

Augmented reality pictorial storybook: How does it influence on elementary school mathematics anxiety?

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Abstract: This study aims to explore the effect of media Augmented reality pictorial storybook on the anxiety of elementary school students in mathematics learning. This study used a quantitative approach with a quasi-experimental type of research. The experimental design used was a pretest-posttest control group design. The sample of this study was 60 students of fifth grade elementary school which were divided into two groups, namely the experimental group and the control group. The sampling technique used is cluster random sampling. The data were collected by using a mathematical anxiety questionnaire which was analyzed by means of a comparison technique, score trend test, and t-test. The results showed that the use of Augmented reality pictorial storybooks can reduce students' anxiety levels in mathematics learning. This can be seen from the average value of the pretest and posttest in the experimental class which showed a more significant decrease in anxiety towards mathematics learning (47.73%) than the decrease in anxiety in the control class (4.73%). The t-test results show that the significance value is 0.00 (<0.05), which means that Augmented reality pictorial storybooks have a significant effect on students' anxiety in mathematics learning.

Keywords: Augmented Reality, Pictorial Storybook, Mathematics Anxiety, Elementary School.

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INTRODUCTION

The presentation of mathematics material in the learning process at the elementary school level is different from the junior high school or the high school level. This is due to different characteristics and mental development. Bruner's theory states that when mathematics is given to elementary school students, teachers must first understand the mental development of students (Lestari, 2014). The mathematical material must be presented through an enactive stage first where real objects must be involved as representations of the concepts presented so that students understand more easily. After that, the material can be presented through iconic stages where mathematical concepts are presented by involving learning media to equalize students' perceptions of the objects described. Finally, when the enactive and iconic stages are successfully passed, then they enter the symbolic stage where the mathematics can be accepted by students in the form of symbols. Thus, students will be able to accept the mathematical concepts given and learning objectives will be achieved easily.

The mathematics is one of the most important lessons to be understood and mastered by students (Prasad, 2011). To a certain extent, the mathematics can help individuals in solving various everyday problems. However, in reality there are still many students, especially at the elementary school level, think that the learning mathematics is a scary lesson. Research conducted by Wangid et al. (2020) stated that the level of anxiety of elementary school students towards learning mathematics was still in the very high category. Anxiety about learning mathematics can have a negative effect on their psychology (Santrock, 2011). This situation will certainly create a sense of discomfort in students when following the learning process. The Hierarchy of Needs theory developed by Maslow states that every individual who wants to achieve self-existence through a learning process must first obtain a sense of security and comfort so that they are physically and psychologically ready to receive the knowledge given (Abbas, 2020). This shows that in learning, the especially mathematics learning, the students should feel safe and comfortable, not the other way around where they feel high anxiety that interferes with their psychology in learning. Psychological disruption of the students will have an impact on decreasing their focus or concentration in following learning which will ultimately have an impact on decreasing their learning achievement (Dasopang et al., 2020).

The students' anxiety in the learning mathematics itself focuses on the disruption of the students' cognitive domains such as a sense of inadequacy, a sense of helplessness, and a sense of worry about the tests given. When the students get a turn to solve math problems given by the teacher, then that's when the students think that they are getting a very big problem that is even impossible to solve (Morsanyi et al., 2014). The anxiety of elementary school students towards learning mathematics is basically due to the difficulty of students understanding mathematics materials given by the teacher in class (Waskitoningtyas, 2016). This student anxiety also has an impact on the difficulty of achieving learning objectives which ultimately results in low student learning. There are several factors that cause elementary school students to have difficulty understanding the mathematics material which leads to the emergence of anxiety in them when dealing with learning mathematics. These factors come from external and internal students themselves. From external factors, the students must face and understand abstract the mathematical material (Laurens et al., 2017). Furthermore, each of the materials is interrelated and related material so that the students must understand step by step from the basic materials before entering the advanced material (Tian & Siegler, 2017). On the other hand, when viewed from internal factors, the cognitive development of elementary school students is at the concrete operational stage (Wolfolk, 2016). At this stage, the students still have difficulty abstracting abstract concepts and are just getting used to

understanding concrete concepts. This is clearly contrary to the material or mathematical concepts that are abstract. Therefore, these factors make it increasingly difficult for students to understand the material or concepts in learning mathematics. However, there are several ways that teachers can do in an effort to overcome these problems, one of which is by using learning media (Alghazali, 2019).

