Received : 5 April 2021
Revised : 22 June 2021
Accepted : 23 June 2021
Online : 30 July 2021
Published: 30 July 2021

DOI: doi.org/10.21009/1.07109

The Effectiveness of using Student Worksheets to Practice Science Process Skills on Hooke's Law Material

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Abstract

This study aims to analyze the effectiveness of guided inquiry-based physics worksheets in training students' science process skills. This case study was conducted at SMAN 4 Sidenreng Rappang with 28 respondents. Students use worksheets based on guided inquiry for four meetings in Hooke's law material. The worksheets were developed using the ADDIE model, consisting of analysis, design, development, implementation, and evaluation, including expert validation. We obtained the expert analysis of student worksheets based on guided inquiry from two experts, namely 3.16 out of 4 Likert scales with a validity percentage of 78.89%. These results indicate that the student worksheets based on guided inquiry are appropriate. Also, the gain test is used to determine the effectiveness of this worksheet. The science process skills test score obtained an average N-gain of 0.69, and this value is included in the medium category. This is shown based on student responses which found that 28 respondents generally gave a positive reaction to guided inquiry-based physics worksheets. This means that students receive guided inquiry-based physics worksheets as an effective learning resource used in learning.

Keywords: effectiveness, student worksheet, science process skills.

INTRODUCTION

In the 21st century, education is at a very rapid development period. Therefore, education is becoming increasingly important to ensure students have the skills to learn and innovate, use technology and media information, and work and survive by using those skills (Malik 2018). The Ministry of Education and Culture of the Republic of Indonesia adopted three educational concepts of the 21st century, especially in developing a new curriculum for elementary school, junior high school, high school, and vocational high school. Trilling and Fadel (in Laura 2014:18) put forth these three concepts: 1) 21st-century skills and knowledge; (2) Scientific learning models; (3) An authentic assessment.

One of the 21st Century learning concepts is a scientific approach that is characteristic and a distinct force of the 2013 curriculum. Permendikbud No. 22 of 2016 on the standard of primary and secondary education processes has hinted at learning goals, including developing attitudes, knowledge, and skills. Attitude gained through the activity "receive, run, cherish, internalize, practice". Knowledge is achieved through the activity of "remembering, understanding, implementing, analyzing, evaluating, creating". Skills acquired through observing, asking, trying, reasoning, presenting, creating. The competency characteristics and the acquisition trajectory also affect the standard process characteristics. In addition, learning also leads to the improvement and balance between soft skills and

hard skills that include aspects of attitude competence, skills, and enforcement. Based on the scientific learning model rules, learning requires learning to focus on learners (Kemendikbud 2016).

The 2013 curriculum is expected to be implemented by 21st-century learning that shifts from teacher-centered to student-centered. One of the ways that you can activate learners in the learning process is to use worksheets for students as one of the learning resources. The statement follows the opinion (Anggraini 2016), which says sheet role students work in learning one of them is as a teaching material that can be educators' role. The use of student worksheet in learning has multiple objectives. The purpose of using for student worksheet according to Arifin (2016), the first to give the students the knowledge, attitudes, and skills that the learners must own, both check the level of students ' understanding of the material that has been presented, and third develops and implements the subject matter that is difficult to convey orally. In addition, student worksheet emphasize the process of discovering concepts, and there is a variety of stimuli through various media and student activities that make learning more meaningful, effective, and enjoyable.

Through the learning process, teachers as facilitators must also use a model or method of learning that is appropriate for learning and demand by learners to be interested in following the learning process and understanding the core of the material presented. Physics learning should be taught as physicists find concepts or facts, namely from observing phenomena, contextualizing, and symbolizing. It is according to science process skills. Science Process skills on physics learning can be trained by choosing the right learning method (Jufri 2017).

According to Subagyo, Wiyanto & Marwoto (2009), a learning method expected to train students in science process skills is learning inquiry. Permendikbud No. 22 the year 2016 explains that to reinforce the scientific approach, integrated thematic (thematic between subjects), and thematic (in a matter) need to be applied inquiry-based learning. There are several types of inquiry: guided Inquiry (guided inquiry), free Inquiry, and modified free inquiry.

