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Examining students' cognitive processes in solving algebraic numeracy problems: A Phenomenology study

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Abstract

Problem-solving can be understood as a cognitive process in which students know facts, processes, concepts, and procedures and then apply the knowledge to solve problems in real situations. Indonesia’s national average achievement of numeracy skills in 2021, the cognitive process of competence reasoning is higher than the competencies of knowing and applying. This study aims to analyze students' cognitive processes in solving numeration problems related to the algebraic domain. The algebraic domain in this study is limited to competencies in making generalizations from patterns in number sequences and object configuration sequences. This research was conducted qualitatively with a phenomenological design using three high-category and three low-category students to achieve data saturation. The supporting instruments are students' answers and interview results related to the algebraic domain. This study concluded that students' cognitive processes in solving numeracy problems associated with the algebraic domain in the high and low categories have different descriptions. This difference in intelligence has an impact when solving math problems. This research can help enrich the understanding of students' cognitive processes and contribute to the development of better mathematics learning strategies and curricula.

Keywords: cognitive processes; numeracy; algebraic

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Introduction

"Cognitive" refers to conscious mental processes, including remembering, reasoning, and knowing, as Pantsar (2019) defines. Montague et al. (2000) describe cognitive processes as proactive online mental activities, also known as "to-do" strategies. These processes involve utilizing existing knowledge, integrating it with new knowledge, and using the resulting ability to make decisions, as Basir et al. (2022) described. Furthermore, cognitive processes pertain to an individual's mental processes, particularly concerning the view that the mind has internal mental states like beliefs, desires, and intentions, which can be understood through information processing. Ekawati et al. (2019) suggest that this is particularly true when dealing with complex cognitive processes involving abstraction, concretization, knowledge, expertise, or learning.)

According to Ferri (2006), six components of cognitive processes are mathematical communication, representational forms, mathematical problem solving, mathematical argumentation, modeling, and technical abilities and skills. Cognitive processes are necessary for each learner to receive, store, retrieve, and process data about the process of solving mathematical problems (Fauziyah et al., 2022), which involves knowledge and one's cognitive system in the cognitive process to get solutions from a problem (Listiawan & Baskoro, 2015). Cognitive processes and mathematical problem-solving are related, so problem-solving can be understood as a cognitive process where students know facts, processes, concepts, and procedures and then apply this knowledge to solve problems in the context of real situations (Kuncoro et al., 2022).

Previously, Fauziyah et al. (2022) revealed that differences in the intelligence of students with Autism Spectrum Disorder (ASD) affect cognitive processes in solving problems based on the Polya procedure. Ekawati et al. (2019) reveal that cognitive processes in solving problems related to broad conservation in students with high abilities carry out more cyclic processes than students with low skills. Kurniadi et al. (2021) explore and provide an overview of cognitive functions, especially using representational forms in mathematical modeling related to gender differences, where men and women solve graph problems using representative forms through three components of cognitive processes. Hayuningrat and Listiawan (2018) describe students' thinking processes with a cognitive-reflective style in solving pattern generalization problems based on Polya measurements. Based on several studies regarding cognitive processes that have been carried out previously, someone still needs to discuss students' cognitive processes related to solving algebraic domain numeration problems.

Information on students' cognitive learning outcomes in Indonesia is obtained from the Minimum Competency Assessment (AKM), which measures reading and mathematical literacy or numeracy (Kemdikbudristek, 2022). The Organization for Economic Cooperation and Development (OECD) defines numeracy as the ability to develop, apply, and interpret mathematics in various circumstances (OECD, 2012). Getenet (2022) suggests that numeracy is the effective application of mathematics to meet the needs of everyday life at home, at work, and for involvement in social life. The ability of adults to successfully participate in society and manage work in everyday life depends on their ability to use and develop their numeracy skills (Gal et al., 2020). Every child must have numerical thinking skills, an understanding of patterns and sequences, and the ability to identify situations where mathematical reasoning can be used to solve problems (DES, 2011). Numerical ability is one of the prerequisites for realizing 21st-century life skills (Sujadi et al., 2022), so numeracy is essential to learn as early as possible.