The learning media is an intermediary that is used by teachers in a learning process that aims to help the process of learning objectives (Williamson et al., 2019). The use of learning media is certainly expected to be one solution to overcome the problem of the difficulty of students understanding abstract mathematical material or concepts. This is because the learning media has many functions that can assist teachers and students in achieving learning objectives. Besides being able to attract students' attention through its attention function (Arsyad, 2011), the learning media can also help abstract concepts that are abstract so that abstract concepts can be conveyed concretely to students (Mulyono & Hidayati, 2020). Therefore, the use of learning media should be very helpful for elementary school students in understanding abstract mathematical concepts. However, the selection of learning media to be used must also be in accordance with the goals and needs of students so that learning objectives are achieved effectively and efficiently.

Elementary school students tend to optimize their visual abilities to understand an object (Lubis et al., 2021; Saputri, 2016). That is, students must see the object described by the teacher so that they can understand the concepts conveyed. This makes the teacher must be able to facilitate the needs and potential of these students by optimizing the use of visual learning media to help the abstraction process of abstract concepts in mathematics learning (Ula et al., 2020). On the other hand, elementary school-age students have other potentials that can be optimized by teachers, namely students like stories that raise stories of life in their environment (Zuchdi, 2012). The use of picture story books as learning media is one of the steps that can be taken by teachers to optimize the potential of these students because they can attract attention while providing understanding to students about the material presented (Lubis & Dasopang, 2020). A picture story book is a book that has 2 components, namely a story component in the form of text and an image component as a form of visualization of the story (Matulka, 2008). The presence of pictures in story books will certainly make it easier for students to understand the text and context of the story presented (Hunt, 2006). Furthermore, the insertion of mathematics materials in a series of picture story books will attract students' attention because in addition to having fun following the story or story, they also get a new and fun math learning experience (Mawanto et al., 2020). The picture story books combined with various technology-based components will increasingly attract the attention of today's students who are part of the Alpha generation (Januariyansah & Rohmantoro, 2018). The use of technology in learning will also help develop high-order thinking skills of elementary school students who are part of the alpha generation (Koesnandar, 2019). Technology-based learning for elementary school students has several advantages, including easy access for students to materials and references that can help them master the concepts being taught (Lubis & Dasopang, 2021).

One of the technology-based components that can be combined with picture story books is the Augmented reality application (Lubis & Wangid, 2019). Augmented reality is one part of the many forms of technological development today (Palmarini et al., 2018). All aspects of life today have felt the impact of the rapid development of existing technology, including the realm of education. Various learning media today have been combined with existing technological developments. The results of Apriliani & Radia's research (Apriliani & Radia, 2020) show that the use of adobe flash multimedia has succeeded in improving the learning outcomes of elementary school students in learning mathematics. Furthermore, Abdullah (2010) in his findings stated that the use of e-learning can help students to more easily understand the materials in mathematics learning so that learning objectives are easy to achieve. These studies seem to show that 1) technological developments have had a very large influence in the realm of education; 2) the students

are very familiar with current technological developments; and 3) technological developments have a positive effect on the realm of education if used wisely and according to need. The presence of Augmented reality is an effort to help visualize existing objects, it can be used in the realm of education to help students understand the given object, especially when the object is still abstract.

Augmented reality is an application that is used to visualize two-dimensional objects into three dimensions so that objects can be visualized in real terms to the user (Kato, 2012). Furthermore, the display of objects visualized by the Augmented reality application helps the user to analyze in detail about an object (Ma & Choi, 2007). The picture story books that are affixed with a touch of Augmented reality application will give a more attractive appearance to students because the visualization of polished images with a touch of Augmented reality will be visualized as if real in front of students (Nee et al., 2012). In addition, the use of picture story books with the help of Augmented reality applications as a medium for learning mathematics can also help present more real mathematical objects so that students are easier to understand the material presented by the teacher (Hanan et al., 2018). Based on this explanation, the Augmented reality pictorial storybook or picture story book with the help of Augmented reality referred to in this study is a picture story book with mathematical materials inserted in it and pictures that can be visualized using Augmented reality applications.

