jurnal βeta kimia
e-ISSN: 2807-7938 (online) dan p-ISSN: 2807-7962 (print)
Volume 5, Number 1, May 2025
http://ejurnal.undana.ac.id/index.php/jbk

The Effect of Guided Inquiry Learning Model on Improving Students' Learning Outcomes in the Periodic Table of Elements Material in Class X at SMA Negeri 1 Sidikalang

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ARTICLE INFO

Article history:
Received:
10 April 2025
Revised:
19 April 2025
Accepted:
06 May 2025

Keywords:
Learning outcomes, Guided Inquiry, Periodic Table of Elements.

ABSTRACT

This research was conducted at SMA Negeri 1 Sidikalang in the 2024/2025 academic year, involving two classes as research subjects. The experimental group, namely Class X MIPA 5, was given learning using a guided inquiry model, while the control group, namely Class X MIPA 6, was given learning using the traditional method. Each class consists of 36 students. The purpose of this study was to determine the effectiveness of the guided inquiry learning model in improving students' understanding of the material on the periodic table of elements. This study used a pretest-posttest design with non-equivalent groups. Data analysis was carried out quantitatively. The results of the t-test showed that the average increase in student learning outcomes in the experimental class reached 79.0%, while in the control class it was 69.6%. Hypothesis testing using the t-test with degrees of freedom (df) 35 and a significance level of $\alpha = 0.05$ showed that the calculated t value ($t_h = 23.46$) was greater than the t table ($t_t = 2.03$). This indicates that there is a significant difference between the two groups. Thus, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. Based on the results of the analysis, it can be concluded that the guided inquiry learning model is effective in improving student learning outcomes on the material of the periodic table of elements.

How to cite: Silitonga, M. (2025). The Effect of Guided Inquiry Learning Model on Improving Students' Learning Outcomes in the Periodic Table of Elements Material in Class X at SMA Negeri 1 Sidikalang, 5(1), 70-79. https://doi.org/10.35508/jbk.v5i1.21187

INTRODUCTION

The government is currently making continuous efforts to implement various innovations and reforms in order to improve the education system in Indonesia. These efforts are supported by the active role of educators, who are not only tasked with executing the curriculum but also bear responsibility for the success of students. In the learning process, educators are expected to introduce innovations that align with policies and breakthroughs developed by the government. Educators are also required to inspire enthusiasm and motivation in students, develop skills in understanding students' characteristics, and enhance learning outcomes so that the learning process can be effective and achieve the expected objectives [1].

Technology has had a significant impact on various sectors, including education in Indonesia. With the rapid and unpredictable changes taking place, there are both challenges and significant opportunities, depending on how these changes are addressed. Therefore, strategic steps and optimal preparedness are needed to face this dynamic. Students and educators are expected to adapt to and keep pace with these changes, while also expanding students' knowledge. After the learning process was conducted online, face-to-face meetings between educators and students have now resumed. However, the shift from online to offline learning still leaves an impact on students' habits, as they continue to use Android devices in their daily activities, including for learning purposes [2].

The daily activities of students, which heavily involve the use of Android devices, require educators to be more creative in designing learning strategies to capture students' interest. This is because students tend to prefer learning activities that are engaging and entertaining, which stimulate their minds to learn [3].

Chemistry is one of the essential subjects to teach, as it enhances logical thinking skills and encourages students' creativity. Effective chemistry teaching can raise students' awareness of scientific processes. To achieve this, educators need to consider two important perspectives in the learning process: connecting chemical concepts with real-life examples and encouraging students to develop a deep understanding of the material. However, many students face difficulties in understanding chemistry concepts. These difficulties arise from the abstract and complex nature of chemical concepts, which require an in-depth understanding. Additionally, many students find chemistry challenging and boring. The difficulties students face in learning chemistry include a lack of understanding of the teaching methods, difficulties in linking various concepts, and limitations in logical, mathematical, and linguistic skills, which ultimately cause barriers in learning chemistry [4], [5].

For the learning process in the classroom to achieve the expected basic competencies, adequate learning resources are required. These resources include educators, textbooks, and supporting facilities and infrastructure. However, in practice, various problems often arise, particularly regarding the availability and quality of textbooks. Along with the development of education, the role of educators has also evolved; they are no longer just information deliverers but facilitators in the learning process. Therefore, the presence of instructional materials or learning guides becomes an essential solution to overcome the limitations of students' understanding and educators' ability to manage classroom learning [6].

