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Using Guided Inquiry Learning with Tracker Application to Improve Students' Graph Interpretation Ability

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Abstract: The graph interpretation ability is an important ability for students in conducting physics experiments. The tracker application in straight motion topic can track objects precisely and accurately. This research aims to find out how the effect of tracker use on straight-motion learning based on guided inquiry on the ability of students' graph interpretation. The sample of this research is students of class X, in one of the State Senior High School in Bandar Lampung. The research design used was one group pretest-posttest. Learning is carried out by conducting guided inquiry-based straight-line experiment activities, then processing experimental data by analyzing experimental videos using tracker software. Data on students' interpretation ability is obtained using a test (pretest-posttest). Data analysis techniques for student learning outcomes using Paired Sample T-Test. Based on the results of the research obtained the average score of the ability to interpret the graph increased by 59.00% with a high mean of N-gain (0.71) at a 95% confidence level. These results indicate that learning by using a tracker can improve the ability to interpret graphics very well. Based on the test results obtained a significance of 0.000, which is less than 0.05, it can be concluded that there are significant differences in the ability of students to interpret graphics before and after learning using a tracker.

INTRODUCTION

Improving the quality of education is directed at improving the quality of Indonesian as a whole, so that they can face challenges locally, nationally, and globally (Subekti, Taufiq, Susilo, Ibrohim, & Suwono, 2018). Education in Indonesia must face the challenges of the 21st century (Jatmiko et al., 2018). But, the quality is still relatively low (Sulistiyowati, Abdurrahman, & Jalmo, 2018). Based on the 2015 PISA (Program for International Student Assessment) in science competence, Indonesia ranked 62nd out of 70 countries. This PISA assessment examines students in the fields of reading, mathematics, and science with test questions that emphasize students' abilities and competencies (OECD, 2018). One of the test indicators in it is interpreting data and graphics. This shows that graph interpretation takes an important role in improving the quality of education, but Indonesian students have difficulty in answering graph interpretation test item.

The ability to interpret graphics becomes important for students, especially when doing physics experiments, graphics will not be useful if not interpreted (Emda, 2014). Students must be able to present graphics forms of

data obtained from experimental activities. However, experiment activities will be a problem if data collection is difficult to observe directly, for example, in the topic about motion. Experiment difficulties about motion are usually when taking time and position data simultaneously so that it becomes one of the factors causing the experimental results to be inaccurate.

To improve the accuracy of experimental results, it is necessary to have motion analysis technology that is able to track the movement of objects, so that they can find data and equations of motion of objects very precisely. Tracker software can analyze videos about motion events, has the ability to track (track) the motion of objects at a time that is more precise and accurate. The motion tracking results of objects are displayed in the form of images, tables, graphs, equations, statistical values as material in the interpretation of experimental results.

One concept that requires graph interpretation is the understanding of the concept of straight motion. Supposedly, straight motion learning using the tracker approach is closer to the theory and has a low error rate. Regular irregular motion experiment has been tested for deviation using the tracker, obtained by the relative repetitive error value of 0.46% and the error relative to the calculated value is 3.90%. The low level of deviation states that the use of video tracker is recommended and is very suitable for use in learning (Nugraha et al., 2017).

To help solve the problem of the low ability of graph interpretation, a learning model that is suitable for learning using a tracker is needed. Stages in guided inquiry learning are problem identification and observation, asking questions, planning investigations, collecting data and implementing, analyzing data, making conclusions, and communicating results (Kurniawati, Wartono, & Diantoro, 2014; Minan, 2016; Putra, Widodo, & Jatmiko, 2016). Through these stages, guided inquiry will encourage students to actively learn to find the concept of straight motion and help bring up data interpretation activities using a tracker that involves experiment activities. Inquiry learning is enough to have a positive impact on students' concept knowledge and skills (Abdurrahman, 2017). Inquiry learning is a learning activity that can direct students to make discoveries, so students can gain deeper knowledge (Azizah, Indrawati, & Harijanto, 2014; Islami, Nahadi, & Permanasari, 2016; Muliyani, Kurniawan, & Sandra, 2017). The inquiry that is applied in the learning process can improve students' ability to make observations and express answers to a problem through data interpretation to obtain a conclusion (P. S. Dewi, 2016).

Some previous studies show that the tracker applications have successfully improved students' learning outcomes (Oktriyeni & Putra, 2019), able to improve the teacher's analytical skills towards motion objects video (Asrizal, Yohandri, & Kamus, 2018) and able to improve students' critical-thinking skills (Fadholi, Harijanto, & Lesmono, 2018).

