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The Development of an Inquiry-Based Science Practicum in Measurement and Heat Subject

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Abstract

This study aims to develop a science-based practical guide for inquiry in measurement subjects and heat. This research uses a research and development approach in which adjusted into three stages are employed, namely collecting information, planning, and developing a preliminary product. The instruments used to collect data in this study are information observation sheets, development plan sheets and product validation questionnaires. Based on the results of the study, it can be concluded that IPA practicum was developed based on inquiry in the measurement and heat materials. Validation result on the aspect of content feasibility shows that the inquiry-based science practical guide is feasible to use with a feasibility percentage of 71.87%. While the validation result on the feasibility aspects of the presentation shows that the inquiry-based science practical guide is suitable to use with a feasibility percentage of 75%.

Keywords: practicum guide, science, inquiry, measurement, heat

INTRODUCTION

National education functions to develop the ability and shape of dignified national character and civilization in order to educate the life of the nation aiming to develop the potential of students to become faithful and fearful people of God Almighty, noble, virtuous, knowledgeable, capable, creative, independent and become a democratic and responsible citizen. Every citizen has the same right to obtain quality education (Depdiknas, 2003). Quality education can be achieved, one of which is, through the competency standards developed in the 2013 curriculum. The graduate competency standard of education units contains three components, namely process capability, content and scope of application of process, and content components. The process component is the minimal ability to review and process content into competence. The content component is the dimension of ability to become a human figure produced from education. The scope component is the minimum environmental extent in which the competency is used and it shows the gradation between one education unit and another (Kemendikbud, 2013). Furthermore, to realize the quality education, a quality learning process is needed. Learning is the process of interactions of students with educators and learning resources in a learning environment (Depdiknas, 2003). Therefore, a particular strategy is needed to realize effective interaction between students, educators and learning resources in a learning environment.

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Natural Science (IPA) is obtained through scientific methods, namely: observing, formulating problems, hypothesizing, collecting data, analyzing data, proving hypotheses, concluding and communicating. Therefore, teaching science is not enough just by explaining the materials. Students must get direct experiences to gain more meaningful knowledge. The science learning process emphasizes direct experience to develop competencies through exploring and understanding the natural environment in a scientific manner (Permendiknas, 2006).

The pre-observations and interview from teachers' working group (MGMP) conducted to reveal the learning processes of natural science were not using the scientific approach properly. Science learning is still dominated by a conventional learning method such as lecturing. Learning resources mainly depend on textbooks. It is rare for teachers to make their own teaching materials that suit the needs of students. In addition, teachers find it difficult to hold activities because there is no practical guide at school. Therefore, it needs to develop a teaching material that can be used to facilitate teachers in applying natural science learning using scientific approaches. The development of science learning modules has been carried out by many researchers (Aji, Hudha, & Rismawati, 2017; Handoko, Sajidan, & Inkuiri, 2016; Nurussaniah & Nurhayati, 2016; Theresa et al., 2013). In addition, the development of the science practicum module has been carried out by many researchers (Syamsu, 2017; Pujani, 2015; Nurussaniah & Nurhayati, 2016). More specifically, the development of a practical guide is still needed to meet the needs of different students. This research will develop a guide to the science-based science inquiry practice. It is expected that after implementing this practical guide, teachers were able to lead experiments easily so that the realization of science learning certainly based on scientific approaches.

METHOD

This research uses a research and development design of Borg and Gall (Borg & Gall, 1983) in which at this initial stage three stages are employed, namely collecting information, planning, and developing a preliminary product. The instruments used to collect data in this study are information observation sheets, development plan sheets and product validation questionnaires. Information questionnaire is used to record information which includes needs measurement and literature study. The plan sheet is used to record and compile a research development plan including the abilities needed in conducting the research, the formulation of the objectives to be achieved and the design or steps of the research. The product validation questionnaire is used to facilitate the validator to assess the feasibility of the product being developed. The research involved three validators, one actual teacher at one of public school in Kubu Raya and two lecturers at one of school education in Pontianak West Kalimantan. Qualitative and quantitative descriptive analysis used to describe the implementation of collecting information and planning. Whereas, quantitative descriptive analysis employing a Likert scale is used to describe the results of product validation by the validator.

