Android Application Development: Permutation of the Same Elements Based on Realistic Mathematics Education

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Abstract: The objective of this development research is to create an android application of probability theory of the same element permutation material based on RME as a learning medium, as well as to assess the quality of the apps created for utilize in learning mathematics. This research used research and development (R&D) method with the 4D development paradigm. There are four steps to the process: define, design, develop, and disseminate. The information analysis approach utilized is a media achievability test conducted by media specialist and material specialists, and a media quality test was conducted by students as responders. The feasibility test results show that the android application of the probability theory of the same element permutation material based on RME is feasible with good criteria, based on an assessment of 87.50 percent by media specialist and an assessment of 84.93 percent by two material specialists. The results of media quality test of 60 students from partner schools showed good criteria, based on an assessment of 80.20 percent by students as responders. The data from the tests suggest that the android application of the probability theory of the same element permutation material based on RME is possible to use as a source of mathematics learning.

INTRODUCTION

The fourth industrial revolution needs students to acquire 21st century skills and mathematical capabilities, such as communication, teamwork, critical thinking (Subekti & Prahmana, 2021), and problem-solving abilities (Widodo, et al. 2019), as well as creativity (Maryanto & Siswanto, 2021) and technological abilities (Siswanto, et al. 2019). Education helps students to achieve a goal in developing interests, talents and behavioral patterns that are useful for their lives (Siswanto & Ratiningsih, 2020). As a result, they encourage instructor to create or execute novel instructing strategies to support students' creativity within the classroom, and the present school curriculum should stress the importance of growing students' creativity (Chan & Yuen, 2014; Qian & Clark, 2016; Subekti & Prahmana, 2021).

The rapid development of science and technology today requires education in Indonesia to take a part in using technology as innovation in learning through the curriculum (Pramadana, et al. 2018).

In Indonesia, the 2013 Educational programs is presently being actualized, which stresses ICT literacy in learning and integrates all disciplines with the utilization of ICT (Siswanto et al., 2019). Because of the rapid advancement of technology, teachers must employ learning media that is up to date. A smartphone is one type of media that can help with learning.

Smartphones are mobile phones or mobile phones that are more practical than computers and can be used anywhere (Pramadana, et al. 2018). Smartphones have the potential to be developed into interactive media for students. Mobile innovation will have a noteworthy impact on understudy learning (Churchill, 2008; Churchill, et al. 2015). Smartphones have made it possible to offer a variety of multimedia, including graphics, video recording, and integrated media (Zhang & Wu, 2016). Students may study anywhere while using their cellphones for social media or leisure (García, Welford, & Smith, 2016). The base of the system utilized is one of the factors to consider when transforming cellphones into mobile learning (m-learning). According to the StatCounter Globalstats survey results from July 2020–July 2021, 91.80 percent smartphones in Indonesia use Android as operating system, followed by iOS 7.98 percent, Windows 0.05 percent, Tizen 0.01 percent, series 40 0.02 percent, and other 0.15 percent (Statcounter Global Stats, 2021). This implies that the Android mobile operating system is used by nearly all cellphones in Indonesia.

Android is a mobile operating system that is built on a customized version of Linux (Pramadana et al., 2018) which was developed by Andy Rubin and colleagues since October 2003 through the Android Company, Inc (Siswanto et al., 2019). Google purchased and took over Android as part of a strategy to integrate it into the mobile sector (Siswanto et al., 2019). Android is still the number one operating system on smartphones today, even though Android also has advantages such as user friendly and open source. User friendly means the android system is very easy to run. Open source means that users can freely develop their own version of the Android system.

The learning media created in this research is an android application that contains material on the probability theory of permutations of the same elements based on RME. This application is a follow-up study of a combinatorics application based on RME which has been made and published by Siswanto, Hilda, and Azhar (2019). In this application, it contains material, practice questions and evaluation of learning from the theory of probability permutation of the same elements with examples of cases of compiling card numbers that were developed based on RME. RME is a mathematics learning technique that provides pupils with real-world experiences. The RME approach's fundamental introduction is that understudies ought to be given the chance to rediscover mathematical concept and ideas with the direction of the instructor by exploring various circumstances and issues that are genuine to them. RME is based on three fundamental principles: guided reinvention through progressive mathematization, didactical phenomenology or phenomena in learning, and emergent models or generating models (Afriansyah, 2016).

