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Developing Android-Based Counting Game as Learning Media to Train Students' Creative Thinking

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Abstrak

Media pembelajaran adalah suatu alat yang bisa membantu proses belajar mengajar, dan sekaligus memiliki fungsi memperjelas makna yang disampaikan dalam sebuah proses pembelajaran, sehingga tercapai tujuan pembelajaran. Media pembelajaran hendaknya mengikuti arus perkembangan teknologi. Salah satu pengembangan media berbasis teknologi ialah game edukasi. Penelitian ini bertujuan untuk mengembangkan media pembelajaran game Titungan berbasis android. Pengembangan Media pembelajaran ini menggunakan metode *RnD (Research and Development)* dengan model pengembangan yang digunakan adalah model pengembangan *ADDIE (analyze, design, development, implementation and evaluation)*. Instrumen yang digunakan terdiri dari lembar validasi media, lembar kepraktisan, pretest, posttest, dan lembar respon siswa terhadap media. Subjek Penelitian ini ialah Siswa Sekolah Menengah Pertama. Media ini telah diujicobakan terhadap 27 siswa kelas VII SMP Pangudi Luhur Ambarawa. Media game Titungan berbasis android telah dinyatakan valid oleh pakar media. Hasil uji kepraktisan mendapat persentase sebesar 91,67% yang termasuk dalam kategori sangat baik. Uji paired t-test dengan taraf signikan 5% menghasilkan signifikan mendekati nol dengan rata-rata posttest lebih tinggi daripada pretest. Berdasarkan ketiga uji tersebut, dapat disimpulkan media ini valid, praktis, dan efektif.
Kata kunci: berpikir kreatif; game titungan; media pembelajaran berbasis android;

Abstract

Learning media is a tool that can help the teaching and learning process, and at the same time has the function of clarifying the meaning conveyed in the learning process, so that learning objectives are achieved. Learning media must follow the flow of technological developments. One of the technology-based media developments is educational games. This study aims to develop learning media for Android-based Titungan games. The development model used in this study is the ADDIE model. The instruments used consisted of media validation sheets, practicality sheets, pretest, posttest, and student response sheets to the media. This media has been tested on 27 grade VII students of SMP Pangudi Luhur Ambarawa. The Android-based Titungan game media has been declared valid by media experts. The practicality test results got a percentage of 91.67% which was included in the very good category. The paired t-test with a significant level of 5% produces a significant close to zero with a higher posttest average than the pretest. Based on these three tests, it can be concluded that this media is valid, practical, and effective.
Keywords: creative thinking; Titungan game; android-based learning media.

I. INTRODUCTION

Learning media is a tool that can help the teaching and learning process, and at the same time it serves a function to clarify the meaning conveyed in the learning process, so that learning objectives are achieved (Abdullah & Yunianta, 2018; Pusporini et al., 2023). According to Indah & M Husni (2013), learning media is useful as a tool to send messages in an effort to achieve their learning goals. Learning media in math subjects might create learning activities more interesting, fun and assist students to understand the lesson better which motivates them to learn both in class and independently (Dewi & Isroah, 2016; Safitra, Hapizah, Mulyono, & Susanti, 2023). It implied that the selection and use of appropriate learning media can support the success of student learning achievement.

Learning media is expected to be adjusted with technological development (Wilujeng & Sudihartinih, 2021). Technology is currently developing into the Industrial Revolution 4.0 stage. Firmadani (2020) said that one of the impacts of technological development to the industrial revolution 4.0 in the education setting was the emergence of technology-based learning media that assist the students to convey material virtually. In education, the industrial revolution 4.0 has allowed the use of digital technology-based visualizations to help the teaching and learning process to be more effective, efficient, interactive, and attractive (Yuniani et al., 2019).

One of the technology-based media developments is educational games. Educational games are games that are educational in nature (Abdullah & Yunianta, 2018; Putri, 2023). Bobik et al., (2006) revealed that a good game could improve children's creative thinking skills (Sari & Afriansyah, 2022). A good game might also train and improve player agility, and player performance (Kusuma et al., 2019; Nadila et al., 2023). Technology-based educational games should not only present the educational value but also fun, challenging and addictive features that can be used as a teaching and learning tool. (Widiyanto & Yunianta, 2021). There are a lot of educational games types, including application-based games that can be accessed via smartphones and computers. This type of educational game has advantages including ease of access, being interactive for users, and providing a user experience in the application. (Yulianti & Ekohariadi, 2020). The problem is that not all educational games can be accessed via smartphones, one of which is the Titungan educational game.