The abstraction of chemical concepts can be more easily understood by students through the use of various representations in the chemistry learning process [7]. These representations can be realized through the application of different teaching models tailored to the material being taught. The selection of an appropriate teaching model can serve as a bridge to help students understand abstract chemical concepts. One commonly used teaching model in chemistry education is the guided inquiry model. This model allows students to identify problems, formulate questions, design hypotheses, collect data, verify results, and draw conclusions [8].

Several previous studies have explored the use of the guided inquiry learning model to improve students' learning outcomes on various chemistry topics, showing that the guided inquiry model is effective in enhancing students' understanding of the periodic table of elements. In these studies, the learning outcomes of students in the experimental class using the guided inquiry model showed significant improvement compared to the control class, which used traditional methods. The guided inquiry model helps improve conceptual understanding and enables students to actively construct knowledge [9], [10].

Research on the use of the guided inquiry learning model to improve students' learning outcomes has been widely conducted. The guided inquiry model increases students' active engagement in chemistry learning, which leads to an improvement in understanding complex chemistry concepts, including the periodic table of elements. The studies show that students taught using this model can develop a deeper understanding of chemistry content through an approach that emphasizes exploration and problem-solving independently [11], [12].

Meanwhile, Wardani's study [13] highlighted that the implementation of the guided inquiry model in other chemistry topics, such as acid-base solutions, also had a positive impact on students' learning outcomes. However, this study did not specifically examine the application of the model in the periodic table of elements material, which has more abstract and complex concepts. This gap presents an opportunity for this research to fill that void.

Previous research by Simaremare [14] showed that the guided inquiry model has the potential to improve students' critical thinking skills in chemistry. However, this research focused more on the development of thinking skills than on understanding specific chemistry concepts, such as those found in the periodic table of elements. Therefore, this study aims to fill this gap by specifically examining how the guided inquiry model affects students' learning outcomes in this material.

Additionally, Rahmadhani's study [15] conducted similar research on chemical reactions and found that the use of the guided inquiry model can enhance students' understanding and learning outcomes. However, like previous studies, its focus was not on the periodic table of elements material, which requires a more specific and in-depth understanding approach. This study will provide important insights into the application of this model in teaching the periodic table of elements at the high school level.

Based on previous research, it is clear that while there have been studies examining the effectiveness of the guided inquiry model in chemistry education, none have specifically investigated its impact on students' learning outcomes in the periodic table of elements material at the high school level. Therefore, this study aims to fill that gap and provide new insights into the development of more effective chemistry teaching methods, particularly in teaching complex foundational concepts such as the periodic table of elements.

METHODOLOGY

This research was conducted in the XI MIPA class at SMA Negeri 1 Sidikalang, located on F.L. Tobing Street, Sidikalang City, Dairi Regency, North Sumatra Province, Postal Code 22218. The study began in the odd semester of the 2024/2025 academic year and concluded in November 2024. The population of this study consisted of all students in the X MIPA class at SMA Negeri 1 Sidikalang for the 2024/2025 academic year, divided into eight groups, each consisting of 32 students. For this study, the sample selection was done randomly. Every member of the population had an equal chance of being selected as a sample, using a random sampling method. This method was chosen because it is assumed that the samples from the existing class groups are homogeneous, meaning there is no significant difference between the classes. Two classes selected through the random method were X MIPA 5 and X MIPA 6. The X MIPA 5 class received the treatment with the guided inquiry model as the experimental class, while the X MIPA 6 class received conventional teaching methods. This study aims to determine whether the treatment provided to the subjects (students) has a significant impact on their learning outcomes. The research design used is the Non-Equivalent Pretest-Posttest Control Group Design, where each group is given a comparable test before and after the treatment to measure their learning levels. Using this design, the two classes receiving different treatments will be compared to see if there is a significant difference in learning outcomes between the experimental and control groups.

Table 1. Non-equivalent pretest-posttest control group design

Class	Pretest	Treatment	Posttest
Experiment	T_1	Y	T_2
Control	T_1	X	T_2

T1 : Pretest
T2 : Posttest
X : Treatment Using the Guided Inquiry Learning Model
Y : Treatment Using the Conventional Learning Model

This study collects quantitative data through a pretest and posttest to measure changes in students' learning outcomes. The testing method used is a multiple-choice written test, designed based on the skill acquisition indicators that have been outlined in the educational module. Before the test is administered to the students, the questions are first validated by experts to evaluate their validity and credibility, ensuring that the instrument used accurately measures the learning outcomes.

