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Metacognition analysis of five grade students in elementary school on numbers

Dyah Triwahyuningtyas, Nyamik Rahayu Sesanti
Elementary School Teacher Education Study Program, Faculty of Education, Universitas PGRI Kanjuruhan Malang, Malang, Indonesia

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ABSTRACT

This study aimed to observe student learning activities in terms of number material metacognition. The method is a case study qualitative research. The research subjects were 30 students of the fifth-grade elementary school in Malang. Data collection techniques use tests and interviews by carrying out three stages: planning, monitoring, and evaluation. The results showed that internal and external factors caused 75% of moderate learning difficulties. Internal factors arise due to a lack of understanding of mathematical concepts, lack of thoroughness, and interest in literacy. Meanwhile, the external media used by the teacher was deemed less supportive, and the class conditions were not conducive. Thus, there is a conclusion that internal and external factors cause students' metacognition analysis.

Corresponding Author:

Dyah Triwahyuningtyas
Elementary School Teacher Education Study Program, Universitas PGRI Kanjuruhan Malang
Bandungrejosari, Sukun, Malang, East Java 65148, Indonesia
Email: dyahtriwahyu@unikama.ac.id

1. INTRODUCTION

Metacognition is a thought that refers to a person's knowledge regarding individual cognitive processes and products that involve abstract processes [1], [2]. Metacognition is very important in human intelligence and is closely related to critical thinking as an inherent element in knowledge about cognition, skills, and independence [3], [4]. Metacognition is a cognitive activity taken as a cognitive object. It contains three main aspects of metacognition: knowledge, experience, and metacognitive skills [5], [6]. Individual awareness of thinking independently in its ability to control processes related to objects academically is obtained from self-understanding to support practical problem solving [6]–[10]. Student awareness that students already know and strategies to apply prior knowledge in new contexts enhance learning [11], [12]. The ability to monitor and manage knowledge cognition processes to regulate, and monitor behavior contributes to perception, memory, intellectuality, and action [13]–[15]. Metacognition occurs when individuals plan, monitor, and evaluate cognitive actions in a learning environment [16], [17].

Based on the results of observations in the field found problems, such as students not liking reading, difficulty understanding reading, especially related to questions that are reading text, so they only read but cannot proceed to the understanding stage. Students are not careful and lack focus, the media used is not supportive, assignments homework is more active parents who do the task. In addition, students have difficulty understanding concepts in numeracy skills using addition and subtraction operations. So, it can be concluded that the student's metacognitive ability is still low. From these problems, Kodipalli [18] stated that students experience problems in metacognition and cannot understand the topic so research is carried out on the collection of natural resources or human resources, life expectancy, level of motivation and tasks given to students, students relate to understanding the concept. Furthermore, research by Elbasri *et al* [19] supports

metacognition to improve strategies, and evaluate individuals and learning methods and their influence on learning success. The application of metacognition through three phases, namely planning, implementation, and evaluation [20]. In addition, metacognition helps optimize problem-solving skills, students are more independent and create a continuous, wise, and effective learning process strategic [21], [22].

Based on previous research, metacognition can control negative thinking and anxiety daily, focusing on independent activities [23], [24]. Metacognition can become independent students, foster an honest attitude, dare to admit mistakes, improve learning outcomes significantly and develop students' abilities in improving their cognitive [25], [26]. Metacognition is significant for academics, mastery of goals, and information and leads to students' academic improvement [27], [28].

Experienced the success of researchers in investigating the thought process in instruction as a key in the problem-solving process of independent behavior [9], [29], [30]. The importance of problem-solving shows that metacognitive knowledge can offset cognition facilities monitoring and controlling strategies [31], [32]. In addition, it can increase if there is feedback between students and educators affecting the learning process of student activities [33].

Metacognition is related to logical thinking as a process, reason, and assessment of forms of thinking dynamically to conclude [34]. Reflects the nature of cognitive processes such as remembering and reading in this type of education and teaching [35], [36], ability to assess knowledge, process understanding, cognitive and skills [37]–[41]. Furthermore, metacognition is a process of cognition related to the cognitive level through monitoring and controlling [42], [43].

