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Analysis of the Skills Process of Students with Dyscalculia in Special Schools (SLB) in Constructing Knowledge Based on Ethnomathematics

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ABSTRACT

Learning difficulties in understanding and achieving success in mathematics were identified among students, including dyscalculia, a condition characterized by an inability to perform arithmetic due to disturbances in the central nervous system. This learning disorder results in a less optimal process of constructing knowledge. This study aims to analyze the process skills of students with dyscalculia in constructing ethnomathematics-based knowledge. The research employed a descriptive qualitative method, in which data were collected from ethnomathematics-based test items and interviews. The study was conducted at a Special School (SLB) in Jambi City with 2 students with dyscalculia. The findings show that dyscalculic students' process skills have not been fully optimal across most skill indicators. The use of ethnomathematics-based test items only assisted students with counting activities. Both students demonstrated assimilation in the observing and counting stages, but failed to determine relationships between the problem and prior information. In the stages of classifying, collecting, and analyzing data, predicting, measuring, and interpreting data, most activities were carried out through accommodation. Additionally, both students were unable to conduct experiments and communicate their results independently. Overall, students with dyscalculia relied more on accommodation in their thinking.

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1. INTRODUCTION

Understanding mathematical concepts requires practice and a way of thinking in learning known as process skills. Through process skills, students can discover and develop facts and concepts on their own, as well as cultivate attitudes and values. This is reinforced by Nensy et al [1], who stated that the use of process skills in learning allows students to construct knowledge more actively and independently. The process of knowledge construction strongly

depends on cognitive abilities, which refer to the capacity to acquire, retain, manipulate, and use information appropriately. In learning activities, teachers need to guide students so they can understand mathematical concepts, especially those with special needs.

Basically, both students with special needs and those without disabilities may experience learning problems [2]. Several learning disorders have been identified among students in schools, particularly those related to understanding and succeeding in mathematics, including dyscalculia.

Dyscalculia is an inability to perform numerical calculations caused by disturbances in the central nervous system [3]. This inability includes weaknesses in social perception, understanding direction and time, as well as memory disorders. Students with dyscalculia also struggle to differentiate geometric shapes, symbols, and number concepts, and have difficulty performing mathematical operations such as addition, subtraction, multiplication, and division [4]. These challenges lead to low or less optimal learning outcomes. This aligns with Erfan [5], who stated that the learning difficulties experienced by students with dyscalculia hinder their learning processes and outcomes, requiring teachers to make extra efforts to ensure the material is easy to understand.

In selecting the research subject, the researcher chose a student with dyscalculia who attends SLBN Prof. Dr. Sri Soedewi Masjchun Sofwan, S.H., Jambi City. Special Schools (SLB) provide education for students who face difficulties in regular learning processes due to physical, emotional, mental, or social disorders, but who possess special intelligence or talents [6]. When a student is identified as having a disorder, special education may be needed to accommodate their needs. Special education becomes appropriate when the needs of the student cannot be met in regular educational programs.

Based on interviews with the coordinator teacher at SLBN Prof. Dr. Sri Soedewi Masjchun Sofwan, S.H., Jambi City, various learning disorders were found among students at the school. Some students struggle with reading, reading and counting, while others struggle only with counting (dyscalculia). According to the vice principal, the diagnosis of students' learning disorders is based on psychological assessments and evaluations conducted by the school. This aims to place students in appropriate classes or groups based on their limitations. The students categorized as having dyscalculia at this SLB are sixth-grade students, who should already be able to understand and master mathematical operations, especially addition and subtraction. This is shown in Figure 1.

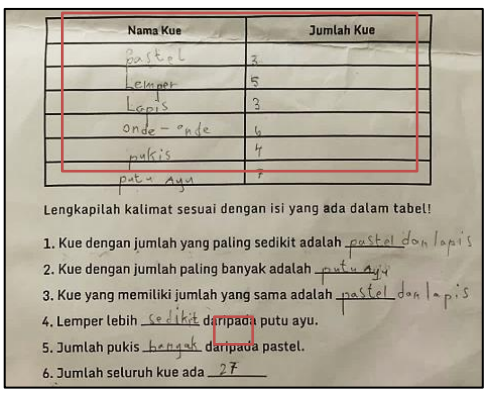


Figure 1. Errors made by a student with dyscalculia in adding numbers

From Figure 1, it can be seen that the student can fill in the table, which is part of the mathematics topic of collecting and presenting data. Data collection is the process of obtaining the required information. The data used to complete the table comes from the results of addition operations performed by the student.

