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Development of Miniature Steam Power Plants as a Media for High School Physics Learning (SMA)

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ABSTRACT

This study aimed to produce a product development in the form of miniature steam power plant that can be used by teachers and students in the learning process to improve their knowledge of physics and scientific thinking skills of students in learning physics to material changes in energy class XI High School. The study was conducted in December 2011 - January 2013 at the Laboratory of Mathematics and Natural Sciences Department of Physics-UNJ. This study uses the research & development (research and development). The study was conducted in several stages: (1) preliminary study, (2) designing media, (3) creation media miniature, (4) functional test and media characteristics, (5) the development of miniature media design, (6) validation by experts (teachers), teachers and students. The trial results miniature steam power plant show that the miniature steam power plant is a medium of learning as a demonstration tool that can assist teachers in delivering learning materials and messages and to develop science process skills. The trial results miniature steam power to attract students in learning physics with topics of interest and use to them so it's easy to understand the material and the message conveyed and the learning that can develop science process skills.

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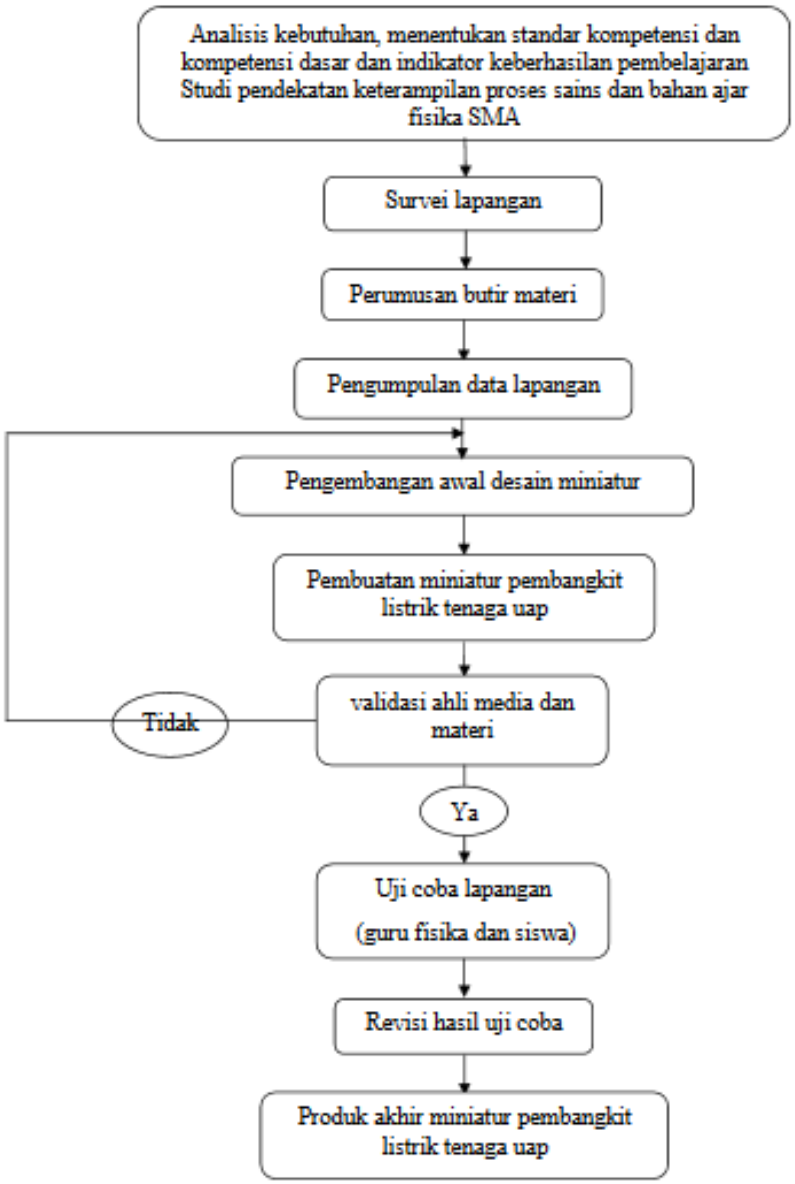
1. INTRODUCTION

