



Providing scaffolding for students with special needs in solving fraction problems in inclusive schools

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ABSTRACT

Inclusive education is a special form of education that emphasizes equal rights and opportunities for all learners, including those with special needs. This study explores the use of scaffolding as an instructional strategy to overcome difficulties in understanding fractional numbers among students with learning barriers. The research aims to describe: (1) the process of implementing scaffolding for students with special needs in fractional number operations, and (2) the scaffolding process for regular students who experience similar difficulties. This qualitative study employed a phenomenological approach with subjects consisting of shadow teachers assisting students diagnosed as slow learners and those with mild intellectual disabilities. Data were collected through written tests, interviews, observations, and documentation, all validated through expert and empirical testing. Data analysis followed the stages of data collection, data display, and conclusion drawing/verification. The findings reveal that scaffolding based on Anghileri's theory effectively supports students in identifying errors and developing self-correction strategies. Shadow teachers adapt instructional scaffolds according to students' needs, emphasizing visual and linguistic learning styles. The study concludes that identifying each learner's Zone of Proximal Development (ZPD) is essential for implementing scaffolding effectively to enhance independent problem-solving skills in learning fractional number operations.

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INTRODUCTION

General math classes require special education for instructing students with specific learning needs (Ballin et al., 2022). The implementation of inclusive education benefits students by increasing understanding, acceptance, and appreciation of diversity (Van



Mieghem et al., 2020). Inclusive schools represent the government's efforts to equalize educational opportunities for all individuals, without discrimination. The implementation of inclusive education provides opportunities for all students with disabilities and those with intellectual potential to participate in general education (Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 70 on Inclusion, 2009 (Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 70 Inclusion, 2009). Inclusive primary schools provide solutions to the government's role in mentoring and sustainable programs (Rasmitadila et al., 2021). The learning needs of inclusive students can be addressed through early identification (Ashari, 2021).

In 2000, the National Council of Teachers of Mathematics (NCTM) described fractions as both a core concept and a challenge in the basic mathematics curriculum (Hariyani et al., 2022). The selection of teaching methods requires various learning opportunities to better explore the teacher's conceptual understanding, thereby developing students' knowledge and addressing misconceptions (Copur-Gencturk, 2021). The model of teaching fractional material to make it easier for students to understand the concept of fractions is preferred by teachers, namely the area model, the cluster model, and the length model (Doğan & Tertemiz, 2020). Students struggle with comparing fractions when the denominators are not equal (Braithwaite & Siegler, 2021). Contextual problems are easier for students to solve than non-contextual ones in fraction problems (Kolar & Hodnik, 2021).

Problem-solving skills are one of the factors in math proficiency (Musser, et al., 2011). Problem-solving skills can help students to understand, connect, and use mathematical concepts (Mauliyda et al., 2019). Students with average and low ability have difficulty in solving math problems so the solutions proposed are unstructured, not thorough, and not systematic (Yayuk et al., 2020). Improving students' problem-solving skills can be through the relationship between teachers and students. The relationship between teacher and student by focusing on students' self-efficacy and reducing math anxiety (Zhou et al., 2020). The provision of scaffolding helps to address unstructured problems so that students can explore problems and lead to the discovery of the best solution (Cho & Kim, n.d.).

Scaffolding is used to support students facing difficulties in learning mathematics (Lei et al., 2020). Learning in the form of questions and thinking encouragement in students is a form of scaffolding that teachers can strive for (Anghileri, 2006). Scaffolding can be said to be a way to make learning easier to support learning to be easily understood by students. Taylor (1993) stated that Vygotsky's theory defines ZPD or zone of proximal development as the distance between the actual developmental process and the level of potential (Suardipa, 2020). ZPD centers on social interaction that can help students' development in learning. The following is a model image of the zone of proximal development scheme.

Scaffolding which is carried out as a learning strategy can be grouped into three stages: the first is the provision of the environment, the second is explaining, reviewing, restructuring, and the third is developing conceptual thinking (Maharani & Subanji, 2018) Julia Anghileri (2006) Description of the three actions of providing scaffolding in learning. The basic level is the provision of an environment that can be done even without a direct teacher. The second and third levels are the interaction between teachers and students in developing learning through explanation, review, and restructuring as well as the development of conceptual thinking (Anghileri, 2006). The following is an explanation of teachers' strategies in implementing scaffolding at three levels.