The observation that has been done at SMA Negeri 4 Sidenreng Rappang is known that students ' science process skills are only 26.94% from a maximum of 100%. This Data shows the maximum science process skills of learners at SMA Negeri 4 Sidenreng Rappang. The researcher found the results of interviews and observations to have not maximally attempted to practice the science process skills in physics learning, that is; (1) Teachers do not have much time to develop physics learning devices specifically to practice science process skills; (2) Unavailability of physics learning devices based on guided inquiry to practice science process skills; (3) Teacher-centered learning causes less motivated students to learn physics that impact low-learners ' science process skills; (4) The rare practice of practical activities because the implementation of practicum can be time-consuming, while the teacher must pursue the submission of the material; (5) Learners are only given theories and are sometimes given demonstrations.

The statement was backed by Sudiarman's research (2015), stating that the low skills of the science process resulted from a lack of a learning process that trained students ' science process skills. Learners only get information from the teacher's subjects without practicing their science process skills. Learners do not have the maximum opportunity to learn science process skills. While learning now emphasizes active learners' involvement. The efforts that teachers have made in activating students in the learning process are using the studentworksheets. However, the student worksheet that the teacher uses have advantages and disadvantages in their use. The statement was backed by Sudiarman's research (2015), stating that the low skills of the science process resulted from a lack of a learning process that trained students ' science process skills. Learners only get information from the teacher's subjects without practicing their science process skills. Learners do not have the maximum opportunity to learn science process skills. While learning now emphasizes active learners ' involvement. The efforts that teachers have made in activating students in the learning process are using the student worksheet. However, the student worksheet that the teacher uses have advantages and disadvantages in their use.

Thus, the learning model of guided inquiry is appropriate when applied in the learning physics because in the process of learning to provide students the opportunity to be active through research activities or experiments so that it is suitable for training the science process skills because the experiment is an indicator of the highest process skills (Ibrahim 2010).

Teachers can design model-guided inquiry according to the level of the intellectual development of learners. The statement was supported by Sadeh & Zion (2012), stating that teachers in conducting

learning with guided inquiry only provide referring questions to learners according to the level of student development, and then students who make ideas. According to Matthew & Kenneth (2013), guided inquiry allows students to develop the ability to identify problems, define hypotheses, formulate problems, collect data, verify results, and draw conclusions under the direction of the teacher. Guided Learning Inquiry includes several steps to be aware of: presenting problems, filing hypotheses, planning experiments, conducting experiments, collecting and analyzing data, and making conclusions.

Juniar Research (2016) is the development of the student worksheet based on guided inquiry to improve the skills of science processes and students ' interest in static fluid learning at SMA Negeri 11 Banda Aceh where these results have been tested against the user's response to the improvement of science process skills using the student worksheet based on guided inquiry is significantly higher than that of students who learned with conventional methods. Another similar study also expressed by Bilgin (2009) also mentions that students with guided inquiry groups who learn cooperatively have a better understanding of the mastery of the material concept of the lesson and demonstrate a positive attitude of students. The statement was justified by the research results conducted by Supriyono (2014), stating that the laboratory of guided inquiry can improve the science process skills. According to Alfionita (2016) that the effectiveness of worksheets effectiveness based on guided inquiry for the learning elasticity and legal Hooke X MAN 1 East Lampung class developed in the study reached 83.87%. Based on the explanation above, researchers are interested in researching the title Student worksheets based on guided inquiry to practice science process skills.

METHODS

The design of research and development of student worksheet based on guided inquiry using the development of model ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Sugiyono 2015). The selection of the ADDIE model as a model used in the development of student worksheet refers to several reasons: the development step is very clear, systematic, and directed to lead to the development process of student worksheet from the beginning to the end, this model development study leads to the productivity of the teacher by producing student worksheet product learning, relevant student worksheet development.

FIGURE 1. Experimental design (before-after). O_1 value before treatment and O_2 value after Treatment

Description:
O_1 = value before treatment
X = Treatment (LKPD based guided inquiry)
O_2 = value After treatment

After product development worksheets, students physics-based guided inquiry is validated and revised after this limited trial is done. Testing was conducted to determine whether the use of student worksheet physics-based guided inquiry effectively used the design of before-after experiments (Sugiyono 2016).