Research on physics learning shows that many factors can make learning physics more interesting, easier to understand and can foster student motivation in learning. Active student involvement is one of the most important factors in achieving the learning process. Students are actively involved in the process of observing, operating a device, or practicing using concrete objects as part of a lesson (Supriono, 2003). Research in the development of instructional media is also often done in an effort to find alternative solutions to problems in learning physics. The use of instructional media in the teaching and learning process can arouse new desires and interests, generate motivation and stimulation of learning activities and even bring psychological influences on students.

The use of instructional media will greatly assist the effectiveness of the learning process as well as the delivery of messages and lesson content so that it can help students improve understanding because it presents information in an interesting and reliable way. This enables the achievement of learning objectives, which in turn can improve student learning processes and outcomes (Azhar Arsyad, 2002).
In the learning process, teachers should use a variety of media and use them to facilitate the delivery of learning materials and messages. Tools that are used such as miniatures, models, props, visual aids and others can help provide concrete experiences and increase learning motivation and increase student absorption. One of the roles of the teacher in learning is as a mediator and facilitator, where the teacher can work on learning resources, choose and use and work on learning media (Azhar, 2005).
The use of miniatures in high school physics learning can provide experience to be able to submit and test hypotheses through experiments, designing and assembling experimental instruments, collecting, processing, interpreting, compiling reports and communicating experimental results verbally (Depdiknas, 2003). In this case students are trained to develop a number of scientific skills which are also called science process skills. Based on the results of student questionnaires showed that 71.43% of students found it difficult to understand physics. By reason of too many symbols, formulas, and terms used as many as 71.43% of the respondents, the reasons for the unclear presentation were 28.57% of the respondents, 85.71% of the respondents had never used media in the form of miniature power plants, then also obtained data that 93.88% of respondents supported , and interested in the development of supporting physics learning in the form of steam power electricity generation media. Based on the things mentioned above, researchers produce miniature media can be used as an alternative to present physics learning to be more interesting. One of the subjects of physics that can use miniatures in classroom learning is the subject of energy change. The use of this miniature is designed to achieve Competency Standards to analyze and visualize changes in energy in the surrounding environment. Research on miniature development as a medium for learning physics aims to improve the quality and quality of physics learning, and is expected to be part of the solution to current physics learning problems.

2. METHOD

The research method used is development (Research and Development). Research development is a process or steps to develop a new product or improve existing products, which can be accounted for. Development research is a process used to develop and validate a package of educational materials, such as learning materials, textbooks, learning methods, instructional designs, which are used in a research development. The resulting product is a miniature set of steam power plants. The use of miniature steam power plants is expected to be an alternative that can be used in explaining material changes in energy in learning physics.



The steps of development research can be grouped into three stages, namely: (1) Preliminary Study; (2) Manufacturing Stage; (3) Implementation Stage. The activities carried out are as follows:

1. Introduction Study

A preliminary study was conducted to obtain information and analyze the problems and needs of teachers in schools to convey the concept of energy change. The preliminary study consists of several stages, namely: The first step, the literature study aims to gather information and theories related to existing problems, especially energy learning. The second step, which is conducting a field survey to obtain data about the real conditions that exist in learning energy. Then the literature study and survey data are analyzed, to form the theoretical model framework to be developed. The third step is to arrange the data collection instrument grids, followed by the fourth step, which is to prepare instruments to assess the learning material requirements. The fifth step is collecting field data.