Various studies have tried to discuss students' anxiety in learning mathematics, including Lubis's research (2019) which states that students' difficulties in learning mathematics can be overcome by using appropriate methods and according to the characteristics and needs of students, so that students can enjoy the learning process of mathematics that is ultimately will be able to help students to achieve learning objectives. Furthermore, Cahyati & Rhosalia's research (2020) states that learning mathematics at the elementary school level must use image media so that mathematical objects can be clearly depicted in students' minds, so that the same perception is obtained from all students towards the objects described in mathematics learning. Another research is Putri & Mustadi's research (2020) which states that the use of story books as a medium for learning science and mathematics is effectively used to overcome student anxiety in learning science and mathematics. This study is here to try to test the effect of a media in the form of a picture story book with the help of an Augmented reality application on reducing anxiety in elementary school students in learning mathematics.

METHODS

Research Design

This study aims to explore the effect of Augmented reality pictorial storybooks on students' anxiety in learning mathematics at the elementary school level. The variables of this study consisted of 2 variables, namely Augmented reality pictorial storybook as the independent variable and anxiety in learning mathematics as the dependent variable. This research used a quantitative approach with a quasi-experimental type of research. The experimental model used was a pretest-posttest control group design involving one experimental class and one control class (Johnson & Christensen, 2014).

Class	Pretest	Treatment	Posttest
Experimental	O ₁	X ₁	O ₂
Control	O ₃	X ₂	O ₄

FIGURE 1. Research design

Description:

O1: Initial conditions of the experimental group

O2: Final conditions of the experimental group

X1: Treatment using Augmented reality pictorial storybook

X2: Treatment does not use Augmented reality pictorial storybook

O3: Initial condition of control group

O4: Final condition of control group

Sample of Research

This research was conducted in the city of Padangsidempuan, North Sumatra province, Indonesia. The population of this research was elementary school students in North Padangsidempuan sub-district. The sample of this study was the fourth-grade elementary school students, totaling 60 students. The determination of the research sample was done by using cluster random sampling technique. The sample of this study was divided into two groups, the first group of 30 students served as the experimental group who received treatment using Augmented reality pictorial storybook media and the second group of 30 students served as the control group, namely the group that did not use Augmented reality pictorial storybook media. The following **Table 1** summarizes the samples involved in this research.

TABLE 1. *Sample of research*

Class	Amount	Average Age	Gender	
			Male	Female
Experiment	30	10.17 years	13	17
Control	30	10.23 years	11	19

Data Collection Technique

The data of this study were obtained by using a questionnaire or questionnaire technique. The questionnaire in this study used a Likert scale (1-4). This research instrument was adopted or refers to the student's mathematical anxiety instrument developed by Jameson (2013) in his research. In the following, the research instrument or questionnaire used in this study is presented.

TABLE 2. *Research questionnaire or questionnaire*

No.	Statement
1	When I solve a math problem, I feel:
2	When I think about doing math, I feel:
3	when I work on a difficult math problem that makes me think hard, I feel:
4	Compared to other subjects, it makes me feel:
5	When I solve a math puzzle, I feel:
6	when I have a difficult math question, I feel:
7	when the teacher calls me to answer math problems, I feel:
8	When teachers show them how to solve math problems, I feel:
9	If I have to add up the numbers on the blackboard in front of the class, I feel:
10	When I make mistakes in math, I feel:
11	Thinking about doing math in class makes me feel:
12	Doing math at home makes me feel:
13	When the teacher gives the class a math problem that I don't understand, I feel:
14	When my teacher said he was going to give me math problems on the blackboard, I felt:
15	When I know that my class will be doing math at school, I feel:
16	When I know that I will be facing a math exam, I feel:

Description:

4 = Very Brave

3 = Brave

2 = Anxious

1 = Very Anxious

Data Analysis

The data obtained in this study was quantitative data which was then analyzed using the average comparison technique, score trend test, and t-test technique. The average comparison was used to determine the average decrease in students' anxiety levels towards learning mathematics. Furthermore, the score trend test was used to categorize students' anxiety levels in learning mathematics. The t-test was carried out in two stages, namely paired t-test and independent t-test. Paired t-test was used to analyze the different values of students' mathematics anxiety in the experimental group between before and after implementing mathematics learning using Augmented reality pictorial storybook media, while independent t-test was used to test the different values of students' mathematics anxiety in the experimental group using Augmented media. reality pictorial storybook with a control group that did not use it. The hypothesis of this research was that Augmented reality pictorial storybook had a significant effect on students' anxiety in learning mathematics. The following was the formula for the tendency of scores referring to the Wagiran formula (Wagiran, 2014).

