The effect of inquiry learning model and logical mathematical intelligence on the learning outcomes of high school students

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Abstract. This research aimed to determine the differences in student learning outcomes through the Inquiry learning model, to see the influence of the interaction between learning models and logical-mathematical intelligence on student learning outcomes, and to find out differences in student learning outcomes through the inquiry learning model in the logical-group mathematical intelligence high and low. The research was conducted at Public High School 2 in South Tangerang City with a sample of 74 students consisting of 37 students in the experimental class and 37 students in the control class. This study used the quasi-experiment method and the research design was treatment by level 2x2. Based on the research results obtained by data analysis and hypothesis testing, it can be concluded that: (1) there are differences in the learning outcomes of students when given the inquiry learning model; (2) there is an interaction effect between inquiry learning models and logical-mathematical intelligence on student learning outcomes; (3) the learning outcomes of students who are taught with the guided inquiry learning model are higher than those taught with the self inquiry learning model in both the high and low logical-mathematical intelligence groups.

1. Introduction

In line with the development of 21st century education, education in Indonesia is expected to produce human resources who have superior competencies who are able to compete globally. Competent and quality human resources will create high productivity and reflect a nation that has high competitiveness [1]. The competence of students can be seen from the value of their learning outcomes.

Learning outcomes according to Gagne is a change in the behavior of students after receiving a learning experience, which is measured through their knowledge, behavior, attitudes and skills [2, 3]. Learning outcomes can be interpreted as the results or values obtained by students after completing learning [4]. Learning outcomes are the results achieved by students after implementing maximum learning efforts [5].

Based on the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 23 of 2016, assessment of student learning outcomes includes aspects of attitudes, knowledge, and skills. In this study, the learning outcomes of students who will be examined are only on the cognitive aspects. According to Bloom's taxonomy, cognitive aspects will be measured by categories: remembering (C1), understanding (C2), applying (C3), analyzing (C4), and evaluating (C5) [6].
To achieve good learning outcomes requires an active role for teachers and students in the learning process at school. The weakness of the learning process in education, especially in physics learning, causes students to be less creative, innovative and productive. Choosing a learning model by the teacher is an important part of learning.

One of the learning models are require to Indonesian curriculum that is centered on students is inquiry learning model. Inquiry learning model means a learning activity that maximally involves all the abilities of students to seek and investigate systematically, critically, logically and analytically so that they can formulate their own findings confidently. Through this activity, students can learn to present problems, create or present hypotheses, conduct experiments to obtain information or data, collect and analyze data, and make conclusions [7].

Inquiry-based learning model is a learning model that can improve students’ inquiry skills [8], improve students' scientific literacy skills [9], increased critical thinking [10], improve academic achievement, attitudes and involvement of students in learning [11], can motivate students to learn physics and learning experiences [12], as well as Guided Inquiry learning models with science performance can improve learning outcomes [13]. Inquiry learning model is a learning activity that involves thoroughly the ability of students to seek and investigate systematically, critically, logically, analytically, so that they can formulate their own findings [14]. In guided inquiry learning, students investigate questions that the teacher has formulated, and the teacher also works as a supporter in developing these problems. However, it does not mean that students only follow what the teacher formulates, but students are expected to carry out an investigation process and discuss with other groups of students to make conclusions. For this reason, guided questions are considered to be a transition from a guided inquiry learning model (structured) to an open inquiry learning model [15]. The inquiry learning model provides opportunities for students to find their own information and concepts by asking questions, formulating problems, formulating hypotheses, collecting data, testing hypotheses, and formulating conclusions.

