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Development of Student Work Sheets Based on 5E Learning Cycle on Simple Harmonic Materials for Technology and Engineering Programs of Vocational School

Handono Suwarno[1], Agus Suyatna[2*], Posman Manurung[3]
[1]SMKN 1 Seputih Agung, Central Lampung, Indonesia
[2]Faculty of Education and Teaching Training, Lampung University, Indonesia
[3] Faculty of Mathematics and Natural Sciences, Lampung University, Indonesia

Abstract:- The education paradigm undergoes a shift that leads to constructivist learning, which initially from teacher-centered becomes student-centered. Constructivistic learning models emphasize the sincerity of students in shaping the knowledge that will be absorbed. One constructivist based learning method is the 5E learning cycle, which will be applied in instructional media in the form of student worksheets for vocational high schools. This development research aims to develop worksheets products in simple harmonic motion materials that are valid for vocational high school technology and engineering programs. The research design refers to the research and development of Borg and Gall until the stage of product testing. Data were collected by expert validation questionnaire, readability questionnaire, convenience questionnaire, attractiveness, benefit and test of student learning outcomes. The product of the development was tested at SMK Negeri 1 Seputih Agung, Central Lampung Regency to find out its effectiveness aspects using a non-equivalent experimental design pretest-posttest control group design. The statistical test of the independent sample t-test was used to test the truth of the hypothesis about the difference in normalized gain values of the experimental class and the control class, while the hypothesis of the average pretest-posttest difference was tested by paired sample t-test. Learning in the experimental class uses development product worksheets while the control class uses conventional worksheets. This study provides results in the form of validation of media experts getting 100%, material experts at 100%, and linguists by 100%. The average normalized gain of the experimental class is 0.4645, higher than the control class of 0.4281. The level of product attractiveness is very high at 80.87%, the high facilitation aspect is 77.86% and the benefit aspect is very high at 80.36%. Other results obtained that students are eager to do activities that can get skills that can be used for everyday life.

***Keywords*:-** *5E Learning Cycle, Student Worksheet, Simple Harmonic Motion.*

I. INTRODUCTION

Learning is a communication activity that is built by the components involved in it such as teachers, students and infrastructure. Good learning requires careful planning. A good learning process will occur if the interaction between teacher and students is in two directions.

Physics learning is one branch of natural science that studies material and phenomena that occur in the universe. Learning physics means learning to study nature, thus the ability to solve problems becomes the main goal of physics learning (Korskunsky, 2004). But in reality, students experience limitations in doing so. The reason that can be identified is that the teaching method used by the teacher may not be attractive so students are more likely to drop Physics as a choice more than the second (Gunasingham, 2009).

The results of observations in the field, the lecture method is still a method by the teacher in learning physics in the classroom. Activities that occur are mostly carried out by the teacher. Students only pay attention to the teacher and record what the teacher wrote on the board. Students don't do much activity. This is coupled with the absence of supporting facilities such as laboratories for the practice of physics. Not every school has laboratory space, especially in suburban schools. This limitation can make physics more abstract and difficult for students to understand (Ornek & Zziwa, 2011). Research conducted by Rusilowati (2007) found a misconception on vibration / wave, while Mulya's research (2011) found misconceptions in vibration material, namely the definition of vibration, differences in deviation and amplitude and factors that affect the frequency of springs. Arifiadi & Djudin (2013) mediated vibration material with flip chart media.

The learning cycle is a planning method that is quite influential in the science of education and consistent with various contemporary theories about how individuals learn. Lawson et. al (1989) introduced the terms Exploration, Term Introduction and Concept Application for the learning cycle that he developed. This cycle then develops into a 4E learning cycle consisting of exploration, explanation, expansion, and evaluation (Martin et. al, 2005). BSCS builds

teaching consists of five phases namely, Engagement, Exploration, Explanation, Elaboration and Evaluation or called 5E (Collette & Chiappetta, 1995).