However, based on the students' answers in Figure 1, it can be seen that students with dyscalculia made mistakes on one of the process skill indicators: calculating the total number of cakes in the table, where the correct total should have been 28. In addition, the students did not meet the indicator of communicating results because they did not articulate or report their final answers. This supports the findings of Saputri et al. [7], who reported that the addition skills of dyscalculic students at Sekolah Luar Biasa Harapan Ibu Metro remained unsatisfactory. These students' achievement level was low. This is in line with the American Psychiatric Association [8], which stated that the mathematical abilities of dyscalculic students are not consistent with their age and educational level. The sixth-grade classroom teacher also confirmed that several students still struggle to follow lessons and solve mathematical problems.

As previously explained, mathematics plays an essential role in human life. Therefore, it is important to examine the cultural aspects within society as part of mathematics learning. In addition to learning activities, culture integrated into mathematics can also serve as an evaluation tool [9]. Ethnomathematics refers to the mathematical practices rooted in cultural activities created by humans in their daily lives [10]. Mathematics learning grounded in culture, commonly known as ethnomathematics, is a method that connects mathematics with local cultural activities, making it easier for students to understand [11]. The school also occasionally uses congklak as a learning medium for counting.

Based on previous research by Kusumawaty et al. [12], dyscalculic students' thinking process when solving mathematical problems involves an initial state of disequilibrium upon first reading the problem. Disequilibrium occurs when students become confused while observing and classifying the problem. Assimilation occurs when dyscalculic students attempt to relate the information they know to what is being asked. Accommodation and equilibrium occur when students correctly gather and analyze data and can communicate the results of proportional comparisons in the given mathematical problem.

Based on previous research by Kamid et al [13], dyscalculic students carried out Polya's problem-solving steps understanding the problem, devising a plan, carrying out the plan, and looking back and also fulfilled all indicators of process skills (observing, counting, measuring, classifying, identifying relationships, making predictions, conducting experiments, analyzing data, interpreting data, and communicating results) on ethnomathematics based questions. However, the study by Pramesti et al. [14] found that students with moderate dyscalculia made progress in classifying and counting with minimal guidance, whereas those with severe dyscalculia required intensive support and showed limited progress.

Based on the explanations of the two previous studies, the research by Kusumawaty et al. [12] only described the thinking processes of students with dyscalculia in solving mathematics problems. Meanwhile, the study by Kamid et al. [13] only examined students with dyscalculia's problem-solving process skills. Therefore, this study focuses on describing

the process skills of students with dyscalculia in constructing ethnomathematics-based knowledge.

In this study, the application of ethnomathematics, using the traditional game of congklak as a medium for problem-solving, is analyzed to understand how students with dyscalculia develop process skills by using congklak seeds to perform addition and comparison operations in the topic of simple data presentation. Based on the findings of Della et al. [15], the congklak medium influences students with intellectual disabilities' counting ability; using congklak seeds of various colors can attract their attention and encourage them to participate more actively and enthusiastically in mathematics learning activities.

Based on the explanation above, an analysis of the process skills of dyscalculic students in solving ethnomathematics-based mathematical problems is necessary. For this reason, the researcher conducted a study entitled "Analysis of the Process Skills of Students with Dyscalculia in Special Schools (SLB) in Constructing Knowledge Based on Ethnomathematics". The purpose of this study is to analyze the process skills of students with dyscalculia in Special Schools (SLB) in constructing ethnomathematics-based knowledge. This study is expected to provide benefits in implementing mathematics instruction by utilizing local cultural themes to improve the quality of mathematics learning, as well as to serve as input for teachers to understand how students with dyscalculia construct their knowledge based on ethnomathematics.

2. METHOD

This study employs a qualitative research design with a descriptive approach, aiming to describe how dyscalculic students develop their process skills in constructing knowledge based on ethnomathematics. In this study, ethnomathematics serves as the basis for the test items by utilizing one of the traditional games, namely congklak. The qualitative method is the collection of data and synthesis of information in a predominantly non-quantitative manner [16]. The descriptive-analytical approach involves describing the facts, followed by analysis [17]. The results of this study are presented descriptively to provide readers with complete information about the findings. The process of knowledge construction based on ethnomathematics among dyscalculic students is analyzed and explained in detail to ensure the validity of the research findings through appropriate qualitative data analysis techniques.

