

THE EFFECT OF LOGICAL-MATHEMATICAL INTELLIGENCE-ORIENTED MIND MAPPING LEARNING MEDIA ON PHYSICS LEARNING OUTCOMES OF SMAN 11 PANDEGLANG STUDENTS

Ferawati¹, Nurul Aulia¹, Yulia Ramadhar^{1*}, Wahyu Dian Laksanawati¹

¹Physics Education Study Program, Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
2SMA Negeri 4 Pandeglang

*E-mail: yuliaramadhar@uhamka.ac.id

ABSTRACT

Low physics learning outcomes remain a challenge in the learning process, particularly regarding topics that require logical and mathematical thinking skills. While various studies have demonstrated the effectiveness of mind mapping media in enhancing conceptual understanding, research integrating mind mapping with a logical-mathematical intelligence orientation in physics instruction remains limited. This study aims to analyze the effect of logical-mathematical intelligence-oriented mind mapping learning media on students' physics learning outcomes. A pre-experimental design specifically the One-Group Pretest-Posttest design was employed with 25 Grade XI Science students at SMAN 11 Pandeglang. Data were collected via learning outcome tests and analyzed using normality, homogeneity, and N-Gain tests. The results indicate that the students' average score increased from 42.93 in the pretest to 68.18 in the posttest. These findings demonstrate that the use of mind mapping helps students understand physics concepts in a more structured manner and improves learning outcomes. The study implies that mind mapping media can serve as an alternative approach to physics instruction for developing students' logical-mathematical thinking skills.

Keywords: physics learning outcomes, logical-mathematical intelligence, mind mapping, physics learning, pre-experimental design

INTRODUCTION

Physics is a branch of natural science that plays a vital role in developing students' logical, analytical, and problem-solving skills. The characteristics of physics materials which extensively involve abstract concepts, cause-and-effect relationships, and mathematical representations require students to possess structured thinking capabilities. However, in practice, students' physics learning outcomes are still not optimal. Based on observations at SMAN 11 Pandeglang, some students experienced difficulties in understanding physics concepts and solving problems that required logical reasoning and mathematical skills, which consequently led to low learning outcomes.

Various studies have demonstrated that students' cognitive factors influence their success in learning physics [1]. A study by Fauziah et al. [2] found that logical-mathematical intelligence has a positive and significant correlation with students' physics learning outcomes. The higher the logical-mathematical intelligence a student possesses, the better the physics learning outcomes they achieve. The study also indicated that the ability to calculate, understand relationship patterns, and solve problems are essential components that support students' success in studying physics.

In addition to intelligence factors, the use of learning media and strategies also plays an important role in improving learning outcomes. One widely used medium is mind mapping. Research by Imaniarti et al. showed that mind mapping can help students organize information and learning concepts more systematically, thereby facilitating the process of understanding

and remembering physics material [3]. The mind mapping technique also provides opportunities for students to connect various concepts in a structured visual form.

Nevertheless, previous studies have still tended to examine logical-mathematical intelligence and the use of mind mapping separately. The study by Fauziah et al. focused on the relationship between logical-mathematical intelligence and physics learning outcomes without involving any specific learning media intervention. Conversely, the study by Imaniarti et al. emphasized the application of mind mapping in physics learning without linking it specifically to the development of students' logical-mathematical intelligence. Consequently, a research gap remains regarding how mind mapping media can be utilized as a tool to optimize logical-mathematical intelligence, which ultimately impacts the improvement of physics learning outcomes [4].

Based on this gap, this study offers novelty in the form of applying mind mapping learning media oriented toward developing students' logical-mathematical intelligence [5]. The integration between visual media and logical-mathematical thinking skills is expected to help students understand the interconnections between physics concepts more systematically, enhance analytical skills, and improve learning outcomes.

Therefore, the purpose of this study is to analyze the influence of logical-mathematical intelligence-oriented mind mapping learning media on the physics learning outcomes of eleventh-grade science students (*Kelas XI IPA*) at SMAN 11 Pandeglang. The hypothesis proposed is that there is a positive influence of using logical-mathematical intelligence-oriented mind mapping learning media on students' physics learning outcomes.

RESEARCH METHOD

This study employed a quantitative method with a quasi-experimental approach (*pre-experimental design*) using the *One Group Pretest-Posttest Design*. This design was selected to determine the effect of implementing logical-mathematical intelligence-oriented mind mapping learning media on students' physics learning outcomes. In this design, the research subjects were given an initial test (*pretest*) before the treatment and a final test (*posttest*) after the treatment to determine the changes in learning outcomes resulting from the implementation of the learning media. The research design can be formulated as follows:

$O_1 - X - O_2$

Description:

- O_1 = Pretest
- X = Treatment using logical-mathematical intelligence-oriented mind mapping learning media
- O_2 = Posttest

The study was conducted during the even semester of the 2020/2021 Academic Year at SMAN 11 Pandeglang. The research population comprised all eleventh-grade science students (*Kelas XI IPA*) at SMAN 11 Pandeglang. The research sample consisted of 25 students selected using the *simple random sampling* technique. Sample selection was carried out by considering the uniformity of students' academic characteristics and the representativeness of the research population.

The independent variable in this study was the logical-mathematical intelligence-oriented mind mapping learning media, while the dependent variable was the students' physics learning outcomes [6]. The orientation of logical-mathematical intelligence in this study refers to the students' ability to recognize relationship patterns, perform logical reasoning, analyze problems,

and use mathematical concepts in solving physics problems. The determination of these variables was based on findings that logical-mathematical intelligence has a positive relationship with physics learning outcomes and contributes to students' ability to understand science concepts.