TABLE 3. *Score tendency formula*

Interval	Information	Score
$(Mi + 1,5 SD) > X \leq (Mi + 3 SD)$	Very high	4
$(Mi) > X \leq (Mi + 1,5 SD)$	High	3
$(Mi - 1,5 SD) > X \leq (Mi)$	Low	2
$(Mi - 3 SD) \geq X \leq (Mi - 1,5 SD)$	Very Low	1

Procedure

The procedures or stages of this research are 1) conducting a preliminary study to find out the field problems; 2) determining the sample from the population with cluster random sampling technique to determine the students involved in the experiment; 3) dividing the sampled students into two groups, namely the experimental group (30 students) and the control group (30 students); 4) conducting a pretest to determine the level of anxiety of students in learning mathematics before being given treatment; 5) carrying out the mathematics learning process provided that the experimental group uses Augmented reality pictorial storybook media, while the control group does not use it; 6) conducting a posttest to obtain data on the level of students' anxiety in learning mathematics after being given treatment; 7) analyzing the data obtained by comparing the tendency of students' anxiety data levels between pretest and posttest; 8) testing the hypothesis with the t-test test technique; 9) drawing conclusions.

RESULTS

Augmented reality picture story books that were tested in this study have several components that can help in overcoming student anxiety in learning mathematics, especially for elementary school students. The first component is the image component. The image component in Augmented reality picture story books is used to visualize the storyline so that students can understand the plot or storyline referred to in the storybook. The images in this Augmented reality picture story book are loaded with attention to the suitability of the storyline, color, contrast, describe the character of each

character, and are made interesting. The determination of the image criteria is intended to realize the story so that it can foster students' imagination on the storyline, so that in the end they will easily understand the story being told. In addition to character images made to visualize the storyline, Augmented reality picture story books are also affixed with other images that can help visualize the mathematics materials being taught so that students can understand abstract mathematical concepts. Here is one of the pictures that was published in Augmented reality picture story books.



FIGURE 2. Augmented reality pictorial storybook content

In addition to images that help visualize stories and concepts in mathematical material, Augmented reality picture story books are also equipped with images with Augmented Reality effects. The Augmented Reality effect is created with the help of an application that aims to visualize image objects into three dimensions so that objects look more real. The Augmented Reality effect will be very helpful in providing understanding to students about very abstract mathematical materials. With the help of Augmented Reality effects, images or objects that were previously only presented in two-dimensional form on the surface of the paper can be visualized in a real three-dimensional form so that students can observe every corner of the object in real time. The Augmented Reality effect can be seen with the help of applications and smartphones that can read barcodes embedded in the specified image. The following is a picture or visualization of the Augmented Reality effect on Augmented reality picture story books.

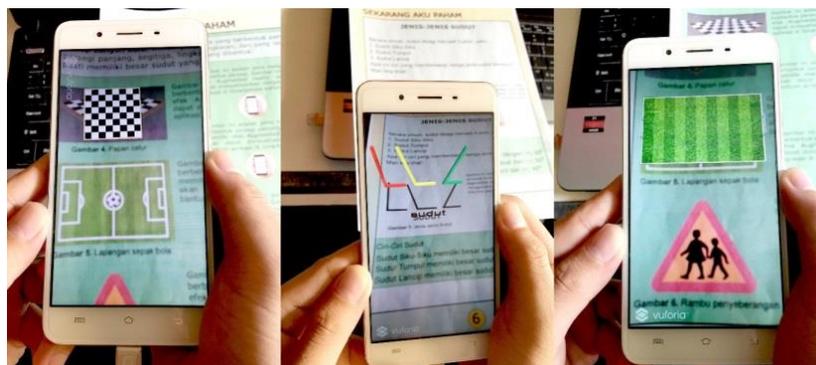


FIGURE 3. Augmented reality effect display

The results of this study indicate that the use of Augmented reality picture story books can reduce the level of elementary school students in learning mathematics. This is evidenced by the anxiety data in this study which showed that there was a significant average decrease in the experimental group between before and before using Augmented

reality pictorial storybooks in learning mathematics. The data in the experimental group showed that the average value of anxiety before treatment was 56.50 (standard deviation 6.17), then after students participated in learning mathematics using Augmented reality picture story books, the average student became 29.53 (standard deviation 3.67). There was a decrease in the average value of student anxiety by 47.73%. Furthermore, the data in the control group showed that the average score of students' anxiety before treatment was 54.93 (standard deviation 5.83), then after the treatment was given using conventional media commonly used by teachers (ordinary picture media), the students' average score became 52.33 (standard deviation 6.00). The average decrease also occurred in the control group, which was 4.73%. These results indicate that the group using the Augmented reality picture storybook media experienced a more significant reduction in anxiety than the group using ordinary picture media.

