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Journeying Through Inquiry-Based Learning: A Focus on Science Process Skills

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ABSTRAK

Penelitian ini merupakan penelitian quasi eksperiment dengan desain pretest posttest control group design. Penelitian ini bertujuan untuk mengetahui ada tidaknya pengaruh model pembelajaran inkuiri terbimbing terhadap keterampilan proses sains peserta didik kelas XI MIPA pada materi sistem gerak di SMA Negeri 1 Kodeoha Sulawesi Tenggara. Penelitian ini dilaksanakan di tahun akademik 2022/2023. Kelas XI MIPA sebagai sampel dengan kelas eksperimen XI MIPA 1 sebanyak 30 siswa dan kelas XI MIPA 2 sebanyak 30 siswa sebagai kelas kontrol. Pemilihan sampel dilakukan dengan random sampling. Pada kelas eksperimen diterapkan model pembelajaran inkuiri terbimbing dan kelas kontrol pembelajaran dilaksanakan dengan model pembelajaran langsung (direct instruction). Hasil tes keterampilan proses sains dengan menggunakan uji-t diperoleh thitung sebesar 2.6837 dan ttabel pada taraf signifikan ($\alpha = 0.05$) sebesar 2.0484 maka thitung > ttabel. Hal ini dapat disimpulkan bahwa terdapat pengaruh model pembelajaran inkuiri terbimbing terhadap keterampilan proses sains peserta didik kelas XI MIPA pada materi sistem gerak di SMA Negeri 1 Kodeoha.

Kata kunci: *Direct Instruction*, Inkuiri Terbimbing, Keterampilan Proses Sains.

ABSTRACT

This research is a quasi-experimental study with a pretest posttest control group design. This study aims to determine the influence of the guided inquiry learning model on the science process skills of students in class XI MIPA on motion systems material. This research was carried out at SMA Negeri 1 Kodeoha, Southeast Sulawesi in 2022/2023 academic year. The study took XI MIPA 1 as experimental class and XI MIPA as the control class. Each class consisted of 30 students. Sample selection was done by random sampling. In the experimental class, the guided inquiry learning model was applied while in the control class was implemented direct instruction model. The results of the science process skills test using the t-test obtained t-count of 2.6837 and t-table at a significant level ($\alpha = 0.05$) of 2.0484, so t-count > t-table. It can be concluded that there is an influence of the guided inquiry learning model on the science process skills of XI MIPA class students on motion systems material at SMA Negeri 1 Kodeoha, Southeast Sulawesi.

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Keywords: Direct Instruction, Guided Inquiry, Science Process Skills.

INTRODUCTION

The most effective way to establish and put into practice values for sustainable development is through education (Vilmala, et.al., 2022). Indonesian Law No. 20 of 2003 states that a method of concentration is on developing students' awareness and personalities to foster a learning environment and learning process so that students become involved (Amka, 2019). At this point, a paradigm shift in science education, particularly biology, is crucial. Prior to this time, teaching and information transmission to pupils were more oriented on the teacher. The present paradigm places students at the center and encourages them to actively seek out and acquire knowledge instead of being centered upon teachers (Ngertini, et.al., 2013).

Biology learning process is part of science that emphasizes giving direct experience. There are three basic components of the nature of science, namely biology as a product, process, and attitude. Biology as a product means biology as an organized body of knowledge consisting of facts, concepts, laws, theories, and generalizations. Biology as a process means as a thinking process. In this case, students can discover and develop for themselves what they are learning, one of it is science process skills. Biology as an attitude means that every student must have a scientific attitude (Sari, 2017). According to Lestari & Diana (2018) science process skills are basic skills that facilitate learning in science which allows students to be active in developing a sense of responsibility, improving learning and scientific methods. Students can develop new knowledge or expand knowledge that they already have by increasing their science process skills. Science process skills are the development of intellectual, social, and physical skills that originate from the basic abilities of students (Andromeda, et.al., 2019). Furthermore, according to Derilo (2019), that every student is required to have sufficient science process skills so that these students can complete scientific investigations in improving students' science process skills. According to Riyadi, et.al. (2015) "The development of science process skills is the main thing to improve the process of science education in Indonesia, so that applied science education should be oriented towards building science process skills". This opinion is also consistent with Rahmah, et.al. (2019) "With a science process skills approach, learning can be more effective to apply, because the physical and mental abilities of both individuals and groups in solving problems can be developed".

