

## Research Article

# Augmented reality-based flat-sided building cards to improve students' understanding of mathematical concepts

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## ABSTRACT

This study aims to improve students' understanding of mathematical concepts by applying augmented reality-based flat-sided wake-up cards media at SMP 10 Sungai Kakap. Experimental research with a quantitative approach was chosen as the method in this study. The instrument used was a description test in the form of pre-test and post-test with a population of 8th graders at SMP 10 Sungai Kakap, Kabupaten Kubu Raya, West Kalimantan which consisted of 2 classes. The research subjects were students of grade 8 B which consisted of 30 students who were selected by cluster random sampling. The data were analyzed using the paired data class t-test. The results showed that students' understanding of mathematical concepts increased after applying mathematics learning using augmented reality-based flat space card media.

**Keywords:** Augmented Reality; Flat-Sided Building Cards; Understanding Concepts; Mathematical

## 1. INTRODUCTION

Mathematical ability by NCTM (2000) is defined as the ability to face problems, both in mathematics and in real life. Mathematical ability at school will usually show whether or not a student can solve problems, especially math problems given. It was further stated that mathematical ability consisted of mathematical reasoning, mathematical communication, mathematical problem solving, concept understanding, mathematical understanding, creative thinking and critical thinking. Each part has an important role in developing the mathematical ability. One of the mathematical abilities that need to be considered by teachers is understanding concepts. NCTM (Bartell, Webel, Bowen, & Dyson, 2013:58) states that the basic goal of learning mathematics is understanding concepts. When a student already understands the concept of mathematics, students will easily be able to solve problems, especially in mathematics. Jacques (Radiusman, 2020) also stated that mathematics is a subject that has a hierarchy where a knowledge in a topic is a continuation of a previously acquired topic so that students are required to be able to understand new knowledge by collecting pieces of information on previous knowledge. Likewise in mathematics, knowledge in mathematics also has a hierarchy so that with this interconnected understanding it is able to make students gain a new and complete understanding of mathematical concepts. Understanding of mathematical concepts in students at school cannot be separated from the role of educators or teachers. Teachers must have the ability to convey mathematical concepts in a good and interesting way. With good delivery, of course, it will make it easier for students to understand the mathematical concepts given. The attractiveness of how to convey the teacher also needs to be considered, because the more interesting the concept is conveyed, the students will be more enthusiastic to listen to the delivery of the concept conveyed by the teacher. Teachers must also be able to build understanding of concepts to students, so that students are able to build, reflect, and articulate student knowledge, so that students have a sense of ownership of knowledge.

Based on the results of interviews by researchers with mathematics teachers in schools, so far teachers have tried various ways to improve students' understanding of concepts. Various applications of learning models, methods, and various media have been carried out, but students' understanding of concepts has only experienced a slight increase. This can be seen from the results of students' daily tests which tend not to increase significantly. The delay in improving test results is certainly a concern for the teacher so that no student concepts are missed so that in the next material students can use the understanding they have in the previous material. Under these circumstances, teachers are still looking for appropriate ways to deal with student problems in understanding mathematical concepts. One of the variations of learning offered by researchers to teachers is to apply technology that is very closely related to student life in today's era. Interesting learning media that are compatible with technology have been widely developed and can be accessed by anyone, including teachers and students. Based on these considerations, the researcher offers teachers to apply learning using augmented reality-based media where students can see only 3 dimensions of a given concept. It is hoped that the application of interesting media will increase student interest in learning so that the concepts given can be absorbed by students more easily. One of the appropriate materials to be conveyed with this medium is geometry material.

Based on the results of the discussion, it was agreed on a learning that applies the media of flat-sided wake-up cards based on augmented reality to improve students' understanding of mathematical concepts. The augmented reality-based flat-sided wake-up card used by the teacher is a space-building card that has been developed by the researcher which is linked to an android application using augmented reality. Cards were chosen as learning media because they have advantages compared to other media. First, the card is easier to carry. Compared to real media in the form of a room or in the form of a book, this card is easier to carry, with a small size of course it can be carried by students easily and can even be stored in students' pockets. Second, it's simpler. Of course, this card form is simpler than the original spatial form. Third, it is easily accessible both through student and school devices. By using an augmented reality-based card, of course, it will be easier to access. Students can link the given card with the android device owned by the student and can be accessed anytime when the student is at home. At school the card can be linked via a tablet device that is already available at the school. Fourth, it's cheaper. The cost of card printing is certainly cheaper than the cost of making space-building media. From these four advantages, an augmented reality-based building card was chosen as a medium that will be applied in spatial learning.

