnah et al (2024) games are categorized as practical if 75% of the game elements are good. Based on the data that has been obtained, it can be concluded that the Android-based games developed have been categorized as practical. The results of this data produce Prototype III which is ready to be tested in the test field.

After testing at the one-to-one and small group stages, data was obtained that students looked enthusiastic when solving number problems using educational games. In addition, students also looked motivated to learn mathematics and made the learning process more active. This is influenced by the elements that the game has elements of challenge and fantasy and arouses curiosity. These results are in line with research by Wulandari et al (2017) and Turgut et al (2017) which showed that the learning process that applies educational games in mathematics has a fairly good impact, where students are more actively pay serious attention to the explanation and have a positive effect on learning achievement.

5. Field Test

In the field test, students' learning process begins with the teacher explaining the concept of integers. Next, students are directed to open a word wall-based game that the teacher has prepared. The teacher explains how to play the game. In the game, several hot air balloons and a train are visible. On the train, there are questions that students must find solutions to. Alternative answers are found in the hot air balloons flying above the train. Students must choose one of the appropriate hot air balloons and put it in an empty carriage on the train. The student who solves the most and the fastest problems will get the highest score. Learning activities like this are carried out in three meetings. At the end of the activity, students are given a questionnaire to see the students' responses to the game used. These responses include usefulness, ease of use, ease of learning numbers, and satisfaction. The following are the results of student responses in terms of learning style.

Table 8. Results Of Students' Responses to The Game

Aspect	Visual	Auditorium	Kinesthetics	All
Useful	38.1%	37.5%	25.0%	33.5%
Easy to use	100.0%	87.5%	100.0%	95.8%
Easy to learn	90.5%	100.0%	75.0%	88.5%
Satisfaction	100.0%	100.0%	75%	91,7%

Table 8 presents an evaluation of students' responses based on four key aspects: usefulness, ease of use, ease of learning, and satisfaction, analyzed across three primary learning styles such as visual, auditorium, and kinesthetic as well as an overall aggregate of all users. the findings indicate that usefulness is relatively low across all learning styles, with visual learners rating it at 38,1%, auditorium learners at 37,5%, and kinesthetic learners at only 25,0%, leading to an overall usefulness rating of 33,5%. however, ease of use is rated very high, particularly among visual and kinesthetic learners, both at 100.0%, while auditorium learners rated it slightly lower at 87,5%, resulting in an overall average of 95,8%.

In terms of ease of learning, auditorium learners reported the highest score at 100,0%, followed by visual learners at 90,5%, while kinesthetic learners had a significantly lower rating of 75.0%, with an overall average of 88,5%. satisfaction levels showed a similar trend, where visual and auditorium learners both reported 100,0% satisfaction, whereas kinesthetic

learners only reached 75,0%. however, the overall satisfaction score was relatively high at 91,7%.

From this analysis, it is evident that the learning material in the game is more effective for visual and auditorium learners compared to kinesthetic learners, who showed lower ratings in usefulness, ease of learning, and satisfaction. while ease of use and satisfaction are generally high, the low usefulness scores indicate that the material may need further improvements to enhance its relevance for all learning styles. additionally, the significantly lower ratings from kinesthetic learners suggest that adjustments are necessary to better accommodate their needs, particularly in making the material more engaging and practical for hands-on learning. From this field tests that the learning material in the game is more effective for visual and auditorium learners compared to kinesthetic learners, and to better accommodate kinesthetic learners, educators should consider incorporating more hands-on, practical activities and showing concern for students' well-being, especially in online learning settings (Stamm et al., 2021).

In addition, with the questions presented and re-displayed in the game, it can be seen that students can remember the concept or how to solve the problems in the game. This means that the use of educational mathematics games can help students understand learning materials. The success of students in learning with the help of educational math games shows that the developed educational math games fulfill one of the functions of learning media, namely as a tool to clarify the delivery of messages and information on learning materials (Arisandy, Marzal, & Maison, 2021).

In the application of educational math games used by teachers and students during learning, teachers and students do not experience difficulties in using them, but make learning more active in using educational math games it only takes 25-30 minutes so that lessons are not disturbed by the presence of educational math games. These results are in line with (Anugrahini, 2017), that game media makes students more independent in learning and makes learning more active. Besides that, the mathematics learning program using Wordwall media has successfully increased students' learning motivation significantly (Yulianto et al, 2024).

CONCLUSION

Based on the results of the data analysis, it was obtained that the Android-based game developed has been categorized as valid when viewed from the aspects of content, construction, language, and ICT. In addition, the android-based game has also been categorized as practical when viewed from the aspects of ease of use, interest, and challenge and can be used in mathematics learning. Students look enthusiastic when solving number problems using educational games. with the questions presented and displayed again in the game, it can be seen that students can remember the concept or how to solve the problems in the game. Educational math games only take 25-30 minutes so that the lesson is not disturbed by the presence of educational math games. Students sometimes do not realize that they miss important messages because they are busy playing games. According to field tests, the game's learning content works better for visual and auditory learners than for kinesthetic ones. Teachers could think about adding more practical, hands-on exercises to better suit kinesthetic learners.

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