Metacognition categorized three intellectual behaviors: knowledge about one's thought processes, regulation of one's actions, beliefs, and intuition [29]. Metacognitive knowledge reflects the individual's capacity for thinking and regulation; Metacognition means controlling each individual's cognition (planning, monitoring, and evaluation) and is often measured as individual learning assessments that can predict or remember the future [44], [45]. Thinking consists of monitoring processes, adjustments, and learning strategies for problem-solving skills [46], [47]. Metacognition refers to the skills to understand the mental state of oneself and others, reason, decide a problem, and solve problems [48]–[51].

Metacognition is a series of mental identification processes both in oneself and others, reasoning about mental conditions. For example, understanding causal relationships between events, thoughts, emotions, and behavior and taking a critical attitude toward one's beliefs, and understanding that ideas are subjective and from different perspectives [52]–[54]. In addition, it helps solve problems, identify problems to be solved, and evaluate them to achieve goals or solutions to improve educational literature [55]. It is facilitating or optimizing change spontaneous thinking processes. So that they become more creative: more likely to lead to new conclusions and realizations, correcting the imagery of the mind, emphasizing spontaneous thoughts and bringing more valuable attention, relating to individual perceptions and as an important center for observing emotional awareness of the state of the body and controlling cognitive activities [56], [57].

Metacognition refers to the cognitive processes involved in the thinking process. The process of reflecting on memory (monitoring) and using the acquired knowledge to manage experience control, both answering and remembering, is organized systematically [58] the cognitive abilities needed to achieve deep and meaningful learning goals individually and socially. The development of metacognition is the ability to see and hear other perspectives. Making students responsible for learning to be more actively involved in the learning process and developing literature suggests a position on student achievement, problem awareness of situations, and ways of thinking as a reflection, action, and solutions to problems [59]. Awareness of problems, situations, ways of thinking, and doing questions and answers focuses on the affective dimensions of learning and improves thinking skills. There are three approaches to thinking ability: learning general thinking skills, subject-specific thinking skills, and teaching thinking skills throughout the curriculum [60]. In addition, motivation increases relevance through evaluation [28].

Metacognition is mathematical reasoning that focuses on the mathematical aspects of an object or event, argues that it is related to the object or event, and then concludes the relationship between these aspects [61]. There are four types of reasoning: induction (general conclusions drawn from experience, deduction (mathematical reasoning and particular conclusions drawn), concluding facts and conjectures into sentences that make sense, then adaptive reasoning, which unites facts, procedures, concepts, and methods to understand mathematical problems [62]. Metacognition includes two main concepts: internal state monitoring and adaptive control strategies based on monitoring and control. Monitoring involves evaluating the information on ongoing cognitive processes. At the same time, control involves monitoring to make decisions on cognitive processes to achieve goals [15], [63].

The concept is consistent with the initial idea of moderate performance and is a significant construction with independent learning used as a learning assessment [64]. The components of independent learning are in the framework of cognitive social theory. There are two definition of metacognition:

i) Metacognitive knowledge, namely self-awareness, procedural, conditional knowledge, and strategies; ii) Metacognition is regulation involves planning, monitoring, cognitive evaluation, operation, selecting, and using cognitive strategies effectively by combining, dispensing, and coordinating various strategies [65]–[67]. Metacognition determines contributes to the assessment being a learning activity [68]. Metacognition suggests that planning regulates cognitive activity, facilitating meaningful knowledge and insight into social regulation [69].

The ability to reflect, understand and control one's learning helps students evaluate the results of the tasks performed by students. It affects students' mathematical problem solving and encourages students to learn mathematics [70]. From individual processes in collaboration, metacognition is collective in solving problems. Reflective metacognition is a product of interaction between a person and the social context [71], [72]. Metacognition includes knowledge and rules related to behavior acting on cognition and managing products as performance can be viewed as a knowledge facility and managing individuals to think related to the components of metacognition [45], [73], [74].

The centralized component of the self-directed learning approach, referring to the process of engaging in self-reflection, has profound implications for both student self-confidence and performance [75]. Aspect refers to knowing and understanding a person related to different tasks such as the state of knowledge and abilities of a person who is aware of personal understanding. Metacognition includes cognitive knowledge, metacognitive regulation, and essential independent learning activities that can inform learning strategies [75], [76]. Metacognition discusses the importance of systems, remembering events, perfecting cognitive processes, solving confusion or error from cognitive processes, and managing information, including ways of reasoning while learning that combines opinions with actions as well as the final results of the process [50], [77], [78].