In addition to these reasons, the researcher also conducted a study of previous research that had been carried out by other researchers who had the same characteristics of the media. One of the studies that became a reference was that conducted by Pradini (2020) which revealed that based on the results of the study, it was in the form of learning media for flat-sided shapes based on Adobe Flash Professional CS5. The quality of the media is in the "Very Good" category with an ideal percentage of 86.36%. The resulting learning media provides an overview to the teacher about the development of learning media based on Adobe Flash Professional CS5. Students are more active and enthusiastic in the learning process and increase student learning outcomes by 67.31% based on the results of the pretest and posttest. After having sufficient theoretical studies, the researchers then developed similar media that produced AR-based mathematics learning media that met the level of validity with an average validator assessment score of 94.83% with a very valid category. After being tested, it was found that the media met the level of practicality with an average student response score of 92% in the very practical category and the teacher's response of 91.67% in the very practical category. The effectiveness is calculated based on the paired sample t test value obtained  $t_{count} > t_{table}$  so that there is a significant difference after applying learning with AR-based mathematics media or in other words it can be said to be effective. Based on the development of the media that has met the criteria of validity, practicality and effectiveness as indicated by an increase in student learning outcomes and is able to meet the criteria for student learning completeness, the researchers believe that media like this can also be used to improve students' understanding of mathematical concepts.

## 2. RESEARCH METHOD

This study uses quantitative research methods. The use of this quantitative method is in accordance with the research objective, namely to see the understanding of students' mathematical concepts after being given learning using the media of flat-sided wake-up cards based on augmented reality. The population in this study were 8th graders of SMP 10 Sungai Kakap, Kabupaten Kubu Raya, West Kalimantan, which consisted of 2 classes, namely class A and class B, all of which consisted of 60 students. The sample was selected using a cluster random sampling technique. Before randomizing the class, the normality and homogeneity test was conducted using the students' daily test scores on the previous material. Based on the test results, the two classes were declared homogeneous and feasible for sampling using cluster random sampling. Based on the results of randomization obtained class 8 B which consists of 30 students. Furthermore, students were given a pretest and then learning by applying the media of flat-sided wake-up cards based on augmented reality, and finally given a posttest. The test questions consist of 5 questions about the material on the flat side in the form of cubes, prisms, pyramids, cones, and spheres. Before the test questions are used, the questions are validated and tested first. Based on the results of the validation carried out by 3 validators, the test instrument made has met the eligibility criteria for the instrument with a high category. The results of the item analysis of the test instrument also showed good results so that it can be concluded that the questions to be used are valid and feasible to be used to obtain research data. After being given learning by using augmented reality-based card media, students were then given 5 posttest questions which had the same indicators as the pretest questions. From the results of the pretest and posttest obtained, then the two values were measured using a paired one-sample t-test to see whether there was an increase in students' understanding of mathematical concepts after being given learning using a flat-sided wake-up card based on augmented reality.

## 3. RESULTS AND DISCUSSION

The data obtained from this study are the results of students' work on the pretest and posttest questions on the flat-sided building material consisting of 5 description questions. Student scores are presented in [Table 1](#).

