

3D Big Book Didactical Design for Developing Numeracy Literacy in Madrasah Ibtidaiyah

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Abstract

Referring to the low results of the AKM (minimum competency assessment), especially in the numeracy literacy component, it is necessary to develop numeracy literacy from an early age in schools. This study aimed to identify the learning obstacles faced by students in the development of numeracy literacy and to design a didactic design to develop students' numeracy literacy at the madrasah ibtidaiyah. This research was a Didactical Design Research (DDR). The participants in this study were 33 fourth-grade students. Data collection was carried out by tests, interviews, and observations. The results of the study show that the initial didactic design was developed in the form of several didactic situations packaged in the form of a 3D Big Book by paying attention to the level of thinking and the level of students' numeracy literacy skills as well as a guidebook for teachers which contains steps of didactic situations, predictions of student responses, and didactic anticipation. The 3D Big Book of numeracy literacy can help in developing students' numeracy literacy skills. Major revisions were made to the steps for using Big Book 3D to make the learning process more effective and conducive.

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INTRODUCTION

The rapid development of science and technology affects the development of the world of education. Education is given to prepare humans to have the ability to solve the problems they face. This requires the government to design a system that does not only aim to develop students' higher-order thinking abilities but also their literacy skills. Therefore, the government is making efforts to develop literacy with the National Literacy Movement (GLN) as an implementation of Permendikbud number 23 Year 2015. The six basic literacies developed include reading and writing literacy, numeracy literacy, scientific literacy, digital literacy, financial literacy, and cultural and civic literacy (Kemendikbud, 2017).

Of the six basic literacy, what can be developed from an early age is numeracy literacy. This numeracy literacy includes aspects of arithmetic, numeracy relations, and arithmetic operations (Mahmud & Pratiwi, 2019). This literacy ability is very important for students to have because numeracy literacy skills can be used by students to solve problems that occur in everyday life (Grasby, et al., 2020). Quinn (as cited in Pangesti, 2018) states that this ability is related to sensitivity to data presentation, understanding patterns and sequences of numbers, and being able to recognize situations where mathematical reasoning can be used to solve problems. Meanwhile, Ekowati, et al (2019) explain that numeracy is related to reasoning in analyzing and understanding a statement through the activity of manipulating symbols or mathematical language found in everyday life.

Based on the results of PISA and TIMSS, students' mathematical literacy abilities in Indonesia are in a low category. Based on the 2015 TIMSS results, Indonesia was ranked 46th out of 51 countries. These results are not much different from the PISA results. In the 2012 PISA, Indonesia was ranked 64th out of 65 countries (Nurvicalesi, Dewi, & Walid, 2019; Ayuningtyas & Sukriyah, 2020). In 2018, Indonesia was ranked 73 out of 79 countries and this result fell from the 2015 PISA results where Indonesia was ranked 62 out of 72 countries (OECD, 2016; OECD, 2019). This is in line with the results of the research by Khoirudin, Setyawati, & Nursyahida (2017) which shows that students' literacy skills in solving PISA questions are still low. In PISA questions, students are required to use mathematical reasoning and use mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena (Colwell & Enderson, 2016). Several other studies also show that students' numeracy literacy skills are still low (Irmawati & Ilmah, 2022; Rakhmawati & Mustadi, 2022; Rohmah et al., 2022; Bima, et al., 2023). One of the inhibiting factors for the development of literacy skills in elementary schools is the low ability of students to understand mathematical concepts and the lack of teacher supervision of numeracy literacy practices in everyday life (Ekowati, et al., 2019). To develop this numeracy literacy ability, teachers must design learning that can facilitate students in developing their numeracy literacy skills.

Learning designed to develop literacy skills must be based on students' learning needs and obstacles in solving numeracy literacy problems (Aryandi & Rikayanti, 2024; Susanti & Aminah, 2024). This is because the presentation of teaching materials made by teachers must pay attention to learning obstacles so that these teaching materials can help students figure out concepts, procedures, or mathematical principles indirectly, but through a series of activities (Suryadi, 2019). Therefore, teachers should be able to present didactic activities that can help students figure out their own concepts but still being guided by the teachers so that students are able to have numeracy literacy skills to solve problems related to everyday life.