In this study, an android application for the theory of probability permutation of the same elements based on RME was developed using a mobile device with the characteristics of using real

problems, using the results of thinking and model construction from students, mathematical modeling, the occurrence of interactions in classroom learning, and the relationship between the subject. So, in this study, we will pack an Android application based on RME with the same element permutation probability theory content in such a way on a mobile device to make it simpler for instructors, especially students, to learn material anywhere and at any time.

M-learning technology can make it easier for students to learn (Portelli & Eldred, 2016). M-learning facilities allow students to learn more freely since they are portable and can be carried place (Kennewell & Beauchamp, 2007), this is one strategy for achieving learning objectives. M-learning is the confluence of e-learning and mobile computing in which materials must be accessible from anywhere, rich in interactions, powerful support for successful learning, and performance-based evaluation (Riady, et al. 2016). M-learning systems take advantage of the mobility nature of mobile phones, to provide a learning function that can be done anywhere and anytime (Pramadana, et al. 2018). Recognizing the potential of mobile technology as a learning resource for students and as a tool to enhance educational activities (Chao, et al. 2011), teachers must be able to use and exploit technology in the learning process, as well as create chances for app creation utilizing smartphones (Demidowich, et al. 2012).

Based on the reasons for the investigate over, the authors want to improve mobile technology-based learning "Android Application Development: Permutations of the Same Elements Based on RME" at the high school level which is named "Permutation Applications" and continue research on RME-based android applications that have been made previously. The learning application developed in this study contains material, practice questions and evaluation of learning from the material permutation probability theory of the same element as the case example of compiling card numbers that were developed based on RME and will be packaged in such a way as to make it easier for teachers, especially students in learning the material anywhere and anytime.

RESEARCH METHODS

This study's Method is a research and development method that attempts to generate specific goods and assess their efficacy (Sugiyono, 2019). This research used research and development (R&D) method with the 4D development paradigm. There are four steps to the process: define, design, develop, and disseminate (Siswanto et al., 2019).

We employed a media validation questionnaire as the tool. The media validation questionnaire is made up of a achievability evaluation sheet and a media quality evaluation sheet that are both arranged employing a Likert scale. achievability evaluation sheets for material specialists and media specialist, and quality evaluation sheets for students' public tests (Widoyoko, 2012).

The data analysis method employed is both qualitative and quantitative. A feasibility test and a media quality test utilizing a questionnaire instrument were used to collect qualitative data. This

application will be verified by material and media specialists to verify the viability of the created application. Before being disseminated, a public test on students from partner schools is conducted to assess the quality of the application that has been created.

RESULTS AND DISCUSSION

Define

This research is a continuation of the research by Siswanto, Hilda, & Azhar (2019) which has been published previously and is also in the stage of conducting a preliminary study including literature study and field study. The literature study carried out is mobile-based learning, and a RME. While field studies on the use of RME in mathematics learning by teachers and restricted interviews with teachers and specialist.

Design

This stage's goal is to create a learning material. We created a draft of the RME application in this step, which includes the processes of creating a narrative board design (manual) and an illustration design (graphic design). The android application that was created contains material, practice questions and learning evaluations from the material permutation probability theory of the same elements with examples of cases of compiling card numbers that were developed based on RME. Based on the design stages completed in each problem:

Manual Storyboarding: The Permutation Manual's narrative or plot is described in the Story Board Manual for the same elements that will be used. Table 1 depicts a sample of the Manual Story Board Composing Card Numbers Stages.

