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Number sticking games extension assisted by augmented reality and pixVerse AI as visual media in supporting Deep Learning for disabilities

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Abstract. Mathematical literacy is an important skill that must be possessed by every individual, including children with special needs (ABK) such as deaf. This study aims to analyze mathematical literacy through number sticking games assisted by augmented reality and pixVerse AI for deaf students. The approach used in this study is a qualitative descriptive approach. The objects used were 8 deaf students at Semarang State Special School and the subjects in this study were 3 students representing the level of mathematical literacy categories. Subjects were taken using purposive sampling. Data collection was obtained through mathematical literacy tests and interviews, as well as documentation. Data analysis is through the stages of data reduction, data presentation, and drawing conclusions. The results of the study showed that mathematics learning on flat shape material through number sticking games assisted by augmented reality and pixVerse AI increased. High category students were able to meet 3 indicators of mathematical literacy, medium category students met 2 indicators, while low category students only met 1 indicator of mathematical literacy. In addition, all students from the high, medium, and low categories considered that learning using number sticking games assisted by augmented reality and pixVerse AI was interesting and useful in understanding flat geometry material.

Keywords: Mathematical Literacy; Number Sticking Games; Augmented Reality; Hearing Impaired; Plane Shapes

INTRODUCTION

In general, mathematics is used to understand concepts, measure, calculate, and assist in decision making. Mathematics is a compulsory subject to be studied at all levels of education from elementary school to college. Mathematics is a field of science that is able to build critical and systematic thinking in order to solve problems in everyday life (Hanan & Alim, 2023). There are several objectives in mathematics education including knowledge and skills.

According to Rasyid (2021), it is explained that in knowledge, students are expected to have an understanding and knowledge of mathematics both to face further studies, as well as for practical use in other subjects and in everyday life, and students understand the relationship between parts of mathematics. Meanwhile, Karomah et al., (2023) said that students' own skills are expected to: 1) have the skills to solve mathematical problems, both those related to everyday life, other fields of study, and in mathematics itself. 2) students are skilled at using mathematical knowledge to support other subjects. 3) students have the ability to analyze, synthesize, and draw conclusions. 4) students have the skills to use measuring instruments, calculating tools, and tables. In this case, the concept of mathematical literacy emerged, which not only emphasizes the ability to calculate and work on problems, but more on understanding, interpreting, and applying mathematical knowledge in situations that are relevant to real life.

Mathematical literacy refers to an individual's ability to recognize, understand, and use mathematics in diverse contexts (Wijaya et al., 2023). Mathematical literacy is not only about understanding mathematical theories and formulas, but also includes the skills to read situations, identify relevant information, analyze problems, and make the right decisions based on mathematical understanding (Hayati & Jannah, 2024). These skills are very important because mathematics is now a tool needed for various professions and fields of science, from technology, economics, to social sciences.

In the context of education, mathematical literacy is highly emphasized, especially with the need to prepare students to face the challenges of the 21st century (Ubaidah et al., 2022). Students are not only required to master aspects of mathematics, but are also asked to be able to apply this knowledge critically and creatively (Hatip & Setiawan, 2021). Therefore, mathematical literacy is an important indicator in assessing the quality of a person's understanding and mastery of mathematics. Based on the educational curriculum in various countries, mathematical literacy is one aspect that receives great attention. International organizations such as the "Programme for International Student Assessment (PISA)", for example, measure mathematical literacy as one indicator of the success of education in a country. Someone who has good mathematical literacy can more easily understand problems and find solutions based on logical and analytical thinking.

Mathematical literacy is an important skill for all individuals, including children with special needs such as deaf children. This is because mathematical literacy can help individuals understand, use, and formulate mathematical concepts in everyday life (Ubaidah & Kusmaryono, 2020). Mathematics is not just numbers and formulas, but also critical thinking skills and relevant problem solving. In this context, children with special needs such as deaf children, mathematical literacy becomes a challenge that requires special attention. Children with special needs who are deaf often face limitations in verbal communication, which can hinder their understanding of mathematical learning materials.

In mathematics lessons, deaf students often still have difficulty distinguishing between types of flat shapes (Nisa & Sugiman, 2021). This statement is confirmed by the results of observations and interviews with teachers of deaf students at Semarang State Special School. According to the interview, the teacher said that students still find it difficult to understand abstract concepts, especially geometric shapes such as flat shapes. This is one of the factors causing low mathematical literacy of deaf students. Low mathematical literacy is also because teachers still use conventional teaching methods. According to Fiddin et al., (2024) conventional teaching methods in learning mathematics are less effective for deaf children. Teaching methods that only rely on the use of textbooks and writing may not be able to meet learning needs optimally. Therefore, a more comprehensive and process-oriented approach is needed in the learning process.

Number sticking games assisted by augmented reality and pixVerse AI are one of the learning media that can be used in mathematics learning. The media involves the use of images or photos that can be "pulled out" to show additional information or explain more complex concepts. Number sticking games assisted by augmented reality and pixVerse AI can be made using simple materials that are easily obtained by teachers, so that it is expected to be able to make it easier for teachers to deliver the material. According to Wisnu Wardana et al., (2022), number sticking games assisted by augmented reality and pixVerse AI can provide students with experience in interacting directly with learning media.

The role of technology in education has grown rapidly, offering a variety of tools and resources that can help improve learning for children with special needs (ABK) such as deaf students. One of them is Augmented Reality (AR) technology, Augmented Reality (AR) is a technology that is currently quite common in everyday life. AR is also a technology in the field of communication and information that combines two-dimensional or three-dimensional virtual objects into the real three-dimensional world (Rizal et al., 2023). One that is often used is in applications installed on smartphones. AR is a real-time combination of virtual objects or digital content. This is in line with research from Albar et al., (2022), which found that augmented reality technology has advantages that can help students understand the material presented by the teacher.

Augmented Reality (AR) can be used as an effective visual media for children with special needs who are deaf in learning, because this technology is able to present interactive visual objects and information that can enrich the learning experience. This makes it easier for deaf children to understand abstract or difficult concepts through concrete and interesting visualizations, so that the learning process becomes more fun and easier to understand (Firdaus et al., 2021). Augmented Reality (AR) can be applied in learning media number sticking games assisted by augmented reality and pixVerse AI which displays images or photos interactively.

Research on mathematical literacy in deaf students is still limited, especially using learning media number sticking games assisted by augmented reality and pixVerse AI which combines augmented reality technology. Most previous studies have focused more on conventional teaching techniques that are less effective in reaching the specific needs of deaf students. Based on constructivist learning theory, students learn better when they can interact with the material directly. Augmented reality allows students to explore the world of mathematics more interactively, thereby improving their mathematical literacy. In addition, the importance of collaboration between teachers and students cannot be ignored. The use of number sticking games assisted by augmented reality and pixVerse AI with augmented reality technology is expected to create better communication between all parties involved in the process of learning mathematics for deaf students.

From several backgrounds, researchers are interested in conducting research that focuses on " Number sticking games extension assisted by augmented reality and pixVerse AI as Visual Media in Supporting Deep Learning for Disabilities". This research is expected to provide new insights into how learning media Number Sticking Games Assisted by Augmented Reality and PixVerse AI with Augmented Reality technology can be used to improve mathematical literacy for students with special needs, as well as provide recommendations for better educational practices.