In addition to the learning model, other factors that can affect learning achievement are logical-mathematical intelligence which is owned by every student. Logical-Mathematical Intelligence is the ability to understand the basics of operations associated with using numbers in everyday life and do correct reasoning [16, 17, 18]. Furthermore, Gardner states that the theory of multiple intelligences provides different dimensions to each individual. This means that in the learning process each student has different characteristics and abilities, including their intelligence. This intelligence profile can affect the learning process and learning outcomes [19]. Logical-Mathematical Intelligence, which is a combination of numeracy and logical skills so that students can solve a problem logically [20], is an intelligence that involves the ability to logically analyze problems, find certain formulas and patterns, and investigate something scientifically [21]. Logical-Mathematical Intelligence is also a person's ability to think inductively and deductively, think according to logical rules, understand and analyze number patterns, and solve problems using thinking skills [22]. Students with Logical-Mathematical Intelligence are able to identify, represent what is known and asked in the problem and find the constituent elements, find the relationship between elements and the similarity of the relationship of each element by thinking about it and accompanied by logical reasons [23].

Logical-Mathematical Intelligence affect foreign language learning [24], the group of students with high Logical-Mathematical Intelligence gives better results in language teaching in ESP courses [25]. Logical-mathematical Intelligence also influences in solving geometric problems [26]. Students with higher Logical-Mathematical Intelligence tend to use more logical connectors in their essay writing [27], there is a significant positive correlation between learning achievement in Financial Accounting courses with Logical-Mathematical Intelligence [28].

Based on the previous description, the authors conducted research on the influence of inquiry learning models and logical-mathematical intelligence on the learning outcomes of high school students. In this study, researchers used two inquiry learning models, namely the guided inquiry learning model and the open inquiry learning model.
2. Method
The research was conducted at SMAN 2 Kota Tangerang Selatan in the 2019/2020 school year. This study uses a quasi-experimental method with the design used is a 2 x 2 level treatment design. The quasi-experiment method aims to predict conditions that can be achieved through actual experiments but there is no control or manipulation of all variables. In this research design, there are two independent variables, namely the learning model (Guided Inquiry and Open Inquiry) and Logical-Mathematical Intelligence, and one dependent variable, namely learning outcomes.

| Logical-Mathematical Intelligence | Learning Models |  |
|----------------------------------|-----------------|---|
| High                             | A₁B₁            | A₂B₁ |
| Low                              | A₁B₂            | A₂B₂ |

Table 1. Research design

In Table 1, it is shown that the first group was given the guided inquiry learning model and the second group was given the open inquiry learning model. Both groups were given a Logical-mathematical Intelligence test.

The scores obtained from the test are then sorted from highest to lowest score. Based on these scores, 27% of the highest scores were taken as the high group Logical-Mathematical Intelligence and 27% of the lowest scores as the low group Logical-Mathematical Intelligence. After the treatment was carried out, a learning outcome test was given at the end of the meeting. Both instruments have been tested for validity and reliability. The data obtained from the two instruments were tested for the analytical prerequisite, namely the normality and homogeneity test, then using the two-way ANOVA hypothesis test.

3. Results and Discussion
The average value of learning outcomes in each group is presented in Table 2. Based on this table it can be explained that: 1) the learning outcomes of students who are taught through the guided inquiry learning model are higher than students who are taught through the open inquiry learning model, 2) The learning outcomes of students who have high logical-mathematical intelligence are greater than students who have low logical-mathematical intelligence, 3) the learning outcomes of students who are taught through the guided inquiry learning model are higher than the learning outcomes of students who are taught through open inquiry learning models in groups high Logical-Mathematical Intelligence, 4) student learning outcomes that are taught through guided inquiry learning models are higher than student learning outcomes taught through open inquiry learning models in the low Logical-Mathematical Intelligence group.

Table 2. Average learning outcomes scores for each group

| Logical Mathematical Intelligence | Learning Models | Total  |
|----------------------------------|-----------------|--------|
|                                  | Guided Inquiry  | Open Inquiry |     |
| High                             | 92.50           | 87.58           | 90.04 |
| Low                              | 80.58           | 67.58           | 74.08 |
| Total                            | 86.54           | 77.58           |      |

The results obtained are in line with Tabun which state that the science learning outcomes of junior high school students in the aspects of knowledge, attitudes, and skills using guided inquiry learning models have increased [29]. This is because in guided inquiry learning, students investigate the questions that the teacher has formulated, and the teacher also works as a supporter in developing these problems. However, it does not mean that students only follow what the teacher formulates, but
students are expected to carry out an investigation process and discuss with other groups of students to make conclusions.