This research was conducted at SLBN Prof. Dr. Sri Soedewi Masjchun Sofwan, S.H., Telanaipura District, Jambi City, during the odd semester of the 2025/2026 academic year. The data used in this study consist of the knowledge-construction processes of dyscalculic students based on ethnomathematics, obtained from think-aloud protocols during students' reading of the information-capturing sheet, students' think-aloud responses to ethnomathematics-based test items, and interviews with the research subjects. The data are qualitative because the analysis focuses on describing the process skills of dyscalculic students in constructing knowledge through ethnomathematics, using data from two dyscalculic students. The research data consist of students' responses collected through primary (data originating from the researcher) and supporting instruments (think-aloud responses while students read the information capture sheet, students' think-aloud responses to ethnomathematics-based test items, and interview results). The subjects of this study were

two students who met the following criteria: enrolled in a Special School (SLB) of Category C (intellectual disability), diagnosed with dyscalculia, currently in the upper elementary level (sixth grade of SDLB), able and willing to communicate with others, able to write and recognize numbers, and able to understand spoken instructions.

The data collection techniques included an information-capturing sheet, an ethnomathematics-based test, and interviews. The information-capturing sheet included a narrative about traditional games that involve calculation (addition and subtraction) and simple data collection. The content was simplified because the subjects had limited ability to process or understand information. The ethnomathematics-based test consisted of two items and was designed to obtain students' processes in solving the given problems. The material used focused on simple data collection related to ethnomathematics. The test was administered after the students completed the information-capturing sheet and was conducted using the think-aloud method. The interviews were conducted simultaneously with the test, during which the researcher asked questions while the subjects solved the problems.

The research procedure consisted of three stages: the pre-field stage, the implementation stage, and the data-analysis stage. In the pre-field stage, the researcher conducted interviews with a teacher at SLBN Prof. Dr. Sri Soedewi Masjchun Sofwan, S.H., Jambi City, to identify and confirm the dyscalculic students, submitted the research proposal, requested permission to conduct the study, prepared the research instruments, and submitted the research permit letter to the school. In the implementation stage, the researcher distributed the information-capturing sheets, administered the ethnomathematics-based think-aloud test accompanied by interviews, analyzed all collected data, and tested data credibility through technical and source triangulation. The final stage involved analyzing the data.

The data analysis procedures included data reduction (data from the test and data from the interview are reduced separately at first, and then combined to obtain a complete understanding of the process skills involved in the students' knowledge construction), data presentation (organizing information so that conclusions can be drawn), and conclusion drawing (conducted continuously throughout the research process).

3. RESULTS AND DISCUSSION

3.1. Results

1) Description of Data for Subject 1 (S1)

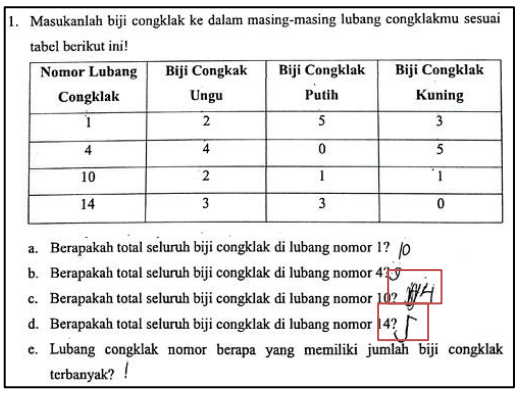
Before working on the questions, S1 was asked to read the information-capturing sheet using the think-aloud method. S1 was able to read it slowly and with guidance from the researcher.

Question number 1 asked the student to place the congklak seeds into each congklak hole according to the number of colored seeds shown in the table. Then, the student was asked to count the total number of congklak seeds in each congklak hole. Finally, the student was asked to compare which congklak hole had the most congklak seeds. During the interview, S1 appeared confused and shook their head when asked about the question. While reading question 1, S1 could perform the think-aloud procedure, but took considerable time

and required the researcher's guidance several times. S1 picked the congklak seeds according to the colors shown in the table while stating the numbers aloud each time they picked a seed, then placed them into the corresponding congklak holes as shown in Figure 2.