Research that uses the 5E learning cycle on physics material has been carried out, including motion and style (Acisli, et. al., 2011), bullet motion (Ornek & ZZiwa, 2011), heat transfer (Putra, et. al., 2018), heat and temperature (Kurnaz & Calik, 2008), static fluid (Pratiwi, 2014), energy (Lalawi, et.al, 2017), elasticity and Hooke's law (Lahmita et.al, 2016).

Research that uses the 5E learning cycle at the vocational school level in physics in Indonesia is still very little. Faizah, et. al, (2017) conducting research on the use of the learning cycle model in physics lessons at Vocational Schools provides an increase in student learning activities. Research using the 5E learning cycle on simple harmonic motion material has not been found.

II. THEORITICAL REVIEW

The 5E learning cycle is one of the learning approaches that applies the inquiry approach in it. This learning cycle results from the development of the previous learning cycle. There are 5 steps that must be applied by the teacher in the class so that the students are active in learning namely Engage, Explore, Explain, Elaboration, Evaluation. Each phase has a specific function and contributes to coherent instruction of the teacher, and formulates students from a better understanding of knowledge, attitudes, and skills in science and technology (Bybee, et, al, 2006).

The steps of each stage are as follows: (1) Involve Stage (Engage): In this stage the teacher usually asks questions or displays something funny and interesting that relates to the problem to be discussed to attract students' interest and attention in learning. The goal is not to find the right answer but to make them ask different questions and ideas. (Feizioglu & Ergin, 2012). (2) Explore stage (Explore): At this stage students discuss in groups to produce some ideas to solve problems. The function of the teacher at this stage is as a guide (Feizioglu & Ergin, 2012). (3) Stage Explain: The results of group work are used as material for class discussion. Students will exchange opinions to discuss the findings of each group. The teacher makes connections between what students learn and what they know beforehand. Next, the teacher gives questions to help students to formulate the concepts of the lesson. At this stage the stage is the most teacher-centered and in the situation required the teacher provides several explanations at the level of basic knowledge. (Bybee, et. al. 2006) (4) Complex stage (Elaboration): At this stage, students are given new problems in the form of new, more complex problems. In this way, they learn new concepts that are not in their minds. Students are encouraged to use newly acquired knowledge, skills, terms and concepts into new situations to apply the things they have learned. (Bybee, et. al., 2006). (5) Evaluation Phase: At this stage, the teacher can conduct a learning evaluation. Evaluation can also be done at each stage, in order to know the development of the learning process experienced by students. (Feizioglu & Ergin, 2012).

The results of Bilgin et. al., (2013) study stated that the 5E learning cycle gave high results to get changes in concepts in learning science concepts and students' understanding of concept words in science lessons. Fajaroh and Dasna (2003) stated that the 5E learning cycle provides an opportunity for students to actively understand concepts in groups. This model can also strengthen the understanding of students' concepts through learning activities that are repeated and expanded in the five learning cycles. The Learning Cycle model that is applied also provides the opportunity for students to be active in learning, so as to be able to increase activity through experiments or practicums involving students directly (Kulsum, 2011). The 5E learning cycle model is a learning model that provides active learning experiences and promotes student inquiry and exploration as a process of learning science. Students build new understanding and develop new skills (Ornek & Zziwa, 2011).

The effectiveness of the 5E learning cycle in learning using worksheets has been done a lot, such as the research conducted by Acisli, et. al (2011) in displacement and style, stating that students can discover and learn the main concepts of independent learning by questioning, seeking, using primary knowledge, associating with everyday life, organizing observations, and observing independent experiments. Kusuma & Rakhmawati (2014) stated that the use of the 5E learning cycle can make students apply high-level thinking skills (HOTS). Kulsum (2011) also provides research results in the form of active students in learning. This means that the use of the 5E learning cycle as a learning model can improve the learning activity process. The use of the 5E cycle in practicums with easy-to-obtain and low-cost materials also gave good results as did Ornek & Zziwa (2011) who calculated the gravitational acceleration using materials around the school.

