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The Effectiveness of Guided Inquiry-Based Worksheets to Improve Students' Critical Thinking Skills on Archimedes' Law Materials

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Abstract

This study aimed to determine the effectiveness of Guided Inquiry-based Student Worksheets on Archimedes' Law. This study used an experimental method with a research design of one group pretest-posttest design. The population in this study was all students of class XI MIA Public Senior High School 1 Sariwangi, the research sample was XI MIA 2. The sampling technique was done by using cluster random sampling. The data collection instrument used a pretest and posttest assessment sheet. Data analysis used statistical tests, namely N-Gain and t-test. The test result of the effectiveness of student worksheets based on guided inquiry using N-Gain analysis obtained a value of 0.97 with high criteria. Furthermore, the result of the t-test showed $t_{count} > t_{(0,995)(30)}$ that it was 4.15>2.75. This indicated that there was a significant difference between the pretest and posttest scores. Based on the average N-Gain and t-test, it can be concluded that guided inquiry-based student worksheets are very effective in improving students' critical thinking skills. The results of this study have the implication that guided inquiry-based student worksheets can be used in the implementation of learning as a form of assistance for students to improve students' critical thinking skills.

Keywords: critical thinking skills; guided inquiry; worksheets

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INTRODUCTION

Education is an important part of everyone in which education can determine human civilization in the future. An important role in education is in shaping the character, mentality of children who will later become adult humans who interact with their environment and do many things both individually and in groups. Part of educations is the curriculum. The curriculum has a very important position in education because the curriculum can regulate and direct educational goals to be achieved and not deviate from the planned goals.

The 2013 curriculum is a curriculum that replaces the existing curriculum, namely the Education Unit Level Curriculum (Kemendikbud, 2013). The learning process in the 2013 curriculum is carried out using a scientific approach and includes three domains, namely attitudes, knowledge,

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and skills. The end result is an increase and balance between the soft skills and hard skills of students, which include aspects of competence in attitudes, skills and knowledge (Kemendikbud, 2013).

The implementation of the 2013 curriculum that has been implemented is expected to help prepare students' skills in facing 21st century developments such as critical thinking skills, creative thinking skills and communication skills (Murti, 2013). This is in line with the development of education in the 21st century requiring logical thinking skills, analytical, critical and creative (Association National Science Teacher, 2011). According to Beers, this skill is important for students to be able to connect concepts and materials so that they are able to understand and solve problems in class (Lestari et al., 2018).

One part of Natural Science is physics. Physics is a systematic effort to build and organize knowledge in the form of explanations that can be tested and predict natural phenomena (Kemendikbud, 2014). However, not a few students in schools view physics as a difficult field of study, because they have to learn abstract formulas and concepts (Astalini et al., 2019). Though physics is a means of logical thinking to solve problems in everyday life.

Dewey (1909) explained that critical thinking is a consideration of a belief or form of knowledge that is received immediately and then viewed from various angles of reasons that support it and various further conclusions that become its tendency, continuously actively and thoroughly (Susilowati et al., 2017). Johnson (2009) defines that critical thinking is part of mental activities such as solving problems, making decisions, persuading, analyzing assumptions and conducting scientific research with a clear and directed process (Haeruman et al., 2017).

Therefore, it is important to improve critical thinking skills. To improve critical thinking skills in learning activities, it is necessary to apply models, teaching materials and student worksheets that can have a good impact. One of them is guided inquiry which can be used as student worksheets. Guided inquiry includes improving student learning outcomes (Nahak & Bulu, 2020). In addition, according to Pratiwi et al., increases mastery of concepts (Hamidah et al., 2018). Student worksheets are sheets that contain summaries and instructions or steps for implementing work that students must do , which refers to the competencies that must be achieved (Prastowo, 2014).

The student worksheets used only present a summary of the material for students in learning and working on important questions and formulas. After a summary of the material, it is followed by an example question and its steps. The student worksheet has not invited students to actively participate in discovering the concept of the material, so students cannot construct existing material themselves. Students' worksheet used by teachers as a means of training students' skills of students and improve learning outcomes is student worksheets that combined with guided inquiry learning (Rokhmah, 2015).