Titungan Game is a board game where players are challenged to arrange numbers by involving arithmetic operations in such a way as to produce the same results as the numbers listed in the boxes on the board game. If the player is successful, then the player has the right to place his/her color chip in that section. The

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player will get a score, if the player manages to arrange his color pieces horizontally or vertically with at least 3 pieces with no breaks by the opponent's pieces. This game is proven not only to train arithmetic operation skills, but also to effectively train students' creative thinking skills. (Widiyanto & Yunianta, 2021). The problem is that this game is a board game that has limited players and requires a lot of media tools (board games), which is quite impractical to use.

Figure 1. Titungan board game.

On that basis, the idea emerged to be able to develop the Titungan board game into an educational game that could be accessed via android. There are several applications that can be used to develop android-based educational games including the adobe animate CC application. This application is part of Adobe graphics and publishing software that can be used to do web design and create interactive HTML animations (Rizkiya, 2019). There are several studies that have used this application to develop educational games such as the research of Sarji et al., (2022) who developed an algebra adventure media based on educational games, Setiawan et al. (2022) who developed interactive multimedia on the material of rows and series, and also the study of Pratama & Waskitoningtyas (2020) and Kurniawan et al. (2022) which developed a reasoning android game and trigonometry educational game development, respectively. Just as the Titungan board game has been proven to train creative thinking skills, the development of the Titungan game is expected to train creative thinking.

Creative thinking is a cognitive ability that allows individuals to use their intelligence in a unique and directed way to produce products. (Potur & Barkul, 2009). Suherman & Vidákovich (2022) stated that creative thinking refers to an individual's skill in exploring new ideas or generating solutions in problem solving. Creativity has 4 main characteristics, namely fluency, flexibility, originality, and elaboration (Hu & Adey, 2002). Fluency is the ability to produce a large number of thoughts or questions; flexibility is the ability to produce varied thoughts; Originality is the ability to think in new ways or unique expressions and Elaboration is the ability to add or describe details (Rasnawati et al., 2019).

There are several studies that have successfully developed learning media to hone students' creative thinking skills such as in the study of Sanusi et al. (2020) which developed an android-assisted Education game, the study of Arisandy et al. (2021) which developed an educational

game using construct 2 assisted by Phet Simulation and also research Mulyadi et al. (2016) and Juwita et al. (2019) which respectively developed flash flipbook media and development of students' workbooks based on the Open-Ended approach.

Based on the previous studies, this study also chose to use adobe animate CC software to create a counting educational game that could be accessed via android, and also train students' creative thinking. The advantages of adobe animate CC software are that it can support various formats, the existence of ActionScript, can be displayed in various media, and is fully integrated with Creative Cloud so that it is safe when used. It was expected that this educational game would be more welcomed by students. In addition, as with the count educational game, this game was also expected to be valid, practical and effective as a tool to promote students' creative thinking skills.

II. METHOD

This research aimed to develop learning media, namely technology-based educational games to be accessed through android. The product produced in this development research was an android-based game that could be used as a tool to train creative thinking skills in integer counting operation material specifically for multiplication and division. Therefore, this research was included in the RnD (Research and Development) research category. The development method used is ADDIE. This method has 5 stages, namely Analyze, Design, Development, Implementation, and Evaluation.

In developing the media, a validation process was carried out to measure the validity of the media from the aspect of learning media and mathematics content in it. This validation process involved media and mathematics experts consisting of lecturers and teachers. After the media was declared feasible, then the media implementation was carried out on the target media users, namely junior high school students.