METHOD

The approach used in this study is a descriptive qualitative method. The researcher chose a descriptive approach because this study focuses on the description stage, namely analyzing and presenting facts systematically. According to Sugiyono (2019), a descriptive approach is an approach that aims to describe, explain, and answer problems related to events experienced by research subjects. Qualitative descriptive research displays data without manipulation or additional treatment. This study aims to provide a comprehensive picture of an event to reveal and clarify the phenomena that occur. This process is carried out by describing several variables related to the problem being studied. This study also interprets and describes data that is relevant to the ongoing situation (Rusandi & Rusli, 2021). This study focuses on the mathematical literacy of deaf students through number sticking games assisted by augmented reality and pixVerse AI.

This research was conducted through various stages, starting from the initial stage, namely determining the location of the research, making a research permit, coordinating with the school through the TU teacher and the teacher of deaf students to determine the research schedule. The place to conduct the research was the Semarang State Special School for the Deaf. The object of this study was the mathematical literacy of all deaf students totaling 8 students with 3 male students and 5 female students at the Sekolah Luar Biasa (SLB) Semarang, Indonesia of Special School for the 2024/2025 Academic Year. In this study, the sampling technique applied was purposive sampling. The researcher determined the sample and chose it because the material on flat shapes was taught in that class. In addition, deaf students still have difficulty in distinguishing the types of flat shapes based on their properties. The research subjects were taken 3 people based on their initial mathematical abilities with categories of high, medium, and low mathematical literacy. Each category of mathematical literacy is represented by 1 student to be the subject of the research. The data in this study consists of primary data and secondary data. Primary data was obtained through mathematical literacy tests and interviews, while secondary data was in the form of references relevant to the topic of this research.

In this study, the researcher acts as the main instrument, while the instruments used in the study include a written test of mathematical literacy on flat shape material consisting of 3 questions covering indicators of mathematical literacy, and interviews. This study uses indicators of mathematical literacy according to the OECD (2022) which are shown in table 1. The results of the mathematical literacy test are categorized based on the level of mathematical literacy ability, namely at high, medium, and low levels. The category of students' mathematical literacy achievement uses the theory (Rachmania & Darwis, 2021) in table 2. After being categorized according to the level of mathematical literacy ability, the results of the mathematical literacy test are confirmed through interviews to determine the level of achievement of each subject based on each category. The researcher conducted interviews with the subjects accompanied by teachers, in addition, the researcher also conducted interviews with teachers as additional information for the researcher. The data analysis technique used is Miles and Huberman data analysis (Sugiyono, 2019), where qualitative data analysis is carried out interactively through stages such as data reduction, data presentation, and drawing conclusions (verification).

Table 1. Mathematical Literacy Indicators According to Ubaidah, et all (2024)

No.	Mathematical Literacy Indicators
1	Identifying mathematical situations
2	reasoning
3	Communicating mathematically
4	Strategizing in problem solving
5	Representing mathematics in everyday life

Table 2. Mathematical Literacy Ability Category Scale

Mark	Mathematical Literacy Ability Category
0-60	Low
61-75	Currently
76-100	Tall

RESULTS AND DISCUSSION

Results

The research was conducted on January 20-21 and January 23, 2025 at SLB Negeri Semarang. The subjects in this study were 8 deaf students at SLB Negeri Semarang. On January 20, 2025 was the first day of the research where students and researchers conducted mathematics learning related to flat shape material using number sticking games assisted by augmented reality and pixVerse AI. On the second day of the research, namely on January 21, 2025, at this second meeting, students worked on a mathematics literacy test related to flat shape material. The third day was the last day of the research, namely on January 23, 2025, on this last day the researcher conducted interviews with students who had been categorized according to the results of the mathematics literacy test. Each category selected one student who was categorized as high, medium, and low.

Mathematics Learning Using Number Sticking Games Assisted by Augmented Reality and PixVerse AI

In this study, researchers carried out the process of learning mathematics related to flat shapes. Researchers used learning media, namely number sticking games assisted by augmented reality and pixVerse AI to encourage increased mathematical literacy of students. All series of learning processes carried out were of course in accordance with the teaching module that researchers compiled based on the stages of the learning model using pull out photo math based on augmented reality technology. The stages of the process of learning mathematics for flat shapes using number sticking games assisted by augmented reality and pixVerse AI are as follows.

1. **First Meeting of Mathematics Learning Material Flat Buildings**

Figure 1. Learning Flat Buildings Using Number Sticking Games Assisted by Augmented Reality and PixVerse AI

At the first meeting in this study, the researcher carried out preliminary activities by informing students to prepare for the learning process. Furthermore, the researcher checked student attendance through the attendance list. After that, the researcher guided students to pray together as the beginning of the learning activity. The researcher also motivated students to be enthusiastic about learning and established class agreements. Before entering the core activities, the researcher delivered an apperception, delivered the learning material to be studied, and informed the learning objectives. The core learning activities began with the student thinking stage. The researcher explained the material on flat shapes by drawing the shapes of flat shapes on the board, then invited students to distinguish the types of flat shapes, such as triangles, quadrilaterals, and circles. Furthermore, the researcher provided an introduction and introduced students to number sticking games assisted by augmented reality and pixVerse AI. At this stage, students begin to think by listening, observing, and understanding important things related to the material studied through the media.

In the second stage, namely speaking, the researcher asked open-ended questions that encouraged discussion and critical thinking. The researcher invited students to observe the media number sticking games assisted by augmented reality and pixVerse AI and compare the differences in each plane figure. The researcher asked the question, "Look at the shape of the circle and square, are they the same?". Next, students were asked to distinguish between triangles, squares, and circles by looking for photos of objects in the shape of triangles, squares, and circles that were randomly selected by the researcher to be attached to the box number sticking games assisted by augmented reality and pixVerse AI according to the title of the box. Then, the researcher informed that behind the box number sticking games assisted by augmented reality and pixVerse AI there is a QR code that can be scanned by students to display the plane figure in real time at the same time. Students were also guided by the researcher to try scanning the QR code using Assemblr Edu which had been installed on the researcher's cellphone. From the results of the scan, students can see the plane figure directly. Students who have difficulty finding and pasting photos of triangular, quadrilateral, and circular objects in number sticking games assisted by augmented reality and pixVerse AI, as well as having difficulty scanning QR codes to project augmented reality three-dimensional flat shapes, can ask questions to the researcher during the question and answer session at this stage. Other students will also respond to each other, and the researcher will accompany and contribute to the discussion. At this stage, the researcher and students then together conclude the learning process that has been carried out regarding the types of flat shapes using number sticking games assisted by augmented reality and pixVerse AI.

In the third stage, namely writing, the researcher gave questions related to flat geometric figures on the board. Students were asked to answer the questions on the board. The researcher then gave appreciation to students who managed to answer the questions correctly. If there were students who had difficulty answering, the researcher would guide the students until they managed to complete the questions.

