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THE DEVELOPMENT OF STUDENT WORKSHEET BASED GUIDED INQUIRY WITH PHET SIMULATION ON WORK AND ENERGY TOPIC

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Abstract *The purpose of this research is knowing the level of LKPD feasibility that contains the Work and Energy material based on the assessment of experts and student responses. This research is the development of Research & Development model (R&D) using 4D method. Stages of research are define, design, develop, and disseminate. This research is limited to develop stage. The subject in this research is class X MIA 1 SMA N 1 Labuhan Deli. The instrument in this research using: LKPD, validation sheet by expert materials, validation sheet by expert media, validation sheet by an expert practitioner, questionnaire students response, and observation sheet by the observer. Technique analysis data consist of technique analysis instrument validation and analysis result. Analysis instrument validation using Likert scale and analysis result of research using a Guttman scale. The result in the level of LKPD based on Guided Inquiry with PhET Simulation according to expert material is "Excellent" (95%); according to expert media is "Excellent" (95%); according to expert practitioner is "Excellent" (96,15%); and result the student responses to LKPD that contains Work and Energy material according to initial testing is "Good" (87,5%), and according to quantitative testing is "Good" (94,11%). So the LKPD based guided inquiry with PhET-Simulation developed that is suitable for student learning on work and energy based on instrument by expert team and students response.*

Keywords:
4D Method,
Guided Inquiry,
LKPD,
R&D.

Introduction

In issue 64 of 2014 Permendikbut on specialization in secondary education, it is stated that the physics part of the natural sciences, one of the compulsory subjects for MIA specialization in high school students. The main goal of learning physics is to enable students to develop experiences and to formulate problems. Students with problems solving skills are able to draw reliable conclusions, to have a global vision, to make informed decisions, to produce good products and to find creative inventions. The skills in problem-solving and creative thinking are important to help students explore the understanding of concepts (U. Kulsum & S.E Nugroho, 2014).

Physics as a discipline is a lesson reasoning and application aspects are very important for the control of science and technology. The physics course closely related to the scientific approach also serve to broaden the knowledge and understanding of matter and energy, to improve scientific skills, stimulate scientific attitudes and educate students to technological products through the application of theories or principles of physics already mastered. Therefore, physics knowledge must be included to allow students to improve their knowledge and skills and should be used to solve the various problems they face. In this case, the thinking skills are very necessary, in

addition to computing skills, observation skills, communication skills, and cooperation skills, as well as skills to respond critically to a problem. Given the importance of physics courses for education, teachers should be able to plan their learning so that students become more interested in physics (Agustina, 2017).

According to No. 20 of 2003 concerning the national education system indicates that the program is a set of plans and arrangements for the purpose, content, learning materials and methods used as guidelines for the implementation learning activities to achieve certain educational goals. Curriculum 2013 requires the implementation of learning physics in schools or science to develop the ability to think, to work, to be scientific and to communicate as one of the most important aspects of skills life (Leonda, *et al*. 2015). Curriculum 2013 is designed to prepare Indonesian citizens who have the ability to live as individuals and loyal citizens, productive, creative, innovative, emotional and capable of contributing to the life of the world, nations, states, and civilization of the world (Permendikbud, 2013).

Based on observation at SMA Negeri 1 Labuhan Deli, showing that physics learning activities often using conventional methods. Teachers more often communicate the material in front of the class and write it on the board. Almost all information comes from teachers and students only as recipients of the information. Then, based interview with physics teachers is absence of laboratory activity because a laboratory hasn't complete tools and material to experiment, just have one laboratory in this school to all level class, and then the rare of the using worksheets of students in learning, which should be used extensively in the learning curriculum 2013.

Based on the result of the interview, to complete student learning based curriculum 2013 in class X at SMA Negeri 1 Labuhan Deli researcher trying to giving alternative solutions from laboratory activities, that is virtual laboratory activities with using utilization technology, namely PhET Simulation. The advantages of PhET Simulation that is: (1) has an attractive animated display; (2) very easy to use; (3) free download; (4) can adjust laptop/PC specification because provide download simulation packet, Java, and flash; (5) can using in online or offline; and (6) have physical concept models easy to understand for students. The disadvantages of PhET Simulation that is: (1) executed application and games are very limited, especially for format files ".jar"; and (2) Need Flash Player updates for Flash that does not update automatically.

