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THE DEVELOPMENT OF RESEARCH-BASED PHYSICS LEARNING MODEL WITH SCIENTIFIC APPROACH TO DEVELOP STUDENTS' SCIENTIFIC PROCESSING SKILL

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ABSTRACT

Physics learning in SMA N 2 Padang was implemented through theory and practicum for verifying the theories. The results of the initial survey showed that the physics teachers had not yet applied the research-based learning. Supporting facilities such as physics lab and its equipment has been already available, but it has not been utilized optimally. Research-based learning is a model that can improve scientific processing skills and learning outcomes of students. The research aimed to produce a valid, practical, and effective research-based physics learning model and devices. This research was a research and development using the 4D model of Thiagarajan. The instrument of this research are interview guides, observation sheets, sheet of validation of model and learning tools, questionnaire for both teachers' and learners' responses, assessment sheets for scientific processing skills, and achievement test. The results showed that the developed model and the learning devices according to the assessment of experts were declared valid. Model and learning devices were practical based on the observation and the questionnaires. The application of research-based physics learning could effectively improve scientific skills and learning outcomes of students. This model is suggested to physics teachers in high school in regard with implementing research-based learning.

Keywords: research-based learning, scientific, scientific processing skill.

INTRODUCTION

Education is expected to produce students who possess the quality to live as a creative, innovative, intelligent, and globally competent individual. With respect to achieving national education goals, one of the Ministry of Education and Culture program is the development of Unit Level Curriculum (SBC) into Curriculum 2013. All levels of education within the frame of Curriculum 2013 is conducted using scientific approach. This student-centered approach is designed in such way that the learners actively construct concepts, laws, and principles through the stages of observing, formulating problems, constructing hypotheses, collecting data, analyzing the data, concluding, and finally communicating the obtained concept, law, or principle (Kemendikbud, 2013). Scientific approach is intended to provide a sense of convenience for learners in mastering the subject. Therefore, the learning environments are expected to encourage students to be active in finding out the case from various sources through discussion, observation, and through the practicum activities.

Implementation of Curriculum 2013 with the scientific approach can be performed on all subjects, including physic subject. Physic examines many natural phenomena using scientific methods, so that it does not only focus on mastery of knowledge in the form of facts, concepts or principles, but also the experience during the invention process using the skills of physical processes (MONE, 2006). The process of the invention can be carried out through inquiry practicum

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activities. Wahyudin & Isa (2010) stated that the application of guided inquiry learning methods can increase interest and understanding of high school students. Practicum is an integral part of learning physics. Learners do not merely learn the theory and calculations using the formula but also doing practicum to deepen the concept mastery.

Laboratory activities provide live experience in learning physics and improve the skills in using the tools, solving problems, and logical thinking. Practicum in physic has its own advantages, whereas learners gain live experience, increase the participation of students either individually or in groups, learn to think through scientific methods or practice the work procedures based on the scientific method. Learning physics with practicum activities are effective to achieve the learning objectives in all competences simultaneously. It also trains the students to apply the theory to be applied into real problems (cognitive), uses instruments (psychomotor) and exercises scientific attitude (affective). One of the advantages of learning by practicum is that the learners can repeat the same activities until they find the correct results. Practicum can be carried out with the help of learner's worksheets corresponding with certain learning model. But the real practices show that the worksheets used by teachers in the school have not yet fulfilled the correct structure proposed by the Ministry of Education (2008). They have not yet been equipped with the usage instructions, supportive information to raise the curiosity of learners, and assessment.

Based on the results of preliminary studies at SMAN 2 Padang, it showed that 71.3% of physics teachers have already used the appropriate learning materials in accordance with the Curriculum 2013. However, not all lesson plans and teaching materials created by the teacher support the achievement of core competences and basic competence in the physics subject well. Teachers still use the common students' worksheet which does not fully support all of the discussions and practicum.