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FINDINGS AND DISCUSSION

The development steps taken in this study can be seen in Fig. 1. This research is an initial study on the development of a practice guide for inquiry-based science. The development steps that have been taken are collecting information, planning, developing preliminary product.

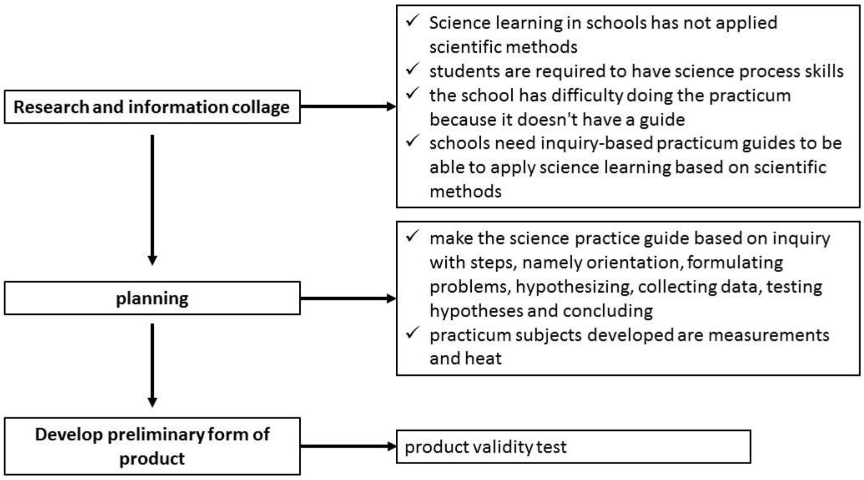

Figure 1. Steps for developing the inquiry-based science practice guide

Based on the result of preliminary research and information collection, it is known that science learning at school has not applied scientific methods, even though students are required to have science process skills. In addition, the schools find it difficult to conduct the practicum because they do not have the practicum guides. Therefore, the schools need inquiry-based practicum guide to be able to apply science learning based on scientific methods.

Afterwards, at the planning stage, the science practice guide is produced based on inquiry following these steps, namely: orientation, formulating problems, hypothesizing, collecting data, testing hypotheses and concluding (Suid & Yusuf, 2016). The practicum subject developed is measurement. Based on the science curriculum, the subject of development is measurement and heat. The purposes of the developed experiment are presented in Table 1.

Table 1. The purpose of the experiment

No	Purpose of the experiment
1	Students are able to measure the amount of length (outside diameter, inner diameter and depth of an object) using the calipers.
2	Students are able to measure the length (thickness of an object) using a micrometer screw.
3	Students are able to observe the process of lengthening of solid objects
4	Students are able to find out the influence of the length of expansion coefficient of a solid to the length of the solid after expanding
5	Students are able to understand that heat moves because of changes in

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	temperature.

Based on results of the preliminary study and information collection and planning stage, a science practice guide is developed based on the inquiry on measurement and heat subjects. A validation is carried out on the inquiry-based science practice guide following the aspects of content feasibility and presentation feasibility. The validation result on the aspect of content feasibility shows that the inquiry-based science practice guide was feasible to use with a feasibility percentage of 71.87%. While the validation result on the feasibility aspects of the presentation shows that the inquiry-based science practice guide is suitable to use with feasibility percentage of 75%. Validation result based on aspects of content and presentation can be seen in Table 2 and 3.