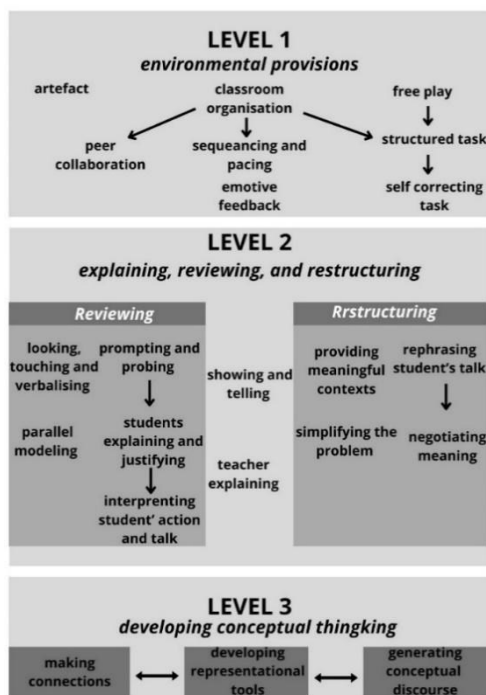


Figure 1. Level levels by anghilery (Anghileri, 2006)

Scaffolding with kinaesthetic and linguistic types is effectively used for students diagnosed with learning disabilities in developing mathematical thinking skills (Lei et al., 2020). Students' solutions and strategies in solving problems are influenced by their initial knowledge, experiential background, intellectual ability, and ability to write in mathematical language (Arifin et al., 2020). The exposure to the above discussion strengthens the effective use of scaffolding in helping PDBK successfully help overcome difficulties. Scaffolding with directional help that is useful to make it easier for students to find mathematical problem solving in fractional material. Students are more enthusiastic about learning when they are wrapped in a comfortable learning atmosphere. Therefore, this research is important to be carried out in revealing how the provision of scaffolding in solving the problem of the fraction number of students with special needs in elementary school inclusion schools. The results of this research can later be useful to review the appropriate scaffolding for students with special needs in elementary school inclusion education.

METHOD

The research was conducted using qualitative research with a phenomenological approach. Qualitative research uses narratives in describing every phenomenon that occurs (Waruwu et al., 2023). The phenomenological approach used in the research is based on the need for research in describing students' learning experiences regarding the phenomenon of scaffolding application (Creswell, 2018). The research aims to describe how to provide scaffolding for students with special needs in learning fractional number material. The subject in this study is a special assistant teacher of PDBK or can be called a shadow teacher for the category of students who are accompanied by a diagnosis of slow learner and intellectual with mild intellectual disabilities in grade 6. The data collection technique in this study used written test instruments, interviews, observations, and documentation. The following is a grid of fractional number writing test questions.

Table 1. Grid Questions for Writing Fractional Numbers Test

Learning Outcomes	Learning Objectives
Students at the end of phase C are expected to be able to compare and sequence various fractions including mixed fractions, perform addition and subtraction operations of fractions, and perform multiplication and division operations of fractions with real numbers.	Students can compare and sort different forms of fractions Students can perform fractional addition and subtraction operations Students can perform multiplication and fractional number division operations

The grid is used for observation guidelines for mathematics learning and interviews for subject teachers and students with special needs. Here are the grids used:

Table 2. Grid of observations and research interviews

Scaffolding	Indicator
First level	Artifacts Preparation Class Organization
Second Level	Explain
Third Level	Development of Conceptual Thinking

The following are the results of the validation calculation of test instrument experts.

$$P = \frac{26}{28} \times 100\% = 92,8\%$$

Expert validation for test instruments obtained a percentage with rounding of 93%, so that the research instrument can be used. The following are the results of the validation calculation of observation instrument experts.

$$P = \frac{11}{12} \times 100\% = 91,6\%$$

Expert validation for observation instruments obtained a percentage of 92% results, so that observation instruments can be used. The following are the results of the validation calculation of interview instrument experts.

$$P = \frac{22}{24} \times 100\% = 91,6\%$$

Expert validation for the interview instrument obtained a result percentage of 92%, so that the observation instrument can be used. The data analysis technique is carried out in three stages, namely: data condensation, data display, and *conclusion: drawing/verifying*. The analysis of the research results uses data coding to facilitate the writing of the exposure of the research results. The following data coding is described. a) Shadow teacher: GS, b) Rumandu (Special Needs Students): Rm, and c) Hisyam (Special Needs Students): Hy. The validity of the research was checked using triangulation techniques, namely observation, interviews, and documentation.