The concept of numeracy in Indonesia includes aspects of cognitive processes, contexts, and domains. Numerical abilities require students to use various cognitive skills in answering questions (Lestari et al., 2022). The cognitive process in the Minimum Competency Assessment (AKM) is divided into knowing, applying, and reasoning. The cognitive knowing process assesses basic knowledge and understanding of facts, processes, concepts, and procedures. The cognitive applying process assesses mathematical abilities in applying knowledge and understanding of facts, relations, processes, concepts, procedures, and methods in real-life situations to solve problems and answer questions. The cognitive reasoning process assesses reasoning abilities in analyzing informational data, drawing conclusions, and expanding understanding in new situations. The AKM 2022 framework categorizes the context in a numeration of three types: personal, socio-cultural, and scientific. The domains in the Minimum Competency Assessment refer to the PISA content domains, namely numbers, geometry, measurement, algebra, data, and uncertainty.

According to Rapot Pendidikan 2022, nationally, more than 50% of junior high school students in Indonesia have not reached the minimum competency limit for numeracy skills (Kemdikbudristek, 2022). Based on the Minimum Competency Assessment results in the 2021 Education Report, the average national numeracy achievement at the reasoning competency is 54.72, higher than knowing competence (54.65) and applying (50.9). Student understanding is vital to reasoning abilities. Mullis and Martin (2017) suggest that an individual needs to identify relevant mathematical concepts or procedures to solve problems in new contexts or situations. Understanding mathematical concepts and procedures becomes a bridge to applying mathematics to solve problems in various contexts and situations (Hayuningrat & Listiawan, 2018). Based on this understanding, the cognitive process of reasoning is influenced by the previous cognitive processes, namely, knowing and applying. Academically, the average of cognitive reasoning processes should be smaller than knowing and applying cognitive processes.

Based on the explanation above, the analysis of cognitive processes in solving numeracy problems can be a reference for teachers, the government, and further research to determine the right strategy to complement deficiencies or overcome student obstacles. The analysis of cognitive processes is essential to support the evaluation program of the education system in Indonesia. Analyzing cognitive processes involved in solving numerical problems can provide insights into students' foundational abilities in problem-solving within a specific field. The cognitive processes in this study are focused on knowing cognitive processes, applying cognitive processes, and cognitive reasoning processes. This research is focused on the algebraic domain because, based on the opinion of Sujadi et al. (2022), one of the most challenging questions in numeracy is the content of change and relationships related to algebraic material. This study aims to analyze students' cognitive processes in solving algebra-related numeration problems.

Methods

This research was conducted to answer how students' cognitive processes relate to solving numeracy problems in the algebraic domain. Qualitative research was chosen as an alternative approach for conducting this research. Qualitative inquiry aims to comprehend and analyze social and human behavior experienced by those involved in a particular social context (Ary et al., 2010). Qualitative methods allow researchers to understand the cognitive processes in solving algebraic numeracy problems more deeply. Researchers can better understand how students think and solve math problems by directly interviewing respondents and observing their actions. Qualitative methods also allow researchers to study individual experiences in solving algebraic-numeracy problems.

In this study, researchers can explore how students' varying cognitive processes influence their problem-solving approaches in mathematics, aiming to gain more comprehensive and holistic insights into the observed phenomena. The phenomenological design was chosen because it allows researchers to explore students' experiences solving numeracy problems in the algebraic domain. It includes how students construct knowledge, understand related concepts, and use strategies to solve numeration problems. According to Creswell (2014), phenomenological research is an approach of inquiry that has roots in philosophy and psychology in which the researcher describes how people perceive a thing. The researchers use the source triangulation technique to study the phenomenon's meaning and significance. Triangulation of this source as a form of triangulation is necessary so that the results are not subjective.

Researchers, as critical instruments, fully control the entire research process. In addition, researchers also used auxiliary instruments in the form of student answers and interview results related to numeracy questions in the algebraic domain. This study's algebraic domain under investigation is limited to fundamental proficiencies in identifying patterns within number and object configuration sequences. This study describes cognitive process indicators in the numeration questions in Table 1.