Table 2. Assessment based on aspect of the feasibility of the content

Indicator	Item	Category
Suitability of subject with basic competency and competency standards	Subject completeness	Valid
	The breadth of the subject	Valid
	Subject depth	Valid
Subject accuracy	Accuracy of concepts and definitions	Quite
	Data accuracy	Valid
	Accuracy of the case	Valid
Update subject	Use case examples found in everyday life	Valid
Encourage curiosity	Encourage curiosity	Valid

Table 3. Assessment based on aspect of the presentation feasibility

Indicator	Item	Category
Presentation techniques	Systematic consistency in learning activities	Valid
	Concept wrestling	Valid
Presentation of learning	Student involvement	Valid

The steps of inquiry which is the basis for the development of the science practice guide are expected to be a guide for teachers to teach science through scientific approaches. At the orientation stage, before starting the experiment, students are invited to think more deeply about what they often encounter in everyday life. Figure 2 shows the orientation given to students about heat transfer.

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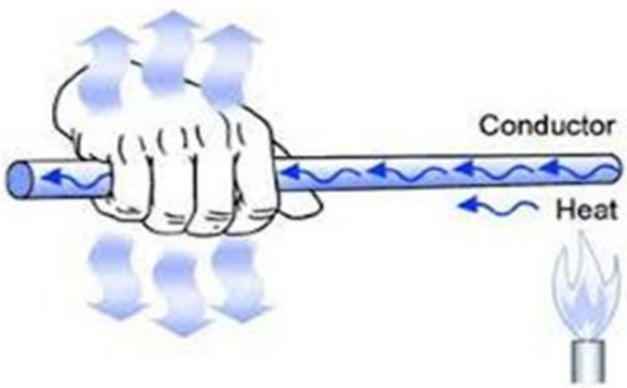

Figure 2. Illustration of heat transfer process (Rokhman, 2014)

Based on Figure 2, students were invited to think “why does one end of the iron heated affect the other end?” This orientation stage trained students to observe and think more deeply about what was being observed, so that questions were asked based on these observations. The questions are directed to be more systematic at the stage of problem formulation. This step trained student to master problem solving skills. In the next stage, students were guided to make temporary answer or hypothesize the problem. Then, students were invited to conduct an experiment to prove the hypothesis that had been made. At this stage, students were trained to process science skills such as observing, classifying, communicating, measuring, predicting and concluding.

The inquiry-based science practice guide is utilized to assist teachers teach with scientific approach. This practice guide includes the stages of scientific approach such as orientation, formulating problems, hypothesizing, collecting data, testing hypotheses and concluding which is integrase of a scientific approach. In scientific approach, students are involved in many scientific activities and think processes to build new knowledge. In addition, teachers can also teach with inquiry-based learning using this practicum guide. One of the learning that can be integrated in scientific approach is inquiry (Kusumaningrum, Ashadi & Indriyanti, 2017). An inquiry learning can be used to replace traditional teacher-centered learning and learning practices that emphasize textbooks. The learning can be used to increase student interest in science, provide opportunities for students to prove through laboratory activities, invite students to solve problems based on logic and evidence, encourage students to carry out further studies to develop more in-depth explanations based on evidence that has been found (Abdi, 2014). The success of inquiry learning to improve student competence has been proven from the results of the study. Learning instruments developed based on inquiry approaches can be used to improve problem-solving skills (Saputri, Fadilah & Wahyudi, 2016). In addition, the use of inquiry stages in an effective module influences students’ learning independence (Saputri, Fadilah & Wahyudi, 2016; Nurhayati, Saputri & Sari, 2015). The ability to think critically can be increased through experimental activities using inquiry-based practicum guides (Nurussaniah & Nurhayati, 2016). An inquiry learning is suitable to be

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applied to improve students' science process skills and of course their understanding of concepts (Nurussaniah, Trisianawati, & Sari, 2017).

CONCLUSION

Based on the results of the study, it can be concluded that IPA practicum was developed based on inquiry in the measurement and heat materials. Validation result on the aspect of content feasibility shows that the inquiry-based science practical guide was feasible to use with a feasibility percentage of 71.87%. While, the validation result on the feasibility aspects of the presentation shows that the inquiry-based science practical guide is suitable to use with feasibility percentage of 75%.

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