The effectiveness of using magic book Math in Mathematics learning during the Covid-19 pandemic in Senior High School

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Abstract. This study aims to find out the effectiveness of using augmented reality-based magic book math at State Senior High School 15 Semarang on student achievement. The type of research used was Quasy Experimental research. The population of this study was X grade students of State Senior High School 15 Semarang. With random sampling technique, two classes were selected, X grade of IPA 4 as the experimental class and X grade of IPA 2 as the control class. Data processing with t comparative test and regression effect test. The results showed that learning was said to be effective which was indicated by: a) the average value of learning achievement in the experimental class was 89.57 which exceeded the Passing Grade 70 limit; b) the effect of student responses can be seen from the value of R square = 0.882 which means 88.2% of student achievement was influenced by student response factors in learning using magic book math based on augmented reality; and c) the average learning achievement of the experimental class was 89.57 while the control class was 70.84, so the experimental class had a significantly better final score average than the control class average.

1. Introduction

Today, in the education world, there are many textbooks circulating in the market, but not in accordance with the demands of the times, for example is a textbook in high school mathematics learning, so far the textbooks available are only in the printed version and have not been associated with the application of renewable technology, from this reality makes teachers must be able to package and make textbooks that are interesting for students [1]. High school schools in Semarang city and its surroundings, both public and private, have not been able to provide augmented reality based textbooks that are able to display 3D objects on every page of the textbook, therefore it is necessary to make an augmented reality based high school mathematics textbook that is able to improve students' ability to understand material mathematics in measurable terms [2].

Based on interviews with several high school mathematics teachers in Semarang city both public and private produced the fact that nearly 100% of high school schools in Semarang city still use mathematics textbooks that have not been touched by renewable technologies such as augmented reality, virtual reality, other mathematical software applications, this becomes
significant findings for the development of textbooks that are able to accommodate these problems [3].

According to observations made by researchers at State Senior High School 15 Semarang, the mathematics learning process is less active and less interesting, this is due to the absence of instructional media used by teachers so that students become bored quickly. Teaching and learning interactions in the classroom are inseparable from the influence of the media used by the teacher in delivering teaching material. The fastest growing now is a smartphone/smartphone. The existence of technology, especially smartphones that are now increasingly developed must be addressed wisely. The phenomenon of the high number of smartphone users is certainly a challenge and opportunity in the education world. The challenge is the abuse of negative things. Besides being a challenge, the existence of smartphones also brings great opportunities to develop technologies that are useful in the education field. One of the benefits that can be taken from the existence of this technology is to use it as an effective, creative and educative learning media. So the educational application media can continue to be developed, one of which is the technology of Augmented Reality [4].

Augmented Reality research aims to develop technologies that allow real-time integration of digital content created by computers with the real world [5]. Augmented Reality allows users to see two-dimensional or three-dimensional virtual objects projected in the real world. This AR technology can insert certain information into the virtual world and display it in the real world with the help of equipment such as webcams, computers, Android phones, and special glasses. Users in the real world cannot see virtual objects with the naked eye, to identify the object needed by intermediaries in the form of computers and cameras that will later insert virtual objects into the real world.

Magic book math is a textbook specifically for high school students that is based on Augmented Reality, which is able to display the augmented reality that is interesting to students. This opinion is in line with the conclusion of Simon that as advances in the development of pedagogical concepts, applications, technology and hardware cost reduction, the use of small-scale augmented reality technology for educational institutions has become very possible in this decade (assuming a careful level of sustainable development) [6]. However, the potential of this technology requires careful attention so that it can truly be utilized to improve educational success. Azuma also revealed the reasons for the use of augmented reality technology in the world of education, namely: (1) supporting interaction between real and virtual environments, (2) the use of interfaces that seem real for object manipulation, (3) learning outcomes for smooth transition between environments real and virtual objects [4].

Based on this background, the problem can be formulated, namely whether learning mathematics using magic book math based on augmented reality is effective? Effective what is meant in this study is (a) learning achievement reaches the minimum completeness criteria, (b) student responses during the learning process have an effect on learning achievement, (c) student achievement in mathematics using augmented reality-based magic book math is better if it is compared with students who do not get this learning. The objectives to be achieved through this research are (a) knowing whether the learning achievement reaches the minimum completeness criteria both individually and classically, (b) knowing whether student responses during the learning process affect learning achievement, (c) knowing whether student achievement in mathematics learning using augmented reality-based magic book math is better than the learning achievement of students who do not get this learning.

2. Methods
This study was included a type of Quasy Experimental research. The population of this study was X grade students of State Senior High School 15 Semarang which consisted of ten parallel classes. Two out of ten classes with equivalent abilities will be the research subjects during the learning trial. One class is an experimental class (that is, a class whose learning uses math learning using augmented reality-based magic book math), and one class is a control class (a class whose learning uses conventional learning groups). With random sampling technique, two classes were selected, X grade of IPA 4 as the experimental class and X grade of IPA 2 as the control class. Due to data collection during the Covid-
19 pandemic, data collection and learning processes were carried out online using the Zoom platform. Questionnaire student responses used Google Form.