What makes this research different from the previous ones is that in this research, the researchers will use a guided inquiry-based tracker application to improve students' graphical interpretation skills in straight-motion learning material. In line with the elaboration to find out the effect of tracker usage on guided inquiry-based straight motion learning on the ability of graph interpretation, this research focused to explore the effect of the use of tracker on regular straight motion learning based on guided inquiry on the ability to interpret high school students.

Tracker is one of the software from Video Based Laboratory (VBL) which has the privilege of being able to present real physical symptoms and their representations, both in the form of quantitative and graphical data

simultaneously (Yuliana, 2016). Tracker allows students to track the motion of an object in a video by creating a trail that follows the motion of objects in the video, then will produce various information such as the position of the object (x, y) at each time (Fitriyanto & Sucahyo, 2016).

Interpreting a graph is the ability to identify and understand the main ideas contained in information, and to understand the relationships between ideas or ideas presented in the graph (Mustain, 2015). The ability to interpret students' graphs measured in this research includes four indicators, namely (1) Identifying graphs and interpreting relationships between variables, (2) Determining data from graphs, (3) Describing graphs based on equations and determining equations based on graphs, (4) Predicting graph based on textual descriptions, pictures, or graphics.

METHOD

The subjects of this research were students of tenth grade (X) Science and Mathematics Program (MIPA) at Senior High School (SMA Negeri 13 Bandar Lampung) in the first semester of the 2018-2019 academic year. Determination of the sample using purposive sampling technique is sampling based on certain considerations. The sampling was done by selecting one class to be selected as a sample to apply the guided inquiry-based straight motion learning material. These considerations are having the same academic ability seen from the average previous learning outcomes that are almost the same. The sample in this research is class X MIPA 6, totaling 28 students.

The experimental design used in this research is one group pretest-posttest. Classes will be given an initial test (pretest) to measure students' initial abilities. Then, it will be given treatment to apply the video tracker use in guided inquiry-based straight-motion learning. Furthermore, the class was given a final test (posttest) in the form of the same problem as the test at the beginning. Assessment of graph interpretation skills is done by pretest and posttest to measure differences in student learning outcomes at the beginning and at the end of learning.

Learning tools used are syllabus, lesson plan (RPP), tracker usage guide, students' worksheet (LKPD), test instruments, and assessment rubrics. Graph interpretation ability rubric uses adoption from Hwang's rubric (Hwang, Chen, Dung, & Yang, 2007). The question instrument consisted of 20 reasoned multiple choice questions and tested the validity and reliability of students XI MIPA 3.

The research data in the form of the ability of students' graph interpretation is obtained by calculating N-Gain between pretest and posttest through the equation (1):

$$g = \frac{s_{post} - s_{pre}}{s_{mak} - s_{pre}} \quad (1)$$

The calculation results are then categorized as Table 1 (Meltzer, 2002).

Table 1. Category of N-Gain

N-Gain	Category
N-gain > 0.7	High
0.3 ≤ *N-gain* ≤ 0.7	Medium
N-gain < 0.3	Low

Normality testing and hypothesis testing are performed using statistical tests. Hypothesis testing using paired sample t-test.

RESULT AND DISCUSSION

This research was conducted in class X MIPA 6, which was attended by 28 students. The learning process lasts for 3 times face-to-face with an allocation of 3 hours per week consisting of 45 minutes per lesson. The results obtained from this research in the form of quantitative data

that is the ability to interpret students' graphics, which are then processed using Microsoft Excel and SPSS 21.0 programs.

Before the pretest and posttest test instruments are used in the research implementation phase, the instrument is tested first to determine whether or not the instrument is used. The instrument was conducted with a total of 34 respondents, and 20 items declared valid and reliable. Validity test results obtained Pearson Correlation values > 0.2869 and reliability obtained Cronbach's Alpha value of 0.732 (reliable).

Quantitative data on the results of the pretest were held at the beginning, while the posttest results were held at the end of the learning can be seen in Table 2. The average pretest was 17.07, and the posttest average was 76.29. Based on the data stated that the ability of students' interpretation of graphics increases.

Table 2. Result of Pretest and Posttest

Parameter	Pretest	Posttest
Lowest Score	6.0	62.00
Highest score	29.0	91.00
Average	17.07	76.29

The results of the N-gain value are shown in Table 3. Based on Table 3, the value of N-Gain gained an increase of 59% with an average N-Gain of 0.71, which showed in the high category.