Table 1. Description of the cognitive process of numeracy questions

Cognitive Process	Aspect	Indicator
Knowing	Remembering	Remember the concept of pattern sequence numbers
	Understanding	Understand the facts on number patterns
	Identifying	Identify what elements are used in the number sequence pattern.
	Counting	Count the number of elements in a particular set of patterns
Applying	Making model	Make a model of the number of beads in a particular series
	Applying	Implement the model that has been created
Reasoning	Making justification / analyzing	Provide an explanation based on the opinions that have been given
	Concluding	Summarize the results of the analysis that has been made.

The correspondence of the test items with the indicators was evaluated by two validators: an expert mathematics lecturer and a school practitioner teacher. On the other hand, the interview guide is used as a reference for conducting in-depth interviews with research subjects to confirm the results of student work. Data were collected using tests and interviews with six research subjects from class VIII at one of the public middle schools in Karanganyar Regency. Selecting a small number of research subjects allows the researcher to understand better students' cognitive processes in solving algebraic domain numeration problems. By only focusing on a few research subjects, researchers can obtain more detailed and in-depth information about each individual being observed. The six subjects were previously categorized into two categories based on the passing grade. Students with a score of more than 70 are included in the high category, while students with a score of less than 70 are included in the low category.

The subject of each category was selected based on a purposive sampling technique. Purposive sampling is a methodical approach based on the idea that selecting the best instances for a study yields the best data and that a sample of cases directly influences the findings of a study (Patton, 2002). The purposive sampling technique enables researchers to select subjects most relevant to the research topic, obtaining more comprehensive and valuable data. In this study, researchers selected students with different categories of mathematical ability to study the cognitive processes involved in solving algebraic numeracy problems. The effectiveness of participant selection in this study is determined by achieving data saturation by including three high-category subjects and three low-category subjects. Limiting the categories to high and low helps maintain clarity and simplicity in participant selection, facilitating data analysis and interpretation. The data analysis technique, as outlined by Miles et al. (2014), includes three key steps: (1) data condensation, (2) data display, and (3) conclusion drawing/verification.

Results

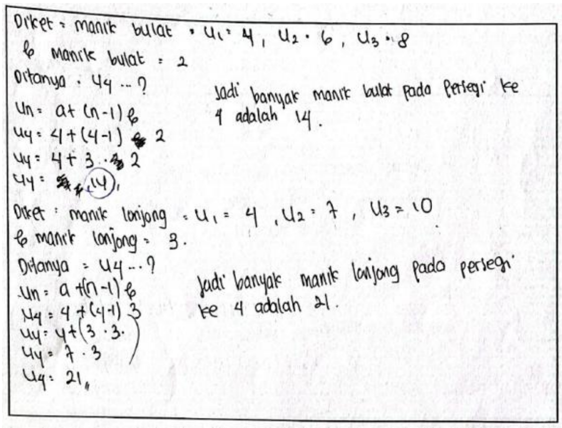
The findings shed light on the strategies students employ, their challenges, and the impact of individual differences on their performance. This research contributes to a deeper understanding of the cognitive processes involved in algebra and provides valuable implications for teaching and learning strategies in mathematics education.

The numeracy problems consist of one stimulus with three questions representing different cognitive processes. The numeracy questions used in this study were compiled based on a cognitive process that consisted of the cognitive processes of knowing, applying, and reasoning. Question 1 describes the cognitive process of knowing; students are asked to find the number of beads in a pattern. Question number 2 describes the cognitive process of applying; students are asked to give a check mark, true or false, and the reasons for a statement. Question number 3 describes the cognitive process of reasoning. Students are asked to give their arguments related to a statement. The analysis results of students' cognitive processes in the high and low categories in solving algebraic domain numeration problems are as follows.