Metacognition is a crucial component in basic science and psychology through complex cognitive experiments, repeated concepts through cognitive experiments, and behavior involving stimuli [79]. There are two conditions terms of explicit (planning, implementation, and evaluation) and implicit (not paying attention to planning, implementation, and evaluation) [80]. For example, metacognition in mathematical theory-based learning techniques means providing opportunities for students and evaluating student learning to analyze mathematical performance from experience, knowledge, and strategies in the mathematical process [81]. Metacognition consists of two levels of function. First, the cognitive level consists of memory, attention, and learning. Second, the metacognitive level observes processes that control processes and occur at the cognitive level, awareness according to behavior [57], which can strengthen and change cognitive processes resulting from the feedback process [78], can see subjective conclusions and concrete. Also, there is a process of working levels from time to time and self-evaluation [57], [82].

There are three levels of metacognition, namely i) Observing, reading, and writing; ii) All cognitive processes through knowledge of cognitive tasks such as strategy users and observations; iii) Understanding, and awareness of the nature of knowledge and criteria for the knowledge process [2], [83]; three aspects of metacognition, namely awareness, thoughts, and feelings. The metacognition rating scale is a rating scale assessing the metacognitive ability of each individual [84], [85]. There are three metacognitive assessments: social identification, forming integration and representation, and flexibility for self or others [86], [87]. Metacognition reflects activities that include forming ideas related to complex thoughts and feelings [88]. For example, teachers rarely use fun communication to share ideas and explain mathematical understanding. In that case, metacognition can improve teacher communicative activities involving students and positively impact learning [89]. The three stages of metacognitive behavior include the relatively new contextual environment, the habit of controlling behavior, and monitoring conscious efforts [90].

Previous research has proven that the impact of metacognition on students has a positive impact, namely helping students control themselves in the learning process and improving students abilities [91]. Metacognition connects creative problem-solving. The locked factors related to creativity such as understanding learning related to self-memory, cognitive systems, learning ways, self-reflection, regulation, and supervision develop the ability to participate in communicative activities based on academic written tests and develop theory [92]–[94]. Combining self-knowledge and contextual knowledge makes decisions based on one's creative achievements or experience [95], [96]. Helping teachers realize that expressing thoughts, and explaining ideas need to be considered in mathematical competence so that it is helpful for strategies in solving problems, either individually or in groups [97], [98]. Then, this research provides valuable benefits for mathematics education, especially in students' metacognitive abilities in number material. In this study, the researcher analyzed students' metacognitive ability in number material in elementary school.

2. RESEARCH METHOD

The method used in this study is qualitative, a case study type of research. The method presents directly the relationship between the researcher and the respondent to the value patterns encountered. The

data collection process is carried out through data reduction, to analyze, direct, and organize the data needed during research. Checking the validity of the data has four criteria, namely the degree of trust, transferability, dependence, and certainty [99].

The research was conducted by observation, written test interviews, and documentation. This written test is in accordance with the stages of metacognition, namely the planning stage, monitoring stage, and evaluation stage. So that the assessment is taken when students can complete the written test in accordance with the stages of metacognition and the results of interviews with students that show good student understanding of the results of written tests that have been done by students.

The population of this study was fifth-grade elementary school students in Malang, Indonesia. This study uses a purposive sampling technique, which is a sampling technique based on sources who are considered to be the most knowledgeable about the data, and problems according to the research to be taken with certain considerations. The research was conducted in the fifth grade of elementary school because the sample needed to know the most about problems in metacognitive ability. In addition, the age of the fifth grade of elementary school ranges from 10 to 11 years, namely the mature age in elementary school which can be seen in their metacognitive abilities both in writing and in interviews. This research was conducted by 30 students with 18 male students and 12 female students.

This research uses case study research with a qualitative type by analyzing textual and analyzing social structures and individual relationships [95]. This research seeks to find meaning, investigate the process aims to understand, study in-depth the background, and maintain the object's integrity. The analysis took place using a description test and interviews. The metacognitive analysis goes through the preparation stages (research design, exploration studies, licensing, and preparation of research instruments), the implementation stage (data collection, data processing, and concluding) then makes a report.