Table 3. Mean of N-Gain

Highest Gain	Lowest Gain	Increase of Mean Score	Mean of N-Gain	Category
77.00	43.00	59%	0.71	High

Based on the data mean graph interpretation in Table 4, shows that the ability to interpret graphs after learning using the highest video tracker on the indicator interprets the relationship between variables, namely 85.82 and the lowest on predicting graphs based on textual descriptions, pictures, or charts that are 68.00.

Table 4. Mean of the Ability Graph Interpretation of each Indicator

Indicator of the Ability Graph Interpretation	Mean
Identify graphs and interpret relationships between variables	85.82
Determine data from the graph	72.26
Graphs based on equations and determines equations based on graphs	75.71
Predict graphs based on textual descriptions, images, or graphics	68.00

Based on the results of the normality test from the pretest and post-test, the significance of 0.91 and 0.85 were obtained with the normally distributed data category. Testing the hypothesis in this research was conducted using the paired sample t-test technique. The goal is to see the difference in the average results of the ability of students to interpret graphs before and after being treated. Based on the paired sample t-test, the significance of 0.00 is less than 0.05, H_0 is rejected, and H_1 is accepted. Thus, it can be concluded that there are significant differences in the ability of students to interpret graphics before and after learning using a video tracker.

After being treated, there was an increase in the ability of students to interpret high graphics. This is evidenced by the high value of N-Gain, which means that learning by using a tracker can improve the ability to interpret graphics very well.

Based on the results of the research, it is clear that learning to use a tracker can improve students' ability to interpret graphics. The use of tracker in straight motion learning material can help to track the motion of objects at a more precise

and accurate time, thus helping students find their own concepts presented in the form of tables, graphs, and the real and practical motion of objects. Through these discovery activities, students will feel something they learned more lasting. he tracker has the ability to track the motion of an object so that it can obtain various information needed in the analysis of a motion event.

After going through the recording activity of a real motion phenomenon using a video recorder, the recording results can be processed in the tracker application. In this way, students can interpret various data displayed in the device, making it easy for students to analyze the motion phenomenon. The use of video tracker contributes to training students' abilities in terms of observing, measuring, designing experiments, data interpretation, and communication (Habibbulloh & Madlazim, 2014).

The high increase in N-Gain can be seen by the completeness of students who exceed the Minimum Completeness Criteria (KKM). The average ability of students to interpret graphs is 76.29, with a KKM value of 73.00. The number of students who complete is 18 people and not complete 10 people. The student completeness graph is shown in Figure 1.

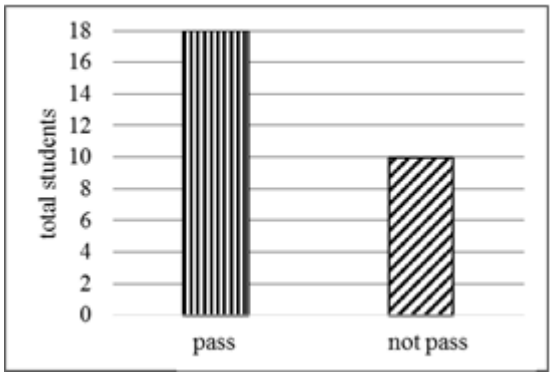

Figure 1. Graph of Completeness of the Ability Graph Interpretation of Student

High graphic interpretation ability is supported by active activities of students in the learning process. Student activities take place very dense, starting from observing a problem, conducting experiments directly, recording experiments, analyzing experimental data using a tracker application, to communicating the results of the experiment. So that students cannot do other activities that are non-educative. Students are very enthusiastic in conducting learning activities using the tracker application because this application is relatively new to students. In accordance with Habibbulloh & Madlazim's (2014) research, student activity during learning activities using a tracker is very active. This is because the tracker application is relatively new to be applied in physics learning, so students feel very interested in knowing the tracker application that can be applied to various physics experiments.

The ability to interpret graphics can improve the ability of interpretation of graphs in each indicator. Based on Table 4, the highest achievement of graphical interpretation ability in guided inquiry-based straight motion learning was found in the ability to identify graphs and interpret the relationship between variables which reached 85.82. This result proves that the use of tracker provides students the opportunity to analyze the results of real experimental videos through software to then look for relationships between physical variables.