Data collection techniques in this study used the documentation method to collect media analysis data, questionnaires to measure the validity and practicality of the media and the test method to measure the impact of media use on students' creative thinking skills. The analysis to test the validity and practicality used formula (i) and the results of the percentage assessment were categorized into five categories which can be seen in Table 1. As for measuring the impact of the media on creative thinking skills, it was done with the test method. The test was conducted twice, namely pretest (test measuring creative thinking ability before the use of media) and posttest (test measuring creative thinking ability after the use of media). This instrument was prepared based on 4 indicators of creative thinking, namely Fluency, Flexibility, Originality and Elaboration. To test whether the media

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can significantly produce students' creative thinking skills, a statistical test was conducted. There were two types of tests, namely the parametric Paired t-test (for data that meets the normality test) and the Wilcoxon nonparametric test (for data that does not meet the normality test).

Assessment percentage:

$$\frac{assessment\ score}{research\ score} \times 100\% \quad \text{..... (i)}$$

Table 1.
Category of Media Validity and Practicality

Interval	Description
$90\% \leq score \leq 100\%$	Very good
$80\% \leq score < 89\%$	Good
$65\% \leq score < 79\%$	Fairly good
$53\% \leq score < 64\%$	Poor
$0\% \leq score < 54\%$	Very Poor

(Aswardi et al., 2019)

III. Results and Discussion

A. Research Results

The development stages used in the android-based Titungan game learning media were the ADDIE model. Therefore, the results of this study were described based on the five stages of the ADDIE model. The following is a description of each model.

1). Analysis Stage

The development of android-based Titungan game learning media started from analyzing the curriculum, material, and situation. The results of the analysis stage obtained the fact that there were students who still had difficulty determining the arithmetic operations of multiplication and division of integers in number material, even though the multiplication material must have been learned in grade 2 at the elementary school level. In the 2013 curriculum there were several competencies that must be mastered, one of which was thinking and acting creatively. However, there was still limited availability of media that teachers could use to train students' creative thinking skills, especially in whole number operations which included multiplication and division. Limited learning media that could train creative thinking based on technology that can be accessed through android smartphones.

2). Design Stage

The next stage was the design stage. This stage began with the preparation of game design components so that they could be used anywhere and anytime. The first step was to arrange the game algorithm components starting from the application logo, then loading the game, play button, and main menu page. In the main menu there were 4 menus, namely indicators, game instructions, games, game info, and exit buttons. This algorithm can be seen in Figure 2.

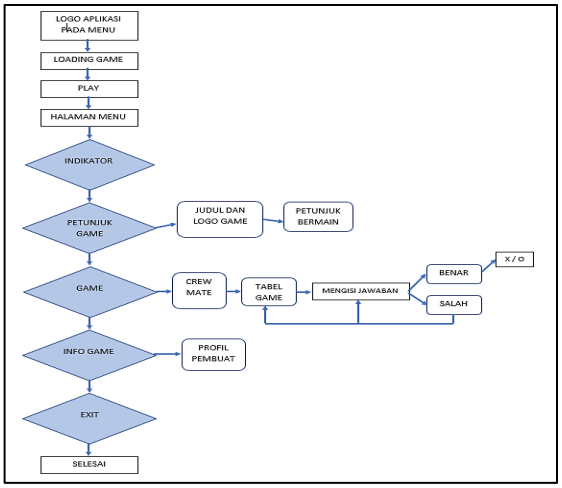

Figure 2. Android-based calculation media algorithm

The second step was to design the game display using the *Canva* application. The third step was to choose software to make the application. The software chosen was using *adobe animate cc* 2020. In addition, at this stage the researchers also compiled validity, practicality, and effectiveness sheets in the form of questionnaire and test instrument sheets.

3). Development Stage

After all the processes at the initial game design stage were completed, the Development stage was carried out. The process of developing the Titungan game which was previously in the form of a board game into an android-based game. The development of this android-based Titungan game took 6 months in the period March - August 2022 to design the content and appearance (theme, color, font type and size) of each component. In the initial appearance of the android-based Titungan game, there was a *loading* game *scene in* the form of a line animation as a pause to open the application (Figure 3) and a game title scene (Figure 4).

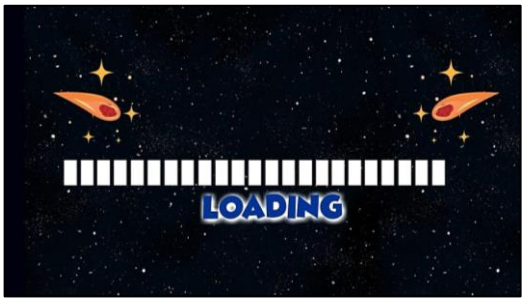

Figure 3. Loading game

Figure 4. Game title

After pressing "*Play*" in the game title section, there would be a main menu display consisting of three sub menus, namely introduction, game, and game info (Figure 5). The introduction section contained the Game icon page (Figure 6) and how to play (Figure 7). The game info section contained the game maker's profile (Figure 8).

