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Analysis of Knowledge Construction Process in Junior High School Students Through Ethnomathematics Based Problem Solving

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ABSTRACT

This study aimed to analyze knowledge construction process on the 8th grade of junior high school through mathematical problem solving based on ethnomathematics for several students with high, medium, and low problem solving abilities. We employ qualitative method to reveal the subject's knowledge construction process. Data collection in this study was carried out by giving problem solving ability test, knowledge construction process test and interviewing 3 research subjects, one student was selected from each level of problem solving ability. Data were analyzed using data reduction, data display, and conclusion drawing. This research describes that students with high problem solving abilities in all four steps of problem solving use assimilation thinking process. Students thinking process whose problem-solving abilities is medium use assimilation thinking process in understanding the problem, creating a solution, and carrying out the plan, while reviewing the answers they use accommodation thinking process. In addition, students with low problem solving abilities in understanding the problem, use assimilation and accommodation thinking processes, in creating a solution, they use the assimilation thinking process, and use accommodation thinking process in carrying out the plan, while reviewing the answers there is imperfect accommodation thinking process.

ABSTRAK

Penelitian ini bertujuan untuk menganalisis proses konstruksi pengetahuan siswa kelas VIII SMP dilihat melalui pemecahan masalah matematis berbasis etnomatematika untuk beberapa siswa dengan kemampuan pemecahan masalah tinggi, sedang, dan rendah. Penelitian dilakukan menggunakan metode kualitatif deskriptif untuk mengungkap proses konstruksi pengetahuan pada subjek penelitian. Pengumpulan data pada penelitian ini dilakukan dengan memberikan tes kemampuan pemecahan masalah, tes proses konstruksi pengetahuan dan mewawancarai 3 subjek penelitian, satu siswa dipilih dari setiap tingkat kemampuan pemecahan masalah. Data dianalisis menggunakan reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa siswa dengan kemampuan pemecahan masalah tinggi dalam keempat tahapan pemecahan masalah melakukan proses berpikir asimilasi. Proses berpikir siswa dengan kemampuan pemecahan masalah sedang dalam memahami masalah, merencanakan penyelesaian, dan melakukan rencana penyelesaian terjadi secara asimilasi, sedangkan dalam memeriksa kembali terjadi secara akomodasi. Kemudian untuk siswa dengan kemampuan pemecahan masalah rendah pada tahap memahami masalah melakukan proses berpikir asimilasi dan

akomodasi, dalam merencanakan penyelesaian melakukan proses berpikir asimilasi, dalam melaksanakan rencana penyelesaian melakukan proses berpikir akomodasi, sedangkan pada tahap memeriksa kembali melakukan proses berpikir akomodasi tidak sempurna.

INTRODUCTION

Education that can hone students' potential so that students can apply the things they learn at school in solving problems in everyday life is education that can support future development (Sholihah & Mahmudi, 2015). Subjects that have an important role in the field of education as well as in dealing with problems in everyday life are mathematics. Students need mathematics which is basic knowledge to support the achievement of learning objectives to get to higher education. In every math learning process, students will always gain new knowledge and understanding. To get this new knowledge, it is very important for students to have the skills to construct student knowledge.

Knowledge construction skills are very important to develop and train, because these skills will be used by students when learning to gain new knowledge and understanding of concepts and theories (Sinuraya et al., 2019). Knowledge construction is the mental process of students taking a number of information then the information is used to build an understanding of what they learn or interpret thoroughly (Setyawan & Rahman, 2013). The knowledge construction process is an activity carried out by students to build their knowledge, which occurs through two constructive processes, namely assimilation and accommodation which will then go through an equilibration process as an adjustment. Assimilation is the process of combining new ideas, understandings, and experiences into a new framework or existing framework (Hendrowati, 2015). While the accommodation process will occur if the new experience obtained is not relevant to the existing scheme, so a new scheme will be formed.