Pictures / Videos	Sound / Dubbing
Concept of Permutations for the same Element	Opening Music or Introduction
When Zainal will finish his task. Zainal is having a hard time and asks his brother for help. The older brother helps Zainal a card game.	"Sis, there is something I still don't understand." "What material I will ask?" "Material permutations if there are several elements in common"
Brother shows the arrangement of cards by lining up on the table with the numbers 1 3 5 5. It shows that there are numbers that can be	"Okay. Let me give you an example. Now we will arrange numbers with four number cards where two cards have the same number, namely five."

created from four number cards, two of which contain the same number.	"Are the numbers formed by Card 1 and Card 2 the same?"
	“Why are Card 1 and Card 2 considering the same?”
Brother also shows many 4 factorial ways, because there are cards that have the same number written on them. That is number 5.	"If all the numbers on the card are different, then the number of ways to arrange the numbers is 4 factorials, which is 24 ways"
Zainal still doesn't understand why cards 1 and 2 are considered the same.	"Look at method 1 and method 2. Are the numbers formed?"
	"Look at method 3 and method 5. Are the numbers formed the same?"
Brother again proved it by showing the arrangement of cards by paying attention to the color of the same number and the arrangement without distinguishing the color of the same number which resulted in 24 ways of permutation of 4 numbers with 2 the same numbers. The arrangement without distinguishing the same number, the number of numbers that can be formed is $\frac{\mathbf{24}}{\ldots\ldots} = \frac{\mathbf{4}!}{\ldots\ldots}$.	"Look at method 4 with method 6. Are the numbers formed the same?"
	"Look at the 7 methods with the 8 methods. Are the numbers formed?"
	By paying attention to the Arrangement column without distinguishing the same numbers, the number of numbers that can be formed is 24 divided by what?
	"2 answer Zainal"

Table 1: Storyboard Manual Draft Arrange the Numbering Cards

Graphic Storyboarding: Storyboard Graphics provides a sketch of the narrative storyline of compiling Card Numbers showing how to arrange cards by paying attention to the same color number and arrangement without distinguishing the color of the same number. Figure 1 shows a snippet of illustration design or graphic design compiling card numbers.

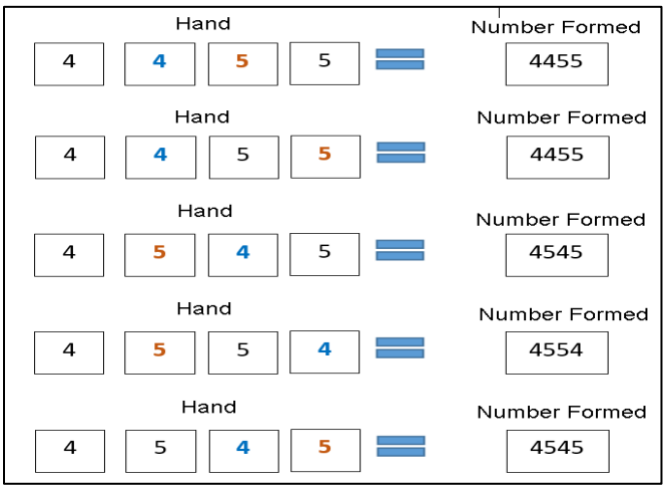

Figure 1: Illustration Design or Graphic Design Permutations with the same Elements for Composing Cards.

Develop

This step of development attempts to turn the design into a learning material. At this step, a draft of an android application material for the theory of probability permutations of the same components is carried out using an example of the case of assembling card numbers, which was produced based on RME includes combining animation phases or motion graphic animation (visual effects) and narrative dubbing.

In this process, you mix permuted frames with the same elements for how to arrange cards that have been stated in visual effects in this procedure, and then offer sound based on the manual dubbing narration. The next step is to examine the duration, dubbing, and transitions between frames in the completed video. The animation process (Visual Effect), Narrative Dubbing, and Motion Graphic Animation film are depicted in Table 2.