The measurement instruments in this study were in the form of tests and interviews. The measurement results using a description test and interview aim to determine the description of students' metacognition of the number material in terms of the factors causing difficulties in learning. Data analysis uses words and actions, data sources, statistics, and documentation.

Data collection is done by planning, implementing, and making reports. This study conducted description-test questions, and interviews aimed to determine students' description of the number material in the factors causing the difficulties experienced by students in number material metacognition. Data analysis uses words, actions, data sources, statistics, and documentation.

3. RESULTS AND DISCUSSION

The results of the study showed the implementation of the description test and interviews. Based on the metacognitive indicators of the research subjects, it is associated with three processes, namely the planning process, the monitoring process, and the evaluation process. At this stage of the planning process, students do not understand the questions or concepts, so they have not completed the questions correctly. The following scenario is a question of metacognition in the form of a problem.

Solve the following problems!
A dolphin is swimming at a depth of 8 meters below sea level.
The dolphin jumps out to 20 meters above sea level.
How high does the dolphin jump?
After the teacher gave the questions, the students answered with an answer of 20 meters.

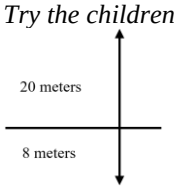
From the students' answers to questions like the scenario, most students still do not understand the questions in the form of stories and problems, so students answer incorrectly between answers and questions.

The monitoring process observes something done by students. For example, experience by students with numeracy skills at operating numbers is incorrectly using basic operations such as addition, subtraction, multiplication, and division, and lack skills in doing mathematics. That is the monitoring stage involving actions taken when actions regulate cognition so that it affects the basic operating processes [100] control processes in test-taking behavior and develop students' metacognitive skills [101], [102]. The evaluation process shows that students have not corrected the answers before they are collected; the conditions are conducive. It affects the concentration of students and takes a long time in the mathematics learning process. That is different from Robson's opinion [103], which states that reviewing, observing, and re-evaluating the quality results during the evaluation process of the activity. The evaluation uses a strategy to improve after learning takes place [104].

The factors that cause learning difficulties consist of two kinds, namely i) Students' internal factors, namely things or circumstances that lack parental love, feel ignored, or feel their parents have never given them love; ii) Environmental factors including Family environment, for example, disharmony in the relationship between father and mother, and the low economic life of the family. This is in accordance with Roebers *et al*. [101] stating that family environmental factors, especially parents, play an essential role in metacognition, such as checking student assignments and monitoring and controlling children's behavior and strategies in handling them; ii) The village/community environment, for example, the slum area and naughty peer groups; iii) School environment, for example, poor condition of the location of the school building such as near the market, the condition of teachers and learning tools are of low quality. So it takes a valuable stimulus for development, and ways of thinking in learning so students need to be respected and listened to by students [103]. Students' metacognition fosters learning to i) Discuss cognitive strategies related to classroom learning; ii) Strategies through students' experiences as learners; iii) Provide opportunities for students to try [105]. Difficulty understanding the concept of counting on test questions. The student is working on the question. There are still some answers that are not appropriate.

The teacher conducts problem-based questioning.

Teacher : "*Pay attention to the questions that the teacher reads!*"
Student : "*Okay, ma'am.*"
Teacher : "*A dolphin is swimming at 8 meters depth below sea level. The dolphin jumped out 20 meters above sea level. What do you know from the math problem that the teacher told you about?*"
Student : "*The dolphin jumps out to a height of 20 meters above sea level.*"
Teacher : "*So that you can solve the problem, what should you do? Understand?*"
Then the teacher added a question.
Student : "*Operation on the number, mam.*"
Teacher : "*Have you ever solved a problem like that before?*"
Student : "*Never.*"
Teacher : "*How high is the dolphin's jump?*"
Student : "*20 meters ma'am.*"
Teacher : "*Is the material modeled from the story questions that the teacher has told? Picture? Try the children describe the problem!*"
Student :



After the students draw, the teacher continues to ask the next problem.