The process of building knowledge occurs when we want to find the answer of a problem (Radani, 2018). In line with the statement from Netekal et al. (2023), in solving a mathematical problem, it is very important to pay attention to well constructed knowledge. NCTM (National Council of Teachers of Mathematics) (2000) express that mathematics learning aims to require student to have mathematical problem solving skills, mathematical connection skills, mathematical communication, mathematical representation skills, and mathematical reasoning skill. Problem-solving ability is one of the essential mathematical competencies that plays a crucial role in the thinking process, serving as an effort to find solutions in order to achieve a specific goal (Satya et al., 2022). One effective approach to improving students mathematical problem solving is ethnomathematics based problem solving. Ethnomathematics has an important role in helping students construct their knowledge. Ethnomathematics facilitates students to be able to construct mathematical concepts well. In addition, the use of ethnomathematics in problems can help students understand and digest information. Ethnomathematics is an expression used to describe the process of learning mathematics that involves culture (Astuti et al., 2023). This approach aims to see how students construct knowledge based on the existing knowledge at each problem solving step in finding answers. By applying ethnomathematics as a learning approach, it is possible for material to be more easily understood by students because the

material is directly related to culture which is an activity in everyday life (Suhartini & Martyanti, 2017). Through student-centered mathematics instruction that emphasizes active student participation in the learning process, students do not merely receive information but are also engaged in the process of knowledge construction (Siswanto et al., 2025). Based on observations made by researchers in class VIII C SMP Negeri 25 Jambi City, when students work on test, the student process in working on the problems given is not same. This is influenced by the cognitive development stage of student is different and has their own schema. Every individual has a basic schema that functions as a support for new concepts and experiences (Ibda, 2015). When the information fits the existing schema, there will be a mental process called assimilation. But when the information is not fit with the scheme, there will be a mental process called accommodation. Based on the interview, the teacher also said that sometimes students still have difficulty when solving math problems that have been explained in the learning process.

Several previous studies have addressed the topic of knowledge construction and problem solving. First, Kurniawan et al. (2017) examined the construction process in solving mathematical problems based on students emotional intelligence. Second, Mulyani et al. (2022) explored the knowledge construction process of students with a visual learning style. Third, Aini & Nugroho (2023) analyzed students knowledge construction in solving geometry problems based on gender differences. However, none of these studies have investigated students knowledge construction in mathematical problem solving as measured by their levels of problem solving ability. This study aims to examine how students with high, medium, and low problem solving abilities construct knowledge during mathematical problem solving. Therefore, this study focuses on analyzing the knowledge construction process of students in solving ethnomathematics based mathematical problems at SMPN 25 Jambi City.

METHOD

This research was conducted in 8th grade of SMPN 25 Jambi City, using descriptive qualitative to analyze students knowledge construction process in solving ethnomathematics based mathematical problems, especially on pythagorean theorem topic. Researchers who act as the main instrument in this study will make direct observations and process data obtained from supporting instruments in the form of test results of students ethnomathematics based problem solving questions and interview results based on the test answers. The subjects of this study were one student with high problem solving ability, one student with medium problem solving ability, and one student with low problem solving ability. Students with high problem solving ability who are able to fulfill all four steps of problem solving correctly, the second group of students with medium problem solving ability who fulfill two or three of the step of problem solving, and finally the third group of students with low problem solving ability who can only fulfill one step of problem solving. The subjects of this study were selected from students of 8th grade of SMPN 25 Jambi City.

Data collection in this study was carried out by giving tests and interviewing research subjects who had been selected based on their level of problem solving ability. The data analysis according to Abdussamad (2021) with the first step, data reduction, the collected data are summarized by selecting essential and relevant information that supports the research while eliminating unnecessary data. Second, data display, in the data display step the reduced data are then organized or categorized based on the students levels of problem solving ability. Third, conclusion drawing, in the conclusion drawing step the initial

conclusions derived from the data reduction and display are further reinforced with strong supporting evidence, allowing for a final, credible conclusion to be formulated.