Overall characteristics of learners gained from data analysis of the five indicators achieved an average value of 62.5%. The observed characteristics are the ability to think critically (56%), cognitive learning style (58), interest (63%), learning motivation (66%), and scientific attitude (67%) during the physics lesson. Characteristics of students during the learning process will affect the achievement of the learning objectives of physics. This is indicated by the less optimal learning outcomes of students of class X SMA N 2 Padang in the first semester of the 2015/2016 academic year. The mastery level of for physics subject of class X MIA 1 only resulted 43.8% from 32 students while class X MIA 2 even obtained lower score of 31.3% from 32 students. This indicated that the learning completion in the classical style classes were still below 85%.

The students' lacking in mastering the concepts of physics is caused by students lacking necessary skills such as problem-solving skills, science processing skills, thinking and reasoning skills. The aforementioned lacking can be observed from the physics learning process which mainly used lecturing method in the form of theory description, elaboration of formulas with the aid of mathematical operations, and solving the problems through calculation. Reif (1995) stated that the informative learning method will result in ineffective learning process since students only acquire nominal knowledge of physics rather than functional one. Many teachers admit that the lecturing method in teaching physics fails to instil a deep understanding toward physics concepts (Hake, 1998; McDermott &Redish, 2009; Redish, 2003). As a result, students do not have the required skills to solve problems and are not able to apply the material they have learned.

Based on the problems encountered in school, it is deemed necessary to develop a model of learning tools such as lesson plans, students' worksheet, modules, and assessment. The worksheet needs to be developed as the guide of learning implementation that supports the achievement of competence of knowledge, attitudes, and skills for students. It contains several work steps including thinking process, working procedure, creativity, and independence to rediscover the concepts, principles, rules, and laws of physics. One model of learning that integrates research within learning to solve the problem of physics is research-based learning. Using this approach, students are guided to solve the problem based on the fact they encountered. Research based learning can be implemented with a variety of learning methods, so that all learning outcomes obtained by students are originated from a simple research they conduct, for example through experiments and field studies (Kynäslahti et al., 2006; Griffith, 2008; Jyrhämä et al ., 2008; Ward, 2013). In physics, research based learning tend to be implemented in the form of practicum activities. By doing lab activities, students are expected to possess the scientific processing skills. This skill provides the students the opportunities to search for information, construct a hypothesis, collect data, analyze data, and make conclusions based on the live experience. The implementation of research based learning through practicum is for the students to have the scientific processing skills and character of a scientist.

Diah (2010) explains that the research-based learning is inspired by the philosophy of constructivism that includes four aspects: learning that builds students' understanding, learning by developing prior knowledge, social interaction learning, and meaningful learning which will be achieved through live experience. Research based learning is an authentic learning (there must be real example), problem solving (answering case and contextual), cooperative learning (togetherness), contextual (hands on and minds on), and the inquiry discovery approach (discovering) grounded on the philosophy of constructivism in which the students' development is cultivated continuously and sustainably. Arifin (2010) claimed that the stage of research-based learning are as follows: exposure stage (introduction stage), lecturing of core knowledge (the step of administering a reference), experience stage (action stage), internal report for feedback (the discussion stage), and the final.

According to Wardoyo (2013), research based learning has seven characteristics implied in the learning process: systematic, active, creative, innovative, effective, objective, and scientific. Those 7 characteristics are in line with the nature of physics learning in curriculum 2013 with scientific approach. Yahya (2010) explains the advantages of research-based learning model are to give enough opportunity for students to observe, to formulate hypotheses, to collect and analyze the data, and to make conclusion. Research-based learning in physics can assist learners in constructing concepts or principles of physics, make the learning more meaningful through the application of scientific processing skill. The result of relevant research shows that the application of life skills oriented research-based learning can increase the activity and essential concept mastery in the Thermodynamics subject (Syakbaniah, 2013). The use of research-based students' worksheet in physics is effective to improve the competence of students at SMAN 1 Padang (Usmeldi, 2015).