Based on the preliminary study, it is found that fourth-grade students experience learning obstacles in the development of numeracy literacy on the subject of numbers. The learning obstacles found were students had difficulties in understanding the problem from the questions given, students already understood the problem but did not know the strategy used to solve the problem, students already knew the strategy used but could not select important data to solve the given problem, and students had difficulties in analyzing the information provided to make a decision (true/false). From these findings, it is known that students experience learning obstacles because students are not used to solving numeracy literacy questions. Besides that, the level of

thinking of elementary school students who are still at the concrete thinking stage makes students have to manipulate concrete objects in understanding the material. This is in line with the research of Mahmud and Pratiwi (2019) which state that in elementary school learning, teachers must guide students so that students are able to build various strategies starting from strategies that involve concrete objects to abstract ones. Therefore, teachers must design learning or teaching materials that involve concrete objects as a bridge for students to be able to develop their numeracy literacy. This numeracy literacy teaching material can be designed in the form of a 3-dimensional Big Book to make it easier for students to build strategies with the help of concrete objects first. Based on this background, the purpose of this research was to develop a 3-dimensional Big Book-based numeracy literacy didactic design at the elementary school level or madrasah ibtidaiyah. This study focuses on the development of numeracy literacy on the topic of numbers with the material of whole numbers (with cognitive levels of understanding, application, reasoning) which is one of the basic materials that students must master from an early age.

METHOD

This study used a qualitative approach with the method of didactical design research (DDR). The DDR method was used because the research was intended to develop a learning design based on student learning obstacles in the development of numeracy literacy in madrasah ibtidaiyah. This study followed the three stages proposed by Suryadi (2010) including the didactic situation analysis, the metapedidactic analysis, and the restorative analysis. The first stage was the analysis of the didactic situation before learning, in which the researcher created an initial didactic design (hypothesis) whose development was based on the results of the analysis of learning obstacles faced by students in developing numeracy literacy. In the second stage, metapedidactic analysis, the researcher analyzed the application of the initial didactical design in learning. This was to collect data on students’ responses and the advantages and disadvantages of the teaching materials that had been made. The third stage was restorative analysis, in which the researcher made a revised didactic design by linking the results of the hypothetical didactic situation analysis with the results of the metapedidactic analysis.

Participants in this study were 33 students of class IV of MI Al-Hidayah GUPPI Cirebon City. The data collection in this study was carried out in three ways, namely testing, interviews, and observation. The data collection by testing was carried out to analyze students' learning obstacles in developing numeracy literacy. This testing instrument was in the form of questions related to numeracy literacy in the form of six items of open-ended questions. Before the instrument is used, content validity is carried out. The content validation process is carried out based on professional considerations by a group of experts to determine the validation of the content of the question items both in terms of material, question construction and in terms of the clarity of the language composed. The following are indicators in the students' numeracy literacy ability test instrument in this study.

Table 1. Student Numeracy Literacy Indicators

No	Indicator
1	Representing mathematical objects or situations Students are able to conclude with various forms of representation in problems related to whole numbers

2	Using problem solving strategies	Students are able to solve problems in various ways in problems related to whole numbers
3	Reasoning and giving reasons	Students are able to reason in problems related to whole numbers

The data collection using interviews was carried out to analyze more deeply the difficulties faced by students related to solving numeracy literacy questions at madrasah ibtidaiyah. The interview instrument was in the form of an interview guide for students. The data collection by observation was carried out when implementing the initial didactical design. The observation was done to find out students' responses to the initial didactic design and the difficulties they faced. The observation instrument was in the form of a learning observation sheet.

