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Analysis of Logical Thinking Ability of Elementary School Students on Symbiosis Material in Science Learning

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Abstract

Logical thinking helps students link facts and draw reasonable conclusions, but it is often weak in elementary science learning, where lecture-based teaching encourages memorisation. This study aimed to describe the initial logical thinking ability of Grade III students on symbiosis material. A descriptive quantitative design was used, supported by qualitative analysis of observations. Seventeen Grade III students of SDN Sumberejo 2 Tuban, selected purposively, took a pre-test measuring three indicators: classification, seriation, and cause-and-effect reasoning. Data were collected through the test and an observation sheet and analysed using means, percentages, and the Miles and Huberman model. The mean score was 5.88 out of 15 (39.2%). One student (5.88%) was in the high category, ten (58.82%) in the moderate category, and six (35.29%) in the low category. Classification was the strongest indicator and cause-and-effect reasoning the weakest: students could often choose or name a correct symbiosis type but could not explain the reason. Overall, the ability is at a basic level, consistent with the concrete operational stage. Teaching that trains cause-and-effect explanation, such as problem-based and inquiry learning, is recommended and should be tested in experimental studies.

Keywords: logical thinking ability; elementary school students; symbiosis; science learning; descriptive analysis

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INTRODUCTION

Education supports students' development not only in knowledge but also in attitudes and thinking skills. Under Law Number 20 of 2003 on the National Education System, education is a conscious and planned effort to create a learning atmosphere in which students actively develop their potential. As modern demands grow, education is oriented not only to understanding content but also to thinking, problem solving, and adapting to technology (Satria & Muntaha, 2021). Logical thinking, the ability to connect facts and draw reasonable conclusions in a structured way, is one such ability. In science learning it helps students understand concepts well and relate them to everyday events. Weak reasoning among elementary

students has been linked to student motivation, teacher attitudes, learning media, and facilities (Dharma et al., 2022).

In elementary school, science learning is the foundation for understanding scientific concepts. Elementary students generally learn best through direct experience, interaction, and concrete activities, in line with Piaget's account of cognitive development, which proceeds gradually and differs between children (Asdah, 2025; Syarifah et al., 2023), so science lessons should be designed attractively and in contexts that are easy to understand. Science is the study of natural phenomena, observed directly or with tools (Yasa et al., 2021). Learning of integrated science and social studies (IPAS) in elementary schools also faces limited learning media, insufficient teacher training, and reliance on conventional methods (Hidayatullah et al., 2025). In practice, however, science lessons still often rely on lectures, so students are passive and tend to memorise. This makes abstract concepts such as symbiosis hard to grasp: students often cannot yet understand relationships among living things logically, which affects their ability to analyse and classify types of symbiosis.

Logical thinking is still low among elementary students. Students tend to memorise information rather than understand how concepts relate logically, and this pattern was found at SDN Sumberejo 2 Tuban. A preliminary observation and pre-test showed that, of 20 students, 75% scored below 50% of the maximum, with a mean of 5.65 out of 18. Most Grade III students could not yet answer questions requiring logical thinking, such as identifying relationships among living things and classifying types of symbiosis. Earlier studies also point to the issue. Yohana Halim and Wahyuningsih (2025) found that the bar model can improve elementary students' logical thinking in mathematics. Arifiya (2023) showed that logical thinking in science can be analysed through indicators such as analysing, drawing conclusions, and understanding cause and effect, although results were not yet ideal. Anggraini and Irawan (2021) reported that students' logical thinking varied across categories but was mostly moderate to low, and Nurlaili et al. (2025) found that students had difficulty linking concepts and drawing conclusions logically. Studies of critical thinking in elementary science report a similar pattern: students' skills were not yet optimal, especially in analysis, evaluation, and inference (Une et al., 2026; Susanti et al., 2025), their answers stayed mostly descriptive (Rahmawati et al., 2025), and Grade III students showed low critical thinking in an IPAS lesson (Lavenita et al., 2026). Elementary students' problem-solving in IPAS was also found to be low (Tobi & Silvester, 2026).

Most of these studies concern lower and upper secondary students (for example, low scientific reasoning among Grade VII students; Maharani et al., 2023) and are often tied to mathematics. Studies of logical thinking in elementary science, and especially of students' initial logical thinking on symbiosis, are still scarce. This study therefore describes the initial logical thinking ability of Grade III students of SDN Sumberejo 2 Tuban on symbiosis material, as a basis for designing more effective science teaching.

METHODS

This study used a descriptive quantitative approach to describe students' logical thinking systematically before any intervention, so that the data reflect real classroom conditions. It was carried out at SDN Sumberejo 2 Tuban during the current academic year. The subjects were Grade III students: the class has 20 students, but only 17 took the pre-test. They were selected purposively, using three criteria: active students, present on the day of the pre-test, and already introduced to the basics of living things.

The object of the study was the initial logical thinking ability on symbiosis material, measured through three indicators: classification, seriation (ordering), and cause-and-effect reasoning. The instruments were a pre-test and an observation sheet. The pre-test consisted of multiple-choice and/or essay items based on the indicators, with a maximum score of 15, and was content-validated. The observation sheet captured supporting information on students' activity and responses while they worked on the test.

Data were collected in two steps: giving the pre-test and observing how students worked on it. Test results were analysed descriptively with means and percentages and categorised as high, moderate, or low according to the score ranges in Table 1. Observation data were analysed qualitatively with the Miles and Huberman model of data reduction, data display, and conclusion drawing (Anggraini & Irawan, 2021).