The research variables in mathematics learning research using augmented reality-based magic books math were as follows. (1) The independent variable, in this study was the student's response. (2) The dependent variable, in this study was learning achievement. Methods of data collection through tests, observation, questionnaires, and documentation [7]. Data analysis techniques in this study included 1) student response data analysis; 2) data analysis on learning outcomes test; 3) preliminary data analysis (homogeneity and normality test); 4) learning effectiveness analysis (regression test, learning mastery test, proportion test, comparative test).

3. Results and discussion

3.1. Initial analysis
From this research, an android-based learning media using Augmented Reality (AR) was produced, called Magic Book Math based on augmented reality. Algebraic material is packaged attractively based on Augmented Reality (AR) at the high school level, using unity 3D, blender software, vuforia development, Corel draw which is packaged attractively and effectively by playing on smartphones and tablets. To calculate the normality of the initial data, it was carried out using the Liliefors test with a significant level of 5%. The hypotheses and criteria in the normality test are as follows [8].

Ho: L0 < L table, then the population is normally distributed
Ha: L0> L table, then the population is not normally distributed

The following results are obtained.

| Class           | N  | L0     | Ltable | Decision          |
|-----------------|----|--------|--------|-------------------|
| Experiment (X IPA 4) | 25 | 0.115  | 0.173  | Normally Distributed |
| Control (X IPA 2)     | 22 | 0.137  | 0.184  | Normally Distributed |

From the table 1, it is clear that 0.115 < 0.173 and 0.137 < 0.184. So L0 < L table in the control class and experimental class with a significant level of 5% with n1 = 25 and n2 = 22 so that Ho is accepted. This means that samples from the experimental class and control class come from samples that are normally distributed.

Homogeneity test is used to test the similarity of the two variances. From calculations with MS. Excel obtained Fcount = 1.57, with alpha = 0.05 and dk numerator (25 - 1 = 24), dk denominator (22 - 1 = 21), so F (0.05) (24.21) = 2.57. The test criteria accept Ho if Fcount < Ftable. Because Fcount < Ftable, namely 1.57 < 2.57, Ho is accepted, so it can be concluded that the variance between groups is homogeneous (same).

3.2. Completeness test of learning achievement
The implementation of limited trials was carried out in State Senior High School 15 Semarang by taking X grade of IPA 4 as an experimental class and X grade of IPA 2 as a control class. Post test data analysis was performed to determine whether the experimental class and the control class, had a difference between conventional learning and learning using Augmented Reality based Magic Book Math media. To find out which learning is better, then use the t-test (right hand) by using the following formula [9].

\[
t = \frac{(X_1 - X_2)}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
\]

Based on calculations with MS. Excel obtained the average experimental class that is x1 = 89.57 and the average control class that is x2 = 70.84 with n1 = 25, n2 = 22 and s = 12.305 so as to obtain t
arithmetic = 6.53. The results of t arithmetic compared with t table. From the t distribution list with a probability of 0.95 and dk = 25, then t 0.95 is 1.78. From the calculation, the tcount is 6.53 and the table is 1.78. Because tcount> ttable is 6.53> 1.78 then Ho is rejected. Based on the above calculation because Ho is rejected, it can be concluded that learning outcomes using the Magic Book Math media based on augmented reality is better than conventional learning models. This proves there are differences in learning achievement because the teacher uses two different treatments between the control class and the experimental class with the average value of the experimental class x1 = 89.57 and the average control class x2 = 70.84.

Augmented reality make five directions for AR in education [10]. Augmented Reality (AR) is an emerging form of experience in which the Real World (RW) is enhanced by computer-generated content tied to specific locations and/or activities. Over the last several years, AR applications have become portable and widely available on mobile devices. Facilitating ubiquitous learning, AR will give learners instant access to location-specific information compiled and provided by numerous sources (2009). Both the 2010 and 2011 Horizon Reports predict that AR will soon see widespread use on US college campuses. In preparation, this paper offers an overview of AR, examines recent AR developments, explores the impact of AR on society, and evaluates the implications of AR for learning and education [11].