The purpose of this study is to produce worksheets (WS) based on the 5E learning cycle on simple harmonic motion material for vocational technology and engineering programs that are valid, easy, interesting and useful.

III. METHOD

The research method used is the development research method. Development refers to the steps proposed by Borg & Gall (1989). Of the ten steps of development, this research is limited until the product testing, namely: (1) analysis of research, needs analysis and proof of concept; (2) product planning and design; (3) initial product development; (4) initial field test; (5) product revisions; (6) large field tests; (7) and final product testing revisions. The preliminary stage is done by distributing questionnaires, conducting interviews, literature studies and field observations to obtain the data needed. Questionnaires circulated to determine the needs of teachers and students in learning. Literature study activities to find literature in the form of the results of previous studies that support this

research. The planning stage is done by drafting a prototype of the student worksheet. The research subjects consisted of material experts, design experts, linguists and one on one test. Data collection techniques using expert validation instruments, readability questionnaires and questionnaires on ease, attractiveness and usefulness of worksheets and student learning outcomes tests before and after learning using WS based on 5E learning cycle compared to conventional worksheets. The study design used quasi-experimental nonequivalent pretest-posttest control group design. The research trial subjects used purposive sampling, namely choosing two classes each for the experimental class and the control class at SMKN 1 Seputih Agung. Data processing techniques by conducting an analysis of the questionnaire expert validation test, small group test, as well as questionnaires of attractiveness, convenience and usefulness. Student learning outcomes were analyzed by normality test and homogeneity test. Two different mean tests were conducted to determine the significant level of difference in posttest results between the experimental class and the control class. Analysis of normalized gain values was conducted to determine the effectiveness of WS developed using formulas according to Hakke (1998).

IV. RESULTS AND DISCUSSION

A. Student Worksheets validity

The average results of student questionnaire answers were obtained 65.9% and the average results of the teacher questionnaire answers were 93.75%. From the results of the questionnaire that was disseminated it was seen that the teacher still used traditional methods, namely still using the lecture method for delivering material. Even though the lecture method conducted by the teacher causes students to only gain oral knowledge so that the knowledge gained by students is abstract knowledge, while physics lessons are closely related between concepts and environment (Damayanti, 2013). Submission of facts given by the teacher is also considered by students to be less so that students' interest and curiosity about the subject matter being taught. Question and answer activities that were carried out were not going well. Students feel less challenged with the situation, consequently students are given less opportunity to develop their thinking skills (Puspitasari & Aminah, 2014). Students should do a lot of asking questions, discussing, conveying ideas or ideas. This shows the activity of students who are good at learning.

The use of lecture methods conducted by teachers is inseparable from the existence of infrastructure in the school. From the results of the questionnaire it was seen that many students stated that the teacher rarely practiced. The results of observations in the field show that this school does not yet have a physics laboratory room. Practicum implementation must be carried out frequently in order to explain the concept of physics. Ornek and Zziwa (2011) gave an example of doing a practicum to calculate the value of gravitational acceleration using simple and easy-to-obtain materials. This shows that if the school does not have a physical laboratory facility with complete practical equipment, it can be anticipated by doing a simple lab using simple equipment.

From these results the authors see there are similarities in the needs of teachers and students in learning physics in SMKN 1 Seputih Agung, which requires an improvement in the learning process. Improvements, especially in increasing student activity when studying physics and overcoming the lack or absence of teaching materials in school. The lack of teaching materials can be overcome by making WS. Whereas to increase student activity, a 5E learning cycle is applied.

WS is a way to facilitate teachers in carrying out the learning process and facilitate students to learn independently and learn to understand and carry out a written task. Written assignments given by students can be theoretical and practical assignments. The theoretical task can be the task of reading learning resources, making a resume and practical assignments that can be in the form of laboratory work or field work (BSNP, 2006).