High-category cognitive process

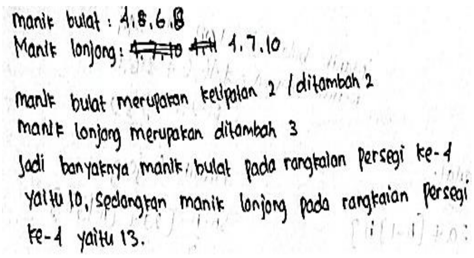
The high category consists of three subjects, namely S_1, S_2, and S_3. The high-category cognitive process analysis results are based on the data of each high-category subject obtained from the answers and subject interviews. The analysis presented results from the overall investigation according to each cognitive process as follows.

The cognitive process of knowing


Diket: manik bulat: U1 = 4, U2 = 6, U3 = 8
b manik bulat = 2
Ditanya: U4 ...?
Un = a + (n-1) b
U4 = 4 + (4-1) 2
U4 = 4 + 3 · 2
U4 = 14
Jadi banyak manik bulat pada persegi ke 4 adalah 14.
Diket: manik lonjong: U1 = 4, U2 = 7, U3 = 10
b manik lonjong = 3.
Ditanya = U4 ...?
Un = a + (n-1) b
U4 = 4 + (4-1) 3
U4 = 4 + (3 · 3)
U4 = 7 · 3
U4 = 21
Jadi banyak manik lonjong pada persegi ke 4 adalah 21.

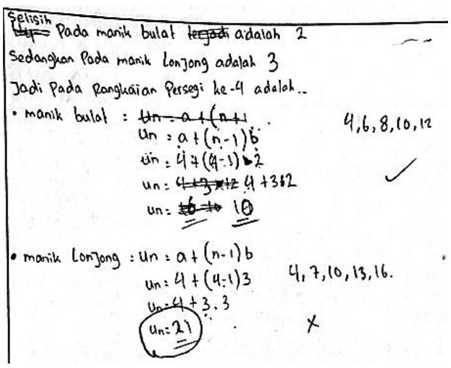
(a)

Translationnow undads: $U_1 = 4, U_2 = 6, U_3 = 8, b = 2$ Asked: $U_4 = \cdots ? U_n = a + (n-1)b U_4 = 4 + (4-1)2$
$U_4 = 4 + 3 \cdot 2$
$U_4 = 14$
So the number of round beads in the fourth pattern is 14.: Oads: $U_1 = 4, U_2 = 7, U_3 = 10, b = 3$Asked: $U_4 = \cdots ? U_n = a + (n-1)b our U_n = 4 + (4-1)3$
$U_n = 4 + 3 \cdot 3$
$U_n = 21$
So the number of oval beads in the fourth pattern is 21


manik bulat: 4, 6, 8
Manik lonjong: 4, 7, 10
manik bulat merupakan kelipatan 2 / ditambah 2
manik lonjong merupakan ditambah 3
Jadi banyaknya manik bulat pada rangkaian persegi ke-4 yaitu 10, sedangkan manik lonjong pada rangkaian persegi ke-4 yaitu 13.

(b)

Translation
Round beads: 4, 6, 8
Oval beads: 4, 7, 10
Round beads are multiples of 2 or plus 2
Oval beads plus 2
So the number of round beads in the fourth pattern is 10, while the number of oval beads is 13


Selisih pada manik bulat adalah 2
Sedangkan pada manik lonjong adalah 3
Jadi pada rangkaian persegi ke-4 adalah..
• manik bulat: Un = a + (n-1) b   4, 6, 8, 10, 12
Un = 4 + (4-1) 2
Un = 4 + 3 · 2
Un = 10
• manik lonjong: Un = a + (n-1) b   4, 7, 10, 13, 16.
Un = 4 + (4-1) 3
Un = 4 + 3 · 3
Un = 21

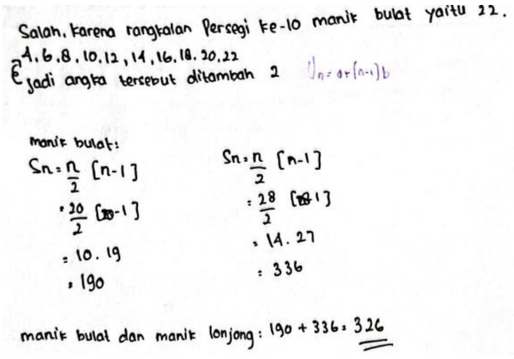
(c)