Based on FIGURE 1, we can explain the experiment by comparing the O2 value with the O1. When the O2 value is greater than the O1 value, the teaching method is effective. Based on FIGURE 1, it can be explained that the researcher experimented by comparing the O2 value with the O1. When the O2 value is greater than the value of O1, then the teaching method to know the effectiveness of student worksheet physics-based guided inquiry has been developed, then judging by the results of the science process skills test before after the study. For this reason, the N-Gain normalized gain formula is used (Haryadi and Pujiastuti 2020).

$$g = \frac{Spost - Spre}{Smaks - Spre} \quad (1)$$

Description:
$Spost$ = Final Test Score
$Spre$ = Initial test Score
$Smaks$ = Maximum score to be achieved

Meanwhile, TABLE 1 is a tool to determine the level category obtained from the result of the N-Gain test analysis so that researchers can evaluate the changes contained in the study in the categories: high, medium, and low.

TABLE 1. Category N-level gain

Limitation	Category
$0.70 \leq g$	High
$0.30 < g < 0.70$	Are
$g \leq 0.30$	Low

RESULTS AND DISCUSSION

Research Results

In preparing guided inquiry-based physics worksheets, several aspects that need to be considered in validation are didactic terms, construction, and technical requirements. From these conditions, it is easier to determine the quality of the worksheets used by students. The validation results obtained from two experts on the student worksheets based on the guided inquiry can be seen in TABLE 2.

TABLE 2. Validation result student worksheet physics based Guided Inquiry

Number	Aspects	Average	Percentage (%)
1	Didactic terms	3.10	77.50
2	Construction terms	3.17	79.17
3	Technical Requirements	3.20	80.00
Average total		**3.16**	**78.89**

Overall the average total score of the three aspects of assessment student worksheet based physics guided inquiry from both experts of 3.16 with a percentage of validity of 78.89%, which indicates that student worksheet physics-driven related inquiry is in the good category with a score percentage of each aspect is at a range of 61%-80%. These results show that student worksheet physics-based guided inquiry is in the valid category because it meets the quality criteria of student worksheet is reviewed from the didactic condition, which has fulfilled effective learning principles. Terms of construction, student worksheet have used the proper and correct Indonesian rules. Technical requirements, writing on the student worksheet following the rules that have been set by either the writing, drawings, and the appearance of student worksheet.

In addition to the results of experts, validation is also done by teachers/practitioners. The results of the response of teacher/practitioner responses showed that the results of the response analysis of 6 teachers/practitioners of high school physics against student worksheet based physics guided inquiry have a tendency to aspects of the language and benefits of student worksheet in the excellent category with a percentage of 100%. As for the format and content aspect worksheets, students in the category is very good also with a percentage of 76.67% on the aspect of the format and 83.33% on the content aspect. Response teachers/Practitioners to student worksheet Physics-based guided inquiry obtained from 6 teachers/practitioners acquired that overall the practitioner provides a very conclusive response to student worksheet physics-based guided inquiry. So it is generally gained that the reaction of teachers/practitioners to student worksheet based physics guided inquiry is in a very agreed or very positive category.

The advantages of student worksheet used by physics teachers in SMA Negeri 4 Sidenreng Rappang are accompanied by an exciting cartoon animation. At the same time, the lack of student worksheet used by teachers is only a short explanation using textual descriptions and workflows, not accompanied by a trial scheme so that the students cannot construct their physical materials and equipment that are

considered initially abstract. Student worksheet for physics practice are currently found only in teaching books, modules, or alone.

In addition, there are no teachers who use student worksheet based on guided inquiry to practice their specialty science process skills on physics subjects. From the above problems stating students are still familiar with the inquiry learning model, then from some kinds of teaching lessons that are best suited is guided inquiry. The statement is supported by Jauhar (2015), stating that the learning model of guided inquiry is suitable for use, especially for students who are not experienced or still familiar with the learning model of inquiry. In the early stages of the teaching, given more guidance, then at the next step, the direction is reduced so that the students can do the inquiry process by themselves. The impact of learning and the accompanying effect of the inquiry model of education is; (1) Can develop science process skills; (2) The investigation model can be developed creatively; (3) Create a creative spirit and a spirit of learning for Learners; (4) Provide freedom or autonomy learning in learners; (5) Enable two-way cooperation (teachers with students and students with learners); (6) Emphasize the nature of the knowledge of the sciences (Simbolon 2015).