The use of worksheets provides more effective results if compared to groups given individually (Kurnaz & Calik, 2008), whereas if practicing, practicum materials can be used from the environment and at low cost (Ornek & Zziwa, 2011) and student motivation increases if the practicum material is used appealing to students (Turk & Calik, 2008). For secondary school students, the contents of WS are more abstract in accordance with the level of mental development of those who are capable of formal thinking (Suyanto & Wilujeng, 2011).

WS learning materials based on the 5E learning cycle were developed based on the stages of research and development of the Borg & Gall model which included: 1) the preliminary research stage; 2) the initial stages of product development planning; 3) expert test stages; 4) Revision stage of product I; 5) initial field test stage; 6) Product revision stage 2; 7) field product testing stage. The material chosen is simple harmonic motion which includes vibrations, waves and sounds that are taught for vocational students in the Technology and Engineering program. Based on the suggestion from the validator, that worksheets must direct students to have lifeskill skills, then changes to the elaboration phase (application) on sub WS 3 are carried out by giving the task of making skills that produce a product. This is in accordance with Tuwoso's (2016) research that one of the learning approaches that can be done in vocational schools is a production-based learning approach.

B. Student Learning Outcomes

The activity of using the results of research and development products begins with the pretest in the experimental class and the control class. This is intended to find out the initial abilities of students in mastering the material to be taught. Based on the results of testing that the average value of the experimental class is higher than the control class with values of 33.86 and 29.12. Both classes have a normal and homogeneous distribution which means that both classes have the same data. The low average value

on the pretest results shows that students' initial understanding of the simple harmonic motion material is low.

The posttest learning outcomes of the experimental class and control class students obtained information that the average value of the experimental class was 64.29 and the average value of the control class was 59.41. After an average difference test was obtained the results of t test analysis at a significant level of 0.05 obtained a value of 0.037, which means that there are differences in learning outcomes between students who use WS based on 5E learning cycle with students who learn to use conventional teaching materials.

The learning outcomes of the experimental class pretest and posttest after the t test were obtained information found there were significant differences in student learning outcomes before and after using WS based on the 5E learning cycle. This is consistent with the research conducted by Acisli et al. (2011) that there are differences in the values of pretest and posttest in the experimental class when using the 5E learning cycle. The normalized gain values of the learning outcomes of the experimental class students obtained a value of 0.4645 and the normalized gain of the control class was 0.4281 which means it was in the medium category.

Komponen	Class	
	experiment	control
N-gain average	0,4645	0,4281
criteria	medium	medium

Table 1:- *N-gain* average of experimen class and control class

Although it is in the same category, but based on the t test, a significant value of 0,000 is obtained. This shows that even though the average value of the experimental class and the control class are in the same category, the use of WS based on the 5E learning cycle provides differences in learning outcomes compared to the control class.

C. Student responses to student worksheets

The results of the questionnaire given to students after the use of WS based on the 5E learning cycle regarding ease, attractiveness and usefulness can be seen in Table 2.

Aspect	Score	Percentage score	Criteria
attractiveness	3,23	80,87%	Very high
Convenience	3,14	78,39%	High
Benefit	3,21	80,36%	Very high

Table 2:- Results of a questionnaire on convenience, attractiveness and benefit

From Table 2, information can be obtained that the level of interest of students to use WS based on 5E learning cycle is 80.89% which means high category. This is in accordance with the results of the Kaltakci and Oktay (2011) study that learning using a worksheet prepared will help students as an effort to foster interest and sympathy of students in interesting physics lessons. The results of the questionnaire about convenience amounted to 78.39% which means in the high category. This is accordance with Belawati (2003), the purpose of preparing WS, which is to make it easier for students to interact with the material, improve the mastery of students 'material, train students' independence of learning; and facilitate the assignment of tasks. The results of the questionnaire on benefits obtained results of 80.36% which is included in the very high category. This is in accordance with the terms proposed by Nieven (1999) about a practical media if the media can be useful and easy to use for teachers and students.