The data analysis in this study followed the flow proposed by Miles and Huberman (as cited in Sugiyono, 2010) including data reduction, data display, and data conclusion drawing/verification. At the data reduction stage, researchers reduce the data that has been collected by summarizing, selecting the main things, focusing on important things that are looking for themes and patterns. This data reduction process is carried out on the results of the students' numeracy literacy learning obstacle test and observation and interview data generated during the study. At the data presentation stage, the data that has been successfully collected is then described. This description includes a description of the difficulties experienced by students in developing numeracy literacy skills, as well as an analysis of the implementation of the numeracy literacy didactic design reviewed from various theoretical perspectives. At the conclusion drawing stage, conclusions are drawn as a result of linking research questions with data obtained in the field.

RESULTS AND DISCUSSION

Results

This study was conducted to determine students' learning obstacles in solving numeracy literacy problems and the development of didactic designs for numeracy literacy on literacy on the topic of numbers with the material of whole numbers in elementary schools or Islamic elementary schools. The presentation is as follows:

1. Learning obstacles experienced by students in developing numeracy literacy in madrasah ibtidaiyah

Before developing a numeracy literacy learning design for number content in grade IV of elementary madrasahs, the researcher first analyzed the learning obstacles faced by students by looking at the results of tests that students had completed. In the preliminary study, an analysis of the elementary schools or madrasah ibtidaiyah curriculum content was also carried out, to see to what extent numeracy literacy can be developed in grade IV.

The researcher gave 6 numeracy literacy questions to 33 fourth grade students of Islamic elementary schools. The six questions given were numeracy literacy questions with number content (whole number arithmetic operations) containing three cognitive levels (understanding, application, reasoning). Each question was equipped with a stimulus in the form of a story/picture that students had to observe. From the results of the analysis of the test answers and interviews with 33 students, students still had difficulty in working on numeracy literacy questions. The identified difficulties were classified as follows.

a. Type 1: students have difficulty in understanding the problem from the questions given

The first difficulty faced by students is that students do not understand the problem given. When the question is given, some students seem confused about what information is in the question, what is asked by the question, and how to do it, so that students work on the questions carelessly. Difficulties like this are categorized as ontological obstacles because students work on questions not based on thinking and only based on intuition. This type of difficulty can be due to numeracy literacy questions that students rarely get, so students are confused in working on them.

b. Type 2: students already understand the problem but do not know the strategy used to solve the problem

The second difficulty is that students already understand the problem but are confused about how to solve the problem. Students know what is being looked for in the question, but are still confused about whether to work on it with addition, subtraction, multiplication, division, or mixed arithmetic operations. The lack of facilitation for students to develop their own problem-solving models by the teacher is also the reason for this difficulty, so that when students are faced with questions that are different from usual, students do not try to solve the problems given in their own way. Therefore, this type of difficulty can also be categorized as a didactical obstacle, a difficulty caused by the learning process

c. Type 3: Students already know the strategy used but cannot select important data to solve the given problem

The third difficulty is that students are still wrong in selecting the data to be used in solving the problem. The literacy questions given are in the form of descriptive questions with distractor numbers to see students' ability to understand the questions/read the data in the questions. This type of difficulty is classified as a didactical obstacle because students are used to being assisted by teachers in working on questions, in determining the data used and how to solve the questions. Students are not used to understanding each question given so that students are wrong in selecting important data that must be used in solving the questions.

d. Type 4: Students have difficulty analyzing the information provided to provide decisions (right/wrong)

The fourth difficulty is difficulty in reasoning questions, students still have difficulty in analyzing the information provided to provide true or false decisions from the statements presented. This type of difficulty can also be classified as an epistemological obstacle because students have limited context regarding the application of number operations on reasoning type questions. This type of difficulty can also be classified as a didactic obstacle because reasoning type questions are rarely presented in learning at MI. So when faced with questions related to reasoning in number arithmetic operations, students experience confusion in giving true or false decisions from the statements provided.

From several types of difficulties that have been identified, it can be seen that three types of learning obstacles, namely ontological obstacles, epistemological obstacles and didactical obstacles were found. These results are used as a reference in developing learning to develop numeracy literacy skills in elementary madrasas by minimizing the learning obstacles experienced by these students. To overcome the learning obstacles, several anticipations are carried out as follows.