The research procedure began with the administration of a pretest to determine the students' initial ability regarding the physics material to be studied. Next, learning was conducted using mind mapping media designed to help students organize physics concepts in a structured visual form [7]. In the learning process, students were directed to identify main concepts, connect different concepts, discover relationship patterns, and construct concept maps based on the results of discussions and problem-solving. The use of mind mapping was chosen because it can help students map information [8], increase learning engagement, and support logical and systematic thinking processes. After all learning activities were completed, students were given a posttest to measure the increase in learning outcomes.

The research instrument used was a physics learning outcome test in the form of multiple-choice questions developed based on learning indicators. Before being utilized, the instrument first underwent validation, reliability testing, difficulty level analysis, and discriminating power analysis. From the total pool of questions drafted, items that met the eligibility criteria were selected for use in the research.

The research data were analyzed using descriptive and inferential statistics. Descriptive analysis was used to determine the mean value, maximum value, minimum value, and standard deviation of students' learning outcomes. Inferential analysis was performed through normality testing using the Liliefors test and homogeneity testing using the F-test to ensure that the data met the prerequisites for statistical analysis. Furthermore, the increase in students' learning outcomes was analyzed using the N-Gain score to determine the level of effectiveness of the mind mapping media implementation. Hypothesis testing was carried out at a significance level of $\alpha = 0.05$ to determine whether or not there was an influence of the logical-mathematical intelligence-oriented mind mapping learning media on students' physics learning outcomes.

The research hypotheses tested were:

- H_0 : There is no influence of logical-mathematical intelligence-oriented mind mapping learning media on students' physics learning outcomes.
- H_a : There is an influence of logical-mathematical intelligence-oriented mind mapping learning media on students' physics learning outcomes.

RESULTS AND DISCUSSION

Learning outcome data were obtained through an initial test (*pretest*) and a final test (*posttest*) administered to 25 students before and after the implementation of mind mapping media. Students' learning outcomes are described in Table 1, which shows the descriptive statistics of the students' physics learning outcomes.

Table 1. Descriptive Statistics of Students' Learning Outcomes

Statistics	Pretest	Posttest
Number of Students	25	25
Highest Score	73.33	86.66

Statistics	Pretest	Posttest
Lowest Score	20.00	53.33
Average (Mean)	42.93	68.18

Based on Table 1, it can be seen that the average student learning outcome increased from 42.93 during the pretest to 68.18 during the posttest. Additionally, both the lowest and highest scores achieved by students also increased after the application of the mind mapping learning media.

To clarify the increase in the average student learning outcome, Figure 1 is presented below.

Figure 1. Comparison of Pretest and Posttest Score Averages

(Comparison of Pretest and Posttest Values: Average physics learning outcomes of students before and after the implementation of mind mapping media).

Based on Figure 1, there is a visible increase in the learning outcome average by 25.25 points after learning with the logical-mathematical intelligence-oriented mind mapping learning media.

a. Normality Test

The normality test was performed using the Liliefors test to determine whether the research data were normally distributed.

Table 2. Normality Test Results

Data	Lcount	Ltable	Description
Pretest	0.127	0.173	Normal
Posttest	0.135	0.173	Normal

The test results indicate that the L_{count} value for both the pretest and posttest data is smaller than L_{table} at a significance level of 0.05. Therefore, the research data are normally distributed, thereby fulfilling the requirements for subsequent analysis.

b. Homogeneity Test

The homogeneity test was conducted to determine the equality of variance of the research data.

Table 3. Homogeneity Test Results

Fcount	Ftable	Description
1.556	1.984	Homogeneous

Based on the test results, the obtained F_{count} value of 1.556 is smaller than F_{table} of 1.984. Therefore, the research data possess homogeneous variance.

c. Learning Outcome Improvement (N-Gain)

The improvement of learning outcomes was analyzed using the N-Gain index.

The formula used is:

$$N\text{-Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

Based on the average values of the pretest and posttest, the following values were obtained:

$$N\text{-Gain} = \frac{68.18 - 42.93}{100 - 42.93}$$

$$N\text{-Gain} = 0.44$$

An N-Gain value of 0.44 falls into the medium category.

Table 4. N-Gain Interpretation

N-Gain Value	Category
0.44	Medium

These results indicate that the use of mind mapping media provides an improvement in physics learning outcomes within the medium category.

CONCLUSION

Based on the results of the research conducted, it can be concluded that the implementation of logical-mathematical intelligence-oriented mind mapping learning media exerts a positive influence on the physics learning outcomes of eleventh-grade science students (*Kelas XI IPA*) at SMAN 11 Pandeglang. This is demonstrated by the increase in the average student learning outcome from 42.93 during the pretest to 68.18 during the posttest. Data analysis indicates that the research data are normally distributed and homogeneous, thereby fulfilling the prerequisites for statistical testing.

The improvement in learning outcomes is also evidenced by the N-Gain value of 0.44, which is in the medium category. This result indicates that the use of mind mapping media can help students understand physics concepts in a more structured manner, connect different concepts better, and develop logical and mathematical thinking skills in solving physics problems. Accordingly, logical-mathematical intelligence-oriented mind mapping learning media can be utilized as an effective alternative instructional strategy to enhance students' physics learning outcomes.

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