The data obtained in this study were also analyzed using a score trend table which aims to determine the distribution of data in 4 categories, namely Very Brave, Brave, Anxious, and Very Anxious. The results of the analysis showed that the results of the mathematical anxiety questionnaire in the experimental group before the treatment was given were 83.33% in the Very Anxious category, 6.67% in the Anxious category, 3.33% in the Brave category, and 6.67% in the Very Brave category. The data changed after the experimental group was given treatment using Augmented reality pictorial storybook media. The results of the posttest score trend table show that 6.67% of students are in the Very Anxious category, 13.33% in the Anxious category, 53.33% are in the Brave category, and 26.67% are in the Very Brave category. Furthermore, the data obtained from the mathematical anxiety questionnaire in the control group showed that the results of the score trend table before receiving treatment were 76.67% of students were in the Very Anxious category, 10% were in the Anxious category, 3.33% were in the Brave category, and 10% are in the Very Brave category. The results of the trend table of posttest scores in the control group are 63.33% in the Very Anxious category, 20% in the Anxious category, 6.67% in the Brave category, and 10% in the Very Brave category. The results of the analysis using this score trend table confirmed the results of the previous average comparison analysis that a significant decrease in student anxiety occurred in the experimental group, namely the group that received treatment using Augmented reality pictorial storybook media in learning mathematics. The following presents the results of the analysis of the score trend table in this study.

TABLE 4. *Analysis of score trends*

Group	Category	Percentage	
		Pretest	Posttest
Experiment	Very high	83.33%	6.67%
	High	6.67%	13.33%
	Low	3.33%	53.33%
	Very low	6.67%	26.67%
Control	Very high	76.67%	63.33%
	High	10%	20%
	Low	3.33%	6.67%
	Very low	10%	10%

The data obtained in this study were also analyzed by inferential statistical techniques using t-test. There are 2 t-tests used, namely paired t-test and independent t-test. Before the t-test was conducted, a prerequisite test was conducted by testing the homogeneity and normality of the data. This is done to ensure that the data comes from a homogeneous population and normal data, as well as to determine the type of statistics to be used. If the data is homogeneous and normal, then parametric statistics will be used. The results of the prerequisite test indicate that the data obtained are in the homogeneous category with a significance value of 0.636 (> 0.05). Furthermore, the results of the

prerequisite test also show that the data obtained in this study are normal data with a statistical value of 0.147 (> 0.05). The results of the prerequisite test lead to a conclusion that the parametric statistical test is feasible to use because the data comes from a homogeneous population and the data type is normal. The statistical test used next is the paired t-test.

The paired t-test in this study was conducted to determine whether there were differences in student anxiety in learning mathematics between before and after using Augmented reality pictorial storybook media. The hypothesis tested in this paired t-test is students' anxiety in learning mathematics between before and after being given treatment using Augmented reality pictorial storybook media. Paired t-test results show that the significance value is 0.00 (< 0.05). These results indicate that the hypothesis is accepted, therefore it can be concluded that there are differences in student anxiety in learning mathematics between before and after being given treatment using Augmented reality pictorial storybook media. Then, an independent t-test analysis was conducted on the research data.

The independent t-test was used to determine whether there was a difference in anxiety between the group using Augmented reality pictorial storybook media (experiment) and the group not using it (control). The hypothesis tested is that there is a difference in anxiety between the group using Augmented reality pictorial storybook media (experiment) and the group not using it (control). The results of the independent t-test showed that the significance value was 0.00 (< 0.05), which means the hypothesis is accepted, therefore it can be concluded that there is a difference in anxiety between the group using Augmented reality pictorial storybook media (experiment) and the group not using it (control). The following table presents the results of the independent t-test carried out in this study.