The student worksheets used still make students 'understanding of concepts still low so that they cannot improve students' critical thinking skills. Students have not been accustomed to constructing the existing concept of material, in this case, especially the sub material of Archimedes' law. This causes when there are various questions students tend to find it difficult to work on these questions, even though they only differ slightly from the questions they are usually done. To construct a concept in a learning material, it can be done by conducting an experiment (Hamidah et al., 2018). However,

experimental activities cannot be carried out by all students if there are not enough tools used. Therefore, with inquiry-based student worksheets this is done virtually so that all students can easily experiment independently. The use of guided inquiry-based student worksheets is expected to help students improve their critical thinking skills, in this case students are guided to find solutions to the problems presented, conduct experiments, analyze, and conclude that they get from the experiments they do independently.

Based on the description above, it can be said that the problem in this study is whether the student worksheets used are effective to improve students' critical thinking skills. This research aims to test the effectiveness of student worksheets to improve students' critical thinking skills.

METHOD

The research design used in this study was a one group pretest-posttest design. Broadly speaking, this study involves two variables, namely the independent variable and the dependent variable. The independent variable in this study is the use of guided inquiry-based student worksheets. The dependent variable in this study is the critical thinking ability of class XI MIA 2 Public Senior High School 1 Sariwangi. The population in this study was all students of class XI MIA Public Senior High School 1 Sariwangi. The research sample was XI MIA 2. The sampling technique was carried out using a cluster random sampling technique . The data collection instrument used the pretest and posttest assessment sheets which contained essay questions.

The method of data analysis is the effectiveness of student worksheets in terms of assessing the improvement of students' critical thinking skills through pre-test and post-test scores. The pretest and posttest questions used a written test in the form of an essay, with a total of five questions. According to Facione, the indicators used in critical thinking skills include (Susilowati et al., 2017):

Table 1 Critical Thinking Ability Indicator

Critical Thinking Skills	Description
Interpretation	Understanding the problem indicated by writing questions that are known or asked correctly.
Analysis	Identify the relationship between the statements, questions and concepts given in the questions correctly.
Evaluation	Use the right strategy in solving problems, complete, correct in doing calculations.
Inference	Draw conclusions correctly.

The data analysis method used is t-test and N-Gain. The formula for the N-Gain test according to Hake (1999) is as follows (Susanti et al., 2019).

$$< g > = \frac{S_{posttest} - S_{pretest}}{S_{\max ideal} - S_{posttest}} \quad (1)$$

Information:

<g> = Increased ability critical thinking

$S_{posttest}$ = Posttest score

$S_{pretest}$ = Pretest score

$S_{\max ideal}$ = Maximum ideal score

Table 2. Criteria N -Gain

Value g	Criteria
(<g>) < 0.3	Low
0.7 ≥ (<g>) ≥0.3	Medium
(<g>) > 0.7	High

Test formula t

$$Md = \frac{\sum d}{n} \quad (2)$$

Then calculate the t value using the following equation:

$$t = \frac{Md}{\sqrt{\frac{\sum d^2 - \frac{(\sum d^2)}{n}}{n(n-1)}}} \quad (3)$$

Information:

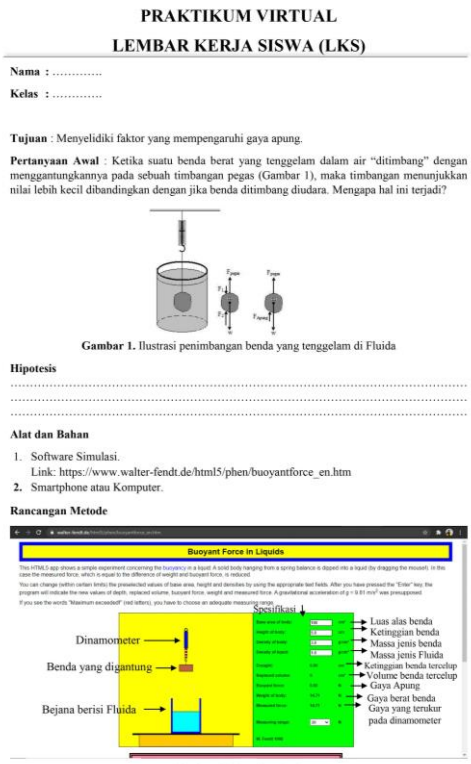
Md = average of the gains between scores pretest and posttest

n = number of students

RESULT AND DISCUSSION

According to Suyono, student worksheets are learning media designed to improve hand on activity (Siddiq, 2018). Student worksheets are learning media based on assignments that must be completed by students and serve to develop skills (Abidin, 2016). Rusman defines student worksheets as learning media that can activate students to acquire and develop concepts through natural science activities (Hidayati, 2014).