First, to anticipate ontological obstacles, learning is provided that presents learning involving concrete objects to be manipulated. From the results of interviews that have been conducted, images alone are not enough as a stimulus because students are not used to solving problems based on numeracy literacy. Concrete objects presented as teaching materials are expected to be able to help students in developing strategies that they use in solving problems. The problems presented are made in stages from the easiest/simplest to the most complex according to the level of numeracy literacy proficiency. In addition, for students who have difficulty understanding the questions, the teacher provides guidance by reading the questions together and providing guidance questions that can direct students in solving the problems.

Second, to anticipate epistemological obstacles, teachers provide diverse situations as stimuli for the development of students' numeracy literacy skills. Teachers also provide stimuli by covering the three indicators of numeracy literacy. Teachers provide stimuli so that students can represent mathematical objects or situations, use problem-solving strategies, and reason and give reasons.

Third, to anticipate didactical obstacles, teachers provide opportunities for students to build their own ideas and express the strategies they use. Students are given several stimuli that are expected to enable students to build ideas from their own knowledge and then discuss the knowledge with the teacher and friends. Teachers also consider the diversity of students' proficiency levels in making teaching materials. This is so that the teaching materials created can be used by students with varying levels of proficiency and stimulate students to produce strategies according to their abilities.

2. Didactic design for developing numeracy literacy in madrasah ibtidaiyah

Based on the research results, several learning obstacles identified were experienced by students in developing numeracy literacy skills in madrasah ibtidaiyah. From the data obtained, the development of this ability is inseparable from students having to get used to solving numeracy literacy problems. In addition, it was also found that most students still had difficulties solving problems even though they had been given story illustrations. For this reason, the teaching material was designed by presenting problems related to students' daily lives and with the help of concrete objects, so that students can manipulate these concrete objects when they solve problems.

The teaching materials designed are in the form of didactical situations, predictions of student responses, and didactical anticipation. Didactic situations are presented in the form of a 3-dimensional Big Book of numeracy literacy containing several illustrations of problems as a stimulus for their numeracy literacy skills. The Big Book 3 dimensions of numeracy literacy designed present a story about "Outing" which is intended to be more contextual with the children's world. The material content is Numbers with the sub-content of Operation with Whole Numbers. The stimulus context is in the form of a social context where the stories presented are in the form of problems that can occur regarding outings with the family.

The predictions of didactic responses and anticipation are presented in the form of a teacher's manual which is used as a guide when teachers implement numeracy literacy learning designs in the classrooms. The following is an example of a teacher's manual book.

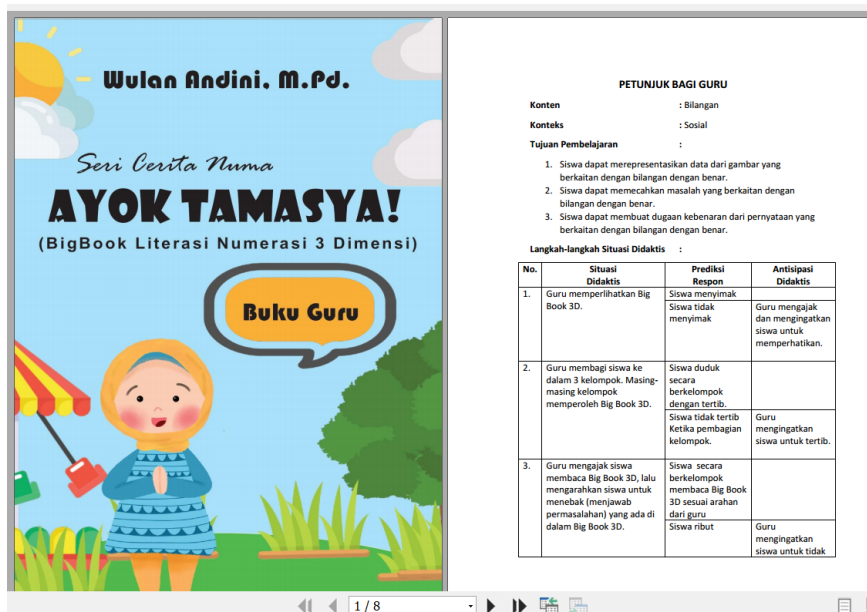


Figure 1. teacher’s manual book

This guidebook contains didactic situations in the form of steps in learning activities carried out by students and teachers, predictions of didactic responses that students might give, and didactic anticipations that teachers can make regarding responses that students might give. With this guidebook, teachers will find it easier to carry out learning because the learning process has been predicted and anticipated, so it is hoped that the development of numeracy literacy using the 3-dimensional Big Book will run more effectively and efficiently.