Research-based physics learning with scientific approach is expected to improve the students' competence mastering the concepts of physics, scientific processing skills, and having the scientific attitude. In relation with the aforementioned facts, two research problems are formulated: (1) How is the development of research-based physics learning model with scientific approach to improve students' scientific processing skill? (2) How are the validity, practicality, and the effectiveness of the research-based physics learning with a scientific approach?

METHOD

The study belongs to the research and development (R & D). Sugiyono (2011) suggested that research and development is a type of research methods used to produce certain product and testing its effectiveness. This study was conducted to obtain information about the users' needs (needs assessment), while the development activities was conducted to produce research-based learning model. The model used is the 4D development model by Thiagarajan. According to Thiagarajan in Trianto (2010), the stages of 4D are defining, designing, developing, and disseminating. The subject of the research is the physics learning model for high school students. The respondents are students and physics teachers at SMAN 2 Padang. The research instruments are the interview guides, observation sheets, sheet of validation of learning models, lesson plans, students' worksheet and assessment. All of those documents are based on the Instruction of Materials Development Guide (Ministry of Education and Culture, 2008). This research also uses questionnaires for teachers' responses and learners' responses, a test for learning outcomes, assessment sheets of scientific processing skill, and attitudes observation sheet.

Based on the collected data, it was analyzed qualitatively and quantitatively. Data of learning model validation, lesson plans, students' worksheet assessment, observation, questionnaires, and test results were analyzed descriptively and then compared with the criteria of validity, practicality, and effectiveness of the learning model. The learning implementation data were analyzed qualitatively by revising readability and action steps in students' worksheet. The revision was made based on the researcher's note, the results of observations toward the learning process, and also the opinions of experts and peers.

RESULT AND DISCUSSION

Research-Based Physics Learning Model with Scientific Approach

The research had produced a model of research-based physics learning with scientific approach. Research-based learning is a learning model that encourages research in the learning process. Research-based learning is ignited by the philosophy of constructivism that includes four aspects; learning that builds students' understanding, learning by developing prior knowledge, social interaction process learning and meaningful learning; in which all are achieved through live

Table 1. Results of Learning Model and Learning Tools Validation

No	Evaluated Aspects	Experts				Mean	Category
		FY	RL	AY	HY		
1	Learning model	79	86	93	91	87,3	valid
2	Lesson plans	89	87	90	91	89,3	valid
3	Students' worksheet	98	91	95	96	95	valid
4	Assessment	85	90	98	92	91,3	valid

Table 2. Students' Learning Outcomes

No	Outcomes Aspects	Meeting				Mean	Category
		1	2	3	4		
1	Knowledge	78,3	80,2	80,8	85,4	81,2	Very Good
2	Skill	71,4	74,5	86,2	88,1	80	Good
3	Attitude	81,6	83,5	85,4	87,2	84,4	Very Good

experience. Research is an important means to improve the quality of learning. Research components consist of background, procedures, implementation, results, discussion, and publication. The six stages of research-based learning model are: (1) exposure stage, (2) the lecturing of core knowledge, (3) experience stage, (4) internal report for feedback, (5) presentation, and (6) final report (Arifin, 2010). The research-based learning model is conducted using scientific approach.

Validity of Learning Model

Research-based physics learning model was validated by three experts. The evaluated aspects were contents feasibility, construction feasibility, and language accuracy. The results of the validation of learning model and tools (lesson plan, learners' worksheets, and assessment) can be seen in Table 1.

The results of the validation of learning models, lesson plans, students' worksheets, and the assessment indicated that the learning model and the learning devices belonged to the valid category.

The Practicality of Learning Model

The trial of learning model was conducted to obtain the data about the practicality of the model and the learning tools. The trial of the model was conducted in four meetings. During the trial, the researcher was assisted by physics teachers of SMAN 2 Padang as the observer. The teachers were in charge of observing the implementation of learning and learners' activity during the class. The practicality of the model was observed through the implementation of learning, and the responses of both teachers and learners. The results of the observations showed that the learning model could be implemented by teachers and learners well. Thus the researcher claimed that the research-based learning model with scientific approaches was practical.