Science practice and science process skills are inextricably linked, and both formal and informal learning of science subject depend heavily on them. Students' capacity to provide answers and find solutions is influenced by their understanding of scientific procedure. The development of intellectual abilities required to understand science topics so depends on the mastery of these skills (Nworgu & Otum, 2013). Science process skills consist of two groups, namely: basic science process skills and integrated science process skills. Basic science process skills consist of six activities, namely: 1) observation; 2) communication; 3) classification; 4) measurement; 5) making conclusions; 6) forecast. Integrated science process skills are a combination of two or more basic science process skills. Integrated science process skills consist of eight activities, namely: 1) identification of variables; 2) data tabulation; 3) create graphics; 4) Linking between variables; 5) obtain and process data; 6) Investigation analysis; 7) formulate hypotheses; 8) conduct experiments to test theory (Nurhayati B., et.al., 2019).

According to preliminary observations made at SMA Negeri 1 Kodeoha for the academic year 2021–2022, despite the fact that some learning activities require students to make observations and ask questions, it is claimed that the teacher does not incorporate science process skills into learning activities. The majority of the students displayed a passive attitude toward learning in class, just waiting for commands or guidance from the teacher. Additionally, the lecture method is employed in the learning process. Science topics are learned by rote when traditional teaching methods are used; in this situation, the teacher is the one who initiates the learning process. Reforms in science education have recently advocated techniques that do not rely on memorizing and support students' ability to think logically. The existence of these problems is certainly not in accordance with biological characteristics. Teachers continue to dominate the educational process and more emphasized to product-focused issues rather than process- and attitude-focused issues. The teacher's choice of an instructional model is one of the variables that affects students' ability to learn science concepts. If the learning model is used in accordance with the features of the material, science process abilities can be improved (Andani, 2019). This approach, which mainly emphasizes inquiry, aims to spark students' enthusiasm in science (Aktamiş, et al., 2016).

By using several sources of knowledge and ideas, students employ the inquiry learning method to deepen their grasp of a subject or problem (Nworgu, 2013). The goal of guided inquiry learning is to immerse students quickly and directly in the scientific method (Juniar, et.al., 2017). Because students are encouraged to be free in developing the concepts they learn, this guided inquiry learning methodology is ideal to utilize in classes with a variety of student numbers (Dewi, et.al., 2020). According to Juniar & Sianipar (2022) said that guided inquiry learning provides more opportunities for students to learn directly. In addition, students have the opportunity to practice the process of developing scientific thinking skills, so this instructional model can be a solution for improving science process skills with direct learning experiences.

According to Nur'aini, et.al., (2015), a sort of scientific process-oriented learning model that stresses actions, skills, and knowledge through active search based on curiosity is the guided inquiry learning model. Amijaya, et.al., (2018) asserts that the guided inquiry learning paradigm was successful in fostering an active learning environment. Since the focus of this learning paradigm is on the student, they become more engaged in the process and the teacher is no longer the only source of information. Furthermore Riyadi (2015) said that the guided inquiry learning model has a learning syntax that makes students able to develop science process skills at high, medium and low academic abilities. The syntax of the guided inquiry learning model consists of five phases, namely: 1) the identification and determining the scope of the problem phase, 2) the hypothesis formulation phase, 3) the data collection phase, 4) the data interpretation phase, and 5) the conclusion development phase. The syntax of the guided inquiry learning model has the potential to be useful in improving students' science process skills (Wulanningsih, et.al., 2012).

By exploring concepts, questions, or problems, students can become actively engaged in their education through inquiry-based learning. The investigations conducted may take the form of laboratory work or other information-gathering activities (Puspito, et.al., 2020). Practical laboratory exercises are an essential component of science learning activities in formal education. In this context, they are beneficial for students to test their knowledge of the scientific theory they have learned, and they can also boost their interest in learning science (Zamhari, et.al., 2022). To grasp and master concepts, laws, policies, principles, and theories, the practicum is conducted in order to satisfy the nature of the processes and values produced via the application of the scientific method and scientific attitude (Defianti, et.al., 2022). Students have the chance to practice how scientists actually conduct science by using the scientific inquiry process while using the scientific inquiry approach. Even though not everyone wants to be a scientist, learning the scientific method is crucial in many ways. Science process abilities and inquiry learning go hand in hand. As a result, engaging in inquiry-based activities helps students develop their science process abilities more effectively (Ergül, et.al., 2011).