The didactic situations presented consist of four didactic situations which are described as follows.

1) The first didactical situation

In the first didactical situation, the teacher invites students to read the introduction to the story together. This is intended to make students focus on the story first. Then students are given a problem related to representing mathematical objects or situations where students are asked to find the height and weight of each child in the story. The problem presented in the first didactical situation is as follows.

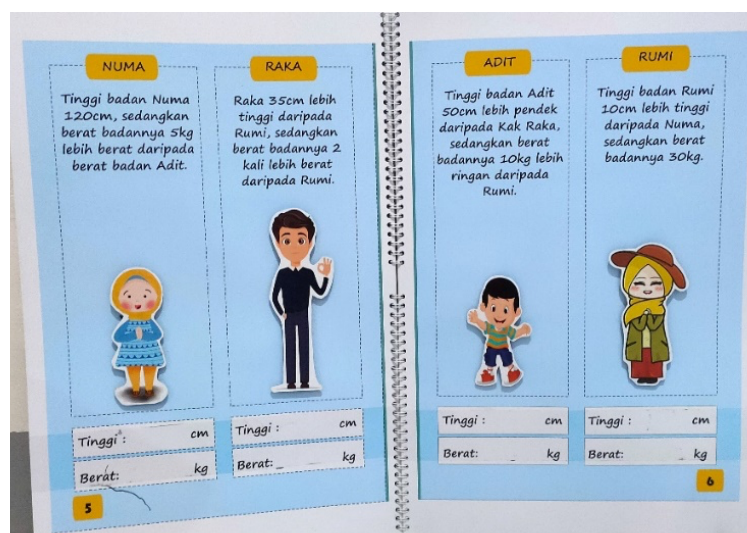


Figure 2. The problem in the didactical situation 1

Students are asked questions by the teacher about whose height and weight are known. After that, students were asked to see the relationship between the size of the height and weight of each child. The teacher can assist students by giving another question, "Who is heavier?". Then the student representative writes the answer of the child's height and weight in the column provided.

2) The second didactical situation

In the second didactical situation, students are given a numeracy literacy stimulus with the indicator using problem-solving strategies. The problem presented in this second didactical situation is to find a ride that the child characters in the story can play. To solve the problem, students must look back at the information in the previous didactical situation. Students must look at the requirements of each ride and select the ride according to the child's height and weight. The problem presented in the second didactical situation is as follows.

