The Development of Work and Energy Student Worksheet Based on Scientific Approach

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Abstract. Physics subjects in school must be carried out scientifically, in order to foster the ability to think, work, be scientific and communicate. This study aims to developed student worksheet based on a scientific approach in work and energy material by using the Borg and Gall model, which done in seven stages: potentials and problems; information gathering; product design; expert validation; design revision; limited product trial and product revision. Based on the feasibility test of the worksheets conducted by experts' validation and students' responses, it was found that the average feasibility score by media experts was 94.8% with the very feasible category and the average feasibility score by material experts was 94.7% with the very feasible category and the average score of the response of students is 83% with a very positive category. Scientific-based worksheets can improve understanding of physics concepts and become a reference for teaching materials for educators.

Keywords: Borg and Gall Model; Student worksheet; Scientific approach; Work and Energy

1 Introduction

Education is an important aspect in the intellectual life of the nation. Various efforts have been made by the government to improve and improve the quality of education. One of the government's efforts is to implement and develop a competency-based curriculum in 2004 and 2006 to become the 2013 Curriculum (Chairi, 2016). The 2013 curriculum aims to produce the nation's next generation who are productive, creative, innovative through strengthening integrated attitudes, skills and knowledge (Yanuarti, 2017). The implementation phase of the 2013 curriculum focuses on the active activities of students through a scientific process with the aim that learning will not only create students who have knowledge competence, but are also able to create students who are good in attitudes and skills.

The 37th State Senior High School (SMA) Jakarta is one of the schools that implements the 2013 Curriculum. In accordance with the 2013 curriculum, physics subjects in high school must be carried out scientifically, in order to foster the ability to think, work, and behave scientifically and communicate as an important aspect of life skills (Sukiminiandari, et al., 2015). The 2013 curriculum uses a scientific approach that emphasizes students to be active in learning which is carried out systematically, through observing, asking questions, gathering information, associating and communicating (Ratnaningsih, 2017; Saregar, 2016; Hosnan, 2014).

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The scientific approach in the 2013 curriculum does not only focus on developing students competence in conducting observations or experiments, but also develops students knowledge and thinking skills so that they can support creative activities in innovation or work (Musfiqon, et al., 2015). Therefore, the learning tools that are arranged must also be based on a scientific approach so that the learning process runs well. One of them is the Student Worksheet (LKS).

Student worksheets can be used as teaching materials for students to understand and study the material, especially in physics. Student worksheets are sheets containing material, summaries, and instructions for implementing learning tasks that must be done by students referring to the basic competencies that must be achieved (Anggraini, et al., 2016). Student worksheets have an important role in learning, one of which is as teaching materials that can minimize student worksheets which are sheets containing material, summaries, and instructions for implementing learning tasks that must be done by students referring to the basic competencies that must be followed. achieved (Anggraini, et al., 2016). The role of educators, however, is to activate students more, in order to activate students, a more enjoyable learning process is needed. Learning using worksheets can further activate students, in finding and developing concepts and can motivate students (Trianto, 2010). In line with the implementation of the 2013 Curriculum, the worksheets used in schools must apply a scientific approach which consists of observing, asking questions, gathering information, associating and communicating.

Through a scientific approach to the 2013 curriculum, the competencies expected of students in terms of attitudes, skills and knowledge can be achieved optimally. Potential intelligence that can be increased through a scientific approach is high-level thinking, the ability to solve a problem systematically, train students in communicating ideas (Machin, 2014). The scientific approach to learning physics can also improve students' scientific literacy skills (Setiawan, 2019). By using a scientific approach, the theory obtained can be applied optimally in everyday life (Purnama, et al., 2015).

Based on the experience of researchers while carrying out Teaching Skills Practice (PKM), at SMA Negeri 37 Jakarta, that the textbooks used as learning resources have implemented the 2013 curriculum. Researchers still found that some students were less active in the classroom learning process and had difficulty understanding the textbooks used in learning physics, because the language used in the textbooks was difficult for students to understand, so physics lessons were considered the most difficult of all other subjects. In addition, the authors also found that physics teachers had not implemented LKS based on a scientific approach when studying physics. These things make students think that physics is an unpleasant subject, considered the most difficult of other subjects, and not easy to learn independently. In this case, educators also have difficulty in conveying the material. Therefore, to help students understand the material, it is necessary to develop LKS.