RESULT AND DISCUSSION

This research focuses on the primary subject, namely shadow teachers who accompany students with special needs with mild-moderate diagnoses. The selection of secondary subjects was two students with a diagnosis of slow learners and intellectual disabilities. Slow learners are one of the diagnoses of students with special needs in inclusive schools. Slow learner is a diagnosis of students who have a delay in learning. The results of Hy's students' learning observation were confusion in calculating in stacks with higher numbers to be subtracted. Slow learner students have abilities that are not appropriate for the age of the student (Sangeeta Chauhan, 2011).

Intellectual disability is one of the diagnoses for someone who has privileges. RM students have an intellectual disability diagnosis which is not easy to socialize with the surrounding environment. Rm students tend to be silent when around many people and

feel disturbed when someone disturbs them with movements or loud noises. So that Rm students need the help of an adult nearby to provide assistance related to their privileges. Special learning programs with the help of shadow teachers provided by the school and in collaboration with parents.

Difficulty in learning fractional numbers of students with special needs in various types of difficulties were found. The type of difficulty found from the results of the 10 questions by Hy and Rm students has several difficulties. The difficulty is reviewed from the Polya problem-solving stage. The stages of problem solving Polya emphasized that there are stages in solving mathematical problems, namely understanding problems, arranging problems, implementing plans, and reviewing (Musser, dkk, 2011). When students experience difficulties in the process of work, the results obtained tend to be errors. (Putri Enlisia dkk., 2020). After 10 questions were done by RM students, the results obtained were 0 correct numbers. While Hy students obtained 0 correct numbers. When problem-solving skills are met, it can be interpreted that one of the math skills has been fulfilled (Kilpatrick dkk., 2001).

Understanding problems well is the first step in solving math problems (Musser, dkk, 2011). There are 8 numbers for students who are not able to understand the problem well described in questions number 1, number 4, number 5, number 6.a, 6.b, number 6.c, number 6.d, and number 7. The errors found from the results of the work of Rm students were due to difficulties in understanding the questions. This is in accordance with the results of student interviews who explained the lack of understanding in the question order. Supported by the results of the shadow teacher's interview which explained that the mathematical ability of Rm students is relatively low when compared to Hy students. When students do not have the ability to understand problems, it will be difficult to organize and plan problem solving.

Understanding the main step problems in order to solve math problems (Musser, dkk, 2011). The results of the work of Hy students are 6 numbers that are unable to understand the problems described in questions number 1, number, number 6.a, 6.b, number 6.c, number 6.d, and number 7. The errors found from the work of Hy students were due to difficulty in understanding the questions. This is in accordance with the results of student interviews who explained the lack of understanding in the question order. Supported by the results of the shadow teacher's interview which explained that the mathematical ability of Hy students is classified as higher when compared to Rm. When the ability to understand problems is not yet possessed by students, then compiling and planning problem solving will be difficult.

The stages of compiling and implementing the plan are carried out after understanding the problem has been done well (Musser, dkk, 2011). However, from the results of the test documentation study, it was proven that Rm students and Hy students experienced difficulties at the stage of compiling and implementing a plan to find the right answer. Rm students have difficulties with questions number 2 and number 3. Meanwhile, Hy students experienced difficulties in number 2, number 3, number 4, and number 5. From the results of the test documentation study, it was explained that errors in compiling and implementing the plan were difficulties in the fraction parts to be compared, the error in the placement of the fraction on the number line, and the error of redrawing according to the fraction. Have problem-solving skills that do not depend on the final result, but on the process of solving mathematical problems (Putri Enlisia dkk., 2020).

The review stage is the last stage in solving mathematical problems (Musser, dkk, 2011). The review is carried out by the students within the time given by the teacher. Students make good use of the time to solve the 10 fractional number problems that have been given. This is in accordance with the results of student interviews which describe the review carried out within the processing time given by the teacher. Supported by the results of the shadow teacher's interview explaining that the opportunity for review was given within the given time. The results of the interview stated that the encouragement was used for students to be more thorough than the answers found, so that the same rights were obtained as regular students.

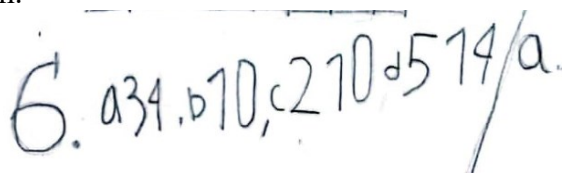
The difficulties faced by students are overcome by teachers using scaffolding. The selection of learning using scaffolding can create a positive learning environment so that students learn mathematics without fear (Kusmaryono, dkk., 2020) The scaffolding given by the teacher is reviewed through Anghileri's theory with 3 levels. The first level of scaffolding is the preparation of artifacts and class organization, the second level is revisiting and rearranging it, and the third level is the development of conceptual thinking through making connections, the use of representational tools, and producing conceptual discourse (Anghileri, 2006).