Students have the opportunity to refine, classify or ask scientifically oriented questions, plan and conduct experiments to collect data regarding questions, formulate explanations from evidence to answer questions, relate explanations to scientific knowledge and communicate and justify explanations (Lati, et.al., 2012). The material used in this study is the motion system. Movement system material is one of the materials that is poorly understood by students due to the large number of Latin languages and the lack of school facilities to support the learning process in class. In addition, the material is conceptual and difficult to understand if students only study and memorize. Pupils need a scientific process by finding the concept themselves in depth (Makhul, 2020).

Numerous earlier studies, like Sari's research (2017), which used the guided inquiry learning model and had an impact on students' science process abilities, demonstrated the effectiveness of the model. The guided inquiry learning model will give students the chance to engage in active learning. In this scenario, students are taught to solve problems and come to conclusions based on experiments and scientific methods. The educator's role is limited to become a facilitator and offering advice to the students who will ultimately be instructed utilizing the guided inquiry learning paradigm.

There were two research objectives in this study. First, to determine the ability of students' science process skills through the application of the guided inquiry learning model on motion system material at SMA Negeri 1 Kodeoha, Southeast Sulawesi. Second, to analyze the effect of the guided inquiry learning model on the science process skills of class XI MIPA students on the movement system material at SMA Negeri 1 Kodeoha, Southeast Sulawesi. Based on the background and problems above, the researchers are interested in conducting research with the title "Journeying Through Inquiry-Based Learning: A Focus on Science Process Skills".

METHODS

This research is a type of quasi-experimental research (Sugiyono, 2013). The research design used in this study was the Pretest-Posttest Control Group Design. In this design, there are two classes that are randomly selected and then the two classes are given a pretest to find out whether there was a difference between the experimental class and the control class in the initial state. The experimental class was given treatment by using the guided inquiry learning model while the control class was given treatment by using the direct instruction learning model. Then a posttest was held on both treatments to determine the effect of the treatment given. The results of the post-test in the control class are used as a comparison of the impact of the treatment given to the experimental class.

The population in this study were all class XI MIPA at SMA Negeri 1 Kodeoha, Southeast Sulawesi consisting of 4 study groups, while the samples in this study were taken by random sampling technique. The entire population in each study group was considered to have relatively the same initial abilities. So that class XI MIPA 1, totaling 30 students, was chosen as an experimental class taught with the guided inquiry learning model and class XI MIPA 2, totaling 30 pupils as a control class taught with a direct instruction.

The main data for the research was students' science process skills that consists of seven indicators. Those indicators are observation, asking question, formulate hypotheses, doing experiment, data tabulation, communicate, and making conclusion. The data was important to explore and exposure student skills that they implemented in the learning process.

The students' science process skills test uses description questions which are guided by indicators and sub indicators of science process skills as many as 14 items. The test questions were made based on the movement system material for class XI MIPA SMA which had been tested for validity by experts. The preparation of the questions begins with the creation of a question grid along with alternative answer keys for each item on the question. The value of students' science process skills is obtained from scoring the students' answers to each item.

The data collection technique used in this study was a scientific process skills test instrument in the form of an objective description that would be used to measure students' science process skills. Analysis of research results using descriptive statistical analysis such as lowest, highest, mean, median, mode, and standard deviation score. Furthermore, students' scientific process skills were categorized according to Fitriyani (2019) that can be seen in Table 1. To verify the hypotheses, statistical analysis through t-test was implemented.

Table 1. Science process skills value categorization

Percentage (%)	Category
86 – 100	Very High

76 – 85	High
60 – 75	Medium
55 – 59	Low
≤ 54	Very Low

RESULT AND DISCUSSION

The results of this study show an overview of the value of the science process skills of students in class XI MIPA 1 who are taught using the guided inquiry learning model and class XI MIPA 2 who are taught using the direct instruction learning model which can be seen in the following Table 2.