The first meeting ended with the researcher giving appreciation to the students who had followed the learning orderly. The researcher and the students reflected and confirmed the summary or conclusion of the material that had been delivered. Based on observations during the learning process, several students still had difficulty in distinguishing photos of triangular, rectangular, and circular objects in the number sticking games assisted by augmented reality and pixVerse AI. In addition, there were still students who had difficulty scanning the QR code behind the number sticking games box assisted by augmented reality and pixVerse AI using the Assemblr Edu application on the researcher's cellphone. In closing, the researcher reminded the material by asking students to mention all the names of the flat shapes that had been learned that day. After that, the researcher guided the students to pray to end the learning and gave a closing greeting.

2. Second Meeting of the Implementation of the Mathematics Literacy Test

Figure 2. Implementation of the Mathematics Literacy Test

In the second meeting, the learning stages were similar to the first meeting, starting with an introduction, continuing with core activities, and ending with a closing. In the second meeting, students had studied the material on flat shapes, implemented learning media number sticking games assisted by augmented reality and pixVerse AI, and explored augmented reality technology by projecting flat shapes in three dimensions by scanning the QR code behind the box number sticking games assisted by augmented reality and pixVerse AI using the Assemblr Edu application on the researcher's cellphone which had previously been introduced in the first meeting.

In the second meeting in the writing stage, students were given mathematical literacy test questions related to the flat shape material that had been studied in the previous meeting. Furthermore, students were asked to work on the test within 60 minutes. During the learning process, the researcher conducted observations and found that students showed ease in understanding and completing mathematical literacy test questions related to flat shapes.

3. Third Meeting of Interview Implementation

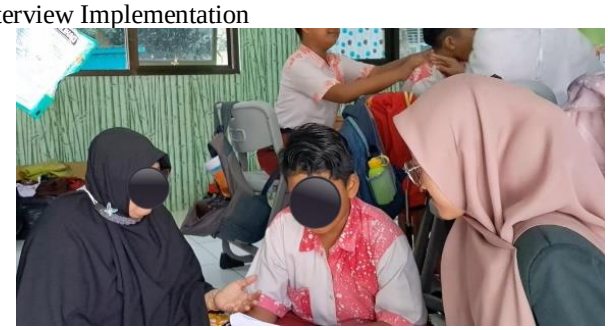

Figure 3. Implementation of interviews with students

In the third meeting, the learning stages took place similarly to the second meeting, starting with an introduction, continuing with core activities, and ending with a closing. In this meeting, the researcher conducted interviews with students based on the results of the mathematical literacy test. The test results showed that there were 3 students in the high category, 3 students in the medium category, and 2 students in the low category. From each category of mathematical literacy, one subject was selected to be interviewed after participating in flat building learning using number sticking games assisted by augmented reality and pixVerse AI. The researcher conducted interviews with the subjects accompanied by the teacher, in addition the researcher also interviewed the teacher.

Student Mathematics Literacy Test Results

From the results of the study, namely the mathematical literacy test taken by 8 students, the level of student literacy abilities will be categorized according to Rachmania & Darwis (2021), namely the high, medium, and low mathematical literacy categories. There are 3 students who are included in the high mathematical literacy category, 3 students are included in the medium mathematical literacy category, and 2 students with the low mathematical literacy category. Then one research subject was taken from each category, namely the high, medium, and low category subjects. In analyzing the mathematical literacy of deaf students through number sticking games assisted by augmented reality and pixVerse AI, subject coding was carried out based on the mathematical literacy category shown in table 3. This coding aims to understand the thinking process of deaf students more effectively and to facilitate data processing and

analysis. Therefore, the thinking patterns of each category of students can be identified systematically so as to provide deeper insight into the understanding and difficulties faced by deaf students in solving mathematical literacy problems related to flat shapes.

Table 3. Coding of Mathematical Literacy Ability Categories

Mathematical Literacy Ability Category	Code
Low	SR
Currently	SS
Tall	ST

The following is the level of mathematical literacy ability of each research subject based on each category of mathematical literacy:

ST Data Analysis

Subject ST successfully completed the problem according to three indicators of mathematical literacy, namely formulating problems mathematically, using concepts, facts, procedures, and mathematical reasoning, as well as interpreting, applying, and evaluating the solutions obtained. From the test results, ST obtained the values as in table 4.

Table 4. ST Mathematics Literacy Test Scores

No.	Subject Name Initials	Question Score			Total Score	Mark
		1	2	3		
1	ATH	10	9	10	29	97

The following are the results of the mathematical literacy test questions for the ST subject on question number 1.

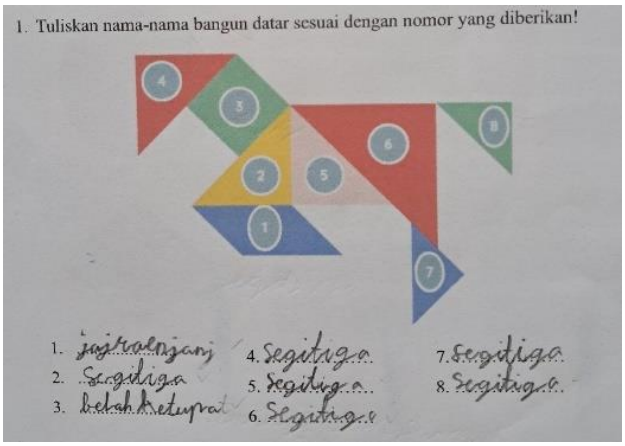

Figure 4. ST's Answer to Question Number 1

Figure 4 shows the results of the written test for subject ST number 1, which was then strengthened through an interview with subject ST accompanied by a teacher to clarify and explain the written answers.

Q: After reading question number one, do you understand the meaning of the question?
ST: Yes, I understand, miss.
Q: What is known in question number two?
ST: Question number one is a flat shape arrangement in the shape of a horse.
Q: Yes, that's right, then what are the questions in question number one?
ST: Write the name of the horse-shaped flat shape according to the number.
Q: How do you solve this problem?
ST: By remembering the shape of flat shapes.
Q: Then, why did you finish by remembering the shape of the plane geometry?
ST: Because it can help me to work on the questions.
Q: Did you solve question number one in order?
ST: I did it in order from picture number one.
Q: Have you finished all of question number one?
ST: Yes, ma'am.
Q: How do you draw conclusions from the answers you have obtained?

ST: Write down the names of the flat shapes that I remember according to the numbers, miss.

From the results of the mathematical literacy test and interviews, subject ST showed that he was able to understand the intent of the questions. Then subject ST was able to formulate the questions given in the questions, namely writing the name of the flat shape according to the number listed on the flat shape . Thus, subject ST has shown that he meets the indicators of mathematical literacy, namely being able to formulate problems mathematically. In addition, subject ST managed to solve the questions with the correct procedure, working on the questions sequentially according to the numbers listed on the flat shape. This shows that subject ST has met the second indicator of mathematical literacy, namely using concepts, facts, procedures, and mathematical reasoning correctly. The results of the interview also showed that subject ST explained that he had completed all the questions in number one which can be seen from the results of the mathematical literacy test that have been completely filled in. This shows that subject ST has met the indicators of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Therefore, it can be concluded that subject ST has succeeded in solving the questions according to the three indicators of mathematical literacy and meets all existing indicators.