The first level is attempted by the teacher, namely by selecting seats with Hy students adjacent to Rm students. This is in accordance with the results of the teacher's interview which describes the selection of seats with the proximity of Hy students and Rm students to facilitate the provision of assistance during learning. In addition, at this level there are efforts in preparing artifacts for learning. The preparation of artifacts utilizes origami paper to facilitate the concept of fractions with concrete objects. In addition, shadow teachers use small boards and large boards in the inclusion room to make it easier for Rm students and Hy students to receive understanding by processing themselves with encouragement. This is in accordance with the results of the teacher's interview which explained that Hy students and Rm students are easier to understand when rewritten with a large whiteboard or a small whiteboard.

Rm students and Hy students find it easier to understand fractional material by rewriting it in concrete form. In line with this, the results of the interview with the shadow teacher described the passion of Rm students, namely drawing. This craze can be seen as the learning style of Rm students, namely the visual learning style. Learning strategies can be chosen appropriately through learning styles, so that students can understand well the material being studied (Putri et al., n.d.). The results of the observation of Hy students' learning, like mathematics as evidenced by the ease of understanding mathematics material when compared to Hy students. In addition, when studying in an inclusion room with a large board in writing a lot of numbers, variables, drawing, and so on. Supported by the results of the shadow teacher's interview who explained that Hy students like to write about mathematics even though when asked he did not understand.

The second level of scaffolding is in the form of helping explain the difficulties experienced by students (Anghileri, 2006). At this level the shadow teacher providing assistance tends to be the same as providing the opportunity to explain what is known, pushing for the correct fraction concept through questions, and rearranging the answers accordingly. Some questions can be improved gradually by Hy students when given scaffolding for review and rearranging the correct answers. The Rm student when given the direction to review, has not been able to find the error. The scaffolding given to Rm students is slightly different, namely by refocusing attention on the problem, providing an opportunity 6.a Rm students are given assistance in the form of a letter variable model

to remind the operation of adding fractional numbers with the same denominator, while Hy students by directing to focus again on the requested question. The following is the answer number 6.a Rm.



Handwritten student work for problem 6.a.1st. The student has written: $6. a \frac{3}{4} + b \frac{1}{10} + c \frac{2}{10} = \frac{57}{10} / a$. The variables a, b, and c are used to represent different fractions being added.

Figure 2. Results of student work Rm number 6.a 1st

Answer number 6.a of the Rm student explained that ZPD has not been seen. The workmanship error in number one gets the right result after receiving scaffolding. Scaffolding provided by shadow teachers using variable letters to facilitate the understanding of the operation of counting the sum of fractional numbers. The teacher directs students to understand the form of fractional number operations with variables. The following are the results of the documentation study on the provision of scaffolding number 6.a.

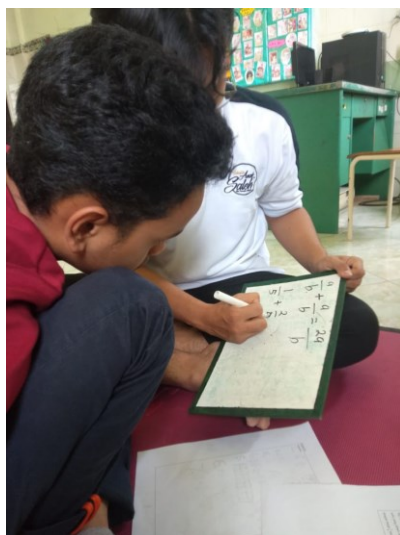
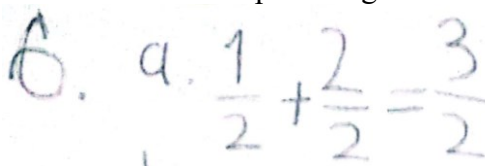


Figure 3. Scaffolding activities

Next, the Rm students reviewed and rearranged the answer to number 6.a. The following is the justification that has been repeated again after the scaffolding received.



Handwritten student work for problem 6.a.2nd. The student has written: $6. a. \frac{1}{2} + \frac{2}{2} = \frac{3}{2}$. The variables a and b are used to represent different fractions being added.