2. Making Phase

At the manufacturing stage begins by determining the initial design of a miniature steam power plant, the initial design is based on a typical power plant model. Material and material needs for the manufacture of miniature steam power plants are very minimum. The main part of this miniature steam power plant is a series of steam generators

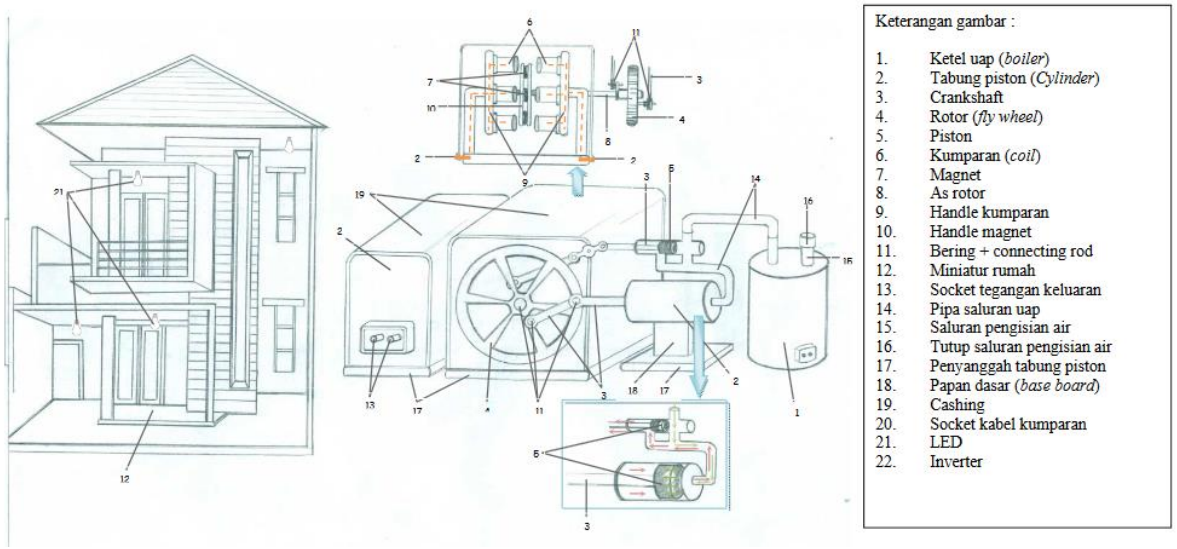
(boilers) connected to pistons and power plant generators which are arranged in the initial design of the initial design of the tool. In the steam engine section, steam generated in the boiler (heating tube) is flowed to the piston so that the steam pressure will move the piston. The rotor that is connected to the piston will automatically rotate too. So that the magnet that is connected to the rotor will rotate and will be tangent to the coil that was described in the initial design. The rotation of the rotor is what will affect the size of the electric voltage generated, the faster the rotation of the rotor, the greater the voltage generated. Furthermore, making a miniature electricity generation as a whole.

3. Validation Phase

The completed miniature model is then made through a validation test by experts. The validation test aims to determine the validity of the resulting miniature model of teaching aids. The validation test consists of material experts and media experts (lecturers) and physics teachers. Material experts and media experts, each consisting of 2 lecturers and a physics teacher consisting of 3 teachers.

4. Implementation Phase

The set of experiments that have been validated will be tested on high school students. Students who participated in the observation of a miniature model of teaching aids were one class. After students take part in the trial props, students are then asked to fill in the questionnaire.



Keterangan gambar :

1. Ketel uap (*boiler*)
2. Tabung piston (*Cylinder*)
3. Crankshaft
4. Rotor (*fly wheel*)
5. Piston
6. Kumparan (*coil*)
7. Magnet
8. As rotor
9. Handle kumparan
10. Handle magnet
11. Bering + connecting rod
12. Miniatur rumah
13. Socket tegangan keluaran
14. Pipa saluran uap
15. Saluran pengisian air
16. Tutup saluran pengisian air
17. Penyanggah tabung piston
18. Papan dasar (*base board*)
19. Cashing
20. Socket kabel kumparan
21. LED
22. Inverter

Miniature steam power plants were developed through the study of literature using several textbooks, journals and searching through the internet. Research on the development of miniature steam power plants is carried out in several stages, namely: 1. Requirement analysis Requirement analysis is the first step in media development. It aims to determine the miniature steam power plant is needed as a medium for learning high school physics.

