Students' Critical Thinking on Integer Operations Material Based on Students' Metacognition

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Abstract. The focus of this research is to describe the critical thinking skills of third-grade elementary school students on integer operations material based on their metacognitive abilities. This research is qualitative descriptive research. Our respondents were 27 third-grade elementary school students. The research instruments used were tests, questionnaires, and interviews. Students were given a metacognition questionnaire, with some items representing a certain level of metacognition. In addition, a test and interviews were carried out to measure students' critical thinking. The results of metacognitive questionnaires showed that the highest and lowest percentage was observed in the assessment indicator (41.92%) and planning indicator (25.05%). Meanwhile, the monitoring indicator attained 34.03%. Besides, in the critical thinking questionnaire, the highest and lowest score was in the interpretation indicator (27.6%) and evaluation indicator (23.2%), respectively. Meanwhile, the analysis indicator attained 24.8%, and the inference indicator attained 24.4%. Student test results found that students with high metacognition present high critical thinking.

Keywords: Critical thinking · Integer operation · metacognitive

1 Preliminary

Thinking ability is described as the ability of students to solve a problem using reasoning. Critical thinking is a 21st-century skill that allows students to make decisions based on available information [1]. Critical thinking skills enable students to solve problems and contribute to students' positive attitudes. Alex Escola et al. reported that using critical thinking predicts a 46.9% reduction in stress levels in Spain [2]. In several Sub-Saharan African countries, the government has openly declared critical thinking skills as a top educational priority to increase global economic competitiveness [3]. Critical thinking also fosters student openness and confidence [4].

Critical thinking is self-regulation in making a decision which results in interpretation, analysis, evaluation, and inference, as well as exposure using evidence, concepts, methodologies, criteria, or contextual considerations that form the basis for making decisions [5]. Critical thinking skills are crucial because it is used in solving problems

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and making the right decisions [1]. Critical thinking skills can be developed in learning mathematics in schools or universities, which prioritize systems, concepts, structures, principles, and careful links between one element and another. Critical thinking ability represents the reasonable and effective thinking ability that focuses on concentrating, consisting of four indicators, namely interpretation, analysis, evaluation, and inference [6]. In this study, we used all of these using these four indicators. Interpretation is a cognitive activity to understand a given problem. Meanwhile, analysis (analysis) is an activity in identifying statements and concepts in the problem, then connecting them. Evaluation (evaluation) is defined as the use of appropriate strategies in solving problems. The inference is the ability to draw conclusions from a given problem.

Assessment of students' critical thinking is critical to cultivating students' critical thinking talent [7]. Critical thinking is a process of making reasonable decisions about what to believe and what to do [8]. However, some school students are reported to have low critical thinking skills. Research from Olenggius (2020) reported low critical thinking skills in mathematics subjects at Sebungkang elementary school [9]. Research from Aenullael also discovered the inability of elementary school students to implement critical thinking in their learning [10]. Puspita also stated that students' critical thinking in one of the Bogor Regency Senior High Schools was still categorized as low [11]. The results of our observations at an elementary school in Malang showed students' inability to clarify problems to identify questions about the summation material, give reasons for a decision in terms of formulating statements in questions, make conclusions and clarify further in assessing the truth of assumptions about operating material, summing up and giving guesswork and cohesiveness of the problem.

Students' critical thinking ability is influenced by metacognitive dimension factors [12]. Metacognition can control cognitive disorders as it is the potential for critical thinking [13], primarily when students have issues with their physical condition that affects their thinking skills. Thus, students are less enthusiastic about studying and concentrating. Metacognition functions related to beliefs also affect students' psychology [14]. For instance, motivation fosters interest in learning and affects students' critical thinking activities. In addition, the anxiety factor affects their thinking process as it correlates with an individual's emotional state towards something that endangers himself or others.