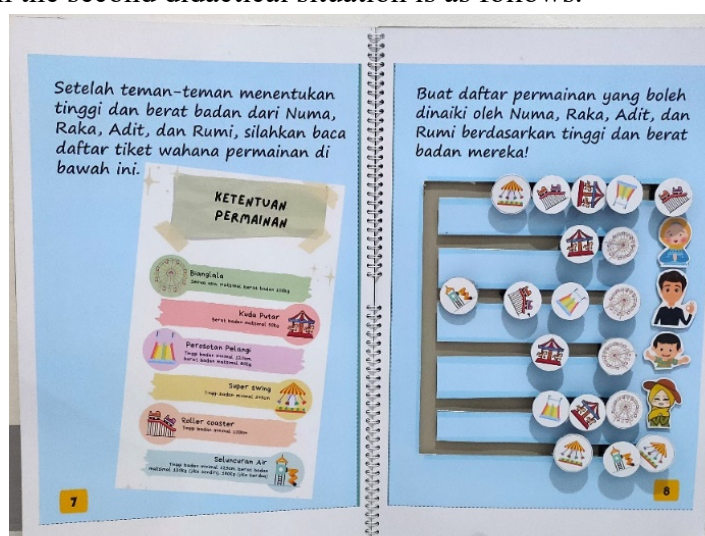


Figure 3. The problem in the didactical situation 2

3) The third didactical situation

In the third didactical situation, students are still given a numeracy literacy stimulus with the indicator using problem-solving strategies. However, the problem presented is more complex which involves the value of money. The problem presented in this third didactical situation is to find a ride that the child characters in the story may play by considering the amount of money and the playing time duration they have. To solve the problem, students must look back at the information in the previous didactical situation. Students must see what ride each child can ride and select the appropriate ride according to the amount of money and playing time duration they have. The problem presented in the third didactical situation is as follows.

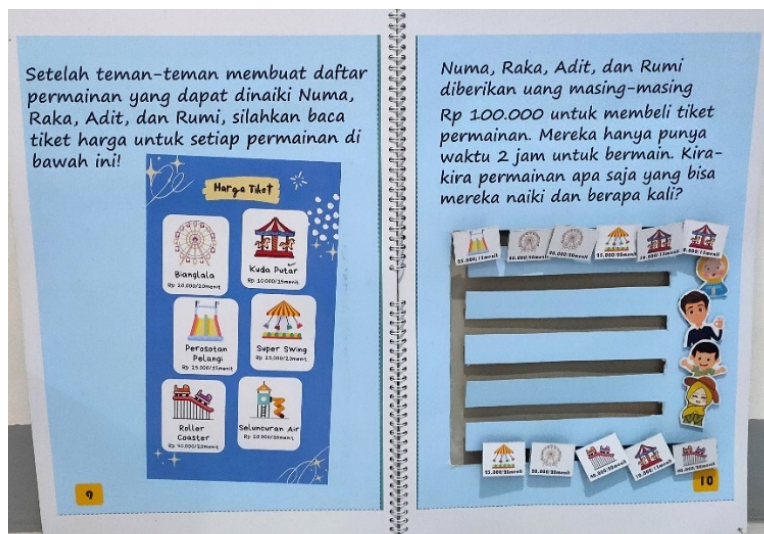


Figure 4. The problem in the didactical situation 3

In this problem, students can give many answers because in the description of the question, there is no information that each character has money that must be used up. This problem is contextual because it indirectly teaches students the concept of saving and requires students to use money according to their needs.

4) The fourth didactical situation

In the fourth didactical situation, students were given a problem with the numeracy literacy indicator of reasoning and giving reasons. Students must be able to select whether the provided statements are true or false. Statements in the fourth didactical situation can be alternated according to the student's choice. Therefore, the statement paper is placed in a container that can be easily taken and replaced. Examples of the problem presented in this fourth didactical situation are as follows.

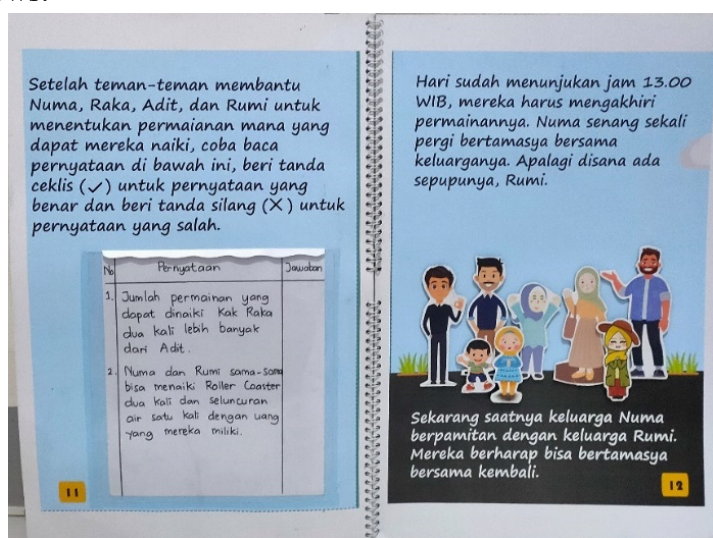


Figure 5. The problem in the didactical situation 4

In answering the truth of the statement, students must use information from previous didactical situations. Then students must determine whether the statements presented are true or false.