Table 2. Descriptive value of pretest and posttest science process skill in the control and experimental class

Statistics	Pretest		Posttest	
	Control	Experimental	Control	Experimental
Lowest Value	10.00	10.00	40.00	50.00
Highest Score	43.00	47.00	85.00	93.00
Average	24.73	24.93	71.43	78.77
Median	25.00	26.00	73.50	82.00
Mode	20.00	27.00	70.00	89.00
Standard Deviation	8.501	10.395	10.214	11.631
Total Students	30	30	30	30

Afterward, students' science process skills were classified into five categories that can be seen in the Table 3.

Table 3. Frequency distribution of science process skills value categorization in the control and experimental class

Percentage (%)	Category	Control Class		Experimental Class	
		Frequency	Percentage (%)	Frequency	Percentage (%)
86-100	Very High	0	0	11	36,67
76-85	High	13	43,34	8	26,67
60-75	Medium	13	43,34	9	30
55-59	Low	2	6,66	0	0
≤ 54	Very Low	2	6,66	2	6,66
Amount		30	100	30	100

Table 3 shows that in the control class, no students were filled the very high category, while in the experimental class, there were 11 students. Majority of students in the control class was filling in the high and medium group.

Recapitulation of the value of science process skills of class XI MIPA students at SMA Negeri 1 Kodeoha for each indicator are presented as graphic in the Image 1 and 2.

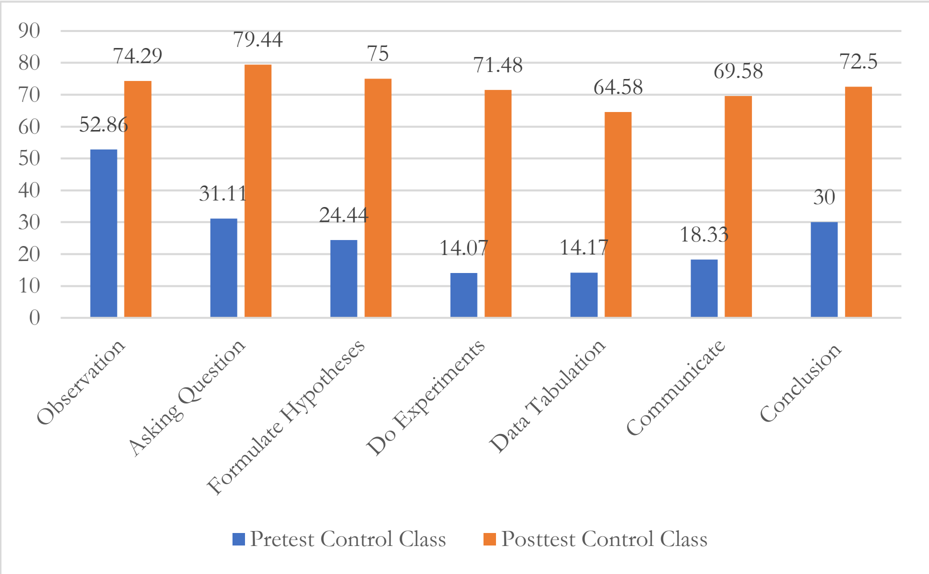

Image 1. Bar chart of pretest and posttest science process skills indicators in the control class