Student response is reviewed in terms of student worksheet physics-based guided inquiry, ease of understanding using student worksheet Physics-based guided inquiry, and motivating learners in learning using student worksheet Physics-based guided inquiry. The result Data of students ' responses to student worksheet physics-based guided inquiry on the franking indicator shows that 52.04% of learners who say student worksheet physics-based taught this inquiry attract and 47.45% of learners who say student worksheet physics-based guided inquiry is exciting.

We reviewed the N-gain level raised by Haake, categorizing G values into three high, medium, and low categories. Category N-level gain test results The students ' science process skills are presented in TABLE 3.

TABLE 3. Category N-level gain (Certified primary Data 2020)

Limitation	Category	Number of respondents	Percentage (%)
g >0.70	High	13	46.43
0.30 ≤ g ≤ 0.70	Are	15	53.57
g < 0.30	Low	0	0
Amount		**28**	**100**

TABLE 3 shows that 46.43% of learners are in the high category from the N-gain test results, and 53.57% of learners are in the medium category. Based on the analysis that has been done, the average value of G is 0.69, and the value is in the medium category of range 0.30 ≤ g ≤ 0.70. The results of the analysis prove that the post-test results are higher than the pretest results. These results indicate that the guided inquiry-based physics student worksheet is effectively used to train students' science process skills.

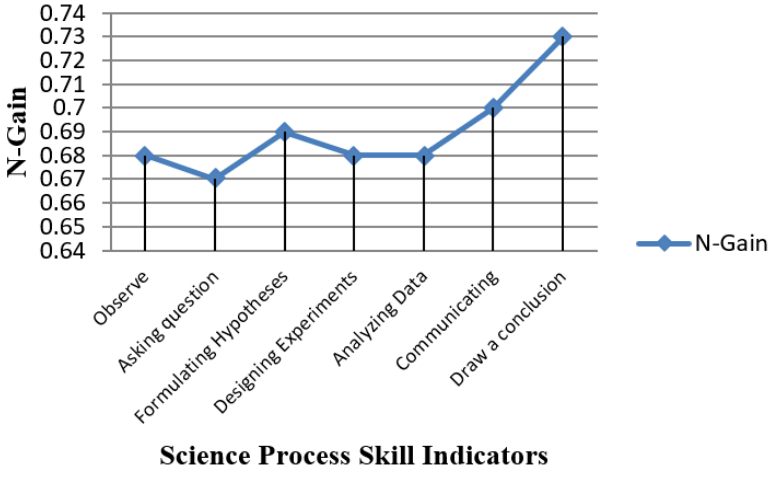

FIGURE 2 N-Gain Test Result for Science Process Skills Indicators

Based on the explanation of the above analysis, the researcher can conclude that student worksheet physics-based guided inquiry are effectively used in learning to practice students' science process

skills. Suppose the pretests scores and post-test skills of science process learners are outlined into several skill indicators such as observing, formulating questions, formulating hypotheses, designing experiments, analyzing data, communicating, and drawing conclusions. In that case, results will be obtained as in FIGURE 2.

FIGURE 2 shows that the N-Gain on the indicators of observing, designing experiments, and analyzing data are 0.68, which means that the ability of students to watch, design experiments, and analyze information is of moderate improvement. The N-Gain on the indicators asking questions is 0.67, meaning that the increase in formulating the hypothesis is that the growth is average. N-Gain on the indicator formulating hypotheses of 0.69 means that the ability to develop ideas increases the learners' moderate. The N-Gain on the communicating arrow is 0.70, meaning that the students' communication ability is high. The N-Gain on the drawing conclusions indicator is 0.73, which means that the power of students to conclude the increase in students is high.

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Discussion

This research is a development study to produce products student worksheet Physics-based guided inquiry, which aids in learning. The learning guided inquiry model stage is used as a guideline for arranging worksheets for students according to Permendikbud No. 22 the year 2016 about process standard in curriculum 2013. One method of learning that can be applied according to curriculum 2013 is guided inquiry. The guided inquiry Model consists of formulating hypothesized questions, designing experiments, conducting experiments, collecting and analyzing data, and drawing conclusions.