Development of a miniature design of a steam power plant The initial design development starts from creating a story board, with the story board making it easier to work on the tool because it visualizes the scenarios in written form into images. After the storyboard is finished the developer starts to design the miniature part manually. Miniature media created are adapted to predetermined scenarios. 3. Making miniature The process of making a miniature is divided into three parts, namely: a. The boiler section (water heater) The boiler section uses stainless steel material, this boiler uses a

casing (cover) the boiler uses wood material that functions as an insulator. In the boiler section there is also a tap that functions as a valve opening and closing the steam channel, besides the boiler is equipped with a barometer as a pressure gauge on the boiler. (fig. 1, 2) b. Steam engine parts (steam engine) Most of the steam engine uses materials in the form of brass and stainless steel. The steam engine consists of two pistons, the first piston tube using brass with an inner diameter of 20.9 mm and a piston diameter of 20.6 mm while the second piston tube with an inner diameter of 7.1 mm and a piston diameter of 6.9 mm. There is a flywheel that changes the piston back and forth into a circular motion. Between the piston and flywheel is connected by a sleeve made of brass which is commonly called a crankshaft. (figure 3) c. Generator section In this section there are coils and magnets that function as converters of mechanical energy into electrical energy. The coil is part of the stator (silent). Total coils are 12 coils arranged in pairs, between pairs of coils there are magnets as commutators (moving) which are arranged in the same magnetic field direction. This generator also has an electric circuit and a microcontroller to measure rotation speed. Display the resulting voltage value and rotor rotation are shown on the LCD, there is an ON / OFF button and there is a USB cable connector to the computer. In this section there are electrical circuit components and a microcontroller to operate and display data to a display or screen. (figure 4) d.Model housing estate In this section there is a housing design that shows the actual situation and conditions. This model consists of 6 houses and one sutet pole, one house consists of one LED and the sutet consists of 4 LEDs. 4. Initial trials by miniature media experts that have been made and then tested by material experts and media experts. The trial was conducted by 4 people consisting of 2 material expert tests and 2 media expert tests to conduct trials on miniature steam power plants. Each expert is given an observation sheet containing statements relating to the suitability of the media with the intended aspects.
Testing of physics teachers After the expert test has been done and has been improved, then a small-scale trial of physics teachers is conducted. A trial of physics teachers was conducted at SMA Negeri 71 Jakarta. Physics teachers who conduct trials as many as 3 people, each teacher is given an observation sheet as a reference to do the trial.

Sample
The set of experiments that have been validated will be tested on high school students.

Instrument
essay with the formulation of the problem and research objectives, this study uses research instruments in the form of:
1. Observation
The observation instrument is used as a reference for miniature trials of steam power plants by media experts and material experts as well as physics teachers and testing students in the learning process.
2. Questionnaire
The questionnaire instrument was used to determine students' interest and motivation in learning physics using miniature media for steam power plants. The rating scale used in each of the miniature steam power plant media questionnaires consisted of five categories, namely:
Score 5: Strongly Agree
Score 4: Agree
Score 3: Neutral
Score 2: Disagree
Score 1: Strongly Disagree

The limits of the accuracy and appropriateness of the miniature model of the power plant to be used as a learning aid are based on the criteria of interpretation of scores for the Likert scale (Ridwan, 2005: 87), namely:
0 - 20%: Strongly disagree
21 - 40%: Less
41 - 60%: Enough
61 - 80%: Good
81 - 100%: Very good