The following are the results of the ST subject mathematics literacy test questions on question number 2.

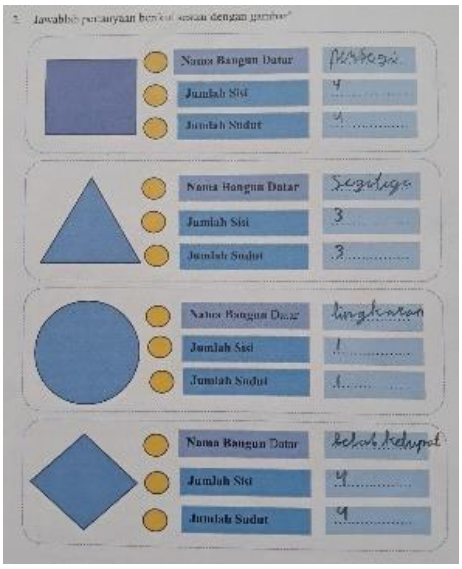

Figure 5. ST's Answer to Question Number 2

Figure 5 shows the results of the written test for subject ST number 2, which was then strengthened through an interview with subject ST accompanied by a teacher to clarify and explain the written answers.

Q: After reading question number two, do you understand the meaning of the question?
ST: I understand, miss.
Q: What is known in question number two?
ST: Question number two has a picture of a square, triangle, circle, and rhombus.
Q: Yes, that's right, then what are the questions in question number two?
ST: Asked to write the name of the shape, count the sides, and count the angles.
Q: How do you solve this problem?
ST: Write the name of the shape first, then count the sides, then count the angles.
Q: Then, why do you use those steps?
ST: I prefer that way because it is easy to answer the questions.
Q: Did you do question number two in order?
ST: I did it in order from the square picture, miss.
Q: From the test results, does the circle have angles?
ST: Yes, sis, because the circle is round.
Q: Have you finished all of question number two?
ST: Yes, ma'am.
Q: How do you draw conclusions from the answers you have obtained?

ST: Write the name of the plane shape according to the picture and write the number of sides and angles according to the picture.

From the results of the mathematical literacy test and interviews, subject ST showed that he was able to understand the meaning of question number two. Then subject ST was able to formulate the questions given in the question, namely writing the name of the plane figure that matches the picture, calculating the number of sides and angles. This shows that subject ST has met the indicators of mathematical literacy, namely being able to formulate problems mathematically. From the results of the mathematical literacy test, subject ST still did not answer the number of angles of a circle correctly. However, subject ST managed to solve the problem with the correct procedure, working on the problem sequentially. This proves that subject ST has met the second indicator of mathematical literacy, namely using concepts, facts, procedures, and mathematical reasoning correctly. In addition, subject ST explained that he had completed all the questions in number two which can be seen from the results of the mathematical literacy test that have been filled in completely. This shows that subject ST has met the indicators of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Therefore, it can be concluded that subject ST has succeeded in solving the problem according to the three indicators of mathematical literacy and has met all the indicators that have been set.

The following are the results of the ST subject mathematics literacy test questions on question number 3.

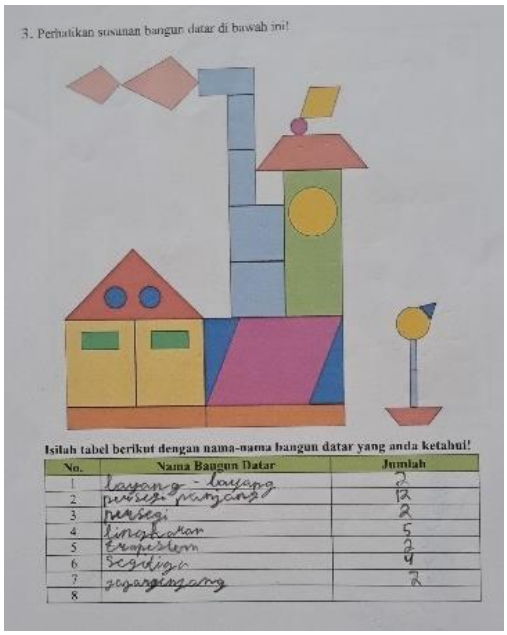

Figure 6. ST's Answer to Question Number 3

Figure 6 shows the results of the written test for subject ST number 3 which was then strengthened through an interview with subject ST accompanied by the teacher to clarify and explain the written answers.
Q: After reading question number three, do you understand the meaning of the question?
ST: I understand, miss.
Q: What is known in question number three?
ST: There are triangles, squares, kites, trapezoids, parallelograms, rectangles and circles in the shape of a house.
Q: That's right, then what are the questions for question number three?
ST: Counting triangles, squares, kites, trapezoids, parallelograms, rectangles and circles.
Q: How do you solve this problem?
ST: Write the name of the shape first, then count the number.
Q: Then, why did you choose those steps?
ST : Easy to solve the questions.
Q: Did you do question number three in order?

ST: I did it by counting the number of kites, rectangles, squares, circles, trapezoids, triangles, and parallelograms.
Q: Have you finished all of question number three?
ST: Yes, ma'am.
Q: How do you draw conclusions from the answers you have obtained?
ST: Count the number of pictures over and over again until the result is the same, then I write down the name and number of pictures.

It can be seen that the results of the mathematical literacy test and the interview of subject ST showed that he was able to understand the intent of the question. In addition, subject ST was also able to formulate the questions given in the question, namely calculating the number of flat shapes according to their type. Therefore, subject ST showed that he had met the indicator of mathematical literacy, namely being able to formulate problems mathematically. However, from the results of the mathematical literacy test, subject ST still did not answer the question of the number of angles of a circle correctly. However, subject ST managed to solve the problem with the correct procedure, namely working on the questions sequentially. This proves that subject ST has met the second indicator of mathematical literacy, namely using concepts, facts, procedures, and mathematical reasoning correctly. Not only that, subject ST also said that he had completed all the questions in number three which can be seen from the results of the mathematical literacy test that have been filled in completely. Therefore, subject ST showed that he had met the third indicator of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Thus, it can be concluded that subject ST has succeeded in solving the problem according to the three indicators of mathematical literacy and meets all the indicators that have been set.

2. SS Data Analysis

Subject SS is able to solve problems according to three indicators of mathematical literacy, namely formulating and fulfilling two of the three indicators, namely formulating problems mathematically and using concepts, facts, procedures, and mathematical reasoning. From the results of the ST test, the scores obtained are as shown in table 5.

Table 5. SS Mathematics Literacy Test Scores

No.	Subject Name Initials	Question Score			Total Score	Mark
		1	2	3		
1	IFT	10	8	3	21	70

The following are the results of the math literacy test questions for the SS subject on question number 1.