RESULTS AND DISCUSSION

A. Research Results

In this study, the impact of implementing various learning models on the academic performance of students in class XI at SMA Negeri 1 Sidikalang is presented through the distribution of survey results. Before conducting the research, the researcher performed an instrument test to ensure the validity of the data, the level of difficulty of the questions, the specificity of the questions, and the reliability of the questions. From the instrument test, which included 40 questions, 20 questions were found to be valid, and 20 others were deemed invalid. Based on this data, only the 20 validated questions were used for data collection, while the invalid questions were excluded from the study. To measure the stability of the data, the reliability analysis yielded an r-value of 0.727, which indicates a reasonably good level of reliability. The data used in this study consists of two types: pretest data and posttest data. Before the implementation of different learning models in the two classes, the pretest was used to measure the students' initial understanding of the Periodic Table of Elements material. After applying the various learning models, the posttest was used to measure changes in students' learning outcomes. The goal of this analysis is to determine whether there is an improvement in the learning outcomes of students who received different treatments. The pretest results showed the following average learning outcomes for students: for the control class, the average pretest score was 30, while for the experimental class, the average pretest score was 46. The posttest results are shown in the table below.

Table 2. Pretest and posttest results for the experimental and control classes.

Source of Data	Control Class	Experimental Class
Pretest	30	46
Posttest	75	86

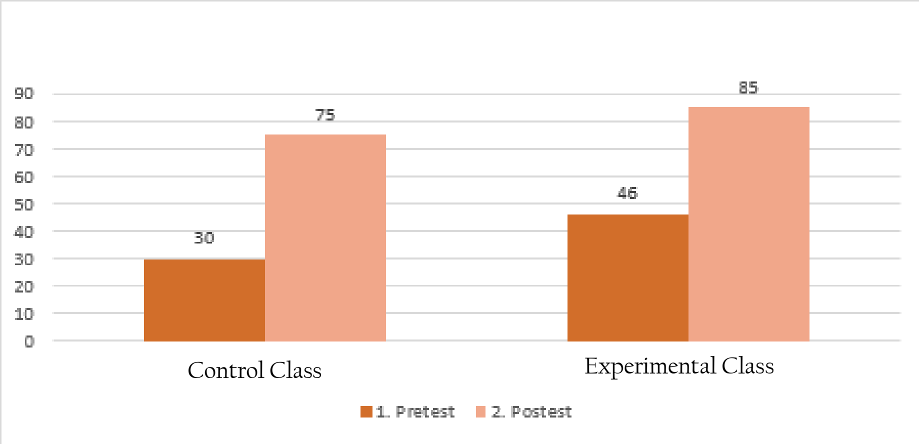

Figure 1. Graph of the Average Learning Outcomes of Students

For the chemistry subject at SMA Negeri Sidikalang, the Minimum Mastery Criteria (KKM) is 75. The average pretest scores in both classes were lower than the KKM, and the average posttest scores were higher than the KKM. To prove that the pretest and posttest data are uniform and normally distributed, a normality test was conducted as part of the requirement analysis in this study.

1. Normality Test

To test for normality, the chi-square test was used, with a significance level (α) of 0.05. The calculated chi-square value (X2) and the chi-square table value were compared [10]; the results indicate that the data is normally distributed if the calculated chi-square value (X2) is greater than the chi-square table value. The normality test results for each of the experimental and control classes are shown in the table below.

Table 3. Normality Test Results for the Research Data

Class	Source of Data	$X^2_{Calculated}$	X^2_{table}	Α	Remarks
Experiment	Pretest	8.777	11.070	0.05	Normal
Control		7.158	11.070	0.05	Normal
Experiment	Posttest	9.551	11.070	0.05	Normal
Control		8260	11.070	0.05	Normal

2. Homogeneity Test

The variance values in both classes for the pretest and posttest data were compared to conduct a homogeneity test. The results of the homogeneity test for the pretest and posttest data are presented in the table below.

