Improving Students' Mathematical Representation Ability Through Challenge-Based Learning with Android Applications

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Improving Students' Mathematical Representation Ability Through Challenge-Based Learning with Android Applications

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Abstract. The rapid advancement of the latest technology, the absence of interactive multimedia in schools, and the inferior ability of students' mathematical representation creating an alternative breakthrough in developing Android-based learning applications. The purpose of the research was to improve the ability of students' mathematical representation through Android Challenge-based Learning. The quasi-experimental, held at Bandung. It involved 79 students, 39 experimental classes and 40 control classes. The findings indicated that there an increased ability of mathematical representations of students with Android-based Challenge-based Learning than students in the control group. There was no difference in the performance of mathematical representation between students with Challenge-based Learning based on Android and conventional learning based on mathematical prior knowledge in the high, medium and low categories. There was interaction in the types of challenge-based learning between the student with Android applications and expository learning based on prior knowledge of mathematics in the high, medium, and low on the ability of students mathematical representation. Challenge-based learning based on Android facilitated the process of conflict, discovery, social interaction, and reflective processes of students so that the ability of mathematical representation is improved while the material easily understood and exciting.

Keywords: Inequality, Quality Education, Sustainable Development Goals, Wellbeing

1. Introduction

The challenge of the industrial revolution era 4.0 requires professional teachers to understand the application of Information and Communication Technology (ICT) which is utilized to increase competitiveness in society. Using Android mobile apps is one of the prospective technologies in the future that has high flexibility and portability as a learning media, especially in mathematics learning where several materials require strong understanding. Therefore, Android mobile apps can be used as representative learning media and can facilitate students to review material learning whenever and wherever students need it[1]. Android mobile apps as high-quality learning media[2].

The reality of the observations in schools is that almost all students can use an Android smartphone device for entertainment purposes such as social media, playing games and watching videos. As stated by [3], that even though students often spend their time playing Android smartphones, the Android-based media of mathematics learning is still difficult to find in schools and not many teachers can

implement Android in mathematics learning. Based on the Mobo Market survey (Indonesia Mobile Data Report Mobo Market, 2015.p 17) the most downloaded types of mobile apps by smartphone users are games that reached 43.71%. This indicates that today's smartphones haven't been widely used in the mathematics learning process, but only for entertainment. From the observations, 83,7% students of Bandung State II Madrasah Aliyah were mostly used Android as their smartphone operating system.

The use of smartphones in learning is not optimal yet and could affect a student's achievement. Following the observation, the side effect of using mobile phones on student achievement shows that students will be more accomplished if they can minimize mobile phones outside of learning activities[4]. This confirms that smartphones owned by students are underutilized in learning. One of the mathematics subjects that is suitable to be taught using Android learning media is geometry material.expressed that geometry involves a lot of spatial visualization objects related to the characteristics of geometry and measurement of flat plane areas and geometry.

The implementation of Android mobile apps must consider the operating system. In this study, Android mobile apps contain learning content consisting of teaching materials, student worksheets, quizzes, and calculators. This calculator is an upgrade from the existing one. The implementation of Android mobile apps as a medium for learning mathematics will make it easier for students to achieve learning goals in the fields of cognitive, affective, and psychomotor[5].

One of the cognitive abilities in mathematics is the ability of mathematical representation. Indicator of representation ability as one process standards, [6] sets the standard of representation that is expected to be mastered by students during learning in school, namely: (1). Make and use representations to recognize, write or record, and communicate mathematical ideas; (2). choose, apply, and translate mathematical representations to solve problems; (3). use representation to model and interpret physical, social, and mathematical phenomena. Representation is a model or form that is used to represent a situation or problem to facilitate the search for solutions. The importance of this ability isn't balanced yet with the student's conceptual ability.

Based on interviews with the mathematics teacher of Madrasah Aliyah Negeri II Bandung, the ability of mathematical representation of most students still needs to be facilitated. Empirically this ability is identified and analyzed in a preliminary study. The test results from 76.9% of 39 students having a hard time representing pictorial essay problems into images, having a hard time representing schematic sin angle areas and phytagorous theorems in trigonometry.

[7]States that there are two types of representations related to students' success in solving mathematical problems, namely (a) pictorial representation, visually displaying objects described in the story, and (b) schematic representation, describing the spatial connection in the subject. According to Goldin [8], representation is a configuration that can represent something in several ways. For example, a word can represent a real-life object, a number can represent the size of geometry, or the same number can represent a position on a number line. To be able to communicate something, a person needs representation in the form of pictures, graphics, diagrams, and other forms of representation. In line with Li's opinion[9]the structure of language in mathematical activities includes external communication such as written and oral representation of symbols, word, graphics, and images. Mathematical abilities associated with communication skills in each process of mathematical activities that involve external communication such as written representation abilities and oral representations in graphics, words, symbols, and images. Representation ability is a mathematical ability by expressing mathematical ideas (problems, statements, definitions, etc. in various ways).

The complexity of the problem can be seen in students' mathematical representation ability, the advancement of science and technology. One effort to facilitate it is to pack the content in Android mobile apps through challenge based-learning. Android applications that encourage students to learn from assignments, teaching materials, and learning projects, by constructing contextually stimulated divergent problems, which challenge students to explore their projects in front of the class.