RESULT AND DISCUSSION

The following describes the process of students knowledge construction in solving mathematical problems:

1. Knowledge construction process of students with high problem solving ability (S1)

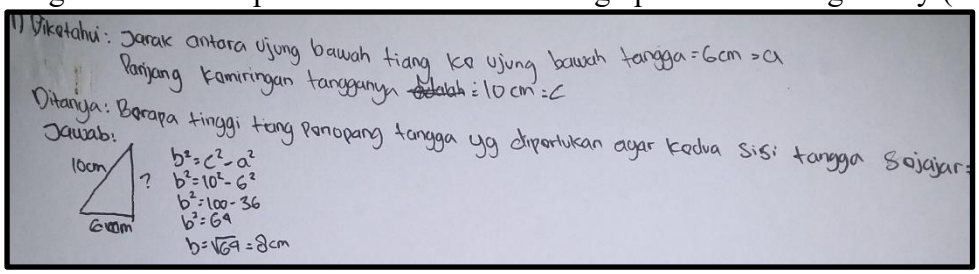

Figure 1. S1's Answer to Question 1

Figure 1. shows that in the problem solving process S1 can re-visualize the information obtained in the form of a right triangle and determine the right formula or formula to solve the problem using the pythagorean theorem formula to find the upright side. Judging from the interview with S1:

P : Explain the steps of the solution that you did

S1 : I use the pythagorean theorem formula to find the upright side. The length of the slope of this ladder is the hypotenuse, so c is 10 cm . If the base is the distance from the bottom end of the pole to the bottom end of the stairs, so a is6 cm . Then c and a are entered into the formula, so 100 - 36 the result is 64. then 64 is multiplied to get the result 8 cm.

S1 can form knowledge by assimilation which is characterized by being able to mention the concepts used correctly and solve problems according to the information obtained. Although in explaining S1 is a little hesitant to answer, but S1 can correctly determine the side that becomes the hypotenuse and base and substitute it into the formula. In addition, S1 was able to recheck the solution he did by checking repeatedly on the answer. Students with high problem-solving abilities tend to apply assimilation effectively in solving mathematical problems because they already have well-structured knowledge frameworks. According to Anderson et al. (2023), assimilation occurs when new information fits into an existing cognitive structure, allowing the learner to solve problems efficiently.

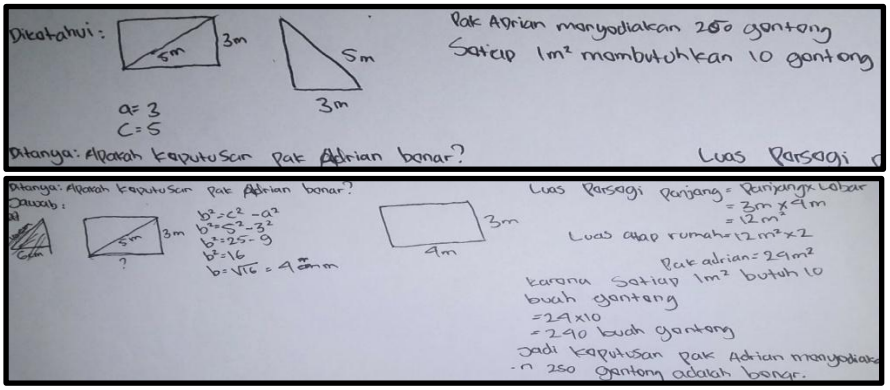

Figure 2. S1's Answer to Question 2

Furthermore, the results of the answer to the second question written by S1 revisualize the roof of the traditional kajang lako house into a rectangle and then put the information obtained into the picture. S1 can re-describe objects based on what is known and asked, and can compile his knowledge by assimilation where this process takes place quickly. This construction process occurs by understanding the images listed on the test questions. S1 is able to understand well the problem given and determine the information known and asked correctly. Figure 2. shows that at the problem solving stage S1 is able to use the right formula to find the upright side. S1 is able to apply the knowledge previously learned, namely the area of a rectangle. From the results of the interview S1 can directly mention the reasons for using the pythagorean theorem formula to find the upright side in solving problem number 2. In the step of doing the problem solving design, the step S1 takes is to find the total area of the roof based on the answers obtained previously. This proves that S1 can use and substitute known information into the formula based on the plan made previously. S1 can also conclude and check the correctness of the final answer correctly so that it can be seen that S1 constructs knowledge by assimilation in the problem solving stage. This aligns with findings by Kusmaryono et al. (2021), which suggest that students with strong cognitive readiness can integrate prior knowledge effectively and perform consistently across problem solving steps.