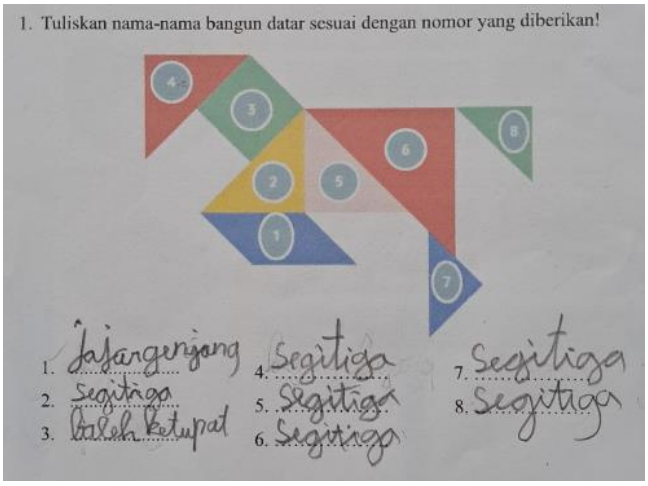

Figure 7. SS's Answer to Question Number 1

Figure 7 shows the results of the written test for subject SS number 1, which was further clarified through an interview with the subject SS who was accompanied by a teacher to clarify and explain the written answers.
Q: After reading question number one, do you understand the meaning of the question?
SS : Understood.
Q: What is known in question number one?

SS: There are triangles, rhombuses, and parallelograms formed into the shape of a horse.
Q: Okay, that's right, then what are the questions in question number one?
SS: Write the name of the image according to the number.
Q: How do you solve this problem?
SS: Remembering pictures of triangles, squares, parallelograms, and rhombuses.
Q: Then, why did you choose to remember the shape of flat shapes?
SS: To make it easier to do the questions, miss.
Q: Did you do question number one in order?
SS: Yes, massage, miss.
Q: Have you finished all of question number one?
SS: Yes, it's all finished.
Q: How do you draw conclusions from the answers you have obtained?
SS: I still have difficulty writing the names of flat shapes, miss.

The results of the mathematical literacy test and interview showed that the SS subject was able to understand the intent of the question. Furthermore, the SS subject was able to formulate the questions given in the question by writing the names of the plane figures according to the numbers listed on each plane figure. Thus, the SS subject has demonstrated fulfillment of the mathematical literacy indicator, namely being able to formulate problems mathematically. In addition, the SS subject successfully completed the questions with the correct procedure, namely working on the questions sequentially according to the numbers listed on the plane figure. This means that the SS subject has fulfilled the second indicator of mathematical literacy, namely using mathematical concepts, facts, procedures, and reasoning correctly. Based on the interview results, it shows that the SS subject said that he had completed all the questions in number one which can be seen from the results of the mathematical literacy test that have been completely filled in. However, the SS subject still has difficulty in writing the names of the types of plane figures. Therefore, the SS subject has not fulfilled the third indicator of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Therefore, it can be concluded that the SS subject has successfully completed the questions according to the mathematical literacy indicators and fulfilled two of the three indicators set.

The following are the results of the math literacy test questions for the SS subject on question number 2.

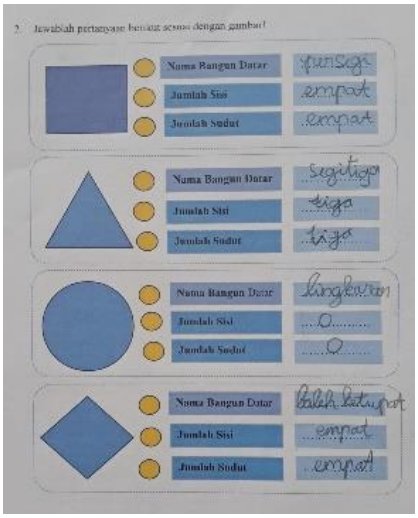

Figure 8. SS's Answer to Question Number 2

Based on Figure 8, the results of the written test for subject SS number 2 were strengthened through interviews with subject SS who were accompanied by the teacher to clarify and explain the written answers.
Q: After reading question number two, do you understand the meaning of the question?
SS: I understand, Sis.
Q: What is known in question number two?
SS: There are pictures of squares, triangles, circles, and rhombuses.
Q: Yes, that's right, then what are the questions in question number two?
SS: Name of the shape, number of sides, and number of angles.

Q: How do you solve this problem?
SS : Counting sides and calculating angles.
Q: Then, why do you use those steps?
SS: Because what is asked is the number of sides and angles.
Q: Did you do question number two in order?
SS: Yes, counting the sides and angles of a square, then counting the sides and angles of a triangle, then counting the sides and angles of a circle, finally counting the sides and angles of a rhombus.
Q: From the test results, does a circle have sides and angles?
SS : No.
Q: Have you finished all of question number two?
SS: Yes, ma'am.
Q: How do you draw conclusions from the answers you have obtained?
SS: I have difficulty determining the sides and angles, miss.

The results of the mathematical literacy test and interview showed that the SS subject understood the intent of the problem. Then the SS subject was able to formulate questions in the problem, namely writing the name of the flat shape according to the picture and calculating the number of sides and angles. Therefore, the SS subject has fulfilled the mathematical literacy indicator, namely being able to formulate problems mathematically. Based on the results of the mathematical literacy test, the SS subject has not given the correct answer regarding the number of sides and angles of the circle. However, the SS subject managed to solve the problem with the correct procedure, namely working on the problem sequentially. This proves that the SS subject has fulfilled the second indicator of mathematical literacy, namely using mathematical concepts, facts, procedures, and reasoning correctly. In addition, the SS subject has completed all the questions in number two which can be seen from the results of the mathematical literacy test that have been completely filled in. In question number two, the SS subject still has difficulty in determining and calculating the sides and angles of the flat shape. So the SS subject has not been able to fulfill the third indicator of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Thus, it can be concluded that the SS subject has succeeded in solving the problem according to the mathematical literacy indicator and fulfilling two of the three indicators that have been set.

The following are the results of the math literacy test questions for the SS subject on question number 3.

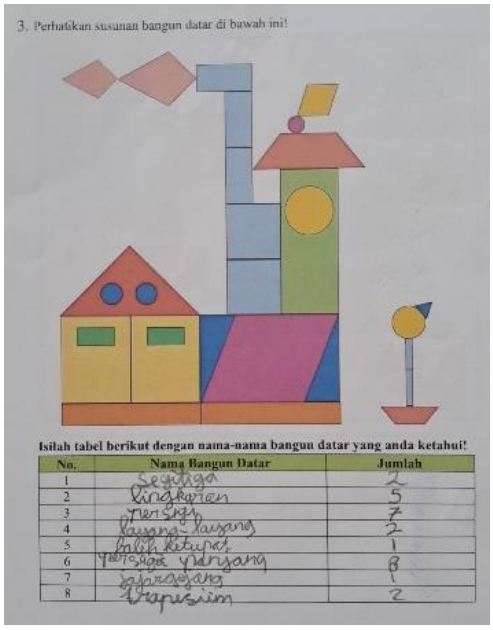

Figure 9. SS's Answer to Question Number 3

Figure 5 shows the results of the written test for subject SS on number 3, which was then clarified through an interview with subject SS accompanied by a teacher to clarify and explain the written answers.
Q: After reading question number two, do you understand the meaning of the question?
SS : Understood.