The student worksheets that were developed were worksheets based on a scientific approach on the business and energy materials. Work and energy material is one of the physics subjects given in class X. Work and Energy are materials that are very closely related to everyday life. To make it easier for students to understand the material, a teaching and learning process is implemented that involves students to understand and practice it directly, namely through experimentation and discussion. To realize this, an approach to the implementation of appropriate learning is applied, namely the scientific approach.

According to research results Arafah et al (2012) LKS can improve learning outcomes and student performance, accompanied by very good student and teacher responses seen from student responses, namely the percentages of 81.33%, 80.08%, and 80.23%. Then according to Fitriana et al (2016) in their research stating that student worksheets using a scientific approach have a potential effect on students' critical thinking skills, it can be seen that on the tests of

students who are categorized as very critical and critical as many as 15 students (55.56%) with test scores from 62 to 100.

Setyorini (2014) suggests that student worksheets can be used by students as a learning guide that can develop character and improve students' cognitive learning outcomes, seen from the results of the percentage descriptive test analysis showing that character development has occurred in the experimental class marked by an increase in scores from 75.70 to 81.95. It can be concluded from previous researchers, that worksheets can improve critical thinking, learning outcomes and are very useful for educators and students. The purpose of this study is to produce worksheets based on a scientific approach that are feasible to use and to determine the students' responses to the resulting worksheets based on scientific approaches.

2 Research Methods

This research was conducted at SMA Negeri 37 Jakarta, in the even semester of 2019/2020 T.A. The research design used in this research is Research and Development (R&D) or what is often called research and development. The product produced in this study is a worksheet based on a scientific approach. Products developed based on the research and development model of Borg and Gall according to (Sugiyono, 2017) include stages, namely potential and problems, information collection, product design, expert validation, design revisions, limited product trials and product revisions.

Data collection in this study used validation sheets and response questionnaires. The validation sheet is used to determine the validity or feasibility of developing LKS based on a scientific approach. While the response questionnaire was used to determine the positive response of students to the use of LKS based on a scientific approach, so that it was feasible to use it in the learning process.

$$P = \frac{\Sigma x}{\Sigma xi} x100\% \quad (1)$$

With P is the percentage, Σx is total value of respondent's answer; and Σxi is the number of ideal values. By using the assessment criteria and categories in the following Table 1:

Table 1. Media and Eligibility Criteria

Rating Percentage (%)	Eligibility Category
81-100%	Very Worthy
61-80%	Worthy
41-60%	Decent enough
21-40%	less worthy
0-20%	Not feasible

The assessment of the student response questionnaire data obtained was analyzed using the following equation:

$$P = \frac{F}{N} \times 100\% \quad (2)$$

With P belongs to Percentage; f = The frequency you are looking for the percentage, and N= Number of frequency/respondent. After that we categories the result according Table 2:

Table 2. Student Responses Categories

Percentage Interval (%)	Category
81-100%	Very Positive
61-80%	Positive

41-60%	Less Positive
21-40%	Not Positive
0-20%	Very Not Positive

3 Result and Discussion

This study produces student worksheets (LKS) based on a scientific approach on the material of work and energy for class X. This study uses research and development procedures by Borg and Gall according to (Sugiyono, 2017). At this stage the researcher only arrived at the stage of product revision 1.

The stages of the research are as follows:

3.1 Potential and problems

Based on the results of observations during teaching skills practice (PKM) at SMAN 37 Jakarta, the problem obtained is the unavailability of physics worksheets based on a scientific approach as teaching materials. In addition, the problem found is that physics practicum activities are rarely carried out in the laboratory during the learning process. Therefore, media that can help and support the learning process of students are teaching materials, one of which is student worksheets (LKS).

LKS based on a scientific approach has been widely circulated among students, but has not been implemented in SMA 37 Jakarta. Even though scientific-based worksheets can be used as alternative learning resources that attract the attention of students actively in constructing their own concepts and helping students understand the material, so that this development is expected to make students more active in learning.

3.2 Information gathering

At the information gathering stage, the literature study was carried out to produce the development of LKS based on a scientific approach on business and energy materials for class X SMA. At this stage the authors conduct curriculum analysis, prepare Core Competencies and Basic Competencies to conduct needs analysis, write achievement indicators, write learning materials, develop learning activities, determine learning resources, determine the type of teaching materials to be made and look for materials from the internet, books and books. from various sources.