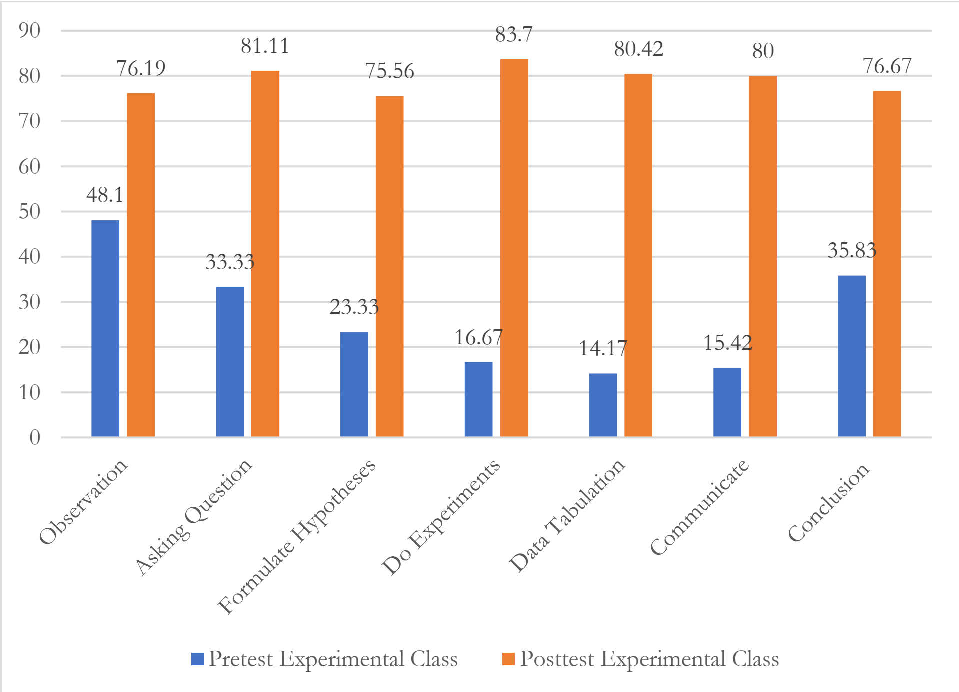

Image 2. Bar chart of retest and posttest science process skills indicators in the experimental class

As can be seen from Figure 1 and 2, students' science process skills increased in both class, control and experimental, after the learning process. Most of the indicators in the experimental class experienced a higher increase than in the control class.

To verify the hypothesis that has been made, an inferential statistical analysis test was carried out through the t test. The test results can be observed in the Table 4.

Table 4. Statistic results of science process skills posttest in the control and experimental class

Statistics	Control Class	Experimental Class
N	30	30
$\dot{X}$	71.43	78.77
t_{count}	2.6837	
t_{table}	2.0484	
Conclusion	There is a difference	

Testing the hypothesis on the posttest data of the experimental class and control class using the t-test found that there is a significant difference between both classes. This is evidenced by tcount> ttable, namely (2.6837 > 2.0484). The result shows that there is a significant difference in the implementation of guided inquiry learning models on students' science process skills in motion system material. The description of the indicators of students' science process skills is as follows:

a) Observation

The increase in the percentage of observation indicators is 28.09% in the experimental class. This increase indicates that students have been able to use their senses in observation and are able to use relevant and adequate facts from observations. Observing skills in this study mean skills using the senses, especially the sense of sight. Simply by looking, students can form inferences or observations. Because students have firsthand experience with gathering data through observation and measurement, the implementation of student-centered learning can help students build their science process abilities in terms of observing and measuring (Balanay & Roa, 2013). The guided inquiry learning model is one of the most student-centered and can help students make observations in the syntax of designing experiments. It involves every student's capacity for systematic, logical, and analytical searching and investigation, enabling students to confidently formulate knowledge. Students utilize their sense of sight to study bone structure, spot differences in the chicken femur before and after soaking it in HCl solution, and see how stimulation affects frog muscles.

b) Asking Question

Science process skills in asking questions had the pretest percentage of 33.33% and the posttest was 81.11%, so that the percentage increased by 47.78% after the guided inquiry learning model was applied. The result indicates that students are able to ask questions with a hypothetical background. The skill of asking questions has been trained during the learning process using student worksheets based on guided inquiry. Students are asked to pose questions or come up with solutions based on the articles that are offered in the student worksheets. Through discussion and question-and-answer sessions with students and teachers, the ability to ask questions is cultivated. This agrees with Novitasari, et.al.'s (2017) assertion that the stage of the guided inquiry learning paradigm, namely the presentation of questions, encourages students to think critically and ask questions to ascertain how to formulate problems. Kirch (2007) asserted that interactions or discussions between teachers and students can enhance students' ability to ask questions and other aspects of the scientific process. This occurs because dialogues encourage frequent idea exchange among students, which causes them to develop fresh inquiries about the subject matter. Students were instructed to construct questions that can be answered by experimenting. They were also supervised to compose interrogative sentences that meet what is being asked.

c) Formulate Hypotheses

The science process skills in preparing hypotheses had the pretest percentage of 23.33% and the posttest was 75.56%, so that it experienced an increase of 52.23% after the guided inquiry learning model was applied. The skill of compiling hypotheses is raised in the exploration stage where students have to make temporary conjectures from the experiments to be carried out. The hypothesis appears based on the phenomena that have been stated before. In accordance with the syntax of the guided inquiry learning model, students are given the opportunity to express their opinions when carrying out the stage of making hypotheses. The teacher guides students in determining hypotheses that are relevant to the problem and prioritizing which hypotheses will be investigated (Novitasari, 2017). Additionally, Nurhayati B. & Hadis (2019) claimed that this activity serves as a roadmap for students to understand the type of information that will be gathered. During the guided inquiry stages, indicators of creating hypotheses are developed through questions derived from an article or discourse, and the application is then made in the form of temporary conjectures or answers.