Q: What is known in question number three?
SS: There is a picture of a house made of flat shapes.
Q: That's right, then what are the questions in question number three?
SS: Calculating flat geometric figures.
Q: How do you solve this problem?
SS: Determine the plane shape, then calculate it.
Q: Then, why did you choose that strategy?
SS: As taught, miss.
Q: Did you do question number three in order?
SS: Order from triangle, circle, square, kite, rhombus, rectangle, parallelogram, and trapezoid.
Q: Have you finished all of question number three?
SS : Yes.
Q: How do you draw conclusions from the answers you have obtained?
SS: Still having trouble calculating the flat shapes, miss.

It can be seen from the results of the literacy test and interviews of the SS subjects that they were able to understand the intent of the questions. In addition, the SS subjects were also able to formulate the questions asked in the questions, namely calculating the number of flat shapes according to their type. Thus, the SS subjects have been able to meet the indicators of mathematical literacy, namely formulating problems mathematically. Meanwhile, from the results of the mathematical literacy test, the SS subjects still did not answer the number of flat shapes according to their type correctly. However, the SS subjects managed to solve the questions with the correct procedure, namely working on the questions based on what is known. Therefore, the SS subjects have met the second indicator of mathematical literacy, namely using mathematical concepts, facts, procedures, and reasoning correctly. Then, the SS subjects also said that they had completed all the questions in number three which can be seen from the results of the mathematical literacy test that they were completely filled in. However, the SS subjects still did not correctly conclude the correct answer. So, the SS subjects have not been able to meet the third indicator of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Therefore, it can be concluded that the SS subjects have succeeded in solving the questions according to the mathematical literacy indicators and fulfilling two of the three indicators that have been set.

SR Data Analysis

Subject SR successfully completed the questions according to three indicators of mathematical literacy and fulfilled one of the indicators, namely formulating problems mathematically. From the test results, SR obtained the values as shown in table 6.

Table 6. SR Mathematics Literacy Test Scores

No.	Subject Name Initials	Question Score			Total Score	Mark
		1	2	3		
1	GTA	3	8	2	13	43

The following are the results of the SR subject mathematics literacy test questions on question number 1.

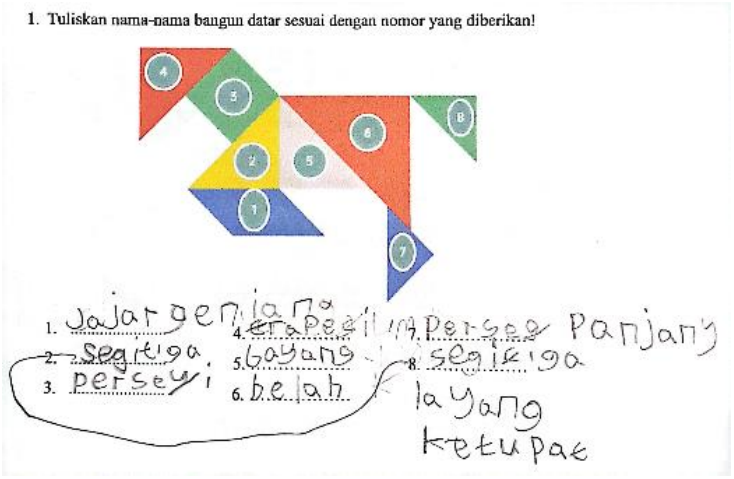

Figure 10. SR's Answer to Question Number 1

Figure 10 shows the results of the written test for subject SR number 1, which was then strengthened through an interview with the SR subject accompanied by the teacher to clarify and explain the written answers.

Q: After reading question number one, do you understand the meaning of the question?
SR: I understand.
Q: What is known in question number one?
SR : Image of a horse made from arranged triangles.
Q: Yes, that's right, then what are the questions in question number one?
SR: the name of a numbered flat shape in the shape of a horse.
Q: How do you solve this problem?
SR: Remembering the shape of flat shapes.
Q: Then, why did you choose to remember the shape of flat shapes?
SR: So that I can answer the questions.
Q: Did you do question number one in order?
SR: Answer from picture number four.
Q: Have you finished all of question number one?
SR : Yes.
Q: How do you draw conclusions from the answers you have obtained?
SR: Difficulty writing the names of flat shapes.

The results of the mathematical literacy test and the SR subject interview showed that they were able to understand the intent of the question. Then the SR subject was able to formulate the questions given in the question, namely writing the name of the flat shape according to the number listed on the flat shape. Therefore, the SR subject has met the mathematical literacy indicator, namely being able to formulate problems mathematically. In addition, the SR subject worked randomly and still had difficulty in writing the name of the flat shape. This shows that the SR subject has not been able to meet the second indicator of mathematical literacy, namely using concepts, facts, procedures, and mathematical reasoning correctly. Based on the interview results, it also showed that the SR subject said that he had completed all the questions on number one which can be seen from the results of the mathematical literacy test that have been filled in completely. However, the SR subject was unable to write the name of the flat shape correctly. So it can be said that the SR subject did not meet the mathematical literacy indicator, namely interpreting, applying, and evaluating the solutions obtained. Thus, it can be concluded that the SR subject has succeeded in solving the problem according to the mathematical literacy indicator and fulfills only one existing indicator.

The following are the results of the SR subject mathematics literacy test questions on question number 2.

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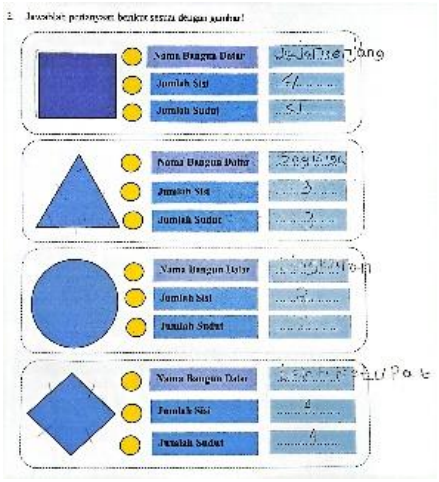

Figure 11. SR's Answer to Question Number 2

It can be seen from Figure 11 that the results of the written test for subject SR number 2 were strengthened through interviews with subject SR accompanied by the teacher to clarify and explain the written answers.

Q: After reading question number two, do you understand the meaning of the question?
SR : Understood.
Q: What is known in question number two?
SR : Draw a rectangle, triangle, circle, and rhombus.
Q: That's right, then what are the questions in question number two?
SR : Number of sides and angles.
Q: How do you solve this problem?
SR : Count sides and angles.
Q: Then, why did you choose those steps?
SR: Don't know, still confused about determining sides and angles.
Q: Did you do question number two in order?
SR : No.
Q: From the test results, does the circle have angles?
SR : Yes.
Q: Have you finished all of question number two?
SR: Yes, ma'am.
Q: How do you draw conclusions from the answers you have obtained?
SR : As per the picture.