Ways of working	Arrangement by paying attention to the same number	Arrangement without distinguishing the color of the same number	Ways of working	Arrangement by paying attention to the same number	Arrangement without distinguishing the color of the same number
1	1355	1355	13	5135	5135
2	1355	1355	14	5153	5153
3	1535	1535	15	5315	5315
4	1553	1553	16	5351	5351

5	1535	1535	17	5513	5513
6	1553	1553	18	5531	5531
7	3155	3155	19	5135	5135
8	3155	3155	20	5153	5153
9	3515	3515	21	5315	5315
10	3551	3551	22	5351	5351
11	3515	3515	23	5513	5513
12	3551	3551	24	5531	5531

Table 2: Combining Animation Phases or Motion Graphic Animation (Visual Effects) and Narrative Dubbing on How to Arrange Cards Permutations.

Dissemination

Following the completion of the application, the product is validated by material and media specialist. This step involves expert validation and test. The result is criticism and ideas that may be utilized to revise the created material so that it can ended up indeed way better.

The objective of material validation is to look at the reasonability of the material given within the android application of the same element permutation probability theory as an example case of assembling card numbers delivered utilizing RME. Using a Likert scale, material specialists give ratings and recommendations on the material presented in the application. Validation was performed by two individuals: Rudi Dwi Pramono, S.Pd, a mathematics teacher at MA Kafila International Islamic School and Nurlaela Rahmawati, S.Pd, a mathematics teacher at South Tangerang 6 High School, which became a partner school in this project

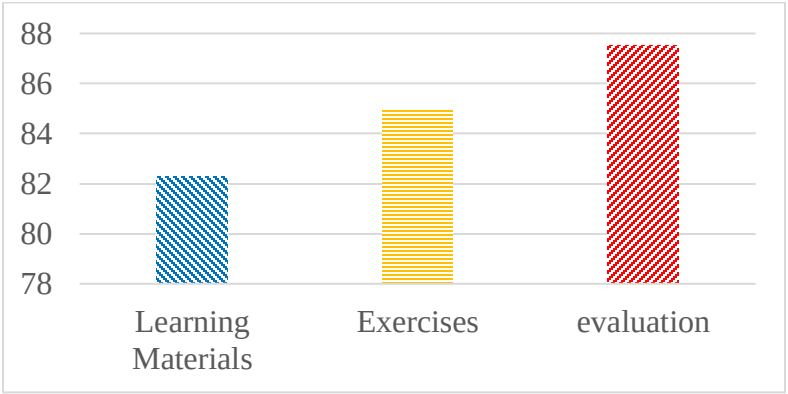

Figure 2: Material Expert Assessment

The assessment result from Rudi Dwi Pramono, S.Pd and Nurlaela Rahmawati, S.Pd as material specialists are 82.29% in learning material aspects, 85.00% in exercise aspects, and 87.50% in evaluation aspects. Overall, the quality of the material is 84.93% with excellent standards judged by two material specialists.

Before being tried on the public, specially partner school students, the validation of the android application media material for the theory of probability permutation of the same elements as the case example of compiling card numbers developed based on RME was tested first. The aspects evaluated include software engineering, authoring, display, and dubbing by Endy Syaiful Alim, S.T., M.T., Ph.D., Head of the Information Technology Development Agency, validated the system (BPTI) Universitas Muhammadiyah University Prof. DR. HAMKA is Computer Science specialist.

