

Developing the Guided Inquiry-Based Worksheet to Support Experiment in Physics Learning

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Abstract. This study aims to develop a student worksheet based on guided inquiry to support physics learning, especially in experimental activities. This type of research is Development Research using ADDIE (Analysis, Design, Development, Implementation, and Evaluation) models. This research used descriptive analysis by calculating the percentage of validation scores. The product developed was validated by experts (material experts and media experts). The results of the material validation showed 90% of the total score. It means that the worksheet is a very feasible category. The results of media validation also showed 93% of the total score (very appropriate category). As a summary, this student worksheet is very appropriate to support physics experiments. Further innovations can be applied using current information technology for better learning activities.

Keywords: student worksheet, guided inquiry, physics experiments

INTRODUCTION

The curriculum in teaching requires teachers to choose the right learning method to involve students actively participating in learning [1], [2]. Science education standards throughout the world emphasize the importance of student involvement in science learning through inquiry [3], [4]. An inquiry is learning that places learning in the investigation of complex problems, not limited to the process of asking questions and investigating empirical data [5], [6]. In recent years, science education focuses more emphasis on students to actively explore and learn [7]. A teacher may arrange this innovation through experimental activities.

Physics is one of the basic sciences developed based on physical observations in nature found in everyday life, so in principle, studying physics is learning about nature [8], [9]. Physics naturally contains complicated concepts and is quite challenging to understand. These difficulties are on complex concept structures, numerical integration, and the inability to associate these concepts in everyday life. The effort to solve this problem is

through experimental activities in the laboratory [10]. Experiments are a characteristic of physics [8] (Bajpai, 2013). However, there are several obstacles. The student faced limited learning time, making it difficult for students to carry out repeated data collection and measured data accuracy in conducting experimental activities. So the experimental activities in the laboratory become boring [11].

The use of information technology in Indonesia is relatively high and allows many people to use it in various activities. However, when integrated with education, its use is relatively low including the use in mobile learning [12]. The need to change the learning paradigm from conventional learning into creative and innovative learning is crucial. All parties involved directly or indirectly must have the ability to utilize technology to enhance learning. The utilization of technology in learning will increase learning motivation and learning achievement [13], [14]. All high school students at this time are part of generation Z or digital generation that can access unlimited information, both in terms of education and matters relating to individual needs [15]. This can be accessed easily through the use of smartphones. Smartphones are currently used intensively for educational purposes in almost all fields, especially in physics and physics education. A smartphone is very suitable to be used as an experimental tool because it has many sensors [10]. Also, the teacher needs to arrange an innovative learning strategy for using tools to support experimental activities. The teacher must be able to plan the learning process to be carried out appropriately and by student needs [16].

Guided inquiry is a teaching strategy that explores every learning activity that can help students build and develop students' knowledge [17]. This strategy is evidenced through the activity of collecting data to investigate a natural phenomenon and search for evidence [18]. A guided inquiry has a positive impact on experimental activities, especially in science learning [17]. Previous studies have explained that these positive effects affect students' scientific achievements and scientific attitudes [19], [20]. The teacher becomes the main factor that influences the implementation of inquiry activities in science learning [21]. Of course, the teacher

must prepare teaching materials that have an essential role in the learning process. The use of teaching materials will facilitate the teacher in implementing student learning processes [22].

A student worksheet is one form of teaching material. Students are required to solve the problems presented to meet cognitive in each learning activity to increase student understanding. The learning process using guided inquiry-based worksheet makes students active and enthusiastic [23]. Learning activities using guided inquiry encourage students to actively search for information in conducting experiments to solve problems they face [22]. Student worksheet as an essential teaching material that explains the activity steps during learning. Uniquely if in learning that integrates technology. Therefore the importance of guidance in helping students to get information about things to do and, at the same time, arranging all students in the class to participate in learning activities [24]. Therefore, this study aims to develop guided inquiry-based worksheets to support physics experimentation activities by utilizing technology (smartphones).