Based on the results of the mathematical literacy test and the interview, subject SR showed that he was able to understand the intent of the question. In addition, subject SR was able to formulate the questions given in the question, namely writing the name of the plane figure correctly. So that subject SR has met the indicator of mathematical literacy, namely being able to formulate problems mathematically. From the results of the mathematical literacy test, subject SR still has not answered the number of sides and angles correctly. Subject SR also has not been able to solve questions with the right procedure, he still cannot count the sides and angles. This proves that subject SS does not meet the second indicator of mathematical literacy, namely using concepts, facts, procedures, and mathematical reasoning correctly. In addition, subject SS explained that he had completed all the questions in number two which can be seen from the results of the mathematical literacy test that have been filled in completely. However, subject SR has not been able to draw conclusions because there are still difficulties in distinguishing the types of plane figures. So subject SR shows that he has not met the third indicator of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. So, it can be concluded that the SR subject has succeeded in solving the problem according to the three indicators of mathematical literacy and only fulfills one indicator, namely formulating the problem mathematically.

The following are the results of the SR subject mathematics literacy test questions on question number 3.

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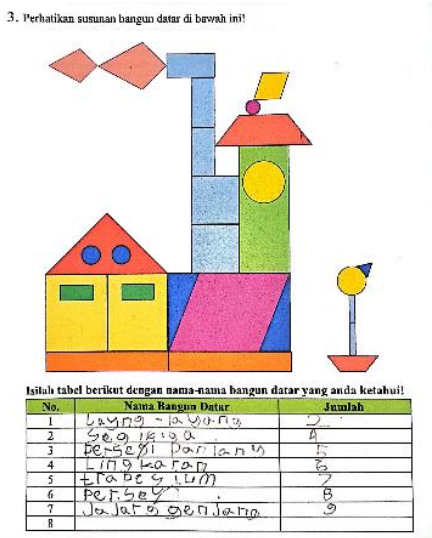

Figure 12. SR's Answer to Question Number 3

Figure 12 shows the results of the written test for subject SR number 3 which was then strengthened through an interview with the SR subject accompanied by the teacher to clarify and explain the written answers.

Q: After reading question number two, do you understand the meaning of the question?
SR: Yes, I understand, miss.
Q: What is known from the question?
SR: There are houses made from triangles, circles, and rectangles.
Q: Yes, that's right, then what are the questions in question number two?
SR : Count the number of images.
Q: How do you solve this problem?
SR: Yes, calculating triangles, circles, and rectangles.
Q: Then, why did you choose those steps?
SR : It's difficult.
Q: Did you do question number three in order?
SR: No, I counted kites, triangles, rectangles, circles, trapezoids, squares, and parallelograms.
Q: Have you finished all of question number three?
SR: Yes, ma'am.
Q: How do you draw conclusions from the answers you have obtained?
SR: There are so many pictures, it's confusing.

From the results of the literacy test and interview, the SR subject showed that he was able to understand the intent of the question. Then the SR subject was able to formulate the questions given in the question, namely the number of sides and angles. This shows that the SR subject has met the indicator of mathematical literacy, namely being able to formulate problems mathematically. Based on the results of the mathematical literacy test, the SR subject still did not answer the number of flat shapes according to their type correctly. This proves that the SR subject has not met the second indicator of mathematical literacy, namely using mathematical concepts, facts, procedures, and reasoning correctly. In addition, the SR subject explained that he had completed all the questions in number three which can be seen from the results of the mathematical literacy test that they have been completely filled in. However, the SR subject has not been able to conclude how many flat shapes there are, kites, rectangles, triangles, parallelograms, circles, squares and trapezoids. This shows that the SR subject has not been able to meet the third indicator of mathematical literacy, namely interpreting, applying, and evaluating the solutions obtained. Therefore, it can be concluded that the SR subject has succeeded in completing the mathematical literacy questions and only meets one indicator, namely formulating problems mathematically.

Student Perception After Learning Using Number Sticking Games Assisted by Augmented Reality and PixVerse AI
High Category Student Perception

The following are the results of an interview with subject ST regarding the process of learning flat shapes using number sticking games assisted by augmented reality and pixVerse AI .
Q: How was your experience in learning flat shapes using number sticking games assisted by augmented reality and pixVerse AI?
ST: It's fun, sis, I'm happy, the box is nice.
Q: Does the teaching method using number sticking games assisted by augmented reality and pixVerse AI help you understand flat shapes?
ST: Yes, I understand. I can recognize parallelograms, trapezoids, and rhombuses.
Q: How do you feel about learning using augmented reality technology?
ST: Very interesting, the image can appear like the real thing.

According to subject ST from the interview results, learning flat geometry material using number sticking games assisted by augmented reality and pixVerse AI is considered interesting and useful. The media can help him in learning various types of flat geometry and facilitate direct visualization. In addition, this learning experience is something new for subject ST, so he feels very happy.

Student Perception is in the Medium Category

The following is a summary of the interview results with subject SS regarding the learning process of flat geometry material using number sticking games assisted by augmented reality and pixVerse AI.
Q: How was your experience in learning flat shapes using number sticking games assisted by augmented reality and pixVerse AI?
SS: Like it, interesting, never get bored of studying.
Q: Does the teaching method using number sticking games assisted by augmented reality and pixVerse AI help you understand flat shapes?
SS: Yes, so I understand.
Q: How do you respond to learning using augmented reality technology?
SS: Interesting, I like it because the image can appear from outside the cellphone.

According to the subject SS in the interview, it shows that learning flat shapes using number sticking games assisted by augmented reality and pixVerse AI is considered interesting and useful. The media helps him in visualizing three-dimensional flat shapes directly through a cellphone. Therefore, making learning mathematics more fun and not boring.

Low Category of Student Perception

The following are the results of an interview with subject SR regarding the learning process of flat geometry material using a number sticking games assisted by augmented reality and pixVerse AI.
Q: How was your experience in learning flat shapes using number sticking games assisted by augmented reality and pixVerse AI?
SR: Yes, sis, interesting.
Q: Does the teaching method using number sticking games assisted by augmented reality and pixVerse AI help you understand flat shapes?
SR : Yes.
Q: How do you respond to learning using augmented reality technology?
SR: Good, I like it. The flat shape image can be seen directly, the image can also be enlarged and reduced.

From the interview results, subject SR said that learning mathematics on flat shapes using pull-out photo math box based on augmented reality technology was interesting and useful. Subject Sr felt that learning was more fun because he could see flat shapes in real time. In addition, the use of augmented reality technology allows him to enlarge and reduce the image of flat shapes, making it easier to visualize.

Interview Results with Teachers

The following are the results of interviews with teachers regarding the process of learning mathematics on flat geometry material using number sticking games assisted by augmented reality and pixVerse AI.
Q: What is your response to the number sticking games media assisted by augmented reality and pixVerse AI in mathematics learning?
G: Interesting, sis, the media number sticking games assisted by augmented reality and pixVerse AI are relatively new for children. So they are interested in learning and also make children active and responsive.
Q: Do students understand the types of flat shapes better after using number sticking games assisted by augmented reality and pixVerse AI ?
G: Yes, ma'am, now I understand. In the past, children still could not distinguish between types of flat shapes, now after using number sticking games assisted by augmented reality and pixVerse AI, they know

the shape of flat shapes such as parallelograms, trapezoids, kites, and rhombuses. In addition, the presence of these media helps students in visualizing flat shapes.