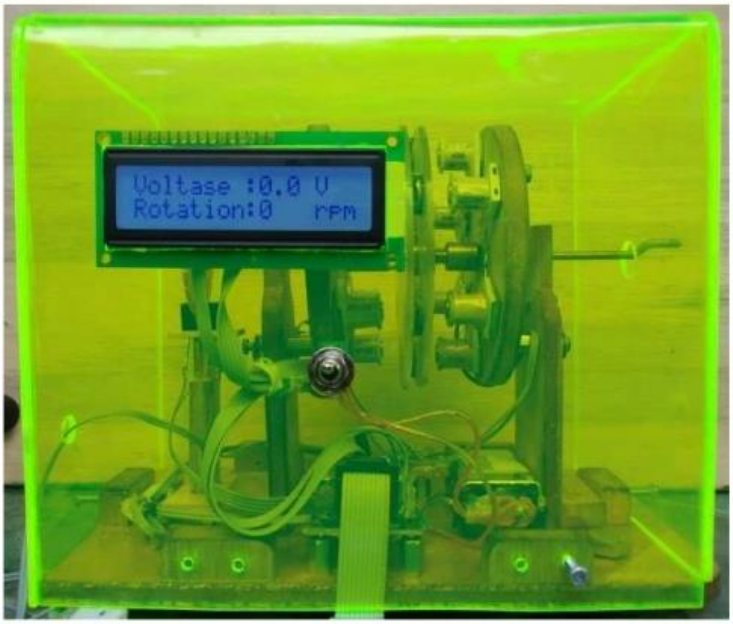
3. RESULTS AND DISCUSSION

Development Stage of Demonstration Media

Previous miniature steam engines were already commonly referred to as steam engine models. The current research development is to develop the model with a miniature model of steam power plants. By adding a generator that functions to convert kinetic energy into electrical energy. This miniature development can be seen from several electrical and non-electrical aspects, form or appearance and is a simple description of the steam power plant (PLTU) that exists in everyday life. Miniature steam power plants were developed through the study of literature using several textbooks, journals and searching through the internet. Research on the development of miniature steam power plants was carried out in several stages, namely:
1. Need analysis
Needs analysis is the first step in media development. It aims to determine the miniature steam power plant is needed as a medium for learning high school physics.
2. Development of the design of miniature steam power plants
The initial design development starts from creating a story board, with the story board making it easier to work on the tool because it visualizes scenarios in written form into images. After the story board is complete the developer starts to design the miniature part manually. Miniature media created are adapted to predetermined scenarios.
3. Making a miniature
The process of making a miniature is divided into three parts, namely: a. The boiler section (water heater) The boiler section uses stainless steel material, this boiler uses a casing (cover) the boiler uses wood that function as an insulator. In the boiler section there is also a tap that functions as a valve opening and closing the steam channel, besides the boiler is equipped with a barometer as a pressure gauge on the boiler.

b. Steam engine parts (steam engine)
Steam engine parts mostly use materials such as brass and stainless steel. The steam engine consists of two pistons, the first piston tube using brass with an inner diameter of 20.9 mm and a piston diameter of 20.6 mm while the second piston tube with an inner diameter of 7.1 mm and a piston diameter of 6.9 mm. There is a flywheel that changes the piston back and forth into a circular motion. Between the piston and flywheel is connected by a sleeve made of brass which is commonly called a crankshaft.

c. Generator parts
In this section there are coils and magnets that function as converters of mechanical energy into electrical energy. The coil is part of the stator (silent). Total coils are 12 coils arranged in pairs, between pairs of coils there are magnets as commutators (moving) which are arranged in the same magnetic field direction. This generator also has an electric circuit and a microcontroller to measure rotation speed. Display the resulting voltage value and rotor rotation shown on the LCD, there is an ON / OFF button and there is a USB cable connector to the computer. In this section there are electrical circuit components and a microcontroller to operate and display data to a display or screen.



d.Model housing mockups

In this section there is a housing design that shows the actual situation and conditions. This model consists of 6 houses and one sutet pole, one house consists of one LED and the sutet consists of 4 LEDs.