Metacognition is the active monitoring, consequent regulation, and orchestration of the process in relation to the cognitive process in achieving concrete or objective goals, which take place intentionally, consciously, and directed at achieving results or goals [15]. The metacognitive ability has three crucial components. According to Magiera & Zawojewski [16], *awareness* is someone's state of thinking. This situation shows the thinking about what is known (tasks, specific knowledge, relevant mathematical knowledge, or strategies in problem-solving), thinking about the problem-solving process, and thinking about the remaining activities. *Evaluation* represents the process of decision-making involving a thinking process on someone's limitations of his mind, the effectiveness of the chosen strategy, an assessment of the results, an assessment of the difficulty of the problem, and an assessment of the progress, abilities, or understanding. Additionally, *regulation* is someone's thinking process about planning the strategy, setting goals, and choosing a solution strategy for solving a problem.

Woolfolk [17] states that metacognitive indicators include the ability to process planning, monitoring, and assessment. Meanwhile, the planning process represents a decision-making process related to the time needed to solve the problem, the strategies used in solving the problem, and the sequence of steps to be implemented. The monitoring process is a direct awareness to conduct an act, including cognitive activities. The assessment process is a decision-making process based on consideration of the thinking and re-thinking results. In this study, we used the metacognition indicators from Woolfolk.

An examination of elementary school students' critical thinking is critical. This study illustrates the critical thinking of elementary school children. The development of elementary school students' critical thinking skills is crucial since it helps teachers in improving their pedagogy [18]. Critical thinking-focused education has now spread from higher education to all educational levels, affecting younger students and youngsters [19].

Research on critical thinking has been done by previous researchers. These studies include critical thinking related to cultural norms, psychology, and student motivation, along with the improvement of creative thinking through innovative learning approaches or analysis of students' critical thinking skills on certain materials. In this study, we investigated students' critical thinking skills based on their metacognition.

2 Method

This study used a descriptive qualitative approach. We explored information about metacognition by giving semi-structured questionnaires and interviews to students. Then, we also provided a test to identify students' critical thinking. Meanwhile, we also used questionnaires to examine students' critical thinking further. Investigation of students' critical thinking includes 1) students with high, medium, and low planning indicators; 2) students with high, medium, and low metacognitive abilities of monitoring indicators; 3) students with high, medium, and low assessment indicators.

The research subjects were 27 third-grade elementary school students. The research procedures consisted of 1) determining the research class; 2) giving questionnaires to students to find out students' metacognition; 3) analyzing the results of the questionnaire; 4) classifying students based on metacognitive indicators, namely planning, monitoring, and assessment indicators; and 5) choosing research subjects according to the criteria.

3 Results and Discussion

The research data were obtained from the results of metacognitive questionnaires, critical thinking questionnaires, and critical thinking tests. The obtained data were analyzed and described.

a. Metacognition Questionnaire Results

Questionnaires given to research subjects represented the planning, monitoring, and assessment indicators. The results of the three indicators are illustrated in Fig. 1.

Of the three indicators, the metacognitive ability that attained the highest result was the assessment indicator (42. 82%). This result suggested that the majority of students

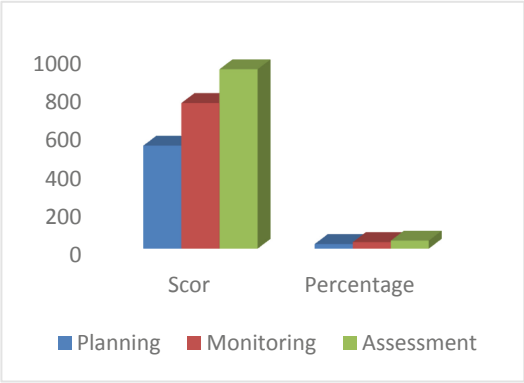

Fig. 1. Results of the metacognition questionnaire

Table 1. Results of the metacognition questionnaire on planning indicators

No	Score	Criteria	Total Students	Percentage
1	22–23	Excellent	6	22.22%
2	20–21	Good	7	25.92%
3	18–19	Average	9	33.33%
4	0–17	Poor	5	18.51%

are more interested only in evaluating action plans. In the monitoring indicator, a 34.09% score was obtained, indicating that some students are interested in monitoring efforts by applying the same strategy to other problems. The lowest score was obtained by the planning indicator (24, 10%).