Translation
The difference in round beads is 2, while in oval beads is 3.
So the fourth pattern is..
Round beads: $U_n = a + (n-1)b U_n = 4 + (4-1)2$
$U_n = 4 + 3 \cdot 2$
$U_n = 10$
l beads: $U_n = a + (n-1)b$
$ourourour U_n = 4 + (4-1)3$
$U_n = 4 + 3 \cdot 3$
$U_n = 21$

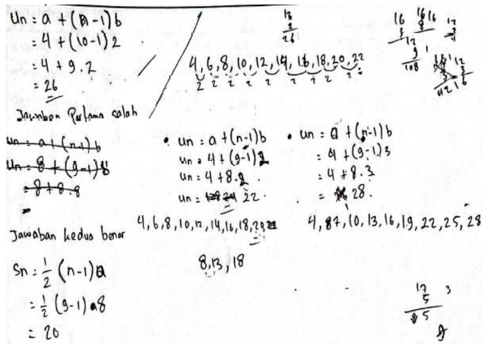
Figure 2. (a) Answer to question number 1 S_1; (b) Answer to question number 1 S_2; (c) Answer to question number 1 S_3

Two of the three subjects in the high category knew that the numeracy problems were related to number sequence patterns. *"The material is a number pattern because there is a pattern,"* explained the subject when asked why the material is a number pattern. Two of the three subjects in the high category know that difference has the symbol *b*, and the first term has the symbol *a*. The n[th] term has the symbol S_n. S_1 counts the number of beads in the fourth square series using the formula (see Figure 2(a)), S_2 uses the non-formulaic approach by adding up to the fourth term (see Figure 2(b)), and S_3 uses two methods, namely the formula and the non-formulaic approach (see Figure 2(c)).

The cognitive process of applying

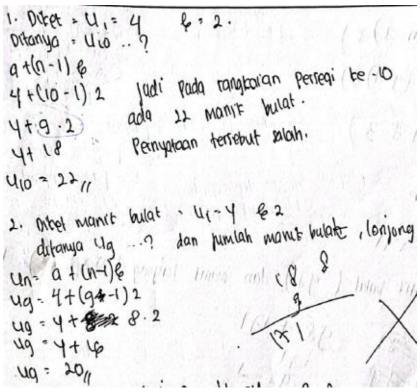


Translation
False, because the 10th set of patterns in the round beads are 22
So that number is added by 2
Round beads and oval beads equal = 190 + 336 = 3a)

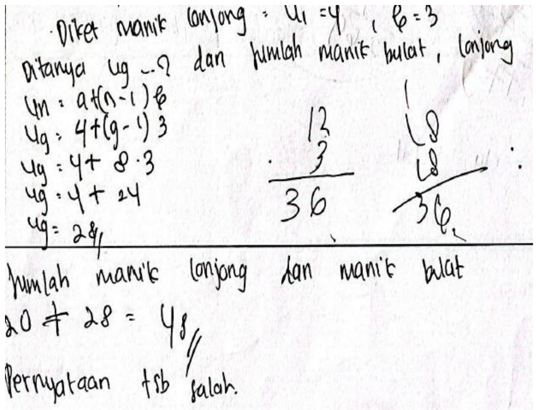


Translation
The first answer is wrong
The second answer is correct

(b)



Translation
So in the 10th pattern, there are 22 round beads
The statement is wrong



Translation
The number of oval beads and round beds s + 28 = 48
The statement is wrong

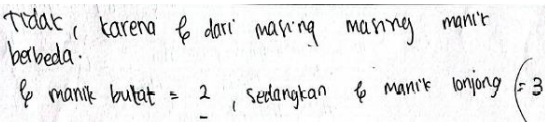
(c)

Figure 3. (a) Answer to question number 2 S_2; (b) Answer to question number 2 S_3; (c) Answer to question number 2 S_1

In the 2nd question, the three subjects in the high category answered incorrectly (see Figure 3), where two of the three subjects checked the statement using the arithmetic sequence formula to find the 10th term. However, the subject did not prioritize the multiplication operation, so the 10th term found was incorrect. S_2 uses the non-formulaic approach in Figure 3(b), and the 10th term found is correct, but this becomes difficult if the asked term is more significant, for example, the 50th term. *"I forgot the formula, so I did it manually,"* explained the subject during the interview.