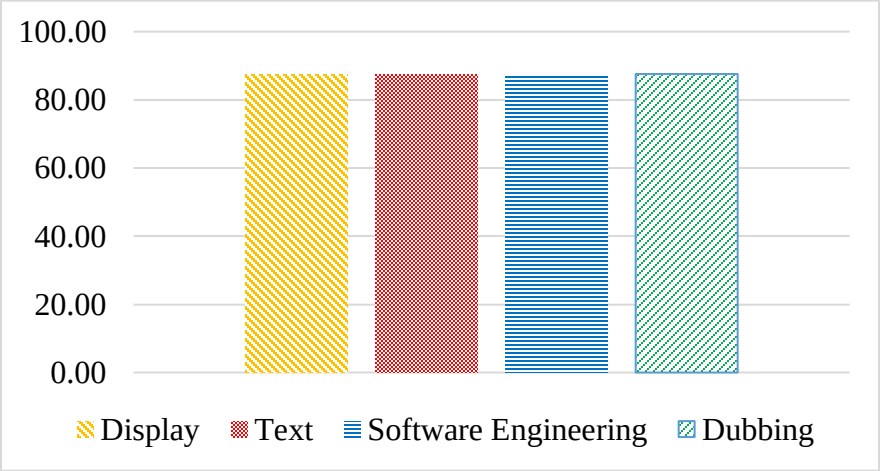

Figure 3: Media Expert Assessment

The assessment result from Endy Syaiful Alim, ST, MT, Ph.D as a media specialist is 87.50% in display quality aspect, 87.50% in authoring aspect, 87.50% in software engineering aspects and 87.50% in dubbing aspect. Overall, the quality of learning media is 87.50% with excellent standards by a media specialist.

The application trial phase with testing and disseminating the android application of the same element permutation probability theory material as the case example of compiling card numbers that was developed based on RME to students in partner schools. This is done to evaluate the application's functionality on different Android devices and using Google form to determine the level of product achievability. Respondents were asked to install the program on their smartphone before using it. The application is deployed via bluetooth, SHAREit, and the researcher-prepared download URL from Google Drive.

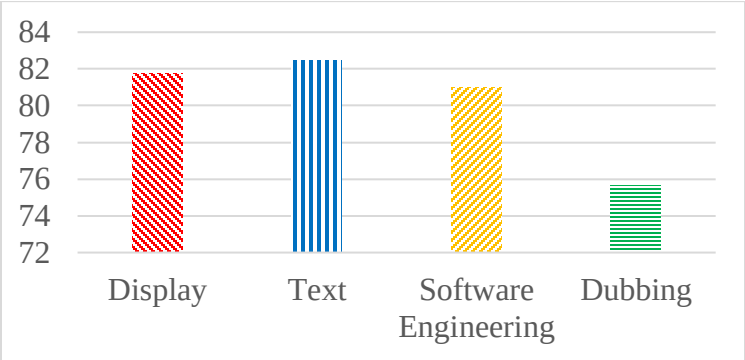

Figure 4: Application Test Results

Based on the results of a general trial to 60 students from partner schools, it was found that 81.73% in display quality aspect, 82.45% in authoring aspect, 81.00% in software engineering aspects, and 75,64% in dubbing aspect. Overall, the quality of learning applications is 80.20% with excellent standards rated by 60 students from partner schools. It is appropriate for use as a source of maths learning Taking after the trial, which was constrained to students at accomplice schools employing a Google forms, the application was upgrade, and the next stage was the distribution stage. This stage deploys the application The application developed in this study is released through the Google Play Store.

CONCLUSIONS

Development of learning media for android application based on RME for the theory of probability permutation of the same elements named "Permutation Application" using the 4D development paradigm consists of four phases. Define as a preparatory study including library investigate and field studies. Design is the form of drafting an RME application with storyboard design (manual), graphic design, combining animation phases or motion graphic animation (visual effects) and narrative dubbing. Disseminate, is the form of expert validation and test. The finished product is an android application material for the theory of probability permutation of the same elements as the case example of compiling card numbers that was developed based on RME named “Permutation Application”. This application was created as a learning medium. The android application that was created contains material, practice questions and learning evaluations from the material permutation probability theory of the same elements with examples of cases of compiling card numbers that were developed based on RME that can be gotten to through Android-based smartphones. This application is bundled in an attractive that it is expected to be a practical and enjoyable learning medium that can be gotten at any time and from any location, as well as to increase student interest in learning mathematics and to be utilized as a implies of free study and as a source of student references.

Overall, the quality of the material is 84.93% with excellent standards judged by two material specialists. while the quality of learning media is 87.50% with excellent standards by a media specialist and the quality of learning applications is 80.20% with excellent standards rated by 60 students from partner schools. Based on the information acquisition comes about, the Android application named "Permutation Application" for the theory of permutation of the same elements as the case example of compiling card numbers, which was developed based on RME, should be utilized as a source of learning math.

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