RESULTS & DISCUSSION

Results

The results come from the pre-test of 17 Grade III students on symbiosis material. The mean score was 5.88 out of a maximum of 15 (39.2%), with a highest score of 15 and a lowest of 0. Overall, students' logical thinking is at a basic level. Table 1 and Figure 1 show the distribution: more than half of the students (58.82%) are in the moderate category, 35.29% are still in the low category, and only 5.88% are in the high category. The mean therefore lies at the lower edge of the moderate band and is best read as low to moderate.

Table 1. Criteria and Distribution of Logical Thinking Ability

Category	Score range	Students	Percentage
High	12–15	1	5.88%
Moderate	6–11	10	58.82%
Low	0–5	6	35.29%
Total		**17**	**100%**

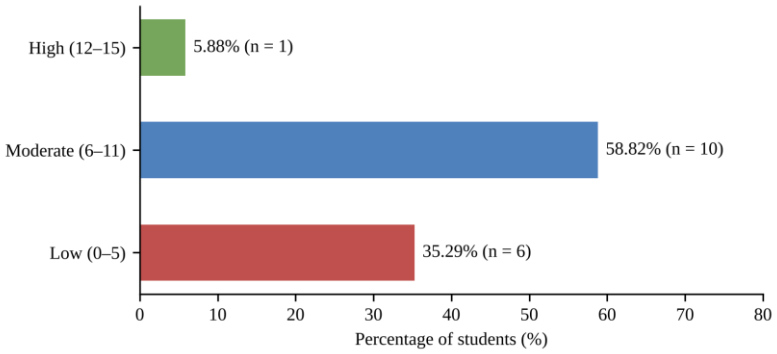


Figure 1. Distribution of students' logical thinking ability by category (n = 17)

Ability by Indicator

Among the three indicators (classification, seriation, and cause-and-effect reasoning), students handled classification items best and cause-and-effect reasoning worst. Many students chose the correct answer but could not give a logical and accurate explanation, especially in essay items. In general, the results show differences in logical thinking among students, with the tendency still at a basic level.

Discussion

The initial logical thinking of Grade III students on symbiosis is low to moderate, which suggests that students cannot yet use logical thinking well to understand symbiosis. The indicator pattern clarifies where the difficulty lies. The high result on classification suggests that most students can group types of symbiosis by observed features, because classification is specific and easier for elementary children to grasp. This agrees with the view that elementary students more readily master concrete skills than more complex thinking (Hayati & Setiawan, 2022).

The low result on cause-and-effect reasoning shows that students struggle to explain relationships among living things logically. They usually recognise examples of symbiosis but cannot explain the reason or relationship behind the interaction, so their thinking has not yet moved to more complex reasoning. Jayakusuma (2023) likewise reported that elementary students have difficulty analysing and drawing conclusions, especially where cause and effect are involved. The many students in the moderate category have a basic foundation that is not yet well developed, while the sizeable low group has difficulty processing information rationally when an explanation is required.

The findings agree with earlier studies that report low and underdeveloped thinking skills among elementary students in science learning (Ningsih et al., 2024) and a tendency to memorise concepts rather than explain them logically (Fadiah et al., 2024). In this study students answered recognition items better than they explained reasons. Piaget's theory of cognitive development offers an interpretation: elementary students are at the concrete operational stage and

understand concrete concepts more easily than abstract ones (Faiq Rahayu & Setiyawati, 2024). The higher classification result reflects reliance on concrete thinking, and the low cause-and-effect result indicates that abstract reasoning, which needs logical links among concepts, is not yet fully available. Teaching habits may add to this: when lessons do not involve complex thinking, students are less used to developing logical thinking (Ningsih et al., 2024). Because the study did not observe teaching practice, this explanation is a plausible inference rather than a tested one.

The results imply that teachers need to train students' thinking, especially cause-and-effect reasoning, through more effective strategies. Problem-based and inquiry learning may help, since problem-based learning has been reported to improve elementary students' critical thinking (Faiq Rahayu & Setiyawati, 2024), and educational games oriented to logical thinking have been developed for lower grades (Ashari et al., 2026). Other studies report that problem-based learning improved fifth-grade students' critical thinking compared with conventional teaching (Huriyah et al., 2026), that mind mapping improved critical thinking in IPAS (Isnaeni et al., 2026), and that AR-based diorama media on ecosystem material produced higher gains in logical thinking than conventional teaching (Zahra & Julianto, 2026). Knowing that the main weakness lies in understanding cause and effect also lets teachers plan lessons that target it, for example by asking students to explain why an interaction benefits or harms each organism.

The study has limitations. First, it involved one class in one school, so the results cannot be generalised. Second, data came only from a pre-test and observation, without in-depth interviews. Third, external factors such as prior learning experience were not analysed. In addition, only 17 of 20 students took the test, and the instrument's validity evidence and reliability, and the item-level indicator scores, are not reported, which limits how strongly the indicator ranking can be interpreted. Further research should examine how logical thinking can be improved, especially cause-and-effect reasoning, with more subjects and varied methods.

CONCLUSION

The initial logical thinking ability of Grade III students of SDN Sumberejo 2 Tuban on symbiosis material is low to moderate and not yet fully developed: the mean pre-test score was 5.88 out of 15, with 58.82% of students in the moderate, 35.29% in the low, and 5.88% in the high category. Classification was the strongest indicator and cause-and-effect reasoning the weakest, so students understand concrete concepts more easily than they reason about relationships.

Teachers should therefore use strategies that engage students in active thinking, such as problem-based and discovery learning, with attention to cause-and-effect reasoning. Because this study was descriptive and involved few subjects, further studies using experimental or quasi-experimental designs are recommended to test how specific learning models improve students' logical thinking.

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