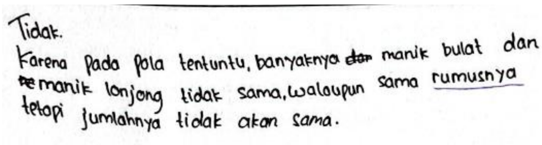
In the second statement, two of the three subjects in the high category knew that it is necessary to use an arithmetic series formula to check this statement. However, the formula used is incorrect, so the mathematical model is wrong. Two subjects in the high category applied the arithmetic series formula to the beads separately, namely by calculating S_n round beads and S_n oval beads separately, then combining them. *"It means 108 round beads, 144 oval beads, a total of 252 pieces, so the second statement is true,"* explained the subject during the interview.

The cognitive process of reasoning



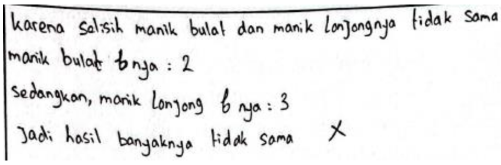
(a)

Translation
No, because the difference between each bead is different
Round beads are 2, while oval beads are 3



(b)

Translation
No, Because in specific patterns, the number of round and oval beads is not the same; even though the formula is the same, the number of beads is not the same.



(c)

Translation
Because the difference between round beads and oval beads is not the same
Round beads are 2, while oval beads are 3
So the result is not the same

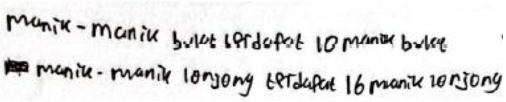
Figure 4. (a) Answer to question number 3 S_1; (b) Answer to question number 3 S_2; (c) Answer to question number 3 S_3

Two of the three subjects in the high category answered disagree based on the results of the analysis that the differences in each bead were not the same; round beads had a difference of 2, while oval beads had a difference of 3 (see Figure 4). *"The difference is that each bead is not the same; round beads are two different, oval beads are three different, one is odd, and the other is even,"* explained the subject during the interview. The three subjects were unsure of their answers because they did not understand the statement's meaning.

Low-category cognitive processes

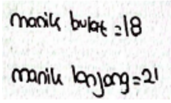
The low category consists of three subjects, namely S_4, S_5, and S_6. The analysis results of low-category cognitive processes are based on the data of each low-category subject obtained from answers and subject interviews. The analysis presented results from the overall analysis according to each cognitive process.

The cognitive process of knowing



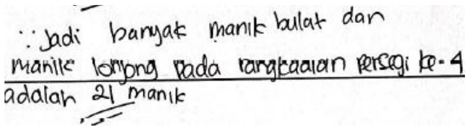
(a)

Translation
There are 10 round beads
There are 16 oval beads



(b)

Translation
Round beads = 18
Oval beads = 21



(c)

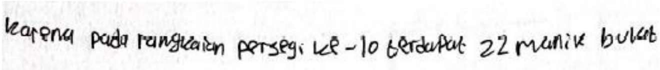
Translation
So the number of round beads and oval beads in the fourth pattern is 21

Figure 5. (a) Answer to question number 1 S_4; (b) Answer to question number 1 S_5; (c) Answer to question number 1 S_6

"I have forgotten the number pattern material," explained two of the three subjects in the low category who did not know that the material related to the problem was a number pattern. Regarding the facts in number patterns such as the first term, difference, and n^{th} term, two of the three low category subjects did not know that the symbol *a* was the first term, the difference had the symbol *b*, and U_n was the symbol of the n^{th} term. The subject did not know how to look for differences, which influenced answering question number 1 (see Figure 5).