There are several types of student worksheets that are used in learning. Based on the type, student worksheets are divided into two types, namely experimental and non-experimental worksheets. Experimental student worksheets have several types, one of which is guided inquiry-based worksheets. The characteristics of guided inquiry –based worksheets include the results of observations that have not been previously determined so that the results of observations made by students can vary, using an inductive approach, namely by observing complex / specific examples so that students can find the principles or concepts being studied and experimental procedures are designed and developed by students. The following is a look at the guided inquiry-based student worksheets.



PRAKTIKUM VIRTUAL

LEMBAR KERJA SISWA (LKS)

Nama : .....

Kelas : .....

Tujuan : Menyelidiki faktor yang mempengaruhi gaya apung.

Pertanyaan Awal : Ketika suatu benda berat yang tenggelam dalam air "ditimbang" dengan menggantungkannya pada sebuah timbangan pegas (Gambar 1), maka timbangan menunjukkan nilai lebih kecil dibandingkan dengan jika benda ditimbang diudara. Mengapa hal ini terjadi?

Gambar 1. Ilustrasi penimbangan benda yang tenggelam di Fluida

Hipotesis

.....

.....

.....

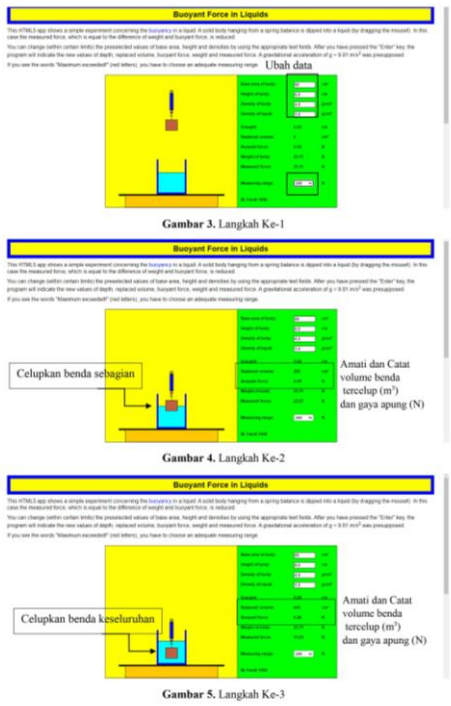
Alat dan Bahan

1. Software Simulasi.
   Link: https://www.walter-fendt.de/html5/phen/buoyantforce_en.htm
2. Smartphone atau Komputer.

Rancangan Metode

Gambar 2. Tampilan Awal

Figure 1 First Page

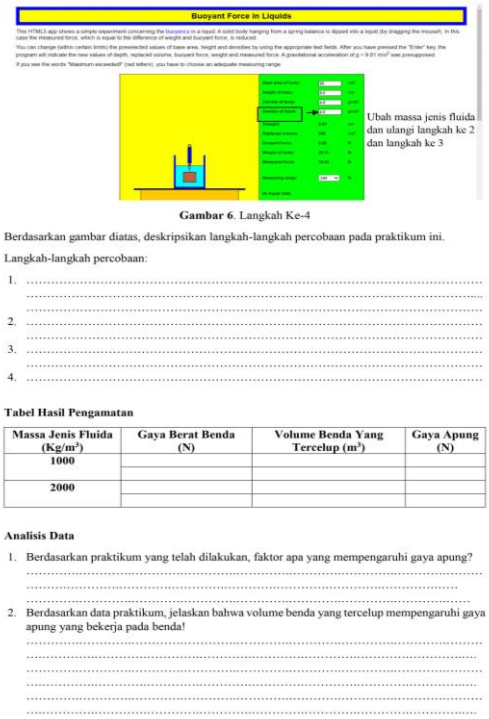


Gambar 3. Langkah Ke-1

Gambar 4. Langkah Ke-2

Gambar 5. Langkah Ke-3

Figure 2 Second Page


Buoyant Force in Liquids

Ubah massa jenis fluida dan ulangi langkah ke 2 dan langkah ke 3

Gambar 6. Langkah Ke-4

Berdasarkan gambar diatas, deskripsikan langkah-langkah percobaan pada praktikum ini.