The identification of the questionnaire based on metacognitive ability on planning, monitoring, and assessment indicators is as follows.

a. 1. Planning Indicator (Table 1).

The metacognition questionnaire results on the planning indicators showed that six students have Excellent metacognitive abilities, while seven, nine, and five students have high ability, fairly high ability, and low ability. Furthermore, the obtained scores for each participant were categorized on high, medium, and low criteria. The score of 85, 70, and 44 were classified as high (AVP), moderate (CNS), and low (DO).

a. 2 Monitoring Indicators

The results of the metacognition questionnaire on the monitoring indicators presented in Table 2 showed that 21 students had low metacognitive abilities. Their low ability is influenced by the number of students unaware of conceptual errors and counting

Table 2. Results of the metacognition questionnaire on monitoring indicators

No	Score	Criteria	Total Students	Percentage
1	22–23	Excellent	1	3.73%
2	20–21	Good	1	3.73%
3	18–19	Average	4	14.81%
4	0–17	Poor	21	77.77%

Table 3. Results of the metacognition questionnaire on assessment indicators

No	Score	Criteria	Total Students	Percentage
1	22–23	Excellent	2	7.40%
2	20–21	Good	5	18.51%
3	18–19	Average	1	3.70%
4	0–17	Poor	19	70.37%

methods. Additionally, four students had a moderate metacognitive ability which was induced by students' inability to correct the wrong summation. Lastly, one student was observed as having excellent, signified by the student's ability to point out and correct the errors in the concept of counting and then corrected it. Furthermore, the obtained scores for each participant were categorized on high, medium, and low criteria. The score of 88, 77, and 66 were classified as high (CA), moderate (SNT), and low (DS).

a. 3. Assessment indicators

The results of the metacognition questionnaire on the assessment indicators shown in Table 3 showed that 21 students have low scores (70.37%), which is influenced by the number of students who cannot evaluate the questionnaire question and statement. Besides, students' motivation to improve concepts and strategies in counting also affected their low scores. In the medium category, there was one student who only knew the ways to describe the counting concept but could not explain the details of the answer. Similarly, one student also presented excellent and high scores as the student was able to describe concepts, use proper summation strategies, and provide a detailed explanation. Furthermore, the obtained scores for each participant were categorized on high, medium, and low criteria. The score of 84, 80, and 66 were classified as high (EFI), moderate (CNSI), and low (DS).

b. The Results of the Critical Thinking Questionnaire

Based on the results of the metacognition questionnaire, nine participants were selected to get involved in the critical thinking examination. These students were given questionnaires and critical thinking tests. The critical thinking questionnaire items represented the indicators of interpretation, analysis, inference, and evaluation. The results of the

Table 4. Research results on planning indicators

Subject	Critical Thinking Indicator	Criteria for Critical Thinking Ability	Questionnaire Score	Test Score
High planning indicators				
AVP	Interpretation	Excellent	96	93.33 (very critical)
	Analysis	Excellent	92	
	Inference	Excellent	90	
	Evaluation	Excellent	92	
Moderate planning indicators				
CNSI	Interpretation	Excellent	80	63.33 (quite critical)
	Analysis	Good	64	
	Inference	Average	60	
	Evaluation	Good	64	
Low planning indicators				
DOS	Interpretation	Average	56	40 (low)
	Analysis	Average	42	
	Inference	Average	48	
	Evaluation	Average	48	

critical thinking skills based on the metacognition questionnaire on planning indicators are presented in Table 4.

As presented in Table 4, the participants with high planning indicators have a great ability to interpret, analyze, infer and evaluate. Meanwhile, participants with moderate planning have excellent interpretation, good analysis, fairly good inference, and good evaluation capability. Participants with low planning indicators have a fairly good ability to interpret, analyze, infer and evaluate.