SMAN 37 Jakarta applies the 2013 revised 2016 curriculum in its learning activities. The development of student worksheets (LKS) based on a scientific approach is carried out on the business and energy materials for class X. The LKS based on a scientific approach on business and energy materials for class X will be produced according to the 2013 revised 2016 curriculum. Furthermore, the researchers developed learning objectives based on Core Competencies (KI) and Basic Competencies (KD).

3.3 Product design

At this stage, develop a plan that formulates capabilities related to existing problems. Making products based on the literature review that has been done. The worksheets produced use A4 paper size, which is 210 x 297 mm. The author uses Adobe Photoshop CS 6 to design the cover of the worksheet. While the design of the LKS content/content section uses Microsoft Office Word 2016.

3.4 Expert validation

A product is said to be feasible if it has been validated by a competent expert in the field, so that the product can be used in learning activities. Validation was carried out on the resulting worksheets using 6 validators, namely 4 material expert validators and 2 media expert validators. The following are the results of the validation of material experts and media experts on the resulting worksheets.

Material expert validator

Material expert validation is done by filling out a questionnaire instrument for assessing the feasibility aspect of the content which consists of 3 indicators, namely the suitability of the material with KD, the accuracy of the material and its up-to-date. The scientific approach aspect consists of 2 indicators, namely the characteristics of the scientific approach and the steps of the scientific approach. The presentation feasibility aspect consists of 4 indicators, namely presentation technique, presentation support, learning presentation and coherence and coherence in the flow of thought.

The aspect of linguistic feasibility which consists of 5 indicators, namely straightforward, communicative, dialogical and interactive, conformity to the development of students and conformity to language rules. With the total number of statements from all indicators totaling 55 statements. This assessment was given by 4 material expert validators, namely Mr. Taat Guswantoro, M.Si and Mrs. Septina Severina Lumbantobing, M.Pd who are UKI physics education lecturers, Mr. H. Rinaldi, S.Pd, MM and Mrs. Emi Darnah, S.Pd who is a physics teacher at SMAN 37 Jakarta.

Based on the results of data analysis on the validation sheet by the validator, the average percentage score for the feasibility of the LKS material is 94.8% from the total of each indicator developed, where the LKS based on a scientific approach on business and energy class X is included in the very feasible criteria. The results of the feasibility test on aspects of content feasibility, aspects of scientific approach, aspects of feasibility of presentation and aspects of linguistic feasibility of LKS based on scientific approaches on business and energy materials developed are presented in the Table 3

Table 3. Analysis of the Feasibility Aspects of Student Worksheet Material Experts

Aspect	Percentage	Category
Content Feasibility Aspect	92,6%	Very Worthy
Aspects of Scientific Approach	95,6%	Very Worthy
Aspects of Feasibility of Presentation	98,0%	Very Worthy
Aspects of Language Eligibility	93,1%	Very Worthy
Average Score	94,8%	Very Worthy

Based on the Table 3, the analysis of material expert data can be seen from each aspect, namely the content feasibility aspect is obtained by 92.6%, the scientific approach aspect is obtained by 95.6%, the presentation feasibility aspect is obtained by 98.0% and the linguistic feasibility aspect is obtained. of 93.1% so that it shows the criteria is very feasible. This research is comparable to research by Ariyanti, et al (2014) that LKS refers to KI and KD, designed and developed for students so that students can learn independently, think critically and creatively, LKS are designed in the form of activities that students must do, have components complete and systematic.

Media expert validator

Validation of media experts was carried out by filling out a questionnaire instrument for assessing the graphic aspect of the feasibility of the worksheets which consisted of 3 assessment indicators, namely the design of the content of the worksheets, the design of the cover of the worksheets, and the suitability of the size of the worksheets with ISO standards with a total of 33 statements from all indicators. This assessment was given by 2 media expert validators, namely Mr. Fajar Adinugraha, M.Pd and Ms. Risma Uly Manalu, S.Kom, M.MSi

Based on the results of the data analysis in the second stage after the revision, the average percentage of LKS eligibility scores was 94.7% of the total of each indicator developed, where the LKS based on a scientific approach on business materials and energy class X was included in the very feasible criteria. The results of the feasibility test on the graphic aspect of the LKS based on a scientific approach to the developed business and energy materials are presented in the Table 4.