Langkah-langkah percobaan:

1. .....
2. .....
3. .....
4. .....

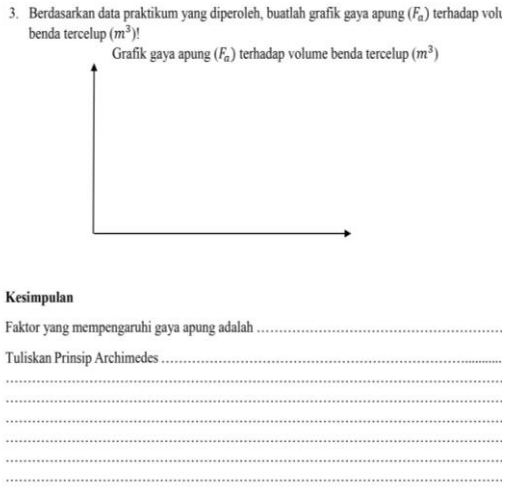
Tabel Hasil Pengamatan

Massa Jenis Fluida (Kg/m^3)	Gaya Berat Benda (N)	Volume Benda Yang Tercelup (m^3)	Gaya Apung (N)
1000			
2000			

Analisis Data

1. Berdasarkan praktikum yang telah dilakukan, faktor apa yang mempengaruhi gaya apung?
2. Berdasarkan data praktikum, jelaskan bahwa volume benda yang tercelup mempengaruhi gaya apung yang bekerja pada benda!

Figure 3 Third Page


3. Berdasarkan data praktikum yang diperoleh, buatlah grafik gaya apung (F_a) terhadap volu benda tercelup (m^3)!

Grafik gaya apung (F_a) terhadap volume benda tercelup (m^3)

Kesimpulan

Faktor yang mempengaruhi gaya apung adalah .....

Tuliskan Prinsip Archimedes .....

Figure 4 Four Page

This guided inquiry-based student worksheet includes steps that emphasize student activity. According to Trianto, the syntax of inquiry learning is as follows (Lovisia, 2018).

Table 3. Syntax of Guided Inquiry Learning

Syntax	Teacher Activities	Student Activities
Asking question	The teacher shows pictures related to Archimedes' law phenomena.	Students listen to the teacher's explanation.
	The teacher asks students to formulate problems with the teacher's direction.	Students formulate the problem as the initial question
Make a hypothesis	The teacher asks students to make hypotheses according to the problems raised.	Students propose hypotheses.
Designing experiments	The teacher distributes worksheets for students to carry out experiments, and guides students to design experiments. In this section the teacher continues to guide students if there are students who have difficulty.	Students design experiments according to guided inquiry worksheets. The method design is presented in the form of images that already have a description, so students must describe each image to find out the practical steps that will be carried out.
Collect data and analyze data.	The teacher asks students to analyze and conclude the experimental data.	Students analyze and conclude experimental data. The data analysis section contains questions that students must answer, to explore Archimedes' law concepts.
Draw a conclusion	The teacher asks students to conclude the activities that have been carried out.	Students make conclusions about the activities carried out.

The effectiveness of student worksheets on students' critical thinking skills in this study was measured the results of the evaluation based on pretest and posttest, the test N -Gain and t-test. The N- Gain test is used to determine the amount of improvement in students' critical thinking skills. The t-test was used to determine the significance of the improvement in student evaluation results.

Based on the results of the pre-test and post-test evaluation, it was found that the N-Gain value was 0.97, so the increase in the evaluation was included in the high criteria. This proves that the student worksheets are used effectively to improve students' critical thinking skills. The result of analysis using the t-test shows $t_{count} > t_{(0,995)(30)}$ that it is 4.15 > 2.75. This indicates that there is a significant difference between the pretest and posttest scores after using guided inquiry-based student worksheets to improve students' critical thinking skills.