The use of PhET Simulation should be supported by the student worksheets. The student worksheets are worksheets containing tasks performed by students, with instructions, the steps to perform a task in a theoretical or practical form. Student worksheet can be used to increase problem-solving skills, creative thinking, and mastery of students' concepts that involve investigative activities and reflective activities such as analyzing the results of investigative data.

The using of student worksheets with PhET Simulation will not be optimal without the use of learning models in the learning process. Learning in curriculum 2013 gives priority to the scientific approach. The investigation is a learning model that applies the scientific approach. In the learning process, students are always used to helping and giving explanations from the teacher to solve problems. Therefore, to more actively improve students in the learning process, it is necessary to use the student worksheet with PhET Simulation based on a guided inquiry.

Based on the background, one strategy to be used to facilitate and help the student in teaching physics, the researcher was conducted research entitled The Development of Student Worksheet Based Guided Inquiry with PhET Simulation on Work and Energy Topic.

Method of Research

This research was conducted at SMA Negeri 1 Labuhan Deli. The type of this research is Research and Development (R&D) using the 4-D method. The method implemented in this study was development research which was limited into three stages: define, design, and develop.

The data collection technique consists of collecting documents and using questionnaires used to design the development of LKPD media and evaluate their appropriateness. Respondents to participated in the data collection were media experts, material experts, and practitioner experts (teacher respons). After revision from expert the workshet can test in student, this worksheet tested with 2 class, first class is X MIA 2 to test LKPD of initial testing on 12 student respondences and the second class is X MIA 1 to test LKPD of quantitative testing on 34 student respondence. The data was collected through assessment sheet of expert and students response questionnaire and further analyzed using the equation bellow:

$$P(s) = \frac{S}{N} \times 100\%$$

Information:

P (s) : percentage of categories

S : number of category scores that have been selected

N : total ideal score

(Sudijono. A, 1987)

In order to make conclusion, the percentage of score was interpreted according to the criteria used in related research. Table 1 shows the criteria used to categorize the score for students response questionnaire and table 2 shows the criteria used to categorize the score for assessment sheet of expert.

Table 1. categorize the score for students response questionnaire

Percentage	Criteria
0 ≤ x ≥ 50	Bad
51 ≤ x ≥ 100	Good

Table 2. Categories of score for assessment sheet of expert

Percentage	Criteria
25 ≤ x ≥ 42,85	Poor
44,64 ≤ x ≥ 62.5	Bad
64.28 ≤ x ≥ 82.14	Good
83.92 ≤ x ≥ 100	Excellent

Result and Discussion

The result in this research based on steps from 4D there are define, design and develop. At the stage define, the determination and definition of learning conditions are carried out. The steps in the define stage include a) Front-end analysis. This front end analysis aims to bring up and establish the basic problems faced by teachers and students in physics learning. b) Learner analysis. This learner analysis is to examine the characteristics of students as an illustration for designing worksheets. c) Task analysis, in task analysis are namely analyzing Basic Competence (KD) and the elaboration of learning indicators. d) Concepts analysis, concept analysis is the identification of the main concepts in the work and energy matter, based on concept analysis designed teaching materials in the form of worksheets with PhET Simulation based guided inquiry with work and energy topic so that learning indicators can be achieved. e) Specifying instructional objectives. Based on task analysis and concept analysis, learning objectives can be formulated.

After the concepts are set, the indicators of learning and learning objectives are formulated, then the next step is to design worksheets with PhET Simulation based guided inquiry. At design stage a draft of teaching material is produced in the form of worksheets with PhET Simulation based guided inquiry whose writing format is based on the guidebook for the development of teaching materials, namely as follows: 1) Title/identity of material, 2) Instructions for learning (student instructions), 3) Core

Competencies (KI), Basic Competencies (KD), Learning Indicators and Learning Objectives, 4) Supporting Information, 5) Models and Key Questions, 6) Practice and Questions.

The development stage aims to produce worksheets with PhET Simulation based guided inquiry that have been revised based on input from the validator expert so that a device can be used in research. Validation doing by validator materials expert, media expert, and practitioner expert. Validator which validated draft I students worksheet physics based Guided Inquiry is lecture physics department as validator materials and media expert then teacher physics school as practitioner expert.