Table 4. Analysis of the Feasibility Aspects of Student Worksheet Design

Aspect	Percentage	Category
Content Design	95.8%	Very Worthy
Cover Design (Cover)	93,3%	Very Worthy
Size conformity with ISO standard Content Design	95,0%	Very Worthy
Average Score	94,7 %	Very Worthy

Based on Table 4 analysis of the media feasibility aspect can be seen from each indicator, namely the design of the LKS content obtained by 95.8%, the cover design of the LKS (cover) obtained by 93.3% and the conformity of the size of the LKS with the ISO standard obtained by 95 .0% so that it shows the criteria is very feasible. This is supported by research by Khoiriyah (2013) which states that the LKS developed has an attractive quality with a score of 3.05 and is easy to understand with a score of 3.17, and is effective for use as a learning medium with a completeness percentage of 93.02%.

3.5 Design Revision

After the validator validates, the data obtained in the form of criticism and suggestions for improvement by the expert validator are used by researchers to revise the development of LKS based on a scientific approach on work and energy materials in class X. The development of LKS based on a scientific approach on the work and energy material for class X is declared valid because it has been revised. The next step, LKS is made in PDF form to be tested in a limited class/limited product trial. The worksheets are tested online to students because the learning process currently applied is distance learning.

3.6 Limited product trial

The limited class trial was carried out using LKS based on a scientific approach to 40 students in class X MIPA 3 and X MIPA 4 at SMAN 37 Jakarta. In this limited class trial, 20 students were taken from each class as respondents. At this stage, the worksheets are tested online to students during physics lessons. Then to find out the student's response to the development of LKS based on a scientific approach by using a response questionnaire sent to online-based students. The product is assessed from the student response criteria which consists of 4 assessment indicators, namely interest, material, language, and scientific learning

components. The following are the results of the analysis of student response questionnaire data obtained in Table 5.

Table 5. Student Responses Result

Aspect	Percentage	Category
Interest	80%	Very Positive
Material/Content	83%	Very Positive
Language	84%	Very Positive
Components of scientific learning	84%	Very Positive
Average Score	**83%**	**Very Positive**

Table 5 shows the data on the results of student responses to the use of physics worksheets based on a scientific approach on the material of work and energy. In table 4.4 there are 4 aspects of the assessment indicators, namely interest, material/content, language and scientific learning components.

Based on the data in the analysis criteria table for changes in scores to percentages, it can be seen that the interest aspect gets a percentage of 80% with a very positive category. The material/content aspect gets a percentage of 83% with a very positive category. The language aspect gets a percentage of 84% with a very positive category. Aspects of scientific learning components get a percentage of 84% with a very positive category. Student responses to the attractiveness aspect of LKS are lower than other aspects. This can be seen in the results of respondents' answers to the attractiveness aspect of LKS based on a scientific approach, most of which stated that the answers strongly agreed and agreed.

However, there were several respondents who stated that they did not agree with several statements in the questionnaire that supported the attractiveness aspect. This means that there are several parts that may need to be improved in order to get LKS based on a scientific approach to development results that are truly appropriate and desired by students. The average score for all aspects is 83%, so it can be concluded that the student's response to the use of LKS based on a scientific approach to class X's business and energy materials is very positive. The following is a graph of student responses to the use of LKS based on a scientific approach.

3.6 Product Revision

The results of the analysis of student response data based on the response questionnaire obtained an average percentage score of 83%, namely in the positive category. So that there was no unfavorable response from students who required the scientific approach-based worksheets to be revised again.

4 Conclusions

Based on research and development conducted by researchers, it can be concluded as follows: Student Worksheets (LKS) Based on Scientific Approach on Class X Business and Energy Materials are suitable for use in the learning process activities. This can be seen from the average percentage score of the material expert's feasibility aspect of 94.8% and the media graphic feasibility aspect of 94.7%. Based on the results of expert validation, the LKS product has been declared feasible. Student responses to the developed LKS products received positive responses from limited product trials. It can be seen from the aspect of interest getting a percentage of 80% in the positive category, the material/content aspect getting a percentage of 83% in the very positive category, the language aspect getting a percentage of 84% in the very

positive category, the scientific learning component aspect getting a percentage of 84% in the very positive category.

Research and development carried out only looks at the feasibility of LKS products and student responses. The development is carried out until the product trial stage is limited, for further researchers it is better to carry out main field trials. The composition of images and designs on the worksheets can be made even more interesting to motivate students to learn physics concepts.

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