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Exploring Physics: Engaging Inquiry-Based Labs for SMAN 1 Muaro Jambi's Class X

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Abstract
This research is a research development which aims to meet the availability of of physic learning materials based inquiry laboratory activities that can improve the effectiveness and attractiveness of the teaching of physics in class X SMAN 1 Muaro Jambi. This research method to adapt the model ADDIE which consists of five main stages of the Analysis, Design, Development, Implementation, and Evaluation. The resulting product has been evaluated through a process of expert validation of learning materials, learning technologies expert validation, testing peers, individual testing, small group testin, and testing of large groups. Data was collected through questionnaires, interviews, and assessment of learning outcomes. From the results of questionnaires and interviews showed that the developed teaching materials physics has been well categorized and fit for use. From the assessment of learning outcomes in the cognitive, psychomotor, and affective successively obtained an average value of students 76, 80, and 80 were categorized as having good learning outcomes.

Keywords: Development; Inquiry Laboratory Activities; Physics Teaching Materials

INTRODUCTION

Learning according to constructivist learning theory is an active process for building knowledge. And knowledge can be built through individuals' direct experiences and interactions with the real world (Yamin, 2011; Sundawan, 2016; Sugrah, 2019). In this case, students are given the opportunity to learn based on direct experience so that students can construct their knowledge based on their previous knowledge and experience. Apart from being able to train students in developing process skills, this condition can also develop their mindset to find their own answers and curiosity (Widyastuti & Pujiastuti, 2014; Ekawati, 2019).

In constructivism, experience and environment sometimes have other meanings than everyday meanings. Experience does not always have to be a person's physical experience, such as seeing or feeling with their senses, but can also be mental experience, namely interacting mentally with an object (Hutapea, 2017; Wedyawati & Lisa, 2019). This acquisition is done by answering questions, exploring and assessing for yourself what is known. Of course, the process of constructing knowledge cannot be carried out alone by students, but rather through interactions formed in the classroom and outside the classroom (Oviyanti, 2013; Saputra, 2014). Therefore, managing students and their learning environment is important in the constructivist learning process (Hamdayani & Sujatmiko, 2019; Fitri, 2020). The learning environment in question includes students, teachers, library staff, laboratories, school principals, learning materials (books, modules and the like) and various learning resources and other learning facilities. Because the process of constructing knowledge in learning plays a very important role in producing or creating quality educational graduates, the main thing that should receive more serious attention is how to create a learning process that gives students the opportunity to construct their own knowledge (Latif, 2020; Anwari et al., 2021).

Physics is a branch of natural science subjects studied with the aim of understanding natural phenomena (Ramil, 2020; Nurmadanti, 2021). In the Education Unit Level Curriculum, it is explained that physics learning is closely related to scientific inquiry activities (Saregar, 2016; Zukmadini et al., 2021). Physics subjects are not only a collection of facts, concepts or principles, but are a process of discovery to foster the ability to think, work and behave scientifically and communicate as an important aspect of life skills (Ministry of National Education, 2006). The curriculum above requires students to be able to develop the ability to think, work and behave scientifically. Thus, in science education, students not only gain knowledge, but also learn about the processes of finding out.

In this regard, the problem is what the learning strategy is to develop the ability to think, work and behave scientifically. The learning strategy recommended by many experts that can develop these three abilities is learning that gives students the opportunity to experience "discovering" learning, not "receiving" learning (Lotulung et al., 2018). Learning opportunities to discover are developed, among others, in the form of learning strategies based on inquiry laboratory activities (Emda, 2017). Laboratory activities are one of the activities for teaching scientific processes. With this activity students can gain various experiences both cognitively, affectively and psychomotorically. Students can also carry out activities like a scientist in discovering concepts or laws in science. In laboratory activities, attention must be paid to the approach used, because laboratory activities carried out by emphasizing the process of discovering concepts and proving concepts can have a different influence on student learning outcomes.