In general, the implementation of the didactical design that was design run smoothly, although some things were noted for improvement. However, from the results of the observation,

students seemed very enthusiastic about participating in learning. The teaching material that is presented in the form of a 3-dimensional Big Book makes students forget that they are learning math materials.

From the results of the implementation of the initial didactical design, several things were revised. First, the students who sat at the very back did not listen to the explanation or participate in solving the problems given by the teacher because the class atmosphere was quite noisy. This happened because the teaching material in the form of a 3-dimensional numeracy literacy Big Book was applied classically. The teacher and several students demonstrated it in front of the class. The revision of this didactical situation is that there is a need for additional Big Books. Students are grouped and each group gets one Big Book for them to manipulate. Students can listen to the teacher's explanation and they directly try to solve problems with their own group Big Book.



Figure 6. The implementation of a three-dimensional Big Book of numeracy literacy media

Second, another revision is made regarding the need for additional answer sheets containing the answers of each student. This will make students more orderly and focused on working on the problems given. Students work on the problems in groups in the Big Book and rewrite their answers on individual answer sheets. Third, students have difficulties in scrolling through 3-dimensional images because all the images are displayed on the Big Book page, so the space for scrolling images is rather narrow. The revised 3-dimensional images are stored in the box first. Then students can take them and stick them according to the answers.

Discussion

The designed numeracy literacy teaching materials are related to the presentation of problems related to students' daily lives. This is because the real context and close to the students' world will be easy to imagine so that students can easily understand the information from the problems presented (Agustina, et al., 2022; Munahefi, et al., 2023). In addition, when solving the problem, students are given assistance in the form of concrete objects available in the book so that students can manipulate the concrete objects when they solve the problem. This is in line with the opinion of Steen, et al. (2007) that the problems presented must involve real contexts, non-routine procedures, and complex reasoning, although they often only require relatively basic mathematics in their solution. The context of the stimulus is a social context with number content where the stories presented are problems that can occur about family outings involving number calculations. The problems given are aimed at optimizing students to be able to adapt to solve their own

problems and can encourage students to gain new knowledge (Radford, 2008; Artigue & Blomhøj, 2013).

The problems presented are not only those that require students to solve them by involving number operations, but also problems that require analysis from students to determine the truth of the statement, students must use information from previous didactic situations. Then students must determine whether the statement presented is true or false. When students can use their numeracy literacy skills, this will make students more sensitive and understand how to use mathematics in everyday life (Sari, 2015). Teaching materials packaged in the form of a 3-dimensional Big Book make students forget that they are learning mathematics material. This is because in learning mathematics it is very important if the problems presented are related to topics related to the child's environment (Firdaus & Herman, 2017).

The revision of this didactic situation is the need for additional Big Books, students are made into groups with each group getting one Big Book for them to manipulate. Students can listen to the teacher's explanation and then they directly try to solve the problem with their respective group's Big Book. In addition, when learning using the Big Book, the students' sitting position must be arranged so that students remain comfortable and learning can be more conducive (Halimatussa'diyah, 2017).

CONCLUSION

The initial didactic design designed to develop numeracy literacy skills in grade IV of elementary madrasahs is presented in the form of a 3-dimensional numeracy literacy Big Book and a teacher's guide book containing four didactic situations given as a stimulus to develop students' numeracy literacy skills. Student responses during the implementation of the initial didactic design were in accordance with the predicted responses. Several learning obstacles still occurred during the implementation of the design. This is because students are not yet familiar with numeracy literacy-based questions. This revised didactic design was developed based on changes in several steps in several didactic situations. The limitations of this study are that the numeracy literacy material is still specific to the topic of numbers, so research is needed related to the development of didactic design of numeracy literacy with other topics. The small sample size (33 students) and only in one school is also a limitation in this study, so further research is needed on the implementation of the revised didactic design with more samples. In addition, testing the effectiveness of using the 3-dimensional Big Book for numeracy literacy is also very necessary so that it can be clearly seen how much influence the use of this 3-dimensional Big Book has on improving students' numeracy literacy.

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