The pretest and posttest evaluations were distributed in the form of essays, according to the indicators of critical thinking skills. Indicators of critical thinking skills in the interpretation section, in this section students formulate in the form of questions that provide direction to obtain answers related to Archimedes' law. In the analysis section, students explain the effect of the density of objects on the concepts of floating, floating, and sinking. In the evaluation section, students use the right strategy in solving problems, complete, correct in doing calculations. In the inference section, students make conclusions correctly.

From the research that has been done, the results of the students' pretest and posttest increased due to the learning process using student worksheets based on guided inquiry. In the student worksheet there are steps in the guided inquiry learning method so that students' critical thinking skills increase. In the results of the pretest and posttest, which showed that students 'critical thinking skills in the cognitive aspects increased because the material on the student worksheets was presented with guided inquiry steps, especially in the step of collecting data to find concepts related to the concept of Archimedes' law which aims so that students can find their own material concepts. This is in line with the opinion (Wahyuningsih et al., 2014) that guided inquiry steps can find their own concepts so that learning becomes more meaningful.

This guided inquiry-based worksheet contains steps that can increase student activity. The first step in this guided inquiry-based worksheet is the initial question. In this step there are problems presented related to the concept of Archimedes' law, so the teacher stimulates and invites students to think about solving the problem. A problem or phenomenon related to Archimedes' law has been presented on a student worksheet, then the students make initial questions about the problem or phenomenon presented. The second step is to propose a hypothesis. In this step, students are stimulated to guess the solution to a problem related to the concept of Archimedes' law. In this step the teacher asks questions to direct students to hypothesize. This step is the most difficult step, this is because students' ability to hypothesize is still low, so the teacher must ask a lot of questions so that students guess what to hypothesize. The third step is collecting data. In this step, instructions are presented to the students to carry out the experiment. The fourth step is the table of observations. In this section, students collect data and write down the experimental results in the table provided. The fifth step is data analysis, in this section there are several questions that must be answered, to explore concepts related to Archimedes' law. The

concept explored in this student worksheet is to investigate the factors that affect buoyancy. The last step is drawing conclusions. In this step students are led to conclude the material that has been obtained in the data collection step.

The effectiveness of this student worksheets is also inseparable from the advantages of inquiry-based student worksheets, namely as learning guide for students independently in the learning process, student worksheet that contains the trial events that can assist teachers in guiding students participated in the experiments and worksheets student who are learning the teaching materials where users can interact with the learning material presented and equipped with problems and experiments to make it easier for users to understand the content of learning material, the experiments presented are really real in everyday life and in the surrounding environment (Khasanah, 2018) . In addition, this inquiry-based student worksheet is highly dependent on the willingness of students to be able to carry out the experiments that have been presented and the understanding of the teacher, if students cannot carry out experiments and the teacher is lacking about the stages of the guided inquiry method then this will hinder the learning process.

In addition, the results of this study show that guided inquiry-based student worksheets are effective in improving students' critical thinking skills. In line with the results of previous research that there has been an increase in students' critical thinking skills (Firdaus & Wilujeng, 2018) , completeness of learning indicators in aspects of knowledge and critical thinking skills has increased (Mubarokah & Kuswanti, 2019) , and guided inquiry-based student worksheets are feasible and effective to improve students' critical thinking (Apriyana et al., 2019).

CONCLUSION

From the results of this research, it can be concluded that guided inquiry-based worksheets are very effective in improving students' critical thinking skills on Archimedes' law material. Based on the average N-Gain and t-test, obtained N -Gain average of 0.97 with high criteria. The result of the t-test shows $t_{count} > t_{(0,995)(30)}$ that it is 4.15 > 2.75. This indicates that there is a significant difference between the pretest and posttest scores after using guided inquiry-based student worksheets to improve students' critical thinking skills. Based on the average N-Gain and t-test, it can be concluded that guided inquiry-based student worksheets are very effective in improving students' critical thinking skills.

The availability of quality student worksheets can help the learning process and can also improve learning outcomes. Therefore, the authors suggest that further researchers develop guided inquiry-based physics student worksheets on other materials, to produce better and more interesting student worksheets to make students more motivated in learning physics.

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