Table 4. Homogeneity Test Results for the Research Data

Class	Source of Data	Variance	$F_{Calculated}$	F_{table} (n-0,05)	Description
Experiment Control	Pretest	8.777 7.158	1.525	1.742	homogeneous
Experiment Control	Postest	9.551 8.260	1.624	1.742	homogeneous

The results of the data requirement tests previously indicate that the research data is normally distributed and homogeneous. Therefore, hypothesis testing can be conducted. The hypothesis was tested using a right-tailed t-test, which compares the average learning gains from both test classes. The calculation results show that students in the experimental class experienced an increase in learning outcomes of 0.587, while students in the control class had an increase of 0.551. The students' learning outcomes and the combined variance of both research groups were increased with the average value, resulting in a t-calculated value of 17.516. Then, using interpolation, the t-calculated value was compared to the t-table value, with degrees of freedom (df) = 70, giving a t-table value of 2.030. The results show that the t-calculated value is greater than the t-table value, with 17.516 being greater than 2.030.

The results support the acceptance of Ha and rejection of H0 in this study. Therefore, students achieved better results in chemistry learning using the inquiry learning model compared to the traditional model. The table below shows how the average growth values of students in each class can be used to calculate the percentage of learning outcome improvement.

Table 5. Percentage of learning outcome improvement

Class	Percentage of Improvement (%)	Standard Deviation	Criteria
Control	79	0.117	high
Experiment	69	0.11	medium

Table 5 shows that the learning outcomes of the experimental class are better than those of the control class. The graph below illustrates the improvement in learning outcomes for both classes:

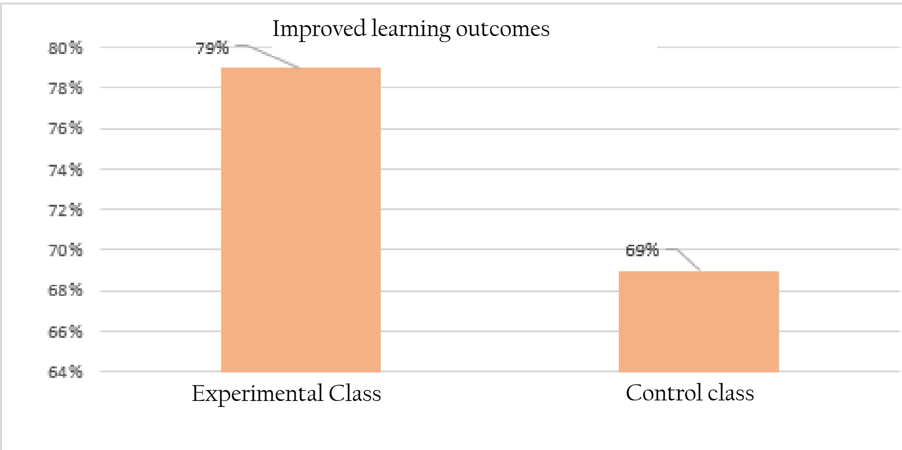

Figure 2. Graph of Percentage Improvement in Learning Outcomes

On the topic of the periodic element system by 10%, the results of students' chemistry learning with the Inquiry Learning Model are better than the conventional method. This is seen in the graph above.

B. Discussion

The results of the data analysis show that the average pretest score for the experimental class was 47.083, while the average pretest score for the control class was 30.972. Based on statistical analysis, the pretest data for both samples were normally distributed. The chi-square (X2) value indicated that, at a significance level of $\alpha = 0.05$, the null hypothesis (Ho) was rejected and the alternative hypothesis (Ha) was accepted. This indicates that the research-based learning model significantly improves students' chemistry learning outcomes compared to the conventional learning model in the 2024/2025 academic year.

In the learning process in the experimental class, the researcher used the guided inquiry method for the Periodic Table of Elements material. In this inquiry-based learning model, the initial strategy implemented by the researcher was to encourage students to develop concepts through the formulation of open-ended questions about the topic being studied. Subsequently, students conducted investigations, analyzed, and found answers independently. This activity encouraged students to actively build their conceptual awareness, making the learning process more interactive and meaningful. This aligns with Ausubel's meaningful learning theory, which states that the integration of concept discovery, concept development, and problem-solving allows students to overcome learning difficulties more effectively. Thus, meaningful learning can enhance learning activities and positively impact students' learning outcomes.

Inquiry-based learning also enables students to develop critical thinking skills, allowing them to better understand and master the learning material. In contrast, in the control class, the learning process was still centered on the teacher with the lecture method. Students only listened to the teacher's explanations, received example problems, and completed exercises. If there were mistakes in students' initial concepts, the teacher corrected them to transform non-scientific concepts into scientific ones. After the concept change process, students were given additional exercises to further understand the material, to build knowledge based on the principles of IPF (Intelligibility, Plausibility, and Fruitfulness). The success of students in lecture-based learning largely depends on their willingness to listen to the teacher and their skills in expressing opinions. In this method, students tend to be passive, while the teacher acts as the central point of learning. Conversely, in the inquiry-based learning model, students are encouraged to be more active in finding solutions to the problems they face, while the teacher acts as a facilitator.