5. Test early by expert

Miniature media that have been created are then tested by material experts and media experts. The trial was conducted by 4 people consisting of 2 material expert tests and 2 media expert tests to conduct trials on miniature steam power plants. Each expert is given an observation sheet containing statements relating to the suitability of the media with the intended aspects.

5. Test the physics teachers

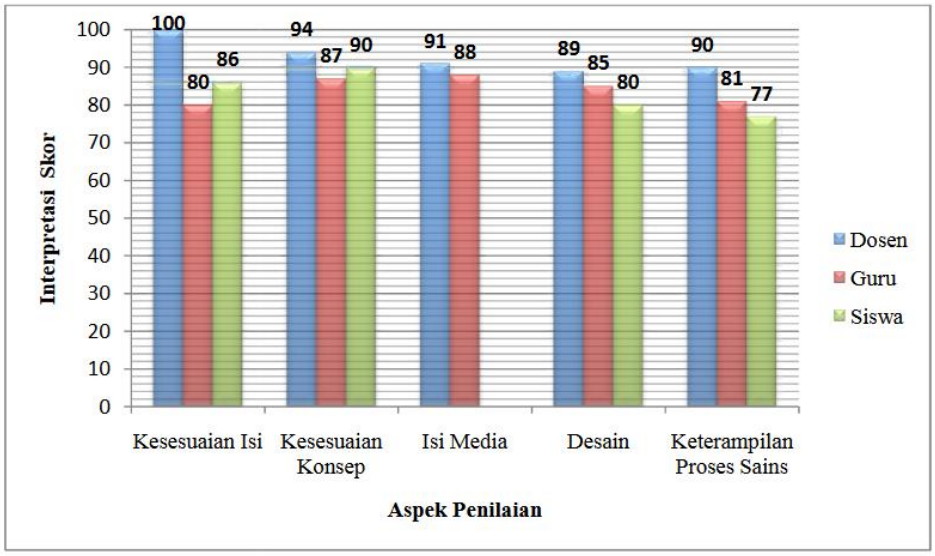
After the expert test is carried out and has been improved, then a small-scale trial of physics teachers is conducted. The trial of physics teachers was conducted at SMA Negeri 71 Jakarta. Physics teachers who conduct trials as many as 3 people, each teacher is given an observation sheet as a reference to conduct trials on miniature steam power plants from the aspect of content suitability which consists of 2 questions, the suitability of the concept consists of 5 questions, content the media consists of 4 questions, the design consists of 8 questions and the exploration of science process skills

consists of 5 questions.
6. Test students
Field testing of students was carried out at SMA Negeri 71 Jakarta with the target population being high school students grade XI. The trial was conducted by demonstrating a miniature steam power plant in the learning process. Observation of the miniature steam power plant is done to find out the science process skills that can be developed in learning physics. Then the students filled out the questionnaire sheet which consisted of 9 questions about students' interest in learning.
7. Improvement of the design of miniature steam power plants
Completion of the design of a miniature steam power plant based on input, suggestions and opinions from the results of trials that have been done previously. From the research stage, the development that has been carried out will produce a miniature media product for steam power plants with all the equipment.

Validity Test Results between Experts (Lecturers), Experts (Teachers) and Students
Media validation Miniature steam power plants are assessed by how many experts and students can assess the advantages and disadvantages of this miniature.