Figure 4. Results of student work Rm number 6.a 2nd

The suitability of the justification of Rm students with the provision of scaffolding is supported by the results of interviews with teachers as follows (W/Gs/II):

Researcher: How did you provide help for mistake 1?

Gs: I use variable letters to make it easier to understand

Researcher: When given a representation tool in the form of variable letters, can students understand it, sir?

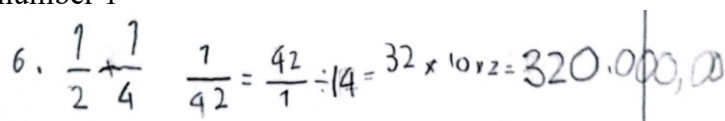
Gs: That is right that students can understand, because with the same letter variable it is easy to use for the operation of counting the sum of fractional numbers

The results of the interview are in accordance with the following student interviews (W/Rm/II):

Research: Can the help provided by the teacher make it easier for you to understand from the wrong answers?

Rm Student: Yes, I can easily understand the mistakes and recall the concept of fractions

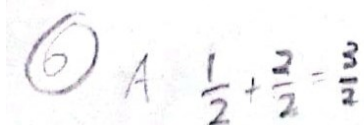
In question number 6.a by Hy students, they obtained incorrect results in the work. Hy students cannot perform fractional number summing operations with the same denominator. The form of ZPD owned by students is by operating different denominators on fractional numbers, but in the process there are errors in equalizing denominators. Here is Hy's answer number 1



6. $\frac{1}{2} + \frac{1}{4} = \frac{1}{42} = \frac{42}{1} = 14 = 32 \times 1012 = 320.000,00$

Figure 5. Results of the work of Hy students' number 6.a 1st

Hy's students' answers got the right results after receiving scaffolding. Scaffolding is given by the shadow teacher by directing students to review the answers according to the questions. The following are the results of the documentation study. Next, students rearrange the correct answers. The following justification has been repeated after the scaffolding received.



6 A $\frac{1}{2} + \frac{2}{2} = \frac{3}{2}$

Figure 6. Results of the work of Hy students' number 6.a 2nd

The suitability of the justification of Rm students with the provision of scaffolding is supported by the results of interviews with teachers as follows:

Researcher: How did you provide help for mistake 1?

Gs: I use the command for answer review. Because the answer placed on the number 6 is the opposite of the number 7

Researcher: When given directions for review, can students understand it, sir?

Gs: Really students can understand and rearrange

The results of the interview correspond to the student interview as follows:

Research: Can the help provided by the teacher make it easier for you to understand from the wrong answers?

Student Hy: Yes, I can easily understand the mistakes and recall the concept of fractions

The assistance in the form of scaffolding given to Rm and Hy students is the same. However, in understanding mathematical calculations, Hy students are superior to Rm. So, it is necessary to make relationships gradually to help understanding. Good interaction in learning has a relationship with interest in learning (Ariastuti, 2020).

The third level of scaffolding is in the form of developing conceptual thinking from the difficulties experienced by students (Anghileri, 2006). The teacher provides some help for Rm and Hy students by making connections through simple questions to encourage the ability to solve fractional number problems. In addition, shadow teachers provide scaffolding by making representation tools in the form of variable letters to facilitate students' understanding of the operation of counting, addition, subtraction, multiplication, and division of fractional numbers. So that with the creation of

relationships and the use of representation tools, Hy students and Rm students can produce conceptual discourse independently through a more appropriate rearrangement of answers. Kinesthetic and linguistic scaffolding are effectively used for PDBK students who are diagnosed with learning disabilities in developing mathematical thinking skills. The following are the results of the test documentation study on answer number 1 of Rm students.

Jawaban:

$$1. 2 \frac{2}{3}$$

Figure 7. Results of the work of students Rm number 1 to 1

Answer number 1 of Rm students explained that ZPD is shown by recognizing fractional symbols. The workmanship error in number one gets the right result after receiving *scaffolding*. *Scaffolding* provided by the shadow teacher by providing a circular-shaped origami paper manipulative medium that can be folded with 5 parts for fractional teaching aids. The origami manipulative media is circular in the shape of 5 parts and accompanied by shading on 1 fraction part. Students with the shadow teacher look for a section that mentions fractional numbers $\frac{1}{5}$. Thus the Rm student can interpret 1 part of 5 fractions equal to fractions $\frac{1}{5}$. Furthermore, the shadow teacher also gives students the opportunity to draw circles on a small board to form a circle that has a fractional number value. From these structured tasks, students can make a connection with the questions they are given. So that students can rearrange the right answers to work on question number 1. The following justification has been repeated after $\frac{2}{5}$ the *scaffolding* received:

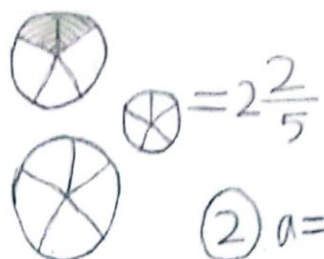


Figure 8. Results of the work of students Rm number 1 to 2

The suitability of the justification of Rm students with the provision of *scaffolding* is supported by the results of interviews with teachers as follows:

Researcher: How did you provide help for mistake 1?

Gs: I use a circular origami paper that is folded into 5 parts

Researcher: When given the manipulative media of origami paper in the shape of a circle, can students understand it, sir?

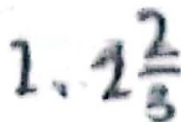
Gs: Really students can understand, because numbers are easier when there is a shape that describes a fraction

The results of the interview correspond to the student interview as follows:

Research: Can the help provided by the teacher make it easier for you to understand from the wrong answers?

Rm Student: Yes, I can easily understand the mistakes and recall the concept of fractions

In question number 1 by Hy students, they obtained incorrect results in the work. Hy's student cannot redraw the mixed fractions in the circle model according to the command in the question. The form of ZPD owned by students is in the form of knowing the shape of the fractional number symbol. Here is Hy's answer number 1.



The image shows a handwritten mathematical expression: $1, 2\frac{2}{3}$. The comma is used as a decimal separator, and the fraction part is $\frac{2}{3}$.

Figure 9. Results of Hy students' number 1 to 1

Hy's students' answers got the right results after receiving *scaffolding*. *Scaffolding* provided by the shadow teacher by providing a circular-shaped origami paper manipulative medium that can be folded with 5 parts for fractional teaching aids. The origami manipulative media is circular in the shape of 5 parts and accompanied by shading on 1 fraction part. Students with the shadow teacher look for a section that mentions fractional numbers $\frac{1}{5}$. Thus the Rm student can interpret 1 part of 5 fractions equal to fractions $\frac{1}{5}$. Furthermore, the shadow teacher also gives students the opportunity to draw circles on a small board to form a circle that has a fractional number value. From these structured tasks, students can make a connection with the questions they are given. So that students can rearrange the right answers to work on question number 1. The following is the justification that has been repeated again after $\frac{2}{5}$ the *scaffolding* received:

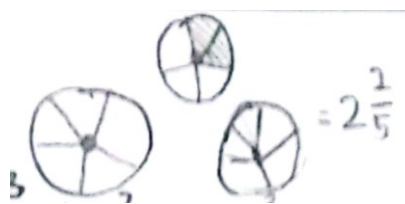


Figure 10. Results of Hy students number 1 to 2

The suitability of the justification of Rm students with the provision of *scaffolding* is supported by the results of interviews with teachers as follows (W/Gs/II):

Researcher: How did you provide help for mistake 1?

Gs: I use a circular origami paper that is folded into 5 parts

Researcher: When given the manipulative media of origami paper in the shape of a circle, can students understand it, sir?

Gs: Really students can understand, because numbers are easier when there is a shape that describes a fraction

The results of the interview are in accordance with the following student interviews (W/Hy/II):

Research: Can the help provided by the teacher make it easier for you to understand from the wrong answers?

Rm Student: Yes, I can easily understand the mistakes and recall the concept of fractions

The assistance in the form of *scaffolding* given to Rm and Hy students is the same. However, in understanding mathematical calculations, Hy students are superior to Rm. students, so it is necessary to create relationships gradually to help understanding. The

following is a documentation study in the provision of manipulative media and relationship making:



Figure 11. Scaffolding Giving of Rm and Hy students

CONCLUSION

The provision of scaffolding on fractional materials for PDBK produces the right answers to the written test given. Scaffolding Anghileri with three levels in total is used by shadow teachers. Teachers strive to provide appropriate assistance for students with special needs. The assistance in the form of scaffolding provided by the teacher as a whole described the Anghileri scaffolding. Scaffolding that is more often used by teachers is at the second level with the help of re-explaining student work mistakes. The understanding of mathematical calculations of Hy students is superior to that of Rm. So it is necessary to make a gradual relationship to help Rm.

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