Thus, students can find out the relationship between variables in the experiment directly; in this case, the students find themselves without having to go through a decrease in the formula. Tracker is one of the software from Video Base Learning (VBL) which will encourage teachers to improve students' ability to solve problems by bringing interesting and complex real-world problems into the class and realistically illustrating (Trudel & Métioui, 2012). Thus, the use of VBL can improve

students' understanding of material about motion.

The achievement of graph interpretation ability in the ability to determine data from the graph reaches 72.26. To be able to determine data based on graphs, it is necessary to have good graph interpretation capabilities. Students must be able to identify, read, and determine the value of physical quantities on graph variables that are presented so that they can find the data information needed. Interpreting graphs has a major role in solving physical problems in graphical form (Anisa, Tandililing, & Mahmuda, 2017). The ability to interpret is related to the ability of space (spatial), logical abilities, and mathematical abilities. In order for the ability to interpret graphs well, the three abilities (space, logic, and mathematics) must be optimally mastered by students (Subali, Rusdiana, Firman, & Kaniawati, 2015).

Achievement of graph interpretation ability in the ability to describe graphs based on equations and determine equations based on graphs reaching 75.71. Through the tracker, students can find out that the graph is a representation of the data in the table. This helps students understand in making and reading graphs based on time and distance data. Knowledge of gradients in the graph displayed on the tracker can help students make an independent equation independently. Based on the results of the research, learning using tracker can improve students' graph interpretation skills. Using a tracker in straight motion learning material can help the students to carry out discovery activities. After going through a real motion experiment activity, the students record a motion phenomenon. The interpretation that the students had not been able to interpret themselves by conducting experiments can be done accurately and precisely using the tracker. The students found their own concepts of straight motion based on the data presented in the form of tables, graphs, and equations of motion of objects. Through these direct and real discovery activities, the students could have experiences that can only be experienced by scientists. Emda (2014) explains that various information related to physics is often presented quantitatively in graphical form. So that the ability to interpret graphics is needed to interpret the information. Graphs are also used to make it easier to interpret the numerical data resulting from an experiment or experiment.

A good graph interpretation ability was supported by the students' activities in the learning process. Students' activities took place intensively starting from observing a problem, conducting experiments directly, recording experiments, analyzing experimental data using a tracker application, and communicating the results of the experiment. The students could not do other activities that are non-educational. They were very interested in conducting learning activities because tracker was a relatively new application to be applied in learning physics. This can be seen directly from their activeness in managing data using a tracker starting from tracking and calibrating to obtain data in the form of tables, graphs, and equations.

The lowest chart interpretation ability in this research is on the ability to predict graphs based on textual descriptions, pictures, or graphs that are 68.00. The low ability of this indicator is due to being able to predict graphs based on textual descriptions, images, or graphics, and it requires high graph interpretation where students must be able to interpret graphs by connecting graphs with the real world and able to represent them into other data forms.

Based on the observation and analysis of the results of students' ability to interpret graphics, an increase in the ability of interpretation of graphs can occur because of applying guided inquiry learning and the scientific approach of

students who are fully active in learning, but this is not the main focus of research analysis but as an analysis amplifier research results in the learning process. Learning that begins with motivating students scientifically is to provide examples of problems in the surrounding environment that are in accordance with the material, followed by conducting experiments according to LKPD guidelines. The existence of the experiment also trains students to be active in doing, observing and interpreting the results of the experiment systematically. Inquiry-based learning and laboratory activities are an effective combination of learning activities (Siregar, 2018). The learning is able to provide opportunities for students to be active in interacting, reflecting, and taking the initiative in discussion activities. Increasing the mastery of students' concepts through inquiry-based learning with laboratory activities is because the concept is not simply obtained from the teacher, but the concept is constructed by students through a series of inquiry processes (Sesen & Tarhan, 2013). Learning by using a guided inquiry model can improve the ability of integrated science processes on indicators of interpreting data (E. P. Dewi, Suyatna, & Ertikanto, 2017).

CONCLUSION

This research concludes that learning using tracker has a significant influence on the ability of students to interpret graphics. The use of tracker based on guided inquiry learning in straight motion learning material can help the students to carry out discovery activities and to track the motion of objects at a precise and accurate time. This can be seen directly from the students' activeness in managing data using a tracker starting from tracking and calibrating to obtain the data in the form of tables, graphs, and equations. To process data using a computer, it would be better to manage data individually using a computer laboratory available at school.

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