2. Knowledge construction process of students with medium problem solving ability (S2)

   Here are the results of S2's work for the first problem:

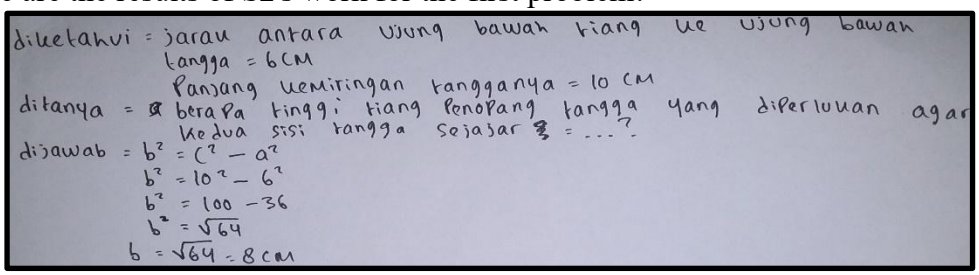

Figure 3. S2's Answer to Question 1

Based on the answers given by S2 in Figure 3, it is shown that S2 can fully understand the problem. S2 wrote the distance between the bottom end of the pole to the bottom end of the stairs and the length of the slope of the stairs correctly as well as the information asked in the problem. In the problem solving process S2 did not illustrate the information obtained into a right triangle first but immediately determined the right formula to solve the problem, namely using the pythagorean theorem formula to find the upright side. The results of the interview S2:

P : Are you sure that your answer is correct?
S2 : pretty sure
P : Did you reviewing the solution process?
S2 : no
P : So, what should be the conclusion of your problem solving?
S2 : The height of the staircase support pole is 8 cm

Based on the results of the interview, S2 tried to explain the steps of the problem solving that he did even though it was not the whole. S2 can form knowledge by assimilation which is characterized by being able to mention the concepts used correctly and solve problems according to the information obtained. Although in explaining S2 was a little hesitant to answer, S2 was able to determine the formula used correctly and

substitute the value of the hypotenuse and base into the formula. In addition, S2 was able to conclude the problem solving that was carried out even though he did not double-check the results of his answers. As Floren et al. (2021) explain, knowledge construction is a dynamic process influenced by learners prior understanding and metacognitive awareness. When students fail to verify their solutions but still apply correct concepts, it suggests partial assimilation.

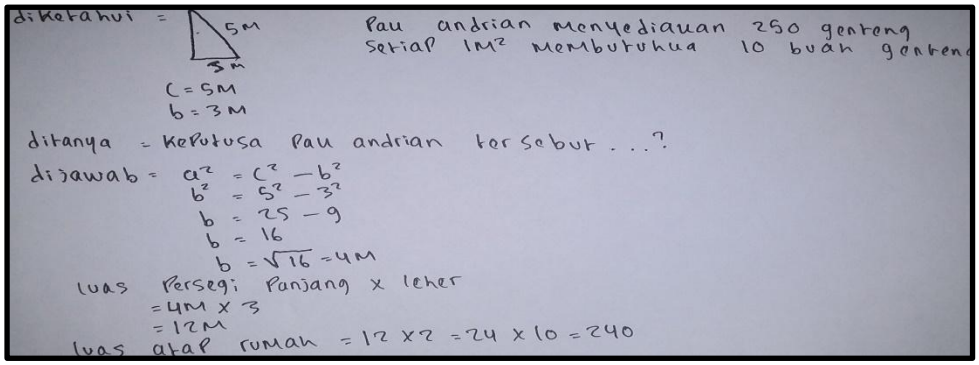

Figure 4. S2's Answer to Question 2

Furthermore, from the results of the known and asked answers to the second question made by S2, to check Mr. Adrian's correct decision requires the length and width of the roof of the Kajang Lako traditional house. S2 visualizes the roof of the house into a right triangle and then puts the information obtained into the picture. It can be seen that S2 can compile his knowledge by assimilation characterized by being able to determine the information known and asked in the second problem. This construction process occurs by understanding the image listed on the test question. Figure 4. shows that S2 correctly answered the upright side or the length of the roof of the traditional house being sought, which is 4 m, but S2 could not determine the correct initial formula for finding the upright side of a right triangle, $b^2 = c^2 - a^2$. S2 is able to apply the knowledge previously learned, namely the area of a rectangle.