Validation test results of experts (lecturers) Based on the five aspects of assessment namely content suitability, concept suitability, media content, design and science process skills, the range of interpretation of average scores in the range of 80-100% (very good). In the validation test carried out that the miniature generator steam power is related to the suitability of the content standards in the SBC and the use of miniature media as a learning aid in schools to help students achieve the basic competencies that must be achieved. (figure 6) Miniature media that have been produced must be in accordance with the concept of physics so as not to cause misconceptions. In addition, miniature media must be interesting, practical, and easy to use so that it can attract students' attention when used in the learning process. Miniature media of steam power plants are expected to provide students with a direct and more concrete learning experience. After a validation test by experts, input is obtained which will be used by researchers to perfect and add value to the miniature display media. These inputs include: a. Need to be equipped with temperature control on the boiler so that temperatures capable of producing steam can be detected b. Need to be equipped with water control on the boiler to find out the volume of water that is in the boiler c. At the piston needs to be refined again to reduce the steam wasted d. Street lights on miniature houses are functioned to make it look more beautiful and attractive e. It is necessary to clarify the relationship between lamp intensity with voltage and rotation on miniature media. Teacher validation test Based on the five aspects of assessment namely content suitability gets an 80% score interpretation, concept suitability is 86.7%, media content is 88.3%, design is 85%, and science process skills are 81.3%. The range of interpretations of the average score is in the range of 80-100% (very good). (Figure 7) Overall, the validation of the miniature steam power display media by the expert (teacher) received various suggestions and input to add value to the miniature visual media, among others: a. The miniature model of the steam power plant to be made more practical and efficient. b. Sources of energy as electricity producers are endeavored to use sources other than electricity. c.Miniature models of steam power plants are strived to reduce the energy wasted into the environment. d. Learning models with the use of tools that are suitable for application in everyday life are very well introduced in the classroom, because they stimulate students to learn more practically and for teachers to stimulate more creative teaching. e. The results of making tools or models can be used as research and applied in everyday life. Test media demonstration of students Based on the results of trials on students, obtained interpretation of content suitability

scores (content), the suitability of concepts and designs in the range of 80-100%. While the interactive aspects are in the range of 70-100%. From the results of the questionnaire, students stated that it was easier to understand the concept of energy change. (Figure 8) In the basic competencies students must have on energy change material, namely to analyze energy change processes that apply the law of conservation of energy by making direct observations, students can gain direct experience gained from the surrounding environment. In addition, the miniature media that have been produced have some shortcomings, including there is difficulty in determining the amount of power produced and it is difficult to know the volume in the boiler. Therefore, further development needs to be done to increase the benefits of miniature media for steam power plants that have been produced.



In the aspect of assessment that discusses the suitability of the content in accordance with competency standards, basic competencies and indicators. In this case, it can be seen that the interpretation of the score of experts (lecturers) is higher than the interpretation of experts (teachers). The range of interpretation of lecturer and teacher scores is at a very good assessment level. It can be concluded that the miniature media of this steam power plant is in accordance with existing competency standards and basic competencies. In the aspect of assessment that discusses the suitability of the concept of understanding in the process of energy change. By showing the energy change processes more simply the level of assessment obtained by experts (lecturers and teachers) and students is at a very good level of assessment. In the aspect of assessment that discusses media content (media content) has the same range is at a very good assessment level. Assessment by experts (lecturers) is above the level of assessment by experts (teachers). In the aspect of assessment that discusses the design of tools that have LCDs on generators and use transparent (acrylic) covers, and on steam engine components that use brass, there needs to be some improvements so that the miniature media of steam power plants can be used more optimally. So the level of assessment by experts (lecturers and teachers) and students is about very good. Suggestions regarding the content of the media and the design of the tool are emphasized on improving the function of the media to be more effective with the complexity of the tool. In the aspect of assessment that discusses the science process skills. To find out the extent of the skills applied by students in the learning process by using media aids. The level of assessment by experts (lecturers) is above the level of assessments by experts (teachers) in a very good range. In the aspect of assessment that discusses the interactive only intended for students to be more motivating students to be more active. The level of assessment

obtained is in a good range.

4. CONCLUSION

The development of miniature display media was carried out to produce media in the form of miniature steam power plants. Based on the results of research and discussion, it can be concluded that miniature steam power plants can be used as high school physics learning media to explain the material of energy change. Miniature steam power plants are also in accordance with competency standards, basic competencies, and learning indicators in the Education Unit Level Curriculum. In addition, miniature steam power plants can facilitate students in understanding learning material, and can develop science process skills and can also be used by teachers as a demonstration tool that helps teachers to simplify and clarify the delivery of learning materials and messages.

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