Figure 2. S1 picking and placing congklak seeds according to color

S1 was requested to count all the congklak seeds by emptying the seeds from each hole rather than counting the numbers on the table. S1 then completed questions a through e. The results are shown in Figure 3.



1. Masukanlah biji congklak ke dalam masing-masing lubang congklakmu sesuai tabel berikut ini!

Nomor Lubang Congklak	Biji Congkak Ungu	Biji Congklak Putih	Biji Congklak Kuning
1	2	5	3
4	4	0	5
10	2	1	1
14	3	3	0

a. Berapakah total seluruh biji congklak di lubang nomor 1? 10
b. Berapakah total seluruh biji congklak di lubang nomor 4? 9
c. Berapakah total seluruh biji congklak di lubang nomor 10? 4
d. Berapakah total seluruh biji congklak di lubang nomor 14? 5
e. Lubang congklak nomor berapa yang memiliki jumlah biji congklak terbanyak? 1

Figure 3. S1 answer results for question number 1

S1 made errors in parts c and d. In part c, S1 initially counted 4 seeds in hole number 10 but appeared unsure and repeated the counting, crossing out the previous result. In part d, S1 miscalculated; the correct answer was 6, but S1 counted and wrote the number 5. For part e, S1 compared the holes by visually observing which hole had the most seeds, instead of comparing the numerical results obtained in parts a, b, c, and d.

Question 2 required the student to place congklak seeds into each hole, as shown in the picture. According to the interview, S1 again appeared confused and shook their head when asked about the question's topic. When reading question 2, S1 performed the think-aloud procedure more quickly than in question 1 but still required guidance from the researcher.

After reading the question, S1 began placing the seeds as shown in the picture. While placing the seeds, S1 pronounced the numbers loudly and correctly. However, when the researcher asked how many seeds were in hole number 1, S1 hesitated initially nodding, then

shaking their head, and finally saying there were no seeds in the hole. S1 showed confusion because they did not understand how to create the table. The researcher reminded S1 of the table from the information sheet previously read, but S1 still could not recall its structure. After the researcher showed the table again, S1 finally remembered and created the table shown in Figure 4.

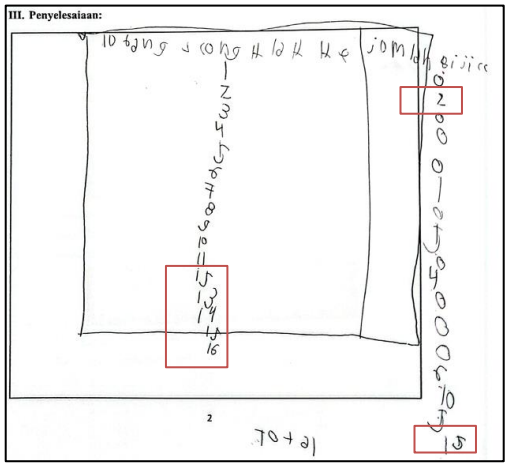


Figure 4. S1 answer results for question number 2

From the results of question number 2 (Figure 4), it appears that S1 made several errors in writing the numbers of the congklak holes and calculating the number of seeds in each hole. S1 wrote the number 15 after 11, and made number-writing mistakes such as writing 2 instead of 0. S1 also miscalculated the total number of seeds, reporting 15 instead of the correct result of 31.

After completing all parts of questions 1 and 2, S1 simply submitted the answer sheet without summarizing or verbally explaining their overall results to the researcher.

2) Description of Data for Subject 2 (S2)

Before working on the questions, S2 was asked to read the information-capturing sheet using the think-aloud method. S2 read it more quickly than S1. After reading the sheet, the researcher gave the test sheet and prepared the congklak board and seeds. While reading the questions, S2 did not know the material's topic but recognized that the questions were related to mathematics. S2 was able to read the questions using the think-aloud method.

After reading, S2 picked the congklak seeds based on the colors shown in the table while stating each number aloud and placing them into the corresponding holes as shown in Figure 5.

Figure 5. S2 picking and placing congklak seeds according to color

For question a, S2 counted all the seeds by removing them from each hole rather than using the numbers in the table. S2 then correctly completed parts a through d. The results are shown in Figure 6.