It can be seen that S2 is able to directly carry out the problem solving plan, although it is less precise in writing the unit of the rectangular area results sought should be m^2. Then to determine whether Mr. Adrian's decision was correct or not, 10 was substituted into the unit m^2 because in the problem it was known that every 1 m^2 needed as many as 10 roof tiles. This caused S2 to be unable to conclude the correctness of Mr. Adrian's decision even though he could re-examine the results of his answer. It can be seen that S2 constructs knowledge by accommodation in the stage of re-examining the answer. Students with medium problem-solving skills often fluctuate between assimilation and accommodation. As Floren et al. (2021) explain, knowledge construction is a dynamic process influenced by learners prior understanding and metacognitive awareness. When required to evaluate outcomes (e.g., Mr. Adrian's decision), they may shift to accommodation due to lack of confidence or incomplete schema.

3. Knowledge construction process of students with low problem solving ability (S3)

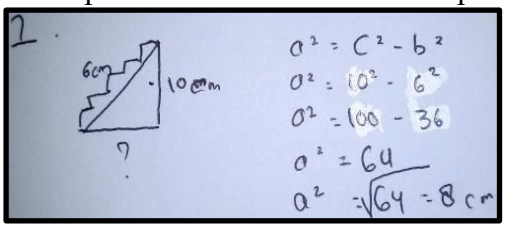

Figure 5. S3's Answer to Question 1

Based on the results of the work S3 did not write information using known and asked on the answer sheet, but only made an illustration of the stairs in the form of a right triangle. However, the length of each side does not match the information contained in the problem. The following is an interview with S3:

P : Why don't you write down the known and asked first to make it easier?
S3 : ee... because I don't understand ma'am, so I immediately wrote the length of the side in the form of a right triangle
P : from the triangle that you drew, which one is known and asked?
S3 : emm... known are sloping side of the ladder 6 cm, the upright side 10 cm, asked the base.

The results of the interview showed that S3 did not understand the problem where S3 incorrectly determined 6 cm as the length of the slope of the stairs and thought the information asked was the length of the base. But at the stage of planning problem solving, S3 can determine the right formula by using the pythagorean theorem formula. S3 is less careful in working on the problem, which is wrong in determining the side that becomes the hypotenuse and base. Although S3 obtained the correct answer, but S3 was unable to understand the real problem of the problem so that the completion process was not correct. Students with low problem solving abilities tend to rely more on accommodation as they often face difficulties aligning new information with prior knowledge. Piaget's theory (as cited in Ibda, 2015) emphasizes that when existing cognitive structures are insufficient, learners must reconstruct their knowledge through accommodation.

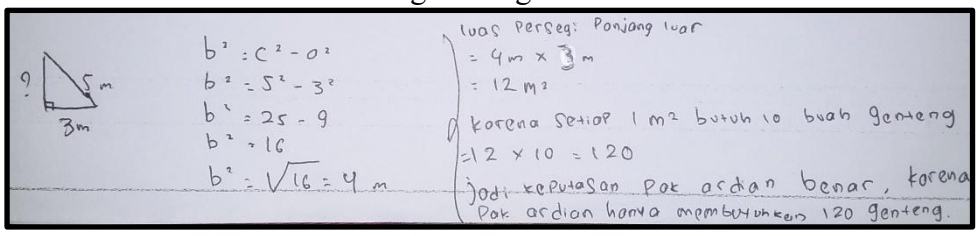

Figure 6. S3's Answer to Question 2

Furthermore, from the answers written S3 describes the roof of the traditional kajang lako house into a triangle and then lists the information obtained into the picture. S3 can re-describe objects based on what is known and asked, and can organize his knowledge by assimilation. S3 did not write the information known and asked from the question on his answer sheet, but S3 was enough to understand the meaning of the question even though he was still hesitant in answering it. Based on the results of the interview, S3 was unable to explain the steps he had written orally and in the process of solving the problem, S3 had not yet found the entire roof area of the Kajang Lako traditional house but only looked for the area of one side of the roof. So in doing the problem solving plan S3 has not used the right procedure. But S3 can draw conclusions from the results of the solution it obtained. In line with research by Mulyani (2019) which states that students who hesitate, misinterpret questions, or fail to explain their reasoning are often in the process of accommodation, indicating gaps in conceptual understanding.