The Effectiveness of Learning Model

The outcomes of the studies in terms of knowledge showed an increase at every meeting. The average value of the outcomes in terms of knowledge is 81.2 and learning completion percentage is 89.8%. The average value of the students' skill is 80 and learning completion percentage is 86.5%. Students' attitudes reached a very good category with an average of 84.4. More than 85% of students had met the criteria of learning mastery standard. Thus it was proven that the developed learning model was effective in improving scientific processing skills.

The integration of scientific approaches into the research-based learning process conducted by adjusting the learning steps. Research-based learning model with scientific approach generated in this study was pronounced valid, practical, and effective to improve the students' science skills. The results of this study are supported by the research conducted by Trisnasih (2013), and Xiaolai & Qinghuai (2011) in which they concluded that the application of research-based learning can enhance the activity, processing skills, and students' learning outcomes in science lessons. Learning with scientific processing skill approach can improve learning outcomes and student learning activities (Haryono, 2006); Susiwi et al., 2009; Wardani et al., 2009). According to Ausubel (Ango, 2002) the activities which cause the students to conduct an investigation into lab activities will cause the learning to

be more meaningful and encourage the development of student competence.

Research-based learning model with scientific approach was conducted in the laboratory. The importance of laboratory activities was to understand the concepts of physics for students which also presented by Ivins and Raghubir. According to Ivins (McComas, 2005), practicum is more effective to help learners in studying the physics concept through the discussion. Raghubir (McComas, 2005) found that students showed a high level of cognitive ability when they directly acquire knowledge through practicum rather than using lab only for verifying the theory they have learned.

Practicum activities were more challenging for students in finding a physics concept compared to the verification activities. Cox (2002) and Jongdee (2009) in their study found that inquiry laboratory activities can improve the performance of students in doing practicum works. Deters (2005) and Weaver et al. (2008) in their study found that inquiry laboratory activities can improve the ability of students to think logically, solve problems, and provide a memorable experience in laboratory activities. Kurnianto et al. (2010) in his research concluded that learning physics with practical activities can develop students' ability to communicate the concept of physics. Inquiry-based laboratory activities can enhance scientific processing skills of students (French, 2002).

Research-based physics learning with scientific approach could trigger the learners to master the competences of physics as a whole, not only the acquisition of knowledge and skills but also internalization of scientific attitudes and behaviour in everyday life, thus becoming their characters. Prayitno & Khaidir (2010) stated that the direct association with the character education leaded to 5i aspects, they are: faith and piety (iman dan taqwa), initiative (inisiatif), industrious (industrius), individuals (individu), and interaction (interaksi). Faith and piety includes obeying divine rules and religious life. Initiative means spirit, the willingness to initiate and to try, unyielding to achieve anything useful. Industrious means hard work, diligent, disciplined, productive, value-added considerations, honest, entrepreneurial spirit. Individuals include the potential quality, diversity and independence. Interaction implies the linkage of one individual with another individual.

The process of attitudes formation was assessed from the fulfilment of attitude indicators. This process could be observed that there was an increasing of number of those who enacted the intended attitude. The process of formation of an attitude basically require a long time, as stated by Nugroho (2011) that the establishment of attitude came with several steps that starts from dissatisfaction, followed by having a vision that is logical and rational, willing to take risks, and responsible to arrive on a consistent stage. At this last stage a change in attitude in a person is happening. It is certainly not an easy task given the numerous challenges faced by students every day. Therefore, in several meetings the level of consistency of the students' attitudes was difficult to be observed.

CONCLUSION

This research had produced a research-based learning model with scientific approach. Research-based learning is a model that encourages research in the learning process. There are six steps of research based learning, they are: exposure stage, lecturing of core knowledge, experience stage, the internal report for feedback, presentation, and final report in which all are integrated with scientific approach. The developed learning model is valid, practical, and effective to improve students' scientific processing skills. The attitude of the students belonged to the very good category. The knowledge and skills of learners reached over 85% degree of completion. The researcher recommends for physics teachers to apply this learning model. Further researches are necessary using different materials using the model that had been developed.

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