Figure 5. Main menu

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Figure 6. Game icon

Figure 7. Game play instructions

Figure 8. Game info

The main content of this game was in the Game menu. The game menu consisted of 2 scenes. The first scene was the *teammate* scene as the player profile (Figure 9). This section must be filled in by the player who will play this game. This game was limited to two players. Therefore, there were two places to fill in the identity of player 1 in the Player 1 section and player 2 in the Player 2 section. After filling in, to start the game click the *Play* section and the second scene would appear, which was the main scene in this game (Figure 10). The second scene encompassed several components. At the top there was a name component that must be filled in by each player. In the center there was a box component with numbers. There was not just one box but 25 boxes, each of which contained numbers with a variety of variations at different levels. This component was just like the Titungan board game. However, this game was unusual compared to the Titungan board game as there was a check facility. With this facility, players could check their answers more independently. On the lower right side there was a description that showed the game time, and at the bottom in the center showed the description of the box that had been selected. The "x" and "o" icons could be seen if the player had filled in the right answer according to the previously selected box. Players must strategize so that they could arrange the boxes that had been answered in order to get the most "x" or "o" icons in the game.

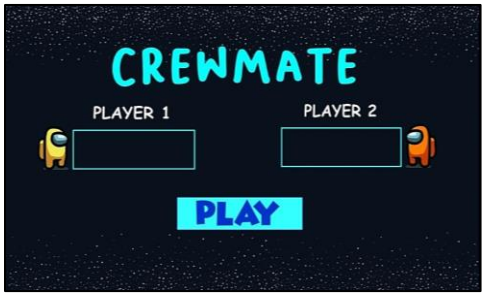


Figure 9. Crewmate game.

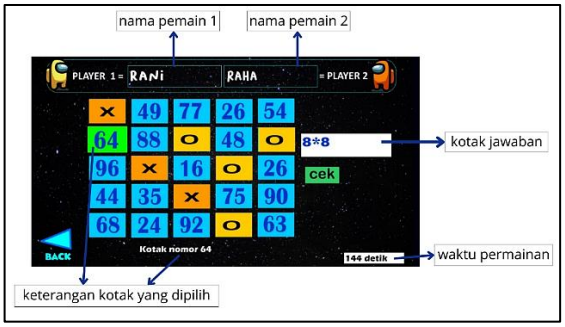
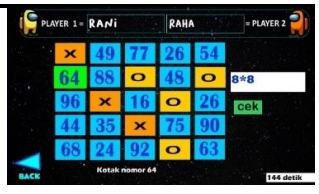
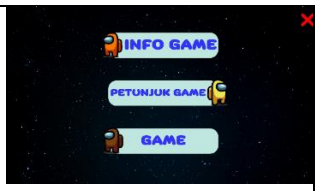
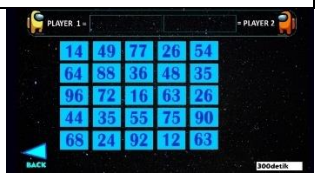


Figure 10. Game view

After the game was successfully compiled, before the game was tested, a validation test was carried out by experts, namely lecturers and mathematics teachers to assess the validity of the media from the media aspect and from the aspect of mathematics learning. The results of the media validity test showed that the android-based Titungan game media was feasible to be tested on students to train students' creative thinking skills. However, the validators provided suggestions for development and improvement of this game. The suggestions and the results of the follow-up of the suggestions given by the validators can be seen in Table 2.

Table 2.
Comments and Suggestions and follow-up

Comments and Suggestions	**Follow-up**
Replacing the "x" symbol with the "*" symbol	
The introduction in the main menu is replaced with game instructions Game titles are annotated with times for	
Added game time	

In Table 2, the validator gave suggestions to be able to replace the symbol of the multiplication calculation operation which previously used the "x" symbol which was then replaced with the "*" symbol. The word introduction on the main menu was suggested by the validator to be replaced with game instructions to make it easier for students to understand. The game time which was originally only 180 seconds was suggested by the validator to be changed to be longer so that students can play the game optimally.