Validation by Material Expert, assessment of LKPD to involves aspect feasibility of presenting material, guided inquiry components, and language used. The results of the evaluation are in the form of useful scores as data. The value is then changed to a percentage and then adjusted to the criteria. Experts assessment criteria are used to improve product quality. Based on result assessment by materials expert, then LKPD which developed stated with percentage average score is 95%. If it is associated with a table of feasibility criteria, the pass mark is included in the "Excellent" criteria. Then LKPD with PhET Simulation-based Guided Inquiry developed meets the feasibility criteria for use in learning physics.

Validation by Media Expert, assessment to LKPD involves aspect experiment of activities, presentation of physical and language usage. The results of the evaluation are in the form of useful scores as data. The value is then changed to a percentage and then adjusted to the criteria. Experts assessment criteria are used to improve product quality. Based on result assessment by media expert, then LKPD which developed stated with percentage score is 95%. If it is associated with a table of feasibility criteria, the pass mark is included in the "Excellent" criteria. Then LKPD with PhET Simulation-based Guided Inquiry the developed meets the feasibility criteria for use in learning physics and can be continued at the feasibility stage for students.

Validation by Practitioner Expert, assessment to LKPD involves aspect display of LKPD, eligibility of contents, Guided Inquiry components, and language. The results of the evaluation are in the form of useful scores as data. The value is then changed to a percentage and then adjusted to the criteria. Experts assessment criteria are used to improve product quality. Based on result assessment by media expert, then LKPD which developed stated with percentage score is 96.15%. If it is associated with a table of feasibility criteria, the pass mark is included in the "Excellent" criteria.

Student Questionnaire Respons, Students Response LKPD with PhET Simulation-based Guided Inquiry it was observed that the quality of the LKPD was well based on the comments of research subjects, namely students SMA class X. The student response was observed using in response to student questionnaires. Calculation of student response analysis using the evaluation of the ideal criteria that can be seen in table 3.

Table 3. student questionnaire respons

No	Testing	Average
1	Initial Testing	87.5
2	Quantitative Testing	94.11
Total Percentage		90.8%
Criterion		**Good**

On discussion, have two main points will be discussed based on the research objectives, Knowing the level of LKPD feasibility that contains the Work and Energy material based on the assessment of experts, Knowing student responses to LKPD that contains Work and Energy material based on student responses from the results of product trials. Development in this product involves three stages there are defined, design, and develop Product development begins by determining the product manufacturing goal to develop. Product development objectives

form the basis to develop the form of equipment and learning tools that will be used during the learning process. The learning tools used in this study are presented in the form of worksheets for students (LKPD). The developed devices are called research products. Then, the validity of the research product was tested to determine the feasibility level of the product to be developed. The feasibility level of learning devices can be determined from theoretical validity and empirical validity, according to Arikunto's opinion (2006). Guided inquiry assisted by virtual laboratory has several advantages over real learning lab. Virtual laboratory tend to be more flexible in its use. Moreover, students are more enthusiastic in learning involving technology in it, such as the use of simulation and other technology based learning media (Saputri, M & Motlan, 2016). Below you will find a description of each of the results of the validation analysis conducted by materials experts, media experts and practitioners experts, as well as the results of student responses and student activities in this study.

Validator materials expert from aspects of the feasibility of the presentation and readability of the material. The feasibility of the presentation of the material is obtained in a percentage of 95% with criteria "Excellent". The feasibility aspect of the presentation of the material shows that the subject contained in the LKPD is in line with the KI and KD of the curriculum 2013. Indeed, in the preparation of the LKPD, reference is made to the learning objectives and the physical description that has been adapted to KI and KD. According to Dinas Pendidikan Nasional (2006), student worksheets must contain basic skills, the existence of basic skills serves as a reference to help students learn in a guided manner. The link between the practical questions and the material is also very well evaluated, which is consistent with the material that refers to the learning objectives. In addition to referring to learning objectives, existing activities within the LKPD should also motivate students for independent learning, as the LKPD essentially operates by conducting teaching and learning activities and has applied the method active learning to students. The clarity of the content of the LKPD is good, which means that the content is delivered in a structured way, LKPD also has a good content richness in accordance with the secondary level of education and a quality of translation well described by concept maps real examples, images conforming to material concepts, giving the meaning or the definition of an always abstract term. In addition, the image quality used in the LKPD is considered clear and interesting.