In general, experimental activities in the laboratory are only oriented towards proving concepts or principles that have been discussed previously, which are referred to as verification laboratory activities. Verification laboratory activities do not help much in developing thinking skills, but laboratory activities that should be carried out are inquiry laboratory activities such as those carried out by scientists when uncovering natural phenomena. Inquiry laboratory activities enable students to: (1) explore symptoms and formulate problems, (2) formulate hypotheses, (3) design and implement methods for testing hypotheses, (4) organize and analyze data, (5) draw conclusions and communicate them (Siregar, 2018).

In connection with the implementation of the Education Unit Level Curriculum, the implementation of inquiry laboratory activities has an important role, considering that the curriculum is written explicitly that one of the competency standards for high school/MA physics subjects is to provide experience for students so they can propose and test hypotheses through experiments (Ministry of National Education, 2006). These Competency Standards will not be achieved optimally if the laboratory activities developed are verification in nature and do not provide opportunities for students to formulate hypotheses and carry out experiments in order to test the hypotheses.

However, in reality, based on the results of observations and interviews conducted at SMAN 1 Muaro Jambi, there are indications that inquiry laboratory activities have not been implemented in the physics learning process. After further observation, one of the reasons why inquiry laboratory activity-based learning has not been implemented is that teachers do not understand the concept of inquiry laboratory activity-based learning. Apart from that, learning guides (teaching materials) that can be used as references for carrying out laboratory activity-based learning are also not available at this school.

So far, teaching materials that can support the implementation of laboratory activities in physics subjects at school are usually in the form of practical guides. The practicum guide can be in the form of a Student Worksheet from the publisher or teacher concerned, a practicum guide issued by the Directorate of General Secondary Education, and a practicum guide contained in the textbook. Student worksheets that come from publishers do not show many practical activities, but mostly show summaries of lesson material accompanied by a collection of questions, especially multiple choice questions. And this certainly cannot accommodate the needs of inquiry laboratory activities. And based on the results of observations, teachers have not developed worksheets or practical guides based on inquiry laboratory activities.

Meanwhile, the practical guidebook issued by the Directorate of General Secondary Education for the project to improve the quality of high schools through the procurement of laboratory equipment still uses the 1994 curriculum in its preparation so that it is no longer in accordance with the current curriculum. Apart from that, schools do not receive assistance in procuring laboratory equipment every year, and usually in a relatively long period of time new schools will receive assistance again. Because of this, we often find laboratory equipment that has been damaged, lost, and so on. This results in the practicum guide and the existing tools no longer being suitable so that teachers experience difficulties when carrying out practicum activities. Apart from that, based on the developer's analysis, this practical guide was created using a verification laboratory activity approach.

For the practical guide in the package book, not all types of practicum that must be carried out are included in the package book. In fact, some textbooks only include very few practical activities in their preparation. Even though physics material requires a lot of practical activities in learning. Apart from that, most of the practicum guides in the existing textbooks do not match the condition of the laboratory equipment available, making implementation difficult (Anggereni, 2021).

Previous research conducted by Hartini et al., (2018) regarding the development of physics teaching materials based on local wisdom to train saraba kawa character. Where the results of this research are physics teaching materials based on local wisdom to train the saraba kawa character suitable for physics learning. The difference between the research conducted by Hartini et al., (2018) and the research conducted by researchers currently lies in the basis on which the media was developed.

Based on the results of observations and interviews conducted by the developer who is also a physics teacher at SMAN 1 Muaro Jambi above, it can be concluded that at SMAN 1 Muaro Jambi there has not been a practical guidebook found that can be used as a reference for teachers and students to carry out inquiry laboratory activities in physics learning. Based on this condition, it is necessary to develop a physics practicum guidebook based on inquiry laboratory activities. Apart from that, the practicum guidebook that will be made is a physics practicum guidebook that is in accordance with the applicable curriculum, in accordance with student needs, in accordance with the tools and materials available, and there is a match between the material taught and the inquiry laboratory activities carried out so that it is able to teach students individually or in groups with the teacher as a facilitator in achieving learning goals.