4). Implementation Stage

The fourth stage was implementation. At this stage the media was tested on grade 7B students at Pangudi Luhur Ambarawa Junior High School totaling 27 students for 2 meetings. The participants that could participate were junior high school students who had not learned multiplication. The first meeting was conducted to conduct a *pretest to* determine the initial ability of students

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which was then continued with the introduction of Titungan game media. The second meeting was used to use the Titungan game learning media as well as filling in the *posttest* and student response questionnaire after using the android-based Titungan game. The student response when playing the Titungan game seemed enthusiastic and challenged to try the numbers in the game. This might be observed further from the results of student responses which would be described at the evaluation stage.

5). Evaluation Stage

The last stage of the ADDIE model was the evaluation stage. The purpose of the evaluation stage was to determine the results of the practicality and effectiveness of this game from the trial/implementation process that has been carried out. The practicality test was carried out by validators, namely lecturers of FKIP UKSW and also mathematics teachers. The recapitulation of the practicality results can be seen from Table 3.

Table 3.
Media practicality test results

Assessment Aspect	(%)	Category
Preparation	90	Very Practical
Usage	95	Very Practical
Storage	90	Very Practical
Average	91,67	Very Practical

According to the results obtained from the practicality test in Table 3, it was implied that the preparation aspect got 90%, which meant that this game was practical in preparation because it did not require a long time to prepare. The installation process of this game only took about 2 to 3 minutes. The use aspect obtained 95% because this game did not require a large storage space and could be used outside or inside the classroom, the media could be used as an appropriate self-learning tool, the media could be used at any time and was not limited by time, and the media might help teachers in delivering number operations material. The storage aspect obtained 90% because this game was easy to save and download and could be used repeatedly. Of the three aspects obtained an average recapitulation of 91.67% which was included in the very good category from the results of these percentages it implied that this game media has been declared practical in training students' creative thinking in multiplication operations.

The results of the effectiveness test were analyzed by testing the difference in the means of the pretest and posttest. The difference in pretest and posttest scores can be seen in Figure 11.

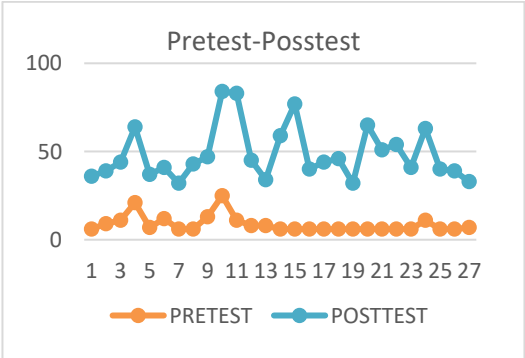

Figure 11. Graph of Pretest and Posttest

From the graph, it appeared that all participants had higher *posttest* scores than *pretest* scores. However, to test whether this applied significantly to the population, a statistical test was conducted. To determine the type of test, a normality test was conducted. The recapitulation of this test can be seen in Table 4.

Table 4.
Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest. postttest	,145	28	,139	,927	28	,051

a. Lilliefors Significance Correction

Data collection of 27 respondents (less than 30), so the normality test used was Shapiro-Wilk. The significant value of the written pretest and posttest was 0.051 (more than 0.05). This indicated that the data was constructed from a normally distributed population. Therefore, the study used a parametric test, namely the paired t-test. The results of this test can be seen in Table 5.

Table 5.
Paired t-test results

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest - posttest	-31,370	12,956	2,493	-36,496	-26,245	-12,581	26	,000

In Table 5, the results of the significant value in the Sig. (2- tailed) column read ,000, which means that the significance value was close to zero which was less than 0.05 with the mean pretest - posttest resulting in (-31.370) or negative. In other words, the mean of the posttest was higher than the pretest. Accordingly, it was concluded that this game could significantly encourage students' creative thinking skills. Not only did it have a positive impact on students' creative thinking skills. This game also received positive responses from students. The recapitulation of students' responses to this game can be seen in Table 6.