TABLE 5. *Independent t-test results*

Variable	<i>Equal Variances Assumed</i>		Information
	Value	Significance Assumption	
Math Anxiety	0.00	Sig. < 0.05	There's a difference

DISCUSSION

Augmented reality pictorial storybook is able to reduce the level of anxiety of elementary school students in learning mathematics through several components in it, namely 1) stories that are lifted from students' lives or experiences; 2) interesting pictures; 3) insertion of math materials and assignments; and 4) Augmented reality effect. The story published in this Augmented reality pictorial storybook is a story about student life in elementary school. The selection of this story or story is so that students can easily understand the storyline because the story is very close to them and has even become part of their daily routine. This is in accordance with the opinion of Kristen Read et al. which states that children will more easily understand stories that tell stories that are close and they have lived. Furthermore, the stories in the Augmented reality pictorial storybook are also targeted to help students achieve learning objectives, in this context is learning mathematics. Therefore, the stories presented tend to lead to mathematics learning materials. This is in accordance with the findings of Desi & Lumbantoruan (2020) which states that the delivery of mathematics material to students can be done using storybook media. In addition to helping provide understanding of concepts to students, story books can also be used to shape students' attitudes through the moral messages contained in them and develop students' skills. Media Augmented reality pictorial storybook in this study is also equipped with pictures.

There are 2 images used in this Augmented reality pictorial storybook, namely visualization images of the storyline and images of mathematical material, some of which are affixed with Augmented reality effects. The visualization pictures of the storyline are made in addition to attracting students' attention as well as to help students as readers understand the storyline or stories in the Augmented reality pictorial storybook. The use of pictures in a picture story book has a function to make it easier for readers to understand the story written on the story line. Furthermore, Nurgiyantoro (2018) explained that in addition to explaining or visualizing stories to make it easier for readers to understand the storyline, images also serve to attract readers' attention. The use of pictures in picture story books tends to increase children's motivation to read. Furthermore, the pictures of mathematical material that are loaded are pictures related to angle material. The use of these images is intended to equalize students' perceptions of the concept or angle material inserted in this media. This is in accordance with Amir's opinion, which explains that the use of images in learning, especially mathematics learning will be able to avoid students' multiple interpretations of the concepts explained so that students can understand them faster.

Some of the pictures in this Augmented reality pictorial storybook are given an Augmented reality effect which aims to make the pictures visually real to students, so that students understand clearly about the appearance of the picture even though it is presented in two-dimensional form. This is in accordance with the opinion of Lee (2012) which states that the effect of Augmented reality can be adopted in the development of learning media so that Augmented reality can visualize objects presented on a flat (two-dimensional) plane to be more real in three-dimensional form. Furthermore, Kangdon Lee (2012) that the use of Augmented reality effects can attract students' attention through a three-dimensional display that makes abstract objects look more concrete. This makes Augmented reality a very good potential to be actualized into learning to facilitate the achievement of learning objectives (Nincarean et al., 2013).

Media Augmented reality pictorial storybook is also equipped with practice questions that can hone students' skills on the material presented by the teacher in learning mathematics. This is in accordance with the findings of Pingge & Wangid (2016) which state that giving practice questions about the material presented can help students to explore, understand, and achieve learning objectives. Furthermore, the findings of Maskur, Nofrizal, & Syazli (2017) stated that giving assignments or practice questions in mathematics learning made it more likely for students to understand and remember the mathematical material presented. The practice questions given are questions that hone problem solving skills. Problem solving ability is one of the skills that must be possessed by students in learning mathematics (Adiansha et al., 2021; Lidinillah, 2008). Honing problem-solving skills in mathematics learning also tends to provide a more meaningful mathematics learning experience (Carden & Cline, 2015).

CONCLUSION

The results of this study indicate that Media Augmented reality pictorial storybook can have a significant effect so that the anxiety of elementary school students towards learning mathematics decreases. This is evident from the results of a significant decrease in the average level of student anxiety after using Augmented reality pictorial storybook media. The results of the score trend also show that there is a significant change in student anxiety after using Augmented reality pictorial storybook media from those who tend to be in the high anxiety category to tend to be low. On the other hand, the results of this study also prove that there is a difference in mathematical anxiety between students who use Augmented reality pictorial storybook media and those who do not. This research has only reached the stage of testing Augmented reality pictorial storybook media on the level of anxiety of elementary school students in learning mathematics. Further research can

raise the topic of applying Augmented reality pictorial storybook media to overcome students' problems in class in a classroom action research.

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