METHOD

The guided inquiry-based worksheet was developed using the R&D (Research and Development) R&D method modified by Borg and Gall (1983). The model used is the ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The analysis phase aims to identify a problem when conducting physics experiment learning. The design phase (design) aims to consider the design of the worksheet made. In this case, the material presented is Newton's Law. The development phase is to develop teaching material products that existed previously. It aims to provide the latest innovations that are following the times through the use of smartphones. Student worksheets developed are adapted to the syntax of guided inquiry consisting of planning, retrieving, processing information, making / creating information, communication / sharing information, and evaluating [25]. The implementation phase aims to implement products made to be validated. The validation instrument for material experts consists of some components. It includes content, presentation, linguistics, and product benefits. The validation instruments for media experts consist of graphics and physical appearance. The indicators for each component are explained in Table 1.

Validation sheet in the form of a questionnaire with the rating used is a Likert Scale with a score of 4 for the Very Good criteria (VG), a score of 3 for the Good criteria (G), a score of 2 for the Poor criterion (P), and a score of 1 for the Very Poor criterion (VP). Calculation of the percentage of each component uses the percentage formula [26].

Also, the percentage of eligibility criteria is explained in Table 2.

Table 1. Target indicators

Components	Indicators
Content	<ul style="list-style-type: none"> ▪ Aspects of guided inquiry-based learning ▪ Completeness and accuracy of Newton's Law material ▪ Learning aspects consisting of knowledge, skills, and attitudes ▪ The contents of worksheet refer to various sources
Presentation	<ul style="list-style-type: none"> ▪ Meaningfulness and benefit of the worksheet ▪ The order of the worksheet offering is clear ▪ Interactive learning (stimulus and response) ▪ Learning aspects that support science process skills
Linguistic	<ul style="list-style-type: none"> ▪ Clear information delivery ▪ Writing the appropriate sentence ▪ Readability of letters, scientific notations, and formulas following theoretical physics ▪ Effective use of language
Efficacy	<ul style="list-style-type: none"> ▪ Learning activities become interesting ▪ Opportunities for students to study independently with the presence of worksheet ▪ Ease students in learning Newton's Laws through experiments
Graphy whole	<ul style="list-style-type: none"> ▪ The use of fonts, types, and sizes ▪ Accuracy in using images ▪ Content Design
Appearance	<ul style="list-style-type: none"> ▪ Layout ▪ Cover design

Table 2. Percentage of eligibility [27]

Interval	Eligibility Criteria
0%-20%	Very not valid
21%-40%	Not valid
41%-60%	Valid enough
61%-80%	Valid
81%-100%	Very valid

A student worksheet is feasible if the percentage reaches more than 61% [28]. There is another assessment in the form of advice and input from experts. An evaluation phase is to evaluate the product, which consists of expert advice and input. This phase is to improve worksheet products to get relevant results and can be used to support learning.

RESULT & DISCUSSION

The validation of products conducted by experts consists of material experts and media experts. The following Figure 1 shows the validation results.

Figure 1 explains the components validated by

the material experts in the student worksheet consisting of the content, presentation, language, and usefulness of the product. The assessment component of the material has an average percentage of 90%. Based on the analysis by material experts, the guided inquiry-based worksheet is very suitable to be used as a support in physics experiment activities.