This study analyzes the knowledge construction process, namely the assimilation process and the accommodation process seen through ethnomathematics-based mathematical problem solving. Table 1. presents the descriptors of knowledge construction process in problem solving adopted from Kurniawan et al. (2017) and Polya (1985):

Table 1. Student process during the construction process in problem solving

Stages of Problem Solving	Knowledge Construction Process	Observed Process
Understanding the problem	Assimilation	Can explain the information known and asked in the problem and can determine whether the known information is sufficient to find a solution to the problem.
	Accomodation	Unable to directly explain the information known and asked in the problem
Devising a plan	Assimilation	Can mention strategies and develop a solution plan based on known information
	Accomodation	Unable to directly plan problem solving according to the known information in the problem
Carrying out the plan	Assimilation	Can solve the problem according to the plan made with the correct calculation algorithm
	Accomodation	Not able to solve the problem directly, but students solve different problems with the problem solving plan made
Reflecting on the solution	Assimilation	Can reflect on the solution done by being able to prove the answer is correct
	Accomodation	Not sure about the correctness of the answer and able to make new problem solving.

Based on the test results and interview transcripts of the three research subjects, the thinking process when solving problem is found in the table 2.:

Table 2. The results of the research subjects tests based on indicators of the knowledge construction process in mathematical problem solving

Subject	Knowledge Construction Process	Understanding the problem	Devising a plan	Carrying out the plan	Reflecting on the solution
S1 Problem 1	Assimilation	√	√	√	√
	Accomodation	-	-	-	-
S1 Problem 2	Assimilation	√	√	√	√
	Accomodation	-	-	-	-
S2 Problem 1	Assimilation	√	√	√	-
	Accomodation	-	-	-	√
S2 Problem 2	Assimilation	√	√	√	-
	Accomodation	-	-	-	√
S3 Problem 1	Assimilation	-	√	-	-
	Accomodation	√	-	√	√
S3 Problem 2	Assimilation	√	√	-	-
	Accomodation	-	-	√	√

The following are the results of the analysis of the knowledge construction process through ethnomathematics-based mathematical problem solving in junior high school students based on the completion of knowledge construction test questions and interviews. Based on the results of the research that has been done, it can be seen that the construction

process carried out by S1 and S2 at the stage of understanding the problem occurs by assimilation. It can be seen from the interviews with S1 and S2 related to the information contained in both the first problem and the second problem. S1 and S2 can directly identify the information in the problem and understand the information well. This is in line with research by Mulyani (2019) which states that a person has assimilated his knowledge when he actively understands and integrates various knowledge. So the researchers concluded that S1 and S2 in the stage of understanding the problem had built knowledge by assimilation on knowledge of details. Knowledge of details is knowledge about events, phenomena, locations, people, sources of information, and so on which are included in factual knowledge (Anderson et al., 2023).

The construction process carried out by S3 at the stage of understanding the problem occurs by assimilation and accommodation. In the second problem, S3 can directly re-describe objects based on what is known and asked, and can organize his knowledge by assimilation. While judging from the direct answer submitted by S3 during the interview regarding the information listed in the first question , S3 experienced an accommodation process in understanding the problem. S3 is a little hesitant in answering what is known and asked and takes longer than S1 and S2 in finding information in the first problem. That means S3 in the stage of understanding the problem has compiled knowledge by accommodation on factual knowledge. In line with research by Mulyani (2019), if someone takes time in the process of understanding the problem it can be said that he builds his knowledge by accommodation. This conclusion is in line with research by Netekal et al. (2023) to solve problems, well-constructed knowledge is very important. In addition, the use of ethnomathematics in problems can help students understand and digest information.