The application of challenge-based learning consists of three important parts: problem-based learning, contextual learning, and project-based learning. Challenge-based learning with Android

applications is seen as learning that can implement the demands of students to work hard using the power of thought when faced with a problem situation that is contrary to the cognitive structure, during the process of learning mathematics. [10] States that teachers as facilitators must prepare problems to build students' skills in solving challenging problems to get the best solution, this condition can't rely solely on problem submission from students but rather requires direction by providing continuous training. As expressed by Harel Guerson that in Philosophy two ways are carried out in the mathematics teaching and learning process, namely the way of understanding such as theorem, evidence, problem and solution, the second is the way of thinking to develop thinking skills. [11]Syntax of challenge-based learning with Android application based includes: (1) The big idea, (2) Essential questions, (3) The Challenge, (4) Guiding questions, (5) Guiding activities, (6) Guiding resources, (7) Solution, (8) Assessment, (9) Publishing.

In addition to empirical reality, there are other factors that can contribute to mathematical representation ability, such as mathematical prior knowledge categorized into three: high, medium and low, with consideration of the varied abilities of Aliyah Madrasah students from state junior high schools, private, Madrasah Tsanawiyah, and also from Islamic boarding schools. So that there is a need for the mathematical prior knowledge test, which is a prerequisite for entering the stage in the next material concept, in this case, the categorization of mathematical prior knowledge functions as a control variable, to determine treatment differences in each category of student's abilities during the learning process.

2. Method

The research method used was a quasi-experiment. The independent variable is Android-based Challenge-based Learning. The dependent variable is the students' mathematical representation ability. Also, there are control variables, namely mathematical prior knowledge which are divided into the high, medium and low category. A quasi-experimental design is a nonequivalent control group design. Data source from the population is all students of class XI of the science department in semester 2018/2019 which consists of 6 classes: class XI IPA 1, XI IPA 2, XI IPA 3, XI IPA 4, XI IPA 5, and XI IPA 6. Samples are taken through simple random sampling techniques, selected from population members that conducted randomly regardless of the social class that exists in the population, and data sources that used as research subjects are students of class XI IPA 4 and class XI IPA 6. Research at Madrasah Aliyah Negeri II Bandung involving the experimental class, one class using Android-based Challenge-based Learning is class XI IPA 6 which consists of 39 students and control class with expository learning is class XI IPA 4 which consist of 40 students. PKM test instrument, mathematical representation ability test, data analysis of Independent t-test, two-way ANAVA test.

3. Result and Discussion

The difference in the achievement of mathematical representation ability between groups of students who carried out challenge-based learning with Android applications and those who get expository learning, data processing results of mathematical representation ability tests are obtained from pretest and posttest scores which are then obtain n-gain for student's mathematical representation ability test.

Table 1. N-gain Statistical Description

Learning	Mean	Std.Deviation
CBL based Android	0,57	0,28
Expository	0,14	0,29

According to the data in Table 1 shows that the average n-gain of the mathematical representation ability test from students who carried out challenge-based learning with Android applications with the score result of 0.57 in the high category is better than students who carried out expository learning with a score of 0.14 in the medium category.

After going through a series of capability test mathematical representation is normally distributed and has a homogeneous variance. The independent t-test is then carried out. The results of the independent t-test for the mathematical representation ability test are presented in Table 2.

Table 2. Calculation of the t-test

t-test for Equality of Means			
T	dF	Sig. (2-tailed)	Mean Difference
-6.688	77	.000	-.43047

The results of the t-test with the help of SPSS can be seen in Table 2 with the Sig. (2-tailed) which is 0,000 <0,05, then H0 is rejected, meaning that there is a difference in the increase in mathematical representation ability between students who carried out challenge-based learning with Android applications and expository learning.

To see the difference in achievement of the ability of mathematical representation based on PKM between classes that took challenge-based learning with Android applications and classes that took expository learning, results of the mathematical representation ability test were obtained from the posttest scores which then obtained the n-gain test scores of students's mathematical representation ability then differentiated based on the PKM score in the categories of high, medium and low.

Table 3.PKM Statistical Data

	PKM	Challenge Based Learning based on Android		Expository	
		Mean	SD	Mean	SD
Posttest	High	56.6	26.26	65.89	14.28
	Medium	72.85	20.69	48.36	17.16
	Low	68	14.2	46.67	17.1
	Overall	69.64	20.61	51.75	17.94

After going through a series of capability test Mathematical representation is normally distributed and has a homogeneous variance. Furthermore, the two-way ANOVA test is shown in Table 4.