Based on the results of interviews with teachers, it shows that the number sticking games media assisted by augmented reality and pixVerse AI have a positive impact on mathematics learning, especially on flat geometry material. The media also attracts students' interest because it is something new, making them more active and responsive in learning. In addition, the use of augmented reality technology helps students understand and distinguish various types of flat geometry, such as parallelograms, trapezoids, kites, and rhombuses. Number sticking games assisted by augmented reality and pixVerse AI also help students visualize flat geometry shapes, therefore the concepts learned become easier to understand. This proves that the use of technology-based media can support more interactive and effective mathematics learning.

Discussion

Based on the results of the analysis, it shows that learning mathematics on flat shape material using number sticking games assisted by augmented reality and pixVerse AI based on augmented reality technology has a positive influence on improving the mathematical literacy of deaf students. During the learning process, researchers and students used number sticking games assisted by augmented reality and pixVerse AI at the first, second, and third meetings. At the first meeting, students showed enthusiasm in participating in the learning, although some students had difficulty because they were still confused about distinguishing photos of objects in the form of flat shapes to be attached to each pull out pgoto math box according to the box title. As an effort to overcome this problem, researchers guided students and asked their friends to do peer tutoring. However, students remained enthusiastic about learning and they began to be more active in learning in class. At the second meeting which was the implementation of the mathematical literacy test, where students showed ease in understanding the meaning of the questions and were able to determine the right steps to solve the questions. Based on the results of the mathematical literacy test that had been carried out at the second meeting, the researcher then conducted interviews with students who were accompanied by the fourth-grade teacher at the third meeting. Interviews were conducted with one student based on test results that had been categorized into three categories of mathematical literacy abilities, namely high, medium, and low. In addition, at the third meeting, the researcher also conducted interviews with teachers as additional information related to the use of number sticking games media assisted by augmented reality and pixVerse AI based on augmented reality technology in improving mathematical literacy.

The differences in the level of mathematical literacy of deaf students in the high, medium, and low categories are based on the results of the mathematical literacy test and the results of interviews conducted during the study. Deaf students who are in the high category are able to meet the three indicators of mathematical literacy. This is due to the use of learning media number sticking games assisted by augmented reality and pixVerse AI which makes learning more interesting and enjoyable as a visual medium, thereby increasing students' interest in learning. Interactive learning with number sticking games assisted by augmented reality and pixVerse AI helps students be more motivated in the learning process. Research conducted by Ningrum & Agustin (2023) also shows that number sticking games assisted by augmented reality and pixVerse AI function as visual learning media containing images and explanations of the subject matter in the box. This can also be confirmed by research conducted by Taufiq & Harsiwi (2024) which revealed that learning media number sticking games assisted by augmented reality and pixVerse AI can support the understanding and learning process of deaf students. The media also influences students' enthusiasm in understanding the material being taught, so that students can absorb flat shape material more quickly and accurately. Number sticking games assisted by augmented reality and pixVerse AI equipped with augmented reality can also visualize abstract concepts, students can better understand the material and learn better. In line with research conducted by Nistrina (2021) which states that augmented reality is a technology that allows students to interact with visual objects as if they were integrated with the real world, thus creating a more realistic interaction experience.

Students with moderate mathematical literacy category are able to fulfill two of the three indicators of mathematical literacy. One of the factors that influences their ability is the lack of in-depth practice in understanding mathematical concepts. In line with the research conducted by Kolar & Hodnik (2021), it was revealed that mathematical literacy requires intensive practice so that students can master the existing concepts. If students do not have enough opportunities to practice and deepen their understanding through various types of mathematical problems, then the development of their mathematical literacy will be hampered. This statement is reinforced by the research of Berisha & Bytyqi (2020) which emphasized that

complex mathematical material that requires high concentration requires more intensive practice and longer study time.

Students with low mathematical literacy category are only able to fulfill one of the three indicators of mathematical literacy. One of the factors that influence their low ability is the lack of motivation to learn and towards mathematics and the incompatibility of students' learning styles in the learning process. This is in line with research conducted by Sultonah et al. (2024) which revealed that the incompatibility between the learning styles of deaf students and the teaching methods applied can lead to low mathematical literacy skills. Research conducted by Kasman & Nur (2022) also emphasized that factors such as family support, a conducive learning atmosphere and appreciation for achievements in learning mathematics play an important role in building students' motivation and learning independence according to their learning styles. Therefore, an environment that provides support and appreciation for the mathematics learning process is needed to improve students' overall mathematical literacy.

Based on the results of interviews with teachers, it was explained that students became more knowledgeable about flat geometry material after using number sticking games assisted by augmented reality and pixVerse AI, so that it can improve the mathematical literacy of deaf students. As stated in the research of Wisnu Wardana et al. (2022) stated that the learning media number sticking games assisted by augmented reality and pixVerse AI as one of the media in improving the acquisition of understanding of mathematics learning for deaf students. The pull-out photo math media equipped with augmented reality technology is something new for students, so it can attract interest in learning and can help students in visualizing abstract mathematical concepts. As evidenced by research conducted by Rodrigues et al. (2022) revealed that deaf students need visual media in learning mathematics to help them understand concrete objects more realistically. Limitations in receiving information auditorily make deaf students more dependent on visual stimulants to develop an understanding of mathematical concepts. Therefore, using interactive visual media such as number sticking games assisted by augmented reality and pixVerse AI that contain images makes it easier for deaf students to connect abstract concepts with real objects. So that the number sticking games assisted by augmented reality and pixVerse AI not only improve the understanding of deaf students, but also make mathematics learning more interesting and effective.

CONCLUSION

Based on the results of the analysis and discussion by considering three indicators of mathematical literacy, it can be concluded that the process of learning mathematics with number sticking games assisted by augmented reality and pixVerse AI based on augmented reality technology on flat shape material takes place systematically. Learning begins at the first meeting with the delivery of material on flat shapes, then continued at the second meeting by conducting a mathematical literacy test. Furthermore, at the third meeting, an interview was conducted with one student accompanied by a class IV teacher based on each level of mathematical literacy category, namely high, medium, and low. After learning with number sticking games assisted by augmented reality and pixVerse AI based on augmented reality technology, students' mathematical literacy showed differences based on their categories. Students with high category mathematics were able to meet all three indicators of mathematical literacy. Meanwhile, students in the medium category were able to meet two of the three indicators set. Meanwhile, students with low category mathematical literacy were only able to meet one indicator of the three mathematical indicators. This shows that the use of number sticking games assisted by augmented reality and pixVerse AI based on augmented reality technology has a positive impact on the mathematical literacy of deaf students with varying levels of achievement according to their abilities.

Teachers and students from all categories, whether high, medium, or low, have a positive perception of learning using number sticking games assisted by augmented reality and pixVerse AI based on augmented reality technology. Students consider the media interesting and useful in helping them understand the material on flat shapes. The technology-based approach not only makes learning more interactive and fun, but also increases student motivation and engagement in understanding mathematical concepts more deeply.

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