Inquiry-based learning is an approach that places students at the center of the learning process, where they actively engage in discovering, exploring, and building knowledge through direct experience. This approach is highly effective in developing learning awareness, curiosity, and scientific thinking skills, which are essential in chemistry learning. Students are not merely passive recipients of information from the teacher but are encouraged to explore and discover the concepts they are studying. The application of inquiry-based learning helps students become more active during the learning process. They are more enthusiastic about participating in discussions, answering questions, and expressing opinions. This is evident from the increased activity of students in asking critical questions, responding to peers' views, and participating in group work. Discussions in class became more dynamic, and students demonstrated a better understanding of the material taught.

Furthermore, the inquiry approach is also highly effective in enhancing critical thinking skills. Students are required to analyze data, make predictions, and draw conclusions based on the available evidence. This strengthens conceptual understanding and develops their ability to solve problems logically. In chemistry learning, critical thinking skills are crucial because many topics require reasoning and hypothesis testing through experiments. Not only does inquiry-based learning enhance cognitive skills, but it also improves students' affective and social aspects. Through group work, students learn to collaborate, listen to others' opinions, and appreciate differing views. The interactions within the group strengthen relationships between students, build a sense of responsibility, and enhance scientific communication skills. This is very different from traditional learning, which tends to make students passive [16], [17].

Research supporting this by H. Herniwati [18] states that inquiry-based learning is highly appropriate for materials requiring analysis, such as redox reactions. The learning outcomes of students improved significantly because they were directly involved in scientific investigation and experiments. Meanwhile, A. S. Tyas and L. Lazulva [19] found that students who learned using the inquiry model were more confident in expressing opinions in class. They also had better scientific communication skills because they were frequently involved in group presentations and scientific discussions. The inquiry approach can enhance students' scientific argumentation and cooperation skills. In chemistry learning, this is essential, as students often face experimental data that need to be analyzed critically together [20].

This research shows that inquiry-based learning is effective in helping students develop learning awareness and foster curiosity toward the material being taught. This makes students respond more quickly to the material through active discussions in class. In addition, inquiry-based learning also increases active participation, critical thinking skills, the ability to conclude, and the ability to express opinions. This active involvement also strengthens peer relationships and enhances their reasoning skills. Unlike traditional learning, where the teacher is the central figure of activity, inquiry-based learning places students at the center of learning. In traditional learning, while the teacher can control the class, students become passive, which reduces the effectiveness of their learning activities.

Based on research conducted at SMA Negeri 1 Sidikalang, it can be concluded that the application of inquiry-based learning is more effective in improving students' learning outcomes compared to the lecture method. This shows that the use of the inquiry-based learning model is highly necessary, especially in chemistry learning, to achieve optimal learning outcomes.

Based on the research conducted at SMA Negeri 1 Sidikalang, the application of inquiry-based learning has proven to be more effective than the lecture method. Students who learned using the inquiry approach showed more significant improvements in learning outcomes, were more active in the learning process, and had higher motivation to learn. The implementation of inquiry helped them understand the material more deeply and apply the concepts learned in everyday life. Thus, inquiry-based learning not only improves learning outcomes but also strengthens important aspects of education such as learning activity, responsibility, collaboration, scientific communication, and critical thinking. Therefore, this learning model is highly recommended to be implemented consistently, especially in chemistry learning, which requires deep understanding, logical reasoning, and practical experience.

CONCLUSION

Based on the results of the study, it can be concluded that there is an improvement in the learning outcomes of students taught using the guided inquiry learning model for the Periodic Table of Elements material, with an increase of 0.790, which falls under the high category, with a percentage increase in learning outcomes of 79.0%, indicating effectiveness. Based on the t-test calculation, it was found that there is a significant effect of using the guided inquiry learning model on improving students' learning outcomes for the Periodic Table of Elements material at a significance level of $\alpha = 0.05$ and df = 35, with the t-calculated value > t-table value, namely 23.46 > 2.03, meaning that Ha is accepted while H0 is rejected. The research results show that the guided inquiry-based learning model improves the learning outcomes of X MIPA 5 students with a percentage of 79.0% and a value of 0.790 for the Periodic Table of Elements material.

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