Teacher : "*Listen to the problem that the teacher talked about. Mr. Maman has a debt install for Rp 25,000, 00. Mr. Maman has Rp 18,000.00 which is used entirely to pay debts. What do you know about the problem?*"
Student : "*Mr. Maman has a debt in the shop of Rp 25,000,00*"
Teacher : "*So that you can solve the problem that the teacher has already made? Tell me what concept you have to understand?*"
Student : "*Cooperative round.*"
Teacher : "*Have you ever solved the problem?*"
Student : "*Never.*"
Teacher : "*How much Mr. Maman's money, now?*"
Student : "*25,000 – 18,000 = 7,000.*" While showing how to work.
Teacher : "*Is it possible from the problem model that can create a model in the form of a number line? Try to draw it in 5000 scale?*"
Student : "*Never ma'am.*"

The statement is not correct from the student's answer. Students who have not focused on working still like to pay attention to other friends. In the planning process, they did not understand the question in question as in the second question; the students did not understand the questions correctly so the students did not try to answer correctly. Cognitive abilities were very lacking in the material, the concepts they did not understand, and the teacher had never given the description questions, but This is different from the first question answered correctly. After working on the questions, the monitoring process re-check before collecting so that students' answers were still not entirely correct. The process of evaluating the answers is

not proper before being collected; for example, in the second question, students already understand the concept, but the drawback is that students lack concentration in counting and operating, so the calculation results are not precise.

Based on the interviews, students were less thorough and less focused on understanding the questions given. Students consider the material difficult when faced with story questions where students have to solve the problem. There has never been a discussion on learning activities when at home. Parents accompany learning to completion.

The factors that cause learning difficulties are the internal causes of students and external causes of students. Internal factors are less in mastering the concept of number material and lack of focus in working on problems. While external factors, namely the media used by the teacher, do not support learning activities, the teacher uses only textbooks and blackboards. The class conditions are not conducive to learning, so they do not concentrate when learning. This is according to Thomas and Mee [105] stated that the learning environment affects students' metacognition by providing stimuli, changing the learning environment, and providing new or alternative activities. So that can facilitate students' metacognition. Teachers need to approach students, including i) Metacognition-based learning; ii) Overall understanding of the nature and structure of the material to be discussed; iii) Communicating and asking questions related to student experiences according to the topic of the material; iv) Being able to become a metacognitive model of cognitive processes and apply appropriate strategies during learning [105].

The students' metacognition analysis results on the material of concept difficulty numbers and problem-solving, namely the analysis results, are 75%. That is a category of moderate learning difficulty level. On the other hand, Thompson research [10] of students did not understand the concept, with more than 90 wrong answers carried out in experiment 1. At the same time, the study by Roebers *et al.* [101] of students' memory of fifth-grade students with an accuracy of 57% impacted conceptual difficulties in solving problems, with the study's results showing average learning difficulties. In addition, understanding the role of metacognition can solve the main problem of understanding concepts in development more effectively in overall academic achievement and building cognitive function [5], [23]. Through reading comprehension by using effective strategies to improve written tests [35]. From the results of these studies, it can be concluded that metacognition can overcome learning difficulties.

4. CONCLUSION

Metacognitive indicators regarding the planning, monitoring, and evaluation processes are still many students who do not meet the three criteria indicators. Factors causing students to experience obstacles in learning: factors that cause learning difficulties internally, namely students are still lacking in mastering the basic concepts of numbers, students are less thorough, and lack literacy interest has not understood the problem well. Furthermore, external factors that cause learning difficulties, namely the media used by teachers, are not enough to support the teaching and learning process, crowded classroom conditions during learning, and lack of attention from parents.

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BIOGRAPHIES OF AUTHORS

Dyah Triwahyuningtyas is a lecturer and researcher of mathematics concentration in primary education. She has written several articles on Mathematics in Primary Education, focusing on the Development of Learning and Teaching, Research and Evaluation in Primary Education. Her email is dyahtriwahyu@unikama.ac.id.

Nyamik Rahayu Sesanti is a lecturer and researcher in primary education concentrating on mathematics. Her works include articles about primary mathematics education related to mathematical problem solving, creative thinking, and the development of mathematics teaching materials. Her contact email address is nyamik@unikama.ac.id.