d) Do Experiments

For doing experiments indicator there was an increase of 67.03%, from pre to post test, after the guided inquiry learning model was applied. This is because in the guided inquiry learning model, students are given the opportunity to design experiments with group discussions. Through discussions, students' experimental skills can develop their thinking. In discussions students can exchange ideas with other students so that students' creativity can increase. This is in line with Fitriyani, et.al.'s opinion, (2016) saying that discussions can stimulate students' creative courage in expressing ideas, getting used to exchanging ideas, and respecting the opinions of others. In addition, through practicum students also have experience in terms of carrying out experiments so that this really helps develop skills in designing experiments. In practicum, students are required to understand what tools and materials are used, the experimental steps, and how to use laboratory equipment correctly.

e) Data Tabulation

Data tabulation science process skills had pretest percentage of 14.17% and the posttest was 80.42%, so that the percentage increased by 66.25% after the guided inquiry learning model was applied. This shows that students are able to understand the contents of the observation table from the carried-out experiments. The data tabulation indicator is the activity of compiling data into tables to organize the amount of information that has been collected so that it can be further processed (Nurhayati B. & Hadis, 2019). In the data tabulation indicators, students carry out data collection activities through observation or experimentation. In the guided inquiry stage, data tabulation indicators are developed through observations and then applied in the form of applying formulas that have been studied in other cases.

f) Communicate

Communication science process skills had increased by 64.58% in the experimental class. This shows that students are able to convey the results of their findings to others. In the guided inquiry learning model, the teacher guides students to communicate the observed data by concluding the results of the experiment in writing so that students can conclude correctly. According to Tawil and Liliasari, (2014) indicators of communicating can be in the form of describing images or empirical data and then transforming them into other forms such as sentences, diagrams, graphs, and so on. Communication skills have been trained during the learning process through writing answers on student worksheets and then students present them in front of the class. In addition, through the group discussion process, students' communication skills can develop. This is in line with the opinion of Djamarah (2002) which says that students' communication skills can develop well if students carry out activities such as discussions.

g) Conclusion

From pretest to posttest, the scientific process skill of drawing conclusions has increased by 40.84% after the guided inquiry learning model is applied. This shows that students are able to conclude an explanation based on evidence and result of observations that have been made. Drawing conclusions is the final stage of the guided inquiry learning model. In the guided inquiry stages, the skills to draw conclusions are developed through practicum and also discussion. Through practicum, after analyzing the observed data, students draw conclusions by connecting them with hypotheses. This is in line with the results of research conducted by Asni (2015) which states that the application of the guided inquiry learning model can improve students' science process skills, including the skills to draw conclusions.

Based on the results of the science process skills posttest, the overall achievement of the science process skills indicators in the experimental class was better than the control class. This is because in the learning process using the guided inquiry model, students are trained to be actively involved in the learning process so that they can develop their skills. Through the stages of the guided inquiry learning model, students are given the opportunity to experience firsthand how scientists discover concepts. Starting from an observation then questions arise from these observations, hypotheses/temporary answers arise which need to be proven experimentally. To prove the hypothesis is true or not, the data from the experimental results are analyzed to obtain a conclusion. In addition, the guided inquiry learning model is carried out in groups so that it can train students' abilities to work together, exchange ideas, and communicate.

CONCLUSION

Based on the results of the statistical test analysis that has been carried out, it can be concluded that there is an influence of the guided inquiry learning model on the science process skills of class XI MIPA students on motion systems material at SMA Negeri 1 Kodeoha, Southeast Sulawesi. Some suggestions are proposed that related to the results. When the guided inquiry learning model is applied, it is hoped that students will pay attention to the explanations presented by other friends. The application of the guided inquiry learning model should improve time planning so that learning does not exceed the allotted time. For future researchers, it is hoped that they can develop and strengthen the results of this research in order to improve the quality of the teaching and learning process, especially in Biology subjects.

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