The formulation of the problem in this research is (1) how to develop a physics practicum guidebook based on inquiry laboratory activities in class X at SMAN 1 Muaro Jambi; (2) what kind of laboratory activity-based practicum guidebook is interesting and effective for learning physics in class X at SMAN 1 Muaro Jambi; (3) What requirements must be met so that the practical guidebook based on laboratory activities developed is good; (4) how to use this practical guidebook based on inquiry laboratory activities; (5) by whom and under what conditions can this practical guidebook based on inquiry laboratory activities be used; (6) what is the form of a physics practicum guidebook product based on inquiry laboratory activities that can be used as a reference at SMAN 1 Muaro Jambi; and (7) what is the impact of using a physics practicum guidebook based on inquiry laboratory activities for class X students at SMAN 1 Muaro Jambi. It is hoped that this research can meet students' needs and improve physics learning outcomes in schools both from cognitive, psychomotor and affective aspects so that over a certain period of time it can contribute to efforts to improve the quality of education graduates at SMAN 1 Muaro Jambi.

RESEARCH METHODS

Research Type

The model for developing teaching materials in the form of a physics practicum guidebook based on inquiry laboratory activities follows the system-oriented learning system design model, namely the ADDIE model. This model shows the basic stages of learning design that are simple and easy to learn. Based on the ADDIE development model, the procedures in this research are divided into 5 stages. The stages are as follows: 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation.

Research Procedure

At the analysis stage, what the researchers carried out was to obtain information about the state of physics learning at SMAN 1 Muaro Jambi and the possibility of developing teaching material product models that were more appropriate to the needs of physics learning in schools based on inquiry laboratory activities. This activity is carried out through activity (1) context analysis. This context analysis aims to obtain data about the characteristics of physics subjects and learning conditions, infrastructure, teaching staff and students at the school; (2) analysis of needs for developing physics teaching materials; and (3) analysis of the relationship between physics subjects in high school and learning based on inquiry laboratory activities. The data collection techniques used for this analysis activity are through documentary studies and interviews.

The next step is to design teaching materials. In this stage the researcher prepares the schedule, team, specifications for teaching materials, structure of the material, and form of evaluation of the teaching materials to be developed. After the design stage is complete, it continues with the development stage. The development step is the drafting of physics teaching materials in the form of a physics practicum guidebook based on inquiry laboratory activities. After the draft of teaching materials is complete, the developer carries out expert validation. The types of expert validation carried out include validation of material experts and learning technology experts. These experts provide feedback, comments and suggestions on the teaching materials that have been created. The evaluation results in the form of comments and suggestions are used as a basis for carrying out revision activities on the teaching materials developed. This activity is carried out more than once (iterative cycle) until the teaching material is declared suitable for testing in the field by experts. Teaching materials that have been validated by experts are then tested on study field teachers. Teachers in this field of study were also asked for responses, comments and suggestions on revised teaching materials based on expert validation. From the results of this evaluation, the developer made further revisions to the teaching materials developed. The revised teaching materials were then tested on students (individual trials, small group trials) to see the practicality (ease and difficulty of implementing the material referring to the inquiry laboratory activity approach) and effectiveness (how students were able to understand the material) of the teaching materials developed. After carrying out learning activities that refer to the developed teaching materials, students are interviewed to provide responses, comments and suggestions for the developed teaching materials.

The revised results based on individual trials and small group trials were then tested again on actual research subjects as a field test (large group trial). Products that have been tested on large groups must meet quality criteria, namely validity (from experts and teachers in the field of study), practicality and effectiveness. This stage is called the implementation and evaluation stage.

Data Collection Technique

The data collection techniques used in this research were questionnaires, interviews, assessment of learning outcomes. The questionnaire is used to collect data in the form of suggestions for improvement regarding the accuracy of the components of teaching materials, the accuracy of the content of teaching materials, the accuracy of the design of teaching materials, the quality of the content of teaching materials and the quality of the message of teaching materials as well as the attractiveness of the teaching materials being developed. Suggestions for improvement and suitability of teaching materials were obtained from the expert team (validation stage). The nature of the questions in the questionnaire are open questions. Interviews are used to collect data regarding the attractiveness and suitability of the teaching materials developed to students' needs. Meanwhile, learning outcomes assessment is used to collect data about the effectiveness of student learning after using the product-developed teaching materials. The assessments carried out are cognitive, psychomotor and affective assessments. The effectiveness of developing