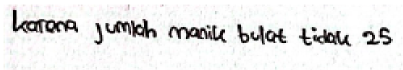
Based on the low understanding of facts in number patterns, two out of three subjects did not know how to find the fourth term. Subjects need to be given an understanding in advance, that round beads and oval beads have a repeated addition pattern, so to find beads in the fourth series, the pattern found in round and oval beads is needed.

The cognitive process of applying



(a)

Translation
Because in the 10th pattern, there are 22 round beads.



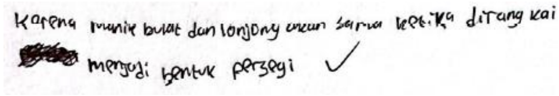
(b)

Translation
Because the number of round beads is not 25

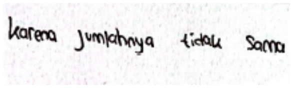
Figure 6. (a) Answer to question number 2 S_4; (b) Answer to question number 2 S_5

Two of the three subjects in the low category answered incorrectly in the first statement, whereas one used a non-formulaic approach to check the statement. Two of the three subjects only ticked the statements and did not attempt to answer manually (see Figure 6). The three subjects did not know how to check this statement using the formula for the n^{th} term of the arithmetic sequence. In the second statement, the three subjects did not know why the formula used to check the statement was an arithmetic series S_n, because they only guessed. *"I am just guessing because I forgot the formula,"* explained the subject during the interview. The three subjects did not know what formula to use, so when asked; they did not know at all. The three subjects had no idea how to answer the second statement. After being given the formula, the three subjects could correctly count the number of beads. The three subjects need guidance regarding which sequence to combine round and oval beads and form a new number sequence.

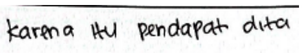
The cognitive process of reasoning



(a)



(b)



(c)

Translation Because round and oval beads will be the same when strung together into a square shape
Translation Because the numbers are not the same
Translation Because that is Dita's opinion

Figure 7. (a) Answer to question number 3 S_4; (b) Answer to question number 3 S_5; (c) Answer to question number 3 S_6

Two of the three low categories agreed with the opinion in the third statement. The subjects thought that round and oval beads would be the same when strung into a square shape (see Figure 7(a)). The subjects did not understand the statement's meaning of a specific pattern. The three subjects were not sure about the results of their analysis because they did not understand the meaning of the questions.

Discussion

This study describes the stages of the cognitive process referring to the Minimum Competency Assessment carried out by students in solving algebraic numeracy problems. This can help understand the difficulties experienced by students in solving algebraic numeracy problems and provide a deeper view of the cognitive strategies students use in solving problems. The algebraic domain's cognitive process of knowing consists of remembering, understanding, identifying, and calculating (Kemdikbudristek, 2022). The cognitive process of applying to the algebraic domain includes aspects of modeling and applying. The cognitive reasoning process in this study consists of two aspects: making justification/analyzing and concluding.

The results of the description of students' cognitive processes in the high category are that, in the cognitive process of knowing, students remembered the material of number patterns where the concepts explained are only in general, understood the facts of number patterns (*a*, *b*, and), identified how to look for differences, the first term, and the n^{th} term, as well as counting, but students did not prioritize multiplication operations. In the cognitive application process, students can create a model based on the numeracy task after being given the formula and then apply the created model. In model creation, the subject experienced difficulties because they forgot the formula, thus unable to solve the problem. Previous research also supports these findings. A study by Zebua et al. (2020) found that students often struggle with remembering and applying mathematical formulas. A disparity between the comprehension of concepts and the mastery of formulas poses obstacles when solving mathematical problems (Pérez, 2018; Tambychik & Meerah, 2010). After being given the arithmetic series formula, the three subjects could make a model and apply the model that had been made. In implementing this, the subject did not prioritize multiplication operations. This error continued, supported by students' lack of mastery of the material (Yulianingsih & Dwinata, 2018). The research results on the cognitive process of reasoning show that students had difficulty analyzing, and the conclusions explained are inappropriate. The subject is used to working on problems with a formula, so when faced with a problem requiring reasoning, the subject becomes confused. In addition, the subject did not interpret daily conditions through story problem exercises, so it was difficult to face problems that required reasoning (Sartika & Puspitasari, 2013).