Table 6.
Data on students' responses to the media

Statement	Percentage (%)	Category
the instructions for using the media are easy to understand	92,22	Very good
media attracts interest in learning math	94,44	Very good
Media is easy to understand in its use	96,67	Very good
media can be used for learning while	92,22	Very good

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playing		
media can help in practicing creative thinking	94,44	Very good
Average	94,00	Very good

The average result of the percentage of student response statements was 94% and was in the very good category. This was due to the students' positive perspective towards this game and found it interesting and easy to use and it also had instructions that guide them to understand the game. It was considered as media that is not monotonous because it was packaged in an android-based game.

B. Discussion

The android-based Titungan game learning media had been declared valid to train students' creative thinking in multiplication operations. This was due to the development of this media that started from an analysis that included material and situation analysis. Therefore, the resulting product was appropriate with the curriculum and students' characteristics. In addition, the validator stated that this media was valid to use to encourage students' creative thinking and as a prerequisite learning media for students in the material of integer multiplication operations. This is in line with the research of Arwudarachman et al., (2015) which stated that the importance of analysis before media development was used to answer research questions by describing the results of data from a data analysis.

The practicality test results had stated that the android-based Titungan game had been declared practical for use in training students' creative thinking with a percentage of 91.67% which was a very practical category. This Titungan game media display was design in an android-based digital game that is in accordance with the characteristics of students in the industrial revolution 4.0 which is in line with research by Susilo & Prasetyo, (2020). Susilo & Prasetyo, (2020) which said the use of android-based media might effectively increase student motivation and enthusiasm for learning. As in research Windawati & Koeswanti, (2021) which stated that learning media in the form of android-based educational games was in accordance with the student development in the industrial revolution 4.0 which attracted student enthusiasm and interest in learning.

Figure 12. Game Implementation

This android-based Titungan game learning media was not only valid and

practical, but had also been declared effective for training creative thinking. The results of the *paired t-test* mean difference test between the *posttest* and *pretest* concluded that the *posttest was* significantly better than the *pretest*. This was due to *Open Ended* questions and the time-based characteristic which might improve students' creative thinking. Therefore, a parametric test with a *paired t-test was* used and a significant result of ,000 was obtained which means that the significance value is close to zero which is less than 0.05 which can be seen in Table 4 and Table 5.

The advantage of the android-based Titungan game was that the media could be played repeatedly but with time challenges. Rahmawati et al. (2022) in research on the utilization of the *Quiziz* application said students would be more focused, more challenged and motivated to manage time as well as possible. In relation to this research, the students would be more motivated to finish if challenged by time. Android-based Titungan learning media was also practical in its use, easy to access, and move, did not require large storage space and could be used outside or inside the classroom. The media could be downloaded and used repeatedly and could be used at any time, so that it could motivate students to use it. This Titungan game media display was integrated in an android-based digital game that was in accordance with the characteristics of students in the industrial revolution 4.0 which is in line with research (Susilo & Prasetyo, 2020) entitled android-based *2D mobile learning* teaching materials which stated the use of android-based media might effectively increase student motivation and enthusiasm for learning.

The Titungan game learning media presented an *open-ended* problem shown in figure number 11. As in the research on analyzing students' mathematical creative thinking skills by (Ayu et al., 2020) said *Open-Ended* questions were able to stimulate students' creative thinking skills, so that habituation to using *Open-Ended* questions could make students more creative. This android-based Titungan game also trained social interaction skills, because playing the game must interact well so that there were no differences of opinion with playing opponents, as in research (Kosanke, 2019) who said that in *two players* to *multiplayer* games invites students to interact and socialize between players.

Figure 13. Main view of the Titungan game with *Open Ended* questions

IV. CONCLUSION

This study had successfully developed Titungan game learning media which was

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previously a board game into an android-based so that it could be accessed through an android-based smartphone by applying the ADDIE development model. The results showed that the Titungan game learning media was valid, practical, and effective for use in training students' creative thinking. Based on this, it is recommended for teachers to be able to use the android-based Titungan game as a medium to facilitate students in developing students' creative thinking skills. Unlike the Titungan board game, this game was still limited to the multiplication operation, therefore, it is recommended that further studies be carried out to develop the Titungan game which involves other operations as well as the Titungan board game.

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