3.3. Students’ responses result

Students respond to the media of Augmented Reality (AR)-based magic book math by filling out a questionnaire given by the researcher via the google form link for students to fill out. The questionnaire link is given to students after students have finished using Augmented Reality (AR)-based magic book math media. This is done so that researchers know how well Augmented Reality (AR)-based magic book math media is used for students. The results of the analysis of student responses for each question are presented in the following table 2.

| Number | Criteria                                                                 | Score | Percentage |
|--------|---------------------------------------------------------------------------|-------|------------|
| 1.     | Learning by using math book math media is able to improve students' spatial skills more fun than just using the lecture method | 113   | 90,4       |
| 2.     | I can understand math learning better                                     | 106   | 84,8       |
| 3.     | The use of magic book math media based on virtual augmented reality is able to increase student enthusiasm for learning | 109   | 87,2       |
| 4.     | With the magic book math media based on virtual augmented reality, it makes me more active in learning | 104   | 83,2       |
| 5.     | Good color composition and media display for interesting learning         | 109   | 87,2       |
| 6.     | Images presented in the magic book math media based on virtual augmented reality clarify mathematical material | 106   | 84,8       |
| 7.     | Learning by using math book math media based on virtual augmented reality is able to increase interaction between students | 104   | 83,2       |
| 8.     | Math book magic media based on virtual augmented reality can improve understanding of concepts and is well presented During the learning, exercises were presented in the magic book math media based on virtual augmented reality which were able to improve students' understanding of mathematics material | 111   | 88,8       |
| 9.     | The exercises in math book math media based on virtual augmented reality are in accordance with the material being taught | 106   | 84,8       |
From the above calculation, the average percentage of the feasibility of Magic Book Math based on Augmented Reality of 85.92% by students. After being converted to a scale conversion table, Augmented Reality based Magic Book Math media is in the range of 81% - 100%. So placing the position on the criteria is very good [12]. The documentation of data collection at SMA Negeri 15 Semarang can be seen in the following figure 1.

**Figure 1.** The process of learning mathematics with magic book math at senior high school.

### 3.4. The effect test of students' responses on learning achievement

To analyze the effect of students' responses on learning achievement used simple linear regression and the results obtained can be seen in Table 3.

| Model      | Sum of Squares | Df  | Mean Square | F       | Sig.  |
|------------|----------------|-----|-------------|---------|-------|
| Regression | 2501.886       | 1   | 2501.886    | 78.862  | .000a |
| Residual   | 697.947        | 22  | 31.725      |         |       |
| Total      | 3199.833       | 23  |             |         |       |

a. Dependent Variable: Learning Achievement
b. Predictors: (Constant), Students’ responses

From the results of the data processing above, the value of $F = 78.862$ and $\text{sig} = 0.000 = 0\%$, which means that $H0$ is rejected. This result in the linear regression equation having the meaning that students' responses affect learning achievement. To measure the magnitude of the influence of student responses on learning achievement can be seen in Table 4.

| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-----|----------|-------------------|---------------------------|
| 1     | .884a| .882     | .772              | 5.632                     |

a. Predictors: (Constant), Students’ responses

The magnitude of the influence can be seen from the value of $R$ square = 0.882 which means that 88.2% of student achievement is influenced by students’ responses factors in learning using augmented reality-based magic book math. Meanwhile, the regression equation can be seen in Table 5.
Table 5. Coefficientsa

| Model                  | Unstandardized Coefficients | Standardized Coefficients |
|------------------------|-----------------------------|---------------------------|
|                        | B  | Std. Error | Beta | t   | Sig. |
| (Constant)             | -37.433 | 13.377    | -2.798 | .010 |
| Students’ Responses    | 1.620 | .182   | .884 | 8.880 | .000 |

a. Dependent Variable: Learning Achievement

From this table, the equation Y = -37.433 + 1.620X means that each students’ responses (x) increases one unit, then learning achievement (Y) increases by 1.620. This research was corroborated by Ferrer-Torregrosa [13], ARBOOK: Development and assessment of a tool based on augmented reality for anatomy. The ARBOOK group received the same standard sessions but additionally used the ARBOOK tool. At the end of the training, a written test on lower limb anatomy was done by students. Statistically significant better scorings for the ARBOOK group were found on attention–motivation, autonomous work and three-dimensional comprehension tasks. Additionally, significantly better scoring was obtained by the ARBOOK group in the written test [14]. The results strongly suggest that the use of AR is suitable for anatomical purposes. Concretely, the results indicate how this technology is helpful for student motivation, autonomous work or spatial interpretation [15]. The use of this type of technologies must be taken into account even more at the present moment, when new technologies are naturally.

4. Conclusion

Learning augmented reality-based magic book math is effective. The effectiveness is because 3 effective indicators have been fulfilled, namely: 1) Students' learning achievement reaches completeness. The average value of the experimental class was 89.57, which was above 70.00. This value indicates the average test score is more than the completeness criteria so that it can be concluded that classical learning achievement is complete. 2) Students' responses during the learning process affect learning achievement. It can be seen from the magnitude of the influence or contribution of students' responses to learning achievement of 88.2%. c. There is a difference in learning achievement between the experimental class and the control class. It appears that the average test score of the experimental class learning outcomes is 89.57, much better than the control class learning outcome test score average of 70.84.

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