The results of students' cognitive processes are in a low category; in the cognitive process of knowing, students did not remember the concept of number patterns. Mathematical understanding is essential for thinking when solving mathematical problems and real-life problems (Mulyani et al., 2018). Low-category subjects had difficulty stating facts in numerical patterns and only wrote the final answer on paper. This aligns with many students who have difficulty understanding mathematical symbols, writing down their thoughts in solving problems, predicting, and making decisions (Irfan, 2017; Siswono, 2016; Winata et al., 2021). Students cannot work because they do not know the procedure used to solve the problem (Septiahani et al., 2020). Subjects are not used to changing contextual problems in number patterns into sequences, so they are confused when remembering number sequence patterns. The subject cannot interpret the meaning of the words or terms in the questions (Septiahani et al., 2020). During the cognitive process of applying, students are required to retrieve formulas from memory, enabling them to independently apply them (Johns et al., 2022). A lack of understanding of concepts related to number sequence patterns causes subjects in the lower category not to know that the problem can be solved by adding manually (Guo, 2022; Kania, 2018). When the subject is told the formula for finding the n^{th} term, the subject can continue the following calculation process. Students cannot analyze the questions in the questions, so the answers are given soberly (Hutajulu et al., 2019). Subjects in the lower category still need a companion to provide a formula so they can solve the problem. The research results on the cognitive process of reasoning show that students have difficulty analyzing, and the conclusions drawn are not appropriate. This could be because the students did not understand the concept of number sequence patterns from the beginning, making it increasingly difficult for them to analyze and reason through the problem.

Based on the results of student work and interviews, it is known that several factors influence students' cognitive processes in solving numeracy problems in the algebraic domain, such as mastery of concepts, numeracy skills, and motivation to learn. Isnarto (2016) suggests problem-solving requires understanding problems, identifying concepts, finding generalizations, making plans, and organizing previous skills. This can help teachers develop effective learning strategies to help students overcome difficulties encountered in solving algebraic numeracy problems. Teachers can conduct briefings, recall mathematical concepts, and carry out exercises to train students' numeracy skills (Anggraini & Setianingsih, 2022). The implications of this research for learning mathematics in schools are that teachers can use this research to develop more effective learning strategies, such as providing more structured subject matter and opportunities to practice solving numeracy problems in the algebraic domain. In this case, this research can help improve students' ability to solve numeracy problems in the algebraic domain and strengthen mathematics learning in schools.

Conclusion

The results of the description of students' cognitive processes in the high category are that, in the cognitive process of knowing, students remember the number pattern material where the concepts explained are less specific. Students understand the facts of number patterns (*a*, *b*, and), identify how to find differences, the first term and the n^{th} term, and count, but students do not prioritize multiplication operations. In the cognitive process of applying, students create and apply models according to the numeration task after being told the formula. The results of the students' cognitive processes in the low category are that in the cognitive process of knowing, students do not remember the concept of number patterns. Students mention and identify several facts in number patterns, and counting needs to be assisted because they have forgotten the number pattern material. In the cognitive process of applying, students need to be told the formula; then, they can apply it independently. The results of research on the cognitive process of reasoning in the high and low categories showed that students had difficulty analyzing and concluding because they did not understand the meaning of the numeration questions.

The results of this study can also provide implications for further research in mathematics education. Researchers can use the results of this study as a basis for conducting further research on students' cognitive processes in solving algebraic numeracy problems, as well as exploring other factors that influence students' ability to solve mathematical problems. This research can also enrich students' understanding of cognitive processes and contribute to developing better mathematics learning strategies and curricula.

Conflicts of Interest

There is no conflict of interest regarding the publication of this manuscript.

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Author Contributions

Monika Agnes Henny Kinanti: Conceptualization, writing - original draft, and visualization; **Imam Sujadi:** Validation and supervision; **Diari Indriati:** Validation and supervision; **Krida Singgih Kuncoro:** Writing - review & editing.

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