Based on the research results from the ethnomathematics-based problem solving test results that have been carried out, it can be seen that the construction process carried out by the three subjects when devising a plans occurs by assimilation. During the interview, the three subjects were able to directly mention the concepts and problem solving steps used in the first and second problems. The three subjects can also find the diagonal length of the flat roof of the Kajang Lako traditional house. So it can be said that the three subjects when devising a plan have constructed their knowledge by assimilation to conceptual knowledge. Conceptual knowledge includes how information is interrelated through schemes, models, mental and theoretical (Anderson et al., 2023). So it can be said that S1, S2, and S3 in the process of measuring have compiled their knowledge by assimilation on knowledge of techniques and methods. Knowledge of techniques and methods included in procedural knowledge is how to think and solve problems (Anderson et al., 2023). In this case S1, S2, and S3 showed how to think by deciding the formula they used to solve the first and second problems. In addition, the three subjects can directly explain the problem-solving strategy that will be carried out so that it can be said that the subject in devising a plan has constructed his knowledge by assimilating strategic knowledge. Strategic knowledge is included in metacognitive knowledge which is knowledge about various strategies that can be used to understand material, learning strategies and problem solving (Anderson et al., 2023). In addition, ethnomathematics also has an important role in helping students construct their knowledge. Ethnomathematics facilitates students to be able to construct mathematical concepts well.

Based on the data exposure, it can be seen that the construction process carried out by S1 and S2 when carrying out the plan occurs by assimilation. While S3 did it by accommodation on both questions. In line with research by Mulyani (2019) which states

that if someone looks confused, has little difficulty in answering, and takes time to reread the problem then someone is said to compile their knowledge by accommodation. S1 and S2 can directly find the total area of the roof based on the answers obtained previously. So it can be said that S1 and S2 in the process of carrying out the plan have compiled knowledge by assimilation on knowledge about algorithms. In line with the opinion of Anderson et al. (2023) that knowledge of algorithms is included in procedural knowledge which includes techniques, algorithms, methods, and skills which are all called procedures. While S3 takes longer than S1 and S2 in solving the problem. S3 has been able to solve the problem based on the problem solving design that he designed in general although it is difficult to explain the steps he has written orally and in the process of solving the problem, S3 has not been able to find the overall area of the roof of the Kajang Lako traditional house but only looking for the area of one side of the roof. So in doing the problem solving plan S3 has not used the right procedure.

Based on the data exposure, it can be seen that the construction process carried out by S1 at the stage of reflecting on the solution occurs by assimilation. S1 can give conclusions from the solution obtained and is able to reflect on the answer by ensuring that the value substituted into the formula is correct. So that researchers can determine that S1 at the stage of reflecting on the solution has compiled his knowledge by assimilation on knowledge of principles and generalizations. Knowledge of principles and generalizations is part of conceptual knowledge which is knowledge to examine problems by summarizing various facts and events (Anderson et al., 2023). While S2 and S3 construct their knowledge by accommodation at the stage of reflecting on the solution. The results of the S2 interview showed that S2 repeatedly read the problems given to prove that the results obtained were correct. The results of the problem solving test and interview with S3 showed that S3 was not sure of the correctness of the answer to the problem because he did not understand the information known and asked in the problem.

The three research subjects can fulfill the indicators of the knowledge construction process through ethnomathematics-based mathematical problem solving. Where the three subjects managed to solve the problem with steps to understand the problem, design a solution, carry out the design to re-examine. This means that the three subjects constructed their knowledge well using these problem solving stages. Although at some stages some subjects do it with a little longer time. This accommodation thinking process is known to occur one of them because the knowledge construction process is very dependent on the cognitive abilities of students. Learners with good cognitive abilities will find it easy to acquire and retain knowledge and manipulate information. Conversely, learners with poor cognitive abilities will take time to process information. In addition, the learning atmosphere is also one of the elements that influence the way a person constructs knowledge. The knowledge construction process can be supported through constructivist learning environments, such as learning that focuses on solving problems that are relevant to the students environment, one of which is culture.

CONCLUSION

From this research, it can be concluded that the research subject constructs knowledge from the environment actively in understanding the problems, devising a plan, carrying out the plan, and reflecting on the solution through adaptation of assimilation and accommodation so as to achieve balance. The learning carried out produces something useful in life, so that learning becomes meaningful. The results of this study are expected to help teachers to better understand the abilities of students, as well as pay more attention

to knowledge construction errors that can affect students' learning processes and outcomes. Moreover, it is important to realize that with good problem solving skills, students can construct their knowledge correctly. Therefore, it is important for teachers to implement and ensure that students have a good understanding of each use of the procedure so that it can be used according to the problem. So that students not only memorize, but really understand it so that students can get used to solving other problems.

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