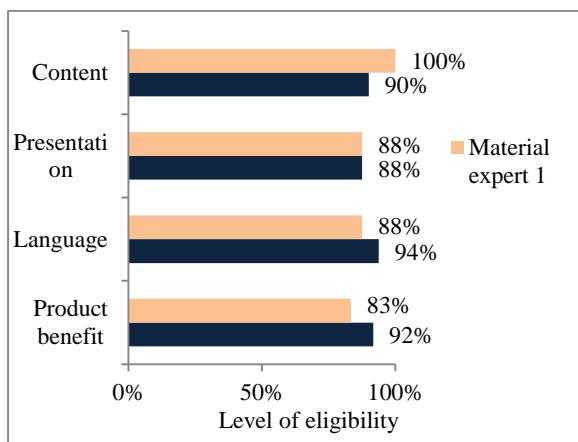


Figure 1: Validation results by material experts

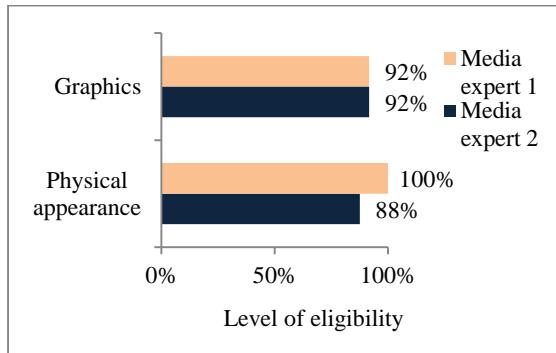


Figure 2: Validation results by media experts

Figure 2 explains the components validated by the media experts in the student worksheet consisting of graphics and physical appearance. The assessment component of the media has an average percentage of 93%. Based on the analysis by media experts, the guided inquiry-based worksheet is very suitable to be used as a support in physics experiment activities.

The product in this development research was the student guided inquiry-based worksheet to support physics experiments. This development research used the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The validation was based on expert judgment, both the material and media. The phase-in of these stages was the analysis based on the needs of students and teachers in the school. The design of the student worksheet made is in Figure 3.

The contents of the student worksheet consist of the title of the experiment, the purpose of the

experiment, tools, and materials, experimental procedures, data analysis, conclusions, and questions. The development phase is to improve the worksheet products that previously made. Through the use of guided inquiry models and smartphones as experimental devices integrated into the student worksheet, innovation was made in products. Sensor-based applications on smartphones help students detect physical quantities such as acceleration in the subjects of Newton's Law [29]. This measurement can be done easily through application assistance on smartphones[30]. In the student worksheet that was developed, the researcher explained the application of phyphox as an acceleration sensor.



Figure 3: Student worksheet design

The need to develop a guided inquiry-based worksheet was to assist and facilitate students in understanding physics learning, especially in experimental activities. Implementation was performed through validation conducted by experts consisting of material experts and media experts. To evaluate the product based on the advice and input given by media experts and material experts, there are several things to be improved. They are as follows:

1. the presentation of notations in the equation that was not quite right,
2. the explanation of the normal force in the picture presented,
3. the presentation of the pulley drawings that were not quite right, and
4. the magnitude was still written with scalar notation while the magnitude of the force must be with vector notation.

Suggestions and input like this are significant for researchers to correct mistakes in explaining the concept of learning so that it does not cause misunderstanding when used by students.

The product made in the form of the worksheet based on guided inquiry models has been suitable

to be used as a support for physics experiments. Based on the guided syntax, in student worksheet consisting of planning, the teacher provides physical problems in everyday life. Retrieving, students find and collect data from problems given through experimental activities. Processing information, students process and analyze data. Making/ creating information, students make conclusions from the data. Evaluation, the teacher provides evaluations and rewards students for the results of the experiments that have been conducted. The teacher may assemble the guided inquiry model through student involvement, motivation, and challenging learning following the goals of the 21st century in guiding students to think and learn through inquiry [31], [32].

This statement is in line with the integration of technology through the use of smartphones as supporting tools in 21st-century learning. Learning activities on the student worksheet will direct students to solve the problems given during the experimental activities. Students seek the process of an experiment, and through it, they understand information scientifically. Therefore, in guided inquiry, students are given problems, and they must develop their things but still under the guidance of a teacher [33]. Besides, the student worksheet has been explained about the use of technology such as smartphones so that it is not difficult for students to integrate it into experimental activities.

CONCLUSION

In this research, a developed product is the student worksheet based on guided inquiry to support physics experiments. In line with technological developments, this worksheet integrates the use of smartphones as a supporting learning tool. Based on the validation, the percentage obtained from material experts at 90% is a very feasible category, and from media experts at 93% is categorized as very feasible. So, the worksheet based on guided inquiry is very suitable to be used as a support in physics experiments. By using teaching materials in the form of the guided inquiry-based worksheet, it can assist students to learn independently. However, there is still a role of the teacher as the learning facilitator. Various innovations can also be performed by utilizing the technology used in daily life to enhance learning.

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