Table 4. ANOVA Test Calculation

Source	df	F	Sig.
PKM	2	.304	.738
CLASS	1	6.031	.016
PKM * CLASS	2	4.668	.012

Based on the two-way ANOVA calculation, the following results are obtained: If students have a Sig score of 0.738> 0.05, then H_0 is accepted. This means that there is no significant difference regarding the achievement of students' mathematical representation ability based on mathematical prior knowledge(PKM) in the high, medium and low categories. This is because the mathematical

prior knowledge test was carried out at the first meeting, where the students weren't ready for a sudden test. During the PKM test, students' condition isn't conducive and they're unable to focus when working on the questions. Some of the students worked on the questions recklessly and didn't try to get high scores. Some students with high mathematical prior knowledge test scores didn't pay attention during learning, so some students get n-gain scores and no significant increase in their scores.
Both the experimental class and the control class are classes with different student characters so that learning factors didn't have a significant effect on improving students' mathematical representation abilities. According to the previous experiment [12], mathematical prior knowledge have an impact on students' mathematical communication skills. [13] Expressed clearly that there is a significant influence between mathematical prior knowledge of students on mathematics learning outcomes.

In table 4, if it shows sig. score 0.016 <0.05, then H_0 is rejected. This means that there are significant differences in the student's achievement of mathematical representation ability between classes that carried out challenge-based learning with Android applications and classes that use expository learning. This shows that learning factors have a significant influence on improving students' mathematical representation abilities. Learning has a Sig. score 0.012 <0.05, then H_0 is rejected. That means, there is interaction with challenge-based learning with Android applications and expository learning with the level of PKM (high, medium, low) towards students' mathematical representation abilities. Interaction plot differences in student's mathematical representation abilities are presented in Figure 1.

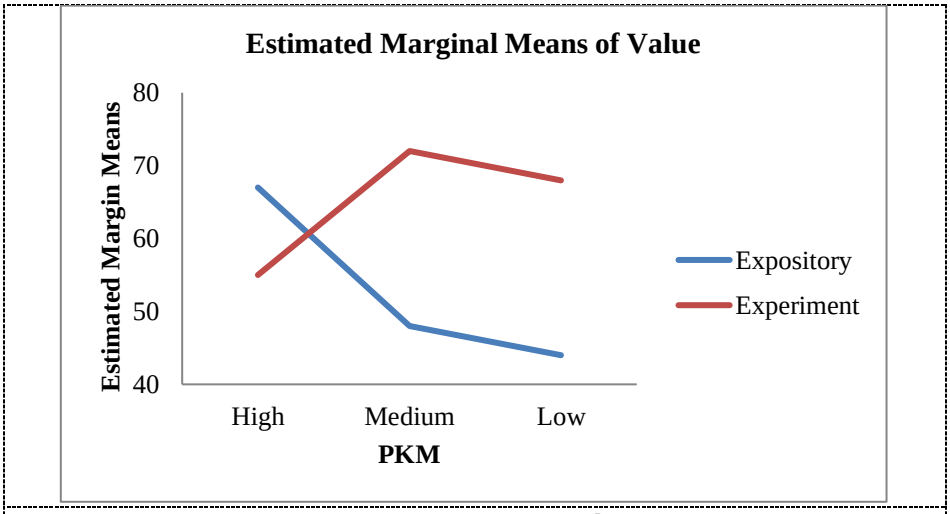

Figure 1. Interaction Plot

Figure 1 Interaction between learning type (CBL with Android applications and Expository) and PKM in high, medium, and low categories on students' mathematical representation abilities. Based on Figure 1, it shows that.

a. Classes that carried out Android-based challenge-based learning with the PKM category are better than the high and low categories and better than the classes that carried out expository learning with high, medium and low PKM categories.
b. Classes that carried out Android-based challenge-based learning with low PKM categories are better than high categories and better than those who carried out expository learning with high, medium, and low PKM categories
c. Classes that carried out Android-based challenge-based learning with PKM categories with high PKM categories are no better than the moderate and moderate categories are better than the class using expository learning with the medium and low PKM categories.

There is an interaction between the learning type challenge-based learning with Android applications and expository learning with students PKM level (high, medium, low) towards students' mathematical representation abilities. According to research [14], [15]that multimedia-assisted challenge-based learning helps in expressing ideas that can bring the cognitive conflict to a lighter level. Research [16], [17]of that learning is done in a social constructivist way, creating, and developing knowledge through assignments, not the result of receiving information from the instructor only, even in professionally modern-day can't just rely on self-acquired knowledge, the involvement of teachers and students to reconstruct the concept of learning material to deal with conflict and the practice of completing continuous tasks is needed, to meet the challenges. The results of [2] show that learning with Android mobile apps is possible to be used as a medium of mathematics learning based on a contextual approach to facilitate students in understanding the concepts. The convenience in understanding material is supported by research [18], [19], [20]which states that the use of images, animation, and sound can help students understand complex material. Learning media is good to support interactive learning because the software has more supreme ability compared with other software in displaying media, graphic combination, animation, sound, and has interactivity with the users [20].

4. Conclusion

There are differences in the achievement of mathematical representation ability between students who carried out challenge-based learning with Android applications and students who carried out expository learning. There is no difference in the achievement of mathematical representation ability between students who carried out challenge-based learning with Android applications and expository learning based on mathematical prior knowledge in the high, medium and low categories. There is an interaction effect between challenge-based learning with Android applications and expository learning as well as mathematical prior knowledge categories (high, medium, and low) to students' mathematical representation abilities.

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