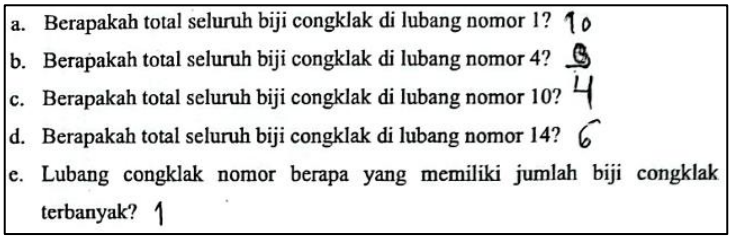

a. Berapakah total seluruh biji congklak di lubang nomor 1? 10
b. Berapakah total seluruh biji congklak di lubang nomor 4? 5
c. Berapakah total seluruh biji congklak di lubang nomor 10? 4
d. Berapakah total seluruh biji congklak di lubang nomor 14? 6
e. Lubang congklak nomor berapa yang memiliki jumlah biji congklak terbanyak? 1

Figure 6. S2 answer results for question number 1

In part e, S2 determined which congklak hole had the most seeds by comparing the results from parts a, b, c, and d.

In question 2, based on the interview, S2 again did not know the material's topic. When reading the question, S2 performed the think-aloud method quickly and accurately. After reading, S2 began inserting the seeds according to the provided picture. While doing so, S2 clearly and correctly stated the numbers.

After inserting the seeds, S2 began answering the question by writing “congklak hole number” and “number of congklak seeds,” but could not create the table even after being reminded about the table from the information sheet. The researcher then showed the table again, but S2 still could not construct it.

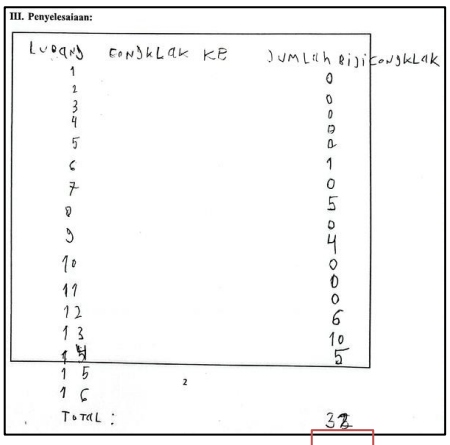


Figure 7. S2 answer results for question number 2

From the results of question 2 (Figure 7), S2 correctly wrote the congklak hole numbers and counted the seeds in each hole. S2 accurately counted and wrote the number of seeds in each hole but made an error in calculating the total number of seeds, writing 32 instead of the correct answer, 31. Interestingly, when verbally counting the total number of seeds, S2 correctly stated “31.”

After completing all parts of questions 1 and 2, S2, like S1, submitted the answer sheet without summarizing or verbally explaining the overall results to the researcher.

3.2. Discussion

In the observing skill, S1 and S2 were able to read the ethnomathematics-based questions using the think-aloud method and paid attention to the given tasks through assimilation, reading the questions quickly without hesitation. According to Nasution [18], observation is carried out by using all senses to notice the object being observed. This aligns with Mulyani [19], who states that a person constructs knowledge through assimilation when the process occurs quickly, without significant cognitive effort. S1 and S2 appeared focused while reading the questions and were interested in solving them. This is also consistent with the findings of Hayuningrat and Listiawan [20], who found that students can read questions fluently using the think-aloud method when observing the questions and images.

In the ability to identify relationships, S1 and S2 were unable to recognize the topic presented in the questions, namely, data presentation. Based on the interview results, neither subject constructed their knowledge to determine the relationship between the question content and the information provided on the information-capturing sheet. Therefore, S1 and S2 did not meet the indicator of determining relationships. According to Lestary et al [21], students who experience anxiety while solving questions tend to show responses such as confusion, discomfort, and pressure, which hinder the resolution of cognitive conflict and make equilibrium difficult to achieve. According to Millah et al [22], students can understand more complex concepts with scaffolding assistance from teachers or more competent peers, which is temporary, structured, and gradually reduced as independence and understanding increase.

In the classifying skill, S1 and S2 did not immediately arrange or fill the congklak holes with seeds according to the color in question 1 or the image in question 2, as they hesitated to complete the task independently without the researcher's assistance. As they began arranging the congklak holes, both subjects repeatedly looked to the researcher for reassurance that their actions were correct. This indicates that S1 and S2 instantly engaged in cognitive processing that required adjustment. Thus, the process of knowledge construction in this skill occurred through accommodation, in which the subjects built new categories because the old ones did not match, leading to a longer time spent classifying the congklak seeds.