Before testing the hypothesis, a normality test is carried out to determine whether the selected sample comes from a normally distributed population as shown in Table 3 and the homogeneity test of variance to determine whether the variance of a population is the same or not. shown in Table 4. In this study, the Shapiro Wilk method was used to test the normality and the homogeneity test to Levene Test.

### Table 3. Normality test data

| Sample           | Total | Sig. | α  | Conclusion |
|------------------|-------|------|----|------------|
| Guided Inquiry   | 37    | 0.15 | 0.05 | Normal     |
| Open Inquiry     | 37    | 0.08 | 0.05 | Normal     |

Based on Table 3, it can be seen that the value is significant so that each sample is normally distributed. Based on table 4, it can be seen that a significant value indicates that the research data has a homogeneous variance. After that, the hypothesis was tested using two way ANOVA.

### Table 4. Homogeneity test data

| Sample                  | Observation | df1 | df2 | Sig   | Conclusion |
|-------------------------|-------------|-----|-----|-------|------------|
| Guide Inquiry, Open Inquiry | 1.466       | 1   | 72  | 0.23  | Homogeneous |

The results of hypothesis testing show that the main effect of the learning model on student learning outcomes is significant so that students who are taught through the guided inquiry learning model get higher scores than students who are taught through the open inquiry learning model. These results are consistent with the research of Nugroho which states that the Guided Inquiry learning model can improve student learning outcomes \( F = 21.755 \) and \( p = 0.000 \) [30], besides that it also improves process skills [31], students become more active [32], improve science skills [33].

Based on Table 5, it can also be seen that there is a significant effect of Logical-Mathematical Intelligence on student learning outcomes \( F = 69.036 \) and \( p = 0.000 \). There is also a significant
interaction between the learning model and Logical-Mathematical Intelligence \((F = 4.428 \text{ and } p = 0.041)\). This is also in accordance with previous research that the learning model and Logical-Mathematical Intelligence have an effect on student learning outcomes. The learning outcomes of students with high Logical-Mathematical Intelligence are better than students with intermediate and low Logical-Mathematical Intelligence [34].

In addition, Table 5 also shows that the learning model used has an effect on students' logical mathematical intelligence. Students with high Logical-Mathematical Intelligence have better affective performance than students with low Logical-Mathematical Intelligence [35]. There is an interaction effect between the provision of instructional media and mathematical logical intelligence on student mathematics learning outcomes [36].

| Students' Learning Outcomes | Sum of Squares | Df | Mean Square | F     | Sig. |
|-----------------------------|----------------|----|-------------|-------|------|
| \(A_1B_1 \times A_2B_1\)     | 145.042        | 1  | 145.042     | 4.666 | 0.042|
| \(A_1B_2 \times A_2B_2\)     | 1014.000       | 1  | 1014.000    | 17.651| 0.000|

Based on Table 6, it can be seen that student learning outcomes taught through guided inquiry learning models are higher than student learning outcomes taught through open inquiry learning models in the Logical-Mathematical Intelligence group or in the Logical-Mathematical Intelligence group. This result is in line with Šafranj's research which states that groups of students with high Logical-Mathematical Intelligence perform better in language teaching in the ESP course. Students with higher Logical-Mathematical Intelligence tended to use more logical connectors in writing their essays [27]. Thus for students with high Logical-Mathematical Intelligence it is very suitable to be given Guided and Open Inquiry learning models.

4. Conclusion
Based on the results of the research obtained by analyzing the data, it can be concluded that there was a significant difference between the learning outcomes of students who were given Guided Inquiry and Open Inquiry learning models; there is a significant interaction effect between learning models and Logical-Mathematical Intelligence on student learning outcomes; there is a significant difference between the learning outcomes of students who are taught with the Guided Inquiry model and the Open Inquiry model in the high Logical-Mathematical Intelligence group; and there is a significant difference between the learning outcomes of students who are taught with the Guided Inquiry model and the Open Inquiry model in the low Logical-Mathematical Intelligence group.

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