The quantitative analysis that has been acquired indicates that the overall total score of the average of the three aspects of assessment student worksheet based physics guided inquiry from both members was 3.16 with a percentage of validity of 78.89%, indicating that student worksheet Fiska based on guided inquiry is in the good category with the score percentage of each aspect are at the range of 61%-80%. The results confirmed that student worksheet physics-based guided inquiry deserves to be used to practice the students ' science process skills because it meets the quality criteria of student worksheet reviewed from the didactic condition, which has fulfilled effective learning principles. Construction requirements, student worksheet Physics-based guided inquiry have been using good and correct Indonesian rules and do not contain SARA elements. Technical requirements, writing on student worksheet physics-based shown inquiry following the rules that have been set either from the writing, picture, or its appearance as in the research conducted by Alfionita (2016) explained that the student worksheet that have been through the internal test and declared valid means that the student worksheet can already be tested externally by the user.

In general, the response given by the teacher/practitioner against student worksheet Physics-based guided inquiry is very positive. The response was given to conclude that worksheets for students-based physics-guided inquiry are constructive for teachers in carrying out the teaching and learning process in the classroom. According to Wulandari (2017), The teacher's response must know the teacher's answer to the student worksheet. If the teacher/practitioner response is in the good or very good category, then the student worksheet can easily use in-class teaching and learning.

Besides the response of teachers/practitioners is also required the response of learners. Overall, learners provide a positive response to student worksheet physics-based guided inquiry that has been used. This means students receive student worksheet physics-based guided inquiry as one of the exciting and effective learning resources. This is evident during the learning process of the learners showing an enthusiastic study interest. The image at every step of the experiment has become an attraction for learners. As the learning process takes place, students can quickly act by step in the worksheets of physics-based guided inquiry. Learners can easily experiment because inside worksheets, the guided physics-based inquiry has been accompanied by hints, directives, and drawings. The images in the student worksheet correspond to the test steps the learners performed in conducting experiments.

Before applying worksheets, students physics-based guided inquiry in the learning process first done pre-tests to know the initial ability of learners. The pre-tests results showed that the average outcome of the student science process was 26.94. From the results of the science process skills test, the skills that the learners have are still immature. Even in similar studies, results are showing that scientific process skills mediate the relationship between gender and scientific creativity (Dikici, Özdemir, and Clark 2020).

After applying the guided inquiry-based physics worksheets for students in the learning process, pre-test and post-test were carried out to describe the skills achieved by participants after learning ended. The results of the N-Gain test showed that N-Gain on the indicators of observing, designing experiments, and analyzing data was 0.68, meaning that the students' ability to watch, design experiments, and analyze data had a moderate increase. The N-Gain on the indicator asking questions is 0.67, meaning that the rise in formulating the hypothesis is that the growth is moderate. N-Gain on the indicator formulating a hypothesis of 0.69 means that developing ideas increase the learners' moderate. The N-Gain on the communication indicator is 0.70, meaning the average students' communication skills increase. The N-Gain on the Drawing Conclusion indicator is 0.73, which means that the ability of students to conclude the increase in students is high.

Reviewed from the N-gain test results There are 46.43% of learners are in the high category, and 53.57% of learners are in the medium category. Based on the analysis that has been done, the average value of G is 0.69, and the value is in the medium category of range $0.30 \leq g \leq 0.70$. The results of the analysis proved that post-test results are higher than pre-test results. The study results were supported by research conducted by Pratama (2020), stating that if N-gain reaches the average score of $0.3 < G < 0.7$, which is included in the medium-normalized gain classification, then the product is considered successful or effective.

CONCLUSION

Based on the results of analysis and research discussion that has been submitted and associated with the formulation of research problems, then some of the main things that can be concluded with regards to the development of student worksheet physics-based, the guided inquiry is as follows.

The result of expert validity towards student worksheet physics-based, guided inquiry according to members is in the correct category because it meets the quality criteria of student worksheet is reviewed from the terms of didactic, which has fulfilled effective principles of learning. Terms of construction, student worksheet have used the proper and correct Indonesian rules. The teacher/practitioner's response to the guided inquiry-based physics student worksheet obtained from 6 teachers/practitioners was found that the overall practice gave a very agreeable answer to the guided inquiry-based physics student worksheet.

Student responses to student worksheets based on guided inquiry Physics are assessed as attractive worksheets developed with an easy flow of activities and easy to understand. As well as motivating in the learning process. Effectiveness of student worksheet based Physics guided Inquiry is effective based on the average N-gain value of 0.69, and the value is in the medium category that is in the range. The results of the analysis proved that post-test results are higher than pre-test results.

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