Validator media expert involves aspect experiment activity, presentation of physical, and language used based Guided Inquiry. Assessment LKPD gets its percentage is 95% with criteria "Excellent". The experimental activities observed from the experiments conducted and included in the criteria are very good because they are presented effectively and easily understood. The presentation of physical of the LKPD display cover and content design must be sensitive to layout, selection of appropriate images, selection of text, and selection of attractive colors based on the evaluation of the elements published by the BNSP, one of them making font and layout, design and readability. However, good learning resources are not only attention to the quality of the presentation but are also effective in motivating students. The elements presented in this LKPD can also motivate students to offer learning activities consistent with the Guided inquiry component. The components are problem identification, hypotheses, inquiry activities, experimental data processing, and experimental data analysis. The questions contained in this LKPD are made as attractive as possible according to the components of the guided inquiry.

LKPD based Guided Inquiry with PhET Simulation which developed and

assessed by teacher physics class X at SMAN 1 Labuhan Deli. Validator practitioner expert involves aspect LKPD display, content feasibility, Guided Inquiry Component and language used. The results of the evaluation conducted by physics teachers referring to several indicators contained in the questionnaire instrument, the average percentage is 96.15% with the criterion of "Excellent". The LKPD display observed from the LKPD included in the criteria is very good or interesting because they are presented the content of LKPD is easily understood and interesting to readability the LKPD. The content feasibility of the LKPD shows that the subject contained in the LKPD is in line with the KI of the curriculum 2013. The components are problem identification, hypotheses, inquiry activities, experimental data processing, and experimental data analysis. The elements presented in this LKPD can also motivate students to offer learning activities consistent with the Guided inquiry component. The questions contained in this LKPD are made as attractive as possible according to the components of the guided inquiry. However, good learning resources are not only attention to the quality of the presentation but are also effective in motivating students.

Student Questionnaire Respons, Initial testing doing after LKPD based Guided Inquiry with PhET Simulation finished revised later LKPD responded by 12 students class X MIA 2 at SMAN 1 Labuhan Deli. The results of the evaluation obtained 87.5% of the value of the "Good" criterion. The aspects evaluated were the appearance of the LKPD, the presentation of the LKPD and the components of guided inquiry learning. Quantitative testing doing after does initial testing. Quantitative testing practice in class X 1 MIA SMAN 1 Labuhan Deli with student responded 34 person. Before submitting a questionnaire to students, they receive an LKPD based Guided Inquiry with PhET Simulation on Work and Energy topic. Students do the instructions according to the LKPD that has been shared. After completing the LKPD, the teacher gave students responded to the questionnaire to LKPD based on a guided inquiry. The results of the evaluation were 94.11%, which was included in the "Good" criterion. The aspects evaluated were the appearance of the LKPD, the presentation of the LKPD and the learning components based on the guided inquiry.

Conclusion and Suggestion

Based on the result of analysis, The result of validation on LKPD based Guided Inquiry with PhET Simulation on Work and Energy topic which assessed by validator materials expert is “Excellent” with average score is 95%. The result of validation assessed by validator media expert is “Excellent” with average score is 95%. The result of validation assessed by validator practitioner expert with average score is 96.15% which include the criterion “Excellent”. The result of questioner student's response on LKPD based Guided Inquiry with PhET Simulation on Work and Energy topic in 2 step testing have been average score is 87.5% with criterion “Good” on initial testing, and have been average score is 94.11% with criterion “Good” on quantitative testing.

There are also suggestions that can be delivered based on the experience of this research are: Research development using instructional 4D model, this resulting LKPD based Guided Inquiry with PhET Simulation on Work and Energy topic need to more an other topic in physics. Learning using LKPD based Guided Inquiry with PhET Simulation on Work and Energy topic this should be done continuously as a habit for students to achieve optimal results. The next researcher should not only stop at the stage of development, but also at the stage of disseminate so that the educational material is more useful and can be used directly by the whole community.

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