In the data collection and analysis skill, S1 and S2 repeated the activity multiple times, stating that they had never encountered similar questions before and were confused about the steps needed. Both subjects performed this skill through accommodation. Students tend to predict a statement that seems reasonable but may not be correct, whereas justification involves testing assumptions using logical grounds [23].

In terms of predictive skill, since S1 and S2 were unable to solve the question directly, they predicted ways to complete the task through accommodation. In planning the solution to a mathematical problem, reflective students generally engage in assimilation and, to a lesser extent, accommodation [20]. Mathematical thinking is a cognitive activity that involves initiating a response to a question, solving it effectively, and gaining insight from the experience [24]. S1 modified the strategy from the information-capturing sheet by counting the number of congklak seeds directly rather than by performing addition from the numbers in the table. Similarly, S2 also requested that seeds be counted directly in the

congklak holes. This aligns with Milla et al. [22], who stated that concrete media allow students to gradually construct understanding from dependence on concrete objects toward independence with mathematical symbols and notation.

In the counting skill, S1 and S2 performed calculations through assimilation: both subjects mentioned numbers aloud while counting the congklak seeds and were able to say the numbers accurately. However, when writing down the numbers on the answer sheet, S1 made several mistakes and later corrected them. This supports the findings of Purwoningtiyas and Masriyah [23], which state that students revise incorrect assumptions until their work becomes correct and they feel confident in their corrections.

In the measuring skill, S1 and S2 were able to compare the number of congklak seeds in each congklak hole. The act of comparing or identifying quantities is a measuring ability, as it reflects the ability to recognize how large or small an object is [18]. However, this comparison emerged through accommodation: at first, both subjects hesitated in their answers, but eventually became confident in their final comparison in question 2. The subjects did not rely solely on prior knowledge but built understanding by adjusting their cognitive schema to determine which comparison was greater, smaller, or equal.

In the interpreting data skill, S1 performed this through accommodation, as he appeared confused and unsure when constructing the table. After being reminded of the table structure from the information-capturing sheet, S1 began to understand and correctly construct the table. Students realize that their initial schema cannot be immediately assimilated into the solution-determining process [23], [25]. Meanwhile, S2 was unable to perform data interpretation in tabular form.

In the experimenting/executing skill, neither S1 nor S2 was able to solve the questions independently. Interviews revealed that both subjects repeatedly stated they did not know how to write answers or record calculations without guidance. Therefore, S1 and S2 did not meet the skill of conducting an experiment.

In the communication skill, S1 and S2 demonstrated accommodation. When reporting their final solution, both subjects submitted only the answer sheet to the researcher, without explaining or concluding their answers verbally. Students did not review the coherence between their answers, questions, and solution steps, yet they believed that the steps taken were appropriate for the required response [23], [26].

4. CONCLUSION

Based on the discussion presented, it can be concluded that dyscalculic students' process skills for constructing ethnomathematics-based knowledge have not been fully optimized across most process skill indicators. During the observing stage, S1 and S2 were able to read and attend to the questions through think-aloud activities using assimilation. However, during the stage of determining relationships, both subjects were unable to link the question material to the information provided in the information-capturing sheet, resulting in this indicator not being met. In the stages of classifying, collecting, analyzing data, and making predictions, S1 and S2 performed the activities through accommodation, as they needed to adjust their cognitive schemes to understand and solve the questions. In the calculating and measuring stages, S1 and S2 were able to verbalize the numbers correctly,

but still made mistakes when writing them down and when comparing the number of congklak seeds. In the data-interpretation stage, only S1 was able to construct the table after being reminded using the information-capturing sheet, while S2 was unable to do so.

Meanwhile, during the experimental stages and while communicating results, both subjects were unable to complete the tasks independently and did not provide conclusions to their answers. Nevertheless, S1 and S2 demonstrated several strengths, including persistence in completing tasks, accuracy in verifying their work, good response to guidance, and better learning outcomes when concrete media were used, indicating that visual and tactile supports effectively facilitate their mathematical learning. Therefore, S1 and S2 predominantly demonstrated process skills through accommodation rather than assimilation in constructing their knowledge, indicating that they require intensive guidance and concrete media in learning mathematics.

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