**Table 1.** Students Pretest score

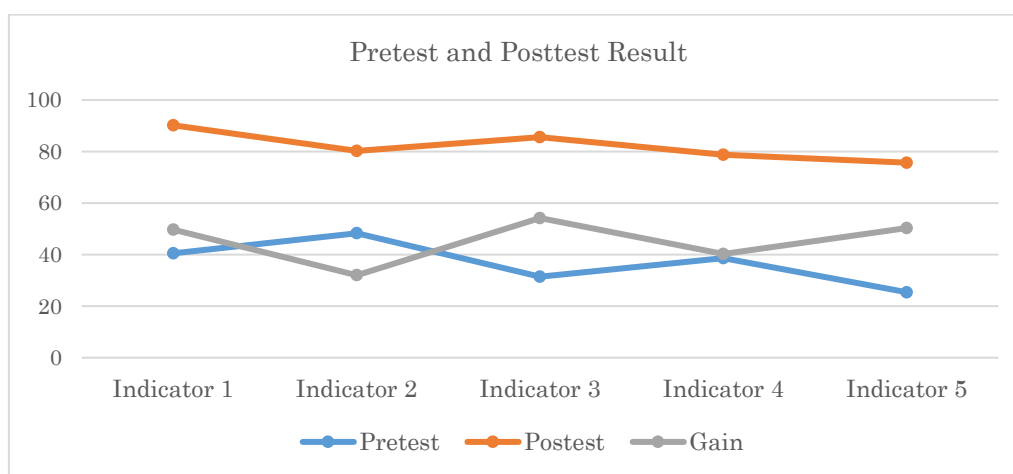
Data	Indicators				
	1	2	3	4	5
Average	40,5	48,3	31,4	38,6	25,4
Total average	36,8				

Based on the data in Table 1, it can be seen that the students' pretest scores have an average score of 36.8. This value was obtained before the students were given learning through the media of flat-sided wake-up cards based on augmented reality. After students get the material with the media created, the data is obtained as in Table 2.

**Table 2.** Students Post-test score

Data	Indicators				
	1	2	3	4	5
Average	90,2	80,3	85,6	78,8	75,7
Total average	82,1				

The data in (Table 2) showed that the posttest results of grade 8 B students have an average score of 82.1. This value is obtained from the average value of students on 5 questions given to see students' understanding of mathematical concepts after learning is applied using the media of flat-sided wake-up cards based on augmented reality. The increase in student scores from pretest to posttest is shown by the following graph.



**Figure 1.** Pre-test and Post-test Results

The results of the pretest and posttest showed an increase in each indicator. In indicator 1 there is an increase of 49.7. Indicator 2 increased by 32. Indicator 3 increased by 54.2. Indicator 4 increased by 40.2 and indicator 5 increased by 50.3. And based on the total average value, there was an increase of 45.3 from the previous value of 36.8 to 82.1.

The data obtained were then tested using statistical tests. Prior to testing, a normality test was conducted to determine the test statistic to be used. Based on the results of the normality test using the chi square test, it was found that the data obtained were normal. Next, a one-sample t-test was conducted to see if there was a significant increase in student learning outcomes from the results of the pretest and posttest. Based on the tests carried out by paying attention to  $\alpha = 5\%$ , the results obtained showed that there was a significant increase. From the results of these tests, it can be concluded that there is a significant increase in students' understanding of mathematical concepts after applying learning using flat-sided wake-up cards based on augmented reality.

The results of this study are in line with research that has been carried out by previous researchers such as the research conducted by Salsabila (2022), which uses cards in learning. The difference lies in the type of card used. This researcher uses an augmented reality-based card as a question card in learning. As for the results of the research, Augmented Reality-Based Question Card Media obtained a validity level of 86% from the results of the material and media validation test with a very good category without revision. The level of practicality of this media is 92.2% with a very practical category to be used as learning media. And at the level of effectiveness of the Augmented Reality-Based Question Card media, it gets a score of 86.6% and the N-gain value of 0.48, which means that Augmented Reality-Based Question Card media is able to improve student learning outcomes in the medium category.

The learning that has been carried out by applying the augmented reality-based card media can increase student scores by 0.48 with 86% of students exceeding the (minimum completeness criteria) KKM. Likewise, the research conducted by Khotimah (2019) which revealed that based on the results of the study, the average validity score of augmented reality-based learning media in the class VIII flat-sided building material was 4.59 which was in the very valid category. Based on student response data, it shows that students have a positive response to Augmented Reality-Based Mobile Learning Media, indicating that at least 80% or more students respond in the agreed category, for each aspect that is responded to. As many as 87% of students were able to achieve the value of learning completeness criteria so that Augmented Reality-Based Learning media was categorized as effective.

## 4. CONCLUSION

Based on the results of the research obtained and the discussion carried out, it can be concluded that there is a significant increase in students' understanding of mathematical concepts after applying learning using augmented reality-based flat-sided wake-up cards.

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## AUTHOR'S CONTRIBUTIONS

The author discussed the results and contributed to from the start to final manuscript.

## CONFLICT OF INTEREST

There are no conflicts of interest declared by the author.

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