D. Student activities towards worksheets based on 5E learning cycle

The implementation of learning activities in the phase of student involvement is done by giving a number of images that must be answered by students to determine the choice of vibrating objects. This is done to attract students' interest in learning and arouse the knowledge they have to be associated with the material to be taught. The purpose of this drawing is to capture the imagination of students and be successful if they are actively motivated to ask questions and learn them. (Acisli, et al, 2011). Debate among students arises by conveying the reasons for choosing an image. Students who have high motivation in learning physics will get higher benefits than those who have low motivation (Pesman, 2015).

The next step is the implementation of the exploration phase, the activity carried out by students is to conduct a vibration experiment lab. Practicum done in a class in the form of a pseudo laboratory. Determination of frequency and period of spring vibration was chosen because springs are more common in students of technology and engineering programs in productive learning activities. Students discuss to determine the initial guess about the spring period. They will also work together to develop equipment and practice materials in accordance with work procedures in the WS. They will collect data as a basis for answering questions on WS. Discussions were conducted to link information and data obtained to be associated with their initial knowledge. The activity they did was in accordance with Ausubel's theory in Dahar (2011) that meaningful learning is a process of linking new information or material with relevant concepts contained in one's cognitive structure. The curiosity of students increased when proposing to measure the level of intensity of their motorcycle exhaust sound. Practical activities extend to the parking lot. This is consistent with the research findings by Acisli, et. al. (2011) that students can find and learn the main concepts of course in their own way of questioning, searching, using primary knowledge, associating with everyday life, organizing experimental tools, and testing their own experiments.

Phase explanation is the phase where students begin to describe what they have learned and understand the material that has been received so far. Students are asked to explain in front of the class the answers to the questions raised in the WS. They display the results of their group discussions and provide answers in accordance with the results of the experiments they did. Students 'interest in expressing

opinions, issuing presumption answers, conducting investigations, then conveying the results of activities in front of the class, is in accordance with research conducted by Faizin et al. (2018) which states that the application of 5E learning cycle models is effective in improving students' scientific attitudes. .

Although Yaman & Karasah (2018) in its research findings stated that the 4E learning cycle has a greater effect in increasing the level of success of learning science, but the 5E learning cycle is more recommended in the field of science education to a significant degree.

In the elaboration phase, students create by making equipment related to simple harmonic motion material but which can be used as a product for everyday life. Simple equipment that is easy to make is to make flutes from paralon. This activity is in accordance with research from Aktas (2013) that in the elaboration phase, the goal is to apply new knowledge and skills to new situations. This is done by the teacher by providing feedback and supporting new material to the class (Cheng, et, al, 2016).

Whilder & Shuttleworth's (2004) research states that 5E learning cycles guide students through learning sequences where they are involved in a topic, explore the topic, give an explanation for their experience, describe their learning, and evaluate it. Although Yemen (2018) in its research findings stated that the 4E learning cycle has a greater effect in increasing the level of success of learning science, but the 5E learning cycle is more recommended in the field of science education to a significant degree.

V. CONCLUSION

WS based on 5E learning cycle on simple harmonic motion material for Vocational Technology and Engineering Programs The results of research and development meet valid requirements for material depth, language and construction. The aspect of attractiveness, convenience and expediency is also met with high results. There are significant differences in learning outcomes between students who use WS as a result of development compared to students who use conventional WS. Students can also develop skills in the form of lifeskill by utilizing the concept of simple harmonic motion. The results of this study are suggested to be able to be used as alternative learning resources for physics learning in vocational schools of technology and engineering programs so that students can be more active in classroom learning.

SUGGESTIONS

- WS teaching materials based on the 5E learning cycle on simple harmonic motion material can be used in the Vocational Technology and Engineering program to facilitate physics learning.
- WS teaching materials based on the 5E learning cycle on simple harmonic motion material need to be tested on a broader scale in vocational schools that have a Technology and Engineering expertise program.
- WS teaching materials based on the 5E learning cycle can be further developed in different physics subject matter.

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