In addition, the results of the critical thinking skills based on the metacognition questionnaire on monitoring indicators are presented in Table 5.

Table 5 shows that participants with high monitoring indicators have a fairly good ability to interpret, infer, and evaluate, along with good analysis ability. Subjects with moderate monitoring indicators have good interpretation, analysis, inference, and evaluation. Subjects with low monitoring indicators have a poor ability to interpret, analyze, infer and evaluate. The results of the critical thinking skills based on the metacognition questionnaire on the assessment indicators are presented in Table 6.

As presented in Table 6, participants with high assessment indicators have an excellent ability to interpret, infer, evaluate and analyze. Participants with moderate assessment indicators have very good interpretation and inference, along with a good ability to analyze and evaluate. Subjects with low monitoring indicators present a fairly good ability to interpret, analyze, infer and evaluate.

Table 5. Research results on monitoring indicators

Subject	Critical Thinking Indicator	Criteria for Critical Thinking Ability	Questionnaire Score	Test Score
High monitoring indicators				
CA	Interpretation	Average	76	73.33 (Critical)
	Analysis	good	80	
	Inference	Average	75	
	Evaluation	Average	76	
Moderate monitoring indicators				
SNT	Interpretation	Average	75	60.33 (quite critical)
	Analysis	Average	74	
	Inference	Average	76	
	Evaluation	Average	76	
Low monitoring indicators				
DOS	Interpretation	Poor	56	40 (low)
	Analysis	Poor	42	
	Inference	Poor	48	
	Evaluation	Poor	48	

In general, the results of the critical thinking test showed that the participants with high scores in planning, monitoring, and assessment categories presented high critical thinking skills. Meanwhile, participants with moderate scores in planning, monitoring, and assessment indicators showed fair critical thinking skills. Finally, the participants with low scores in planning, monitoring, and assessment indicators had low critical thinking ability.

c. Discussion

Research participants with high metacognitive indicators read the questions repeatedly until they understand them. The students also tried to plan the answer strategy to get the right answer. Besides, this student also stated that they enjoy solving challenging problems. The students always looked back at his answers and corrected them before collecting the answer. These students presented excellent critical thinking skills. Students with high critical thinking can identify relevant information, try to think about finding solutions to problems, and use their thinking potential [20].

In contrast, the participants with low metacognitive did not understand the questions and were less thorough in concluding the questions. They faced difficulties in finding the relationship between concepts because of the limited time. Although sometimes they checked the answers, they did not know whether the answer was right or wrong. Their difficulties in meeting the indicators of critical thinking skills are caused by their limited ability to formulate and find other alternatives. These students have difficulties in drawing conclusions and connecting substances between materials, along with the

Table 6. Research results on assessment indicators

Subject	Critical thinking indicator	Criteria for Critical Thinking Ability	Questionnaire Score	Test Score
High scoring indicators				
EFI	Interpretation	Excellent	96	86.67 (very critical)
	Analysis	Excellent	92	
	Inference	Excellent	90	
	Evaluation	Excellent	92	
Moderate assessment indicators				
CNSI	Interpretation	Excellent	80	63.33 (quite critical)
	Analysis	Good	64	
	Inference	Excellent	80	
	Evaluation	Good	64	
Low scoring indicators				
DOS	Interpretation	Average	56	40 (low)
	Analysis	Average	42	
	Inference	Average	48	
	Evaluation	Average	48	

material that has not been studied in depth induced them to tend to be careless in solving problems [21].

4 Conclusion

This study obtained several findings related to critical thinking skills based on the metacognition of third-grade students in elementary school. In general, it is found that third-grade elementary school students who have good metacognition presented excellent critical thinking skills and vice versa. This can be seen from the indicators of metacognition and is associated with indicators of critical thinking skills. Likewise, it can be seen from the critical thinking test results.

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