

INCREASING SCIENCE PROCESS SKILLS USING STUDENT WORKSHEET GUIDED INQUIRY-BASED LEARNING ON A SIMPLE PLANE OF MATERIALS

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Abstract: The study aimed to describe the impact of guided inquiry-based student worksheets on improving the scientific process skills in simple machine materials. This research method uses pre-experimental with the design of one group pretest and posttest. The research targeted samples were students in grade eight junior high schools, 40 Surabaya, Indonesia. The data was obtained by experimental methods with an instrument learning plan, student worksheet, learning implementation sheet, pretest and posttest sheet, and student response questionnaire analyzed in quantitative descriptions. The study results showed that the implementation of learning during two meetings got an average of very good and practical criteria. The target skills are the science process involved in formulating problems, identifying variables, hypothesizing, experimenting, analyzing, concluding, and communicating data. An improvement occurs in professional, scientific process skills. The average N-Gain value obtained 0,75 from the pretest and posttest, categorized as high and effective. The students gave an 88.8% response which was categorized as very good. In conclusion, learning by using guided inquiry-based student works can improve science process skills on simple machine materials.

Keywords: *Student Worksheet, Guided Inquiry, Science Process Skills*

INTRODUCTION

In the world of education, the important thing that must be reviewed is the learning process. The better the learning process will impact learning success. In the learning process, one of the most important things students have to achieve maximum science learning outcomes is science process skills [1]. Scientific process skills are used to discover concepts, principles, and theories, develop existing concepts and refute previous encounters. Scientific process skills are unique intellectual skills that all scientists use. The process function can also be used to understand what is happening. Process competence can encourage discovery, development of facts and concepts, and development of attitudes, insights, and values. Science process skills are important for students because science process skills are a way of thinking critically and using information creatively, learning when making discriminatory observations, and organizing and analyzing facts or concepts. One of the indicators of science process skills is planning experiments through observational activities. By making observations, students will learn to compile a broader thinking framework [2].

The inquiry learning model is one of the learning models that train students' thinking frameworks [2]. Inquiry learning models are divided into several types of models. The inquiry model used is the guided inquiry model. Guided inquiry learning is a learning model where students are free to choose the experiments carried out, but the teacher still determines the steps of the experimental process [3]. Students are free to choose problem formulations, determine

hypotheses, determine variables, and conduct experiments. Guided inquiry is a first-level inquiry where the problem raised can come from the teacher or source from a textbook then students work to find answers to these problems under intensive guidance from the teacher [4]. The discovery of guided inquiry learning is because students are guided carefully to find answers to problems.

The implementation of learning does not effectively run because it causes a lack of media interaction and environmental conditions. This condition is worthy of study in order to improve the quality of learning. The choice of online learning is due to the Covid-19 pandemic. Based on the Circular Letter of the Ministry of Education and Culture (Kemendikbud) of the Directorate of Higher Education Number 1 of 2020 concerning the prevention of the spread of Covid 19 in the world of education where learning is instructed remotely. This causes the implementation of learning for students to be carried out using the online method.

In its implementation, online learning does not require in-person interaction but can be done through various software. In the world of education, this is a new breakthrough because, so far, it has been carried out directly in the classroom but is now online. Changes in learning methods so that adaptation is needed in terms of curriculum, syllabus, lesson plan, and learning media [5].

Based on the results of interviews and direct observations, the science learning process at SMPN 40 Surabaya VIII still did not get maximum results. Based on observations that have been made on

average in each class VIII, 60% of the 40 students get learning outcomes under minimum completeness criteria. This is alleged because students do not really understand the concepts that have been taught. The difficulty is caused by students being passive in the learning process. Students are passive with a lecture learning model carried out by teaching staff. This is supported by online learning so that not every student is present in learning activities. In each lesson, less than 50% of the students are present in each class. This is allegedly what makes student learning outcomes less than optimal. In addition to poor learning outcomes, teachers have also not trained science process skills in students. This is estimated to result in low scores for students' science process skills. Even though it is still in the pandemic era, process skills should still be taught in learning. Teaching staff in schools, especially science, emphasize learning in order to achieve satisfactory learning outcomes but pay less attention to process skills which results in poorly trained students' science skills. Students' science process skills can be improved by using student worksheet inquiry. With student worksheet inquiry, students can conduct science process skills-based learning. With science process skills-based learning, students will gain cognitive knowledge as well as practice process skills. Students' science process skills can be improved with student worksheet inquiry. The student lesson plan can be improved by using student worksheets based on inquiry learning [6]. This increase can occur due to the active role of students in learning activities. However, in the research that has been carried out, learning activities are carried out online or online. Although students play an active role in learning, the student experience will feel less than the active experience in the offline classroom [7].

One way to practice science process skills in pandemic conditions is to use PhET media. PhET or Physics Education Technology (PhET) is a simulation developed by the University of Colorado that contains simulations of learning physics, biology, and chemistry for the benefit of classroom learning or individual learning. PhET simulation emphasizes the relationship between real-life phenomena and the underlying science, supports learning with an interactive and constructivist approach, provides feedback, and provides a creative workplace [8]. With PhET media, students can practice science process skills at school and at home. Learning materials can be made more interesting so that students will be more motivated to learn. In addition, students and teachers can easily get enrichment of teaching materials so that it can improve their understanding and mastery of the material.

The student learning process during the pandemic is carried out by online or distance

learning [9]. Distance learning is considered less effective in understanding students about the material. In addition, with distance learning, utilizing PhET media is considered ineffective because students have not received practicum guidance properly, there are unclear guidelines for the use of PhET, and limited features of PhET [10]. Based on this, face-to-face learning is carried out directly; students will play a more active role in face-to-face learning. In addition, students will find it easier to understand PhET as a medium for conducting experiments because there will be experimental guidelines and guidance on the use of PhET media, and teachers will guide if there are students who are still confused about the operation of PhET media. With PhET students can experiment easily and efficiently.

In the sub-discussion material, the questions asked in the student worksheet still measure low-level knowledge. There is a need for teaching methods to train using student worksheet-based materials and to measure students' scientific competence, one of which is competence in the scientific process. Teachers in non-formal education play an important role in developing scientific process skills as a prerequisite for the application of the scientific method [11]. To help students become science-savvy citizens, a student worksheet based on scientific processability is a summary of the material and writes questions, so it can be practiced by basic scientific process skills with indicators of observation, classification, communication, prediction, reasoning, and measurement skills with indicators of basic science process skills.

With this research, the results of the study can be used as an alternative and effective learning media in science learning. This can be a consideration for teachers in choosing learning media according to the situation and conditions carried out.

RESEARCH METHODS

This study used a pre-experimental type. The research design uses a "One group pretest-posttest design" where the subject is only 1 class without the following control classes [12]:

$$O_1 \text{ X } O_2$$

Information: O_1 = pretest students before learning; X = use of structured inquiry model; O_2 = Student posttest after learning

The research subject was directed at one class of the State Junior High Schools in Surabaya with 18 students of class VIII-B.

The study used several instruments:

1. Observation Sheet of Learning Implementation
The Observation Sheet of Learning Implementation is obtained by making observations on learning activities. The

observation was made by two people. The observer will give a score on the observation sheet on the implementation of learning. The score obtained from the observation sheet for the implementation of learning is then calculated as a percentage, and a category is obtained in the form of not good, good enough, good, or very good.

2. Pretest and Posttest Sheets

Pretest and Posttest sheets are in the form of multiple-choice mixed questions and descriptions. Multiple-choice questions consist of 5 questions and six items of description questions. Each question represents the skill of the science process. each question has a cognitive level of C3.

3. Questionnaire Sheet

The student response questionnaire is prepared in the form of an answer choice with two choices of " Yes " or " No " and will be given a score of 1 for " Yes " and a score of 0 for " No ". The response questionnaire contains questions about students' responses to learning, ranging from how to teach the teacher and understand the material to student responses to the learning media used. The student's response results will then be converted into percentages which are then categorized as very less, less, enough, good, or very good based on the percentages produced. The data collection methods used include:

- a. Observations are needed to find out the teacher's activities.
- b. Pretest and Posttest Sheets to find out the improvement of science process skills.
- c. Questionnaire or questionnaire method to get student reactions after the application of this model.

The data analysis techniques used are as follows:

1. Analysis of Learning Implementation

In the instrument of the learning implementation plan implementation sheet, the structured Inquiry learning model obtains data about teacher activities during learning. The data obtained from the observation sheet is the result of the observer's assessment score, which is then analyzed by determining the mode of each aspect based on the learning implementation criteria. Mode is the data that is often seen or has the highest frequency based on the observations obtained.

The following is a table of learning implementation criteria:

Table 1. Learning Implementation Criteria

Score	Criteria
4	Very Good
3	Good
2	Enough
1	Not Good

[13]

2. Pretest and Posttest sheet

a. Normality Test

This test is useful for knowing whether or not the data is distributed normally. Research data is normal if the signification value > 0.05, and the research data is not normal if the signification value < 0.05. This data analysis technique uses SPSS (Statistical Product and Service Solutions).

b. Paired t-test

The paired t-t test is one of the hypothesis testing methods in which the data used is paired. This test is useful for finding out the average difference between two variables. The t-pair test is tested through SPSS 25 based on decision making, namely H_0 , if the signification value > 0.05, and H_0 is not accepted if the signification value < 0.05.

c. N- Gain

N-Gain (normalized gain) is used to measure the improvement of students' critical thinking skills before and after the structured inquiry model is applied. Here is the formula of N-Gain:

$$N\text{- Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} \times 100\%$$

Here's a table of normalized Gain criteria:

Table 2. Normalized Gain Criteria

Normalized Gain Value	Interpretation
$0.70 \leq N\text{-Gain} \leq 1.00$	High
$0.30 \leq N\text{-Gain} < 0.70$	Moderate
$0.00 < N\text{-Gain} < 0.30$	Low
$N\text{-Gain} = 0.00$	No increase
$-1.00 \leq N\text{-Gain} < 0.00$	There was a decrease

[14]

3. Questionnaire Data

The student response questionnaire is prepared in the form of an answer choice with two choices, " Yes " or " No " and will be given a score of 1 for " Yes " and a score of 0 for " No ". From the questionnaire analysis, the percentage of student responses will then be calculated with the following calculations:

$$\text{Percentage student} = \frac{\sum \text{Student answer "yes"}}{\sum \text{all student}} \times 100\%$$

The results of the percentage calculation are then known to be percentages and will be known as the magnitude of the interpretation of student scores in table 3.

Table 3. Student Response Criteria

Percentage (%)	Criteria
0.01 – 20.99	Very poor
21.00 – 40.99	poor
41.00 – 60.99	Enough
61.00 – 80.99	Good
81.00 – 100	Very good

[13]

RESULT AND DISCUSSION

This research was carried out in the Even Semester of the 2021-2022 Academic Year on a subject for two offline or face-to-face meetings on simple plane material with levers at the first meeting and an inclined plane at the second meeting. Learning activities are emphasized for students who conduct experiments using guided inquiry-based worksheets with the help of PhET interactive media. Students will be trained in science process skills with guided inquiry-based worksheets.

The implementation of the learning model used was observed by two observers consisting of students of Science Education, State University of Surabaya.

Table 4. Percentage of learning implementation

Learning phase	Meet 1	Meet 2
Formulating the Problem	87.50%	90.63%
Identifying Variables	81.25%	88.75%
Creating a Hypothesis	87.50%	87.50%
Conducting experiments	95.83%	79.17%
Analyzing Data	100%	87.50%
Summing Up the Data	93.75%	93.75%
Communicate	87.50%	87.50%

Table 5. Overall Average Percentage of learning implementation

Learning phase	Overall average	Criteria
Formulating the Problem	89%	Very Good
Identifying Variables	85%	Very Good
Creating a Hypothesis	87.50%	Very Good
Conducting experiments	87.50%	Very Good
Analyzing Data	93.75%	Very Good
Summing Up the Data	93.75%	Very Good
Communicate	93.75%	Very Good

Table 6. Student Worksheet Data

Assessed Aspects	Average Score	Criteria
Formulating the Problem	81.25%	Very Good
Creating a Hypothesis	93.75%	Very Good
Identifying Variables	81.25%	Very Good
Analyzing Data	87.50%	Very Good
Summing Up the Data	100%	Very Good
Communicate	93.75%	Very Good

Tables 4 and 5 show that in the learning phase of formulating problems, there is an average score of 89%. In identifying, making the hypothesis, phase of analyzing the data, concluding phase, and communicating phase, the variable gets an average score of 85%, 87.5%, 93.75%, 93.75%, and 93.75%, respectively.

Analyze Student Worksheet

Two guided inquiry student worksheet was

used for two meetings. In meeting one, the guided inquiry student worksheet has been filled, and students do not need to fill it in because the students are carrying out learning for the first time with guided inquiry-based student worksheet media. Student worksheet one serves as an exercise in conducting experiments and, at the same time, as an introduction of science process skills to students. In student worksheet two, students are required to be able to formulate problems, make hypotheses,

identify variables, analyze data, make conclusions, and communicate data, so that data is obtained in Table 6.

Table 6 shows that the students scored very well in every aspect of the science process skills training. It can be seen that in student worksheet two, the students already understood science process skills.

Pretest and Posttest Results

The pretest is carried out at the beginning of the first meeting, and the posttest is carried out after the second meeting. Students' pretest and posttest results can be seen in Table 7.

Table 7. Pretest and Posttest Results

No.	Pretest	Posttest	N-Gain	Criteria
1	20	75	0.69	Moderate
2	40	75	0.58	Moderate
3	10	80	0.78	High
4	40	85	0.75	High
5	20	90	0.88	High
6	20	75	0.69	Moderate
7	50	95	0.9	High
8	30	75	0.64	Moderate
9	50	75	0.5	Moderate
10	30	90	0.86	High
11.	50	90	0.8	High
12	20	85	0.81	High
13	30	85	0.79	High
14	30	75	0.64	Moderate
15	20	85	0.81	High
16	20	90	0.88	High
17	10	85	0.83	High
18	40	85	0.75	High
Average	29.4	83	0.75	High

Table 7 indicates that there is an increase in the value of students' science process skills analyzed using N-Gain. From the pretest and posttest results, there was an average increase from 29.4 to 83. Based on the results of the N-Gain analysis, the results of the pretest and posttest students experienced an increase of 0.71 with high criteria.

The result data from the pretest and posttest are then tested for normality and t-test with the results in the table.

Normality test

The results of the normality test can be seen in the following table 8.

Table 8. Normality test

	Pretest
N (Student)	18
Mean	27.7778
Sig.	0.200

Table 8 shows that the signification value obtained in this study was $0.200 > 0.05$. This shows that the data obtained is normal.

Paired t-test

The results of the paired t-test can be seen in the following table 9

Table 9. Paired t-test

	T	Df	Sig.
Pretest dan Post-test	-16.349	17	0.000

Based on Table 12 can be known the probability value of the sig. 0.000; $p < 0.05$ means that there is a significant average difference between pretest and posttest results with learning using guided inquiry-based student worksheets [15].

Achievement of Science Proses Skills

Data on the results of the achievement of aspects of student science process skills based on pretest and posttest results can be seen in Figure 1.

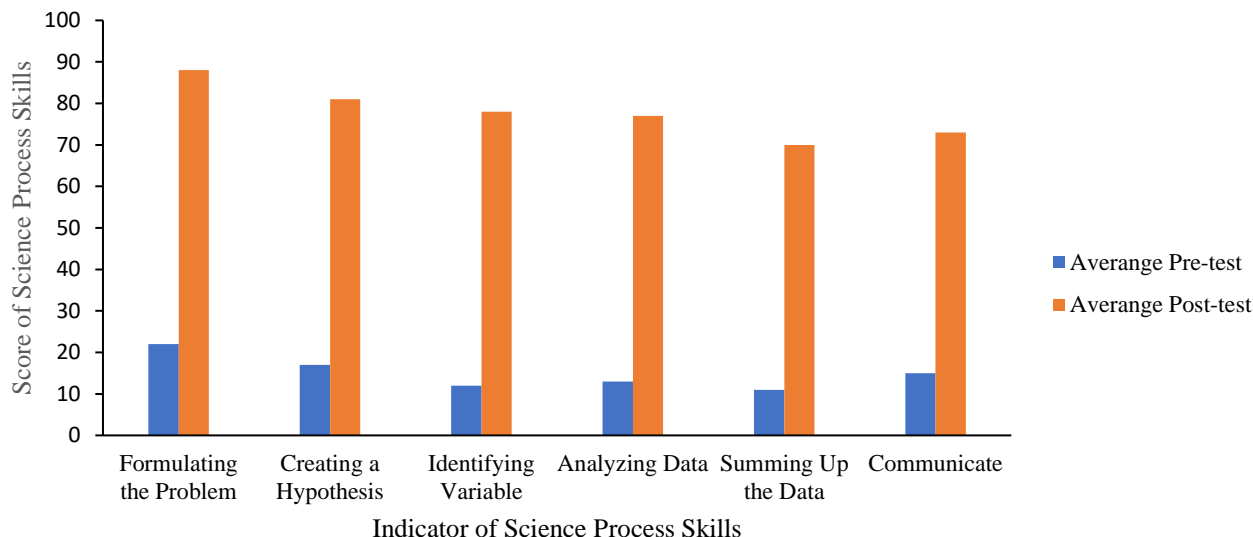


Figure 1. The score of Science Process Skills

Figure 1 shows that the average results of the pretest, the aspect with the lowest achievement in the class is the aspect of communicating with a percentage of 11%, and the aspect that achieves the highest in the class is to formulate a problem with a percentage of 22%. Meanwhile, the average posttest results of aspects with the highest achievement are formulating problems with 88%

and low achievement aspects, namely communicating by 70%.

Questionnaire Data

A response questionnaire was given to the students after doing the posttest at the second meeting. The student response questionnaire can be seen in Table 10.

Table 10. Questionnaire Data

Question Indicator	Student Response	Criteria
Students are interested in the material	94.4%	Very Good
Students interested in the student worksheet	100%	Very Good
Students are interested in the learning atmosphere	88.8%	Very Good
Students are interested in how the teacher teach	94.4%	Very Good
The novelty of student's knowledge of science process skills	93.47%	Very Good
Student interest if science learning carried out by experiment or practicum	87.5%	Very Good
Students interested in the student worksheet	100%	Very Good
Ease of students in understanding science process skills	93.47%	Very Good
Clarity of teacher guidance during learning activities	88.8%	Very Good
Student's knowledge of PhET	58.3%	Enough
Previous learning not using PhET	100%	Very Good
Ease of students understanding the material using PhET	94.4%	Very Good
Ease of PhET in understanding science process skills	94.4%	Very Good
Student pleasure if learning using PhET	94.4%	Very Good
Average	91.6%	Very Good

Based on Table 10, the results of the questionnaire showed that the average student response was very good. There is one indicator that the response is quite adequate, namely, student

knowledge about PhET. Students' knowledge of PhET here means that before learning Using Guided Inquiry-Based Worksheets, students are not fully familiar with PhET media.

Table 4 shows that the learning stage identified an increase in learning implementation variables at the first meeting, where the teacher guided students in determining the research variables so that they were more easily understood by students. At the learning stage, experiments were carried out, and data on the implementation of learning were analyzed, which tended to decrease at the second meeting, where the experiments carried out tended to be more complicated than the first experiment, so the time required for the experiment did not match the estimated time planned, resulting in a decrease in the percentage of learning implementation. Based on the results of the activity observations, the criteria were very good in every aspect of science process skills. Overall, the learning process can be concluded well. Data on the results of the guided inquiry student worksheet can be seen that students scored very well in every aspect of the science process skills training. This happens because the learning process is carried out very well. The learning process carried out at meeting one emphasized the introduction and understanding of students to science process skills so that at the meeting, two students understood science process skills and got a high score in science process skills. In addition to this, learning media uses PhET. PhET is one of many interactive media that are efficient in learning. The PhET media used allows students to conduct experiments that seem to be real [16]. With PhET media, students will also be able to conduct various kinds of experiments easily and without any negative impact if the experiment fails. Therefore, students feel more interested in learning using PhET media. With students' interest in learning, it can increase students' understanding. If students are interested in learning, the student's learning outcomes will be better than not being interested in learning [17]. This is in accordance with the results obtained where in learning with inquiry-based student worksheets guided by PhET media, students feel interested in learning so that the results of the process skills scores that are trained are classified as very good.

Based on the results of the N-Gain, the pretest and posttest results of students experienced an increase of 0.71, which is categorized as high. This increase is due to learning using guided inquiry student worksheets. In the student worksheet, guided inquiry, students will be trained in science process skills. Students' scores are categorized as excellent in every aspect of the science process skills training. This resulted in an increase in students' scores in the posttest. This is also supported by the previous study where the research was conducted. There was an increase in the value of the posttest on the pretest [18]. The posttest data will be higher than the pretest data

because of the learning with inquiry-based student worksheet media [19].

The high N-Gain value is also influenced by the learning process of students receiving science process skills training through guided inquiry student worksheets. In the guided inquiry learning model, at the same time, science process skills will be trained. The results of the average achievement of pretest and average posttests have undergone significant changes in the class. The pretest value is lower than the posttest value in applying learning with a guided inquiry model [20].

The trained science process skills are improving in the classroom. This happened because of the use of guided inquiry-based worksheets as learning providers. With this, students will carry out investigations by formulating problems, making hypotheses, identifying variables, analyzing data, making conclusions, and communicating the results of the investigation. This will be in line with the science process skills being trained so that when learning is carried out using guided inquiry-based worksheets, students will also perform science process skills. This is also evidenced by the achievement of science process skills training in LKS, which is classified as very good. The existence of science process skills in guided inquiry learning allows students to conduct investigations with the encouragement of science process skills to achieve good results [21]. In addition, the improvement of every aspect of science process skills is influenced by the process in which students play an active role in learning. Students themselves conduct experiments directly. It makes students build their own knowledge and makes students smarter. This is in accordance with constructivism learning theory so that it can spur students to continue to be more active. In the constructivism approach, student learning outcomes tend to be higher than in the convection approach [20]. Therefore and encouraged by the excellent implementation of learning by the teacher, it was found that the value of students' science process skills increased significantly.

Based on the results of the normality test, the significance value obtained in this study was $0.200 > 0.05$. This shows that the data obtained is normal. With the data has been proven to be normal, a t-test is carried out. Based on the results of the t-test, a significant value of 0.0007 is known, which states that there is a significant difference in the initial average value (pretest) and the final test (posttest). This is because a significant score shows < 0.05 , which indicates that there is a difference in students' science process skills after treatment.

The average student's response to the questionnaire got very good response. Worksheet-based teaching facilitates the ability of teachers to control the teaching and learning process, which was initially teacher-centered under changing

conditions of learning to become student-centered, where students take their responsibilities seriously for their assignments [8]. The response is in line with the various related instruments. From these responses, students felt interested in the material, worksheets, learning atmosphere, and the way the teacher delivered the material. Students also feel new to the components of the science process skills being trained, so students feel more interested in the learning process. Because of this interest, learning becomes more efficient and conducive. Students' interest in the material or learning can improve student learning outcomes [22]. In addition, the implementation of learning that is categorized as very good can make students easy to understand science process skills. The science process skills trained by the teacher using inquiry-based worksheets are quite easy for students to understand. It is evident from the post-test results of students who have a high average score that the teacher's explanation is also easy to understand during the learning process. The results of the questionnaire also stated that students were interested in conducting experiments or practicum on the next science material so that the concepts in the material could be understood clearly.

In this learning, the teacher uses electronic media, namely PhET, which can be accessed online and offline. The use of media can help in explaining and conducting experiments on various materials, especially simple aircraft materials carried out in research. PhET media itself tends to be new to students. Based on the questionnaire response data, only half of the total sample knew PhET media. Students who know PhET media are only limited to knowing they have never done direct experiments using PhET. This encourages students to be more enthusiastic in the learning process. This encourages students to be able to receive the material well and clearly. Although PhET is a new medium for students, students are enthusiastic about the learning process. In learning, students also prefer learning with PhET media because it is easier for students to understand the material and conduct experiments. [23] also stated that the use of PhET in learning can facilitate students and make student-oriented learning more efficient. In the use of inquiry-based worksheets, students are more active, resulting in an increase in students' science process skills.

CONCLUSION

It can be concluded that learning using guided inquiry-based worksheets on simple aircraft material in class VIII-B SMPN 40 Surabaya has been carried out, and the results obtained are in the very good category. Trained science process skills have improved in all aspects. N-Gain of 0.75, which is categorized as high, and student response questionnaires get a result of 91.6%, which is

categorized as very good. Based on this research, suggestions for further research are to pay more attention to students when conducting experiments. Students can be conditioned so that they do not interfere with the process of learning activities and are more serious about participating in experiments so that the data obtained are appropriate. Learning using guided inquiry-based worksheets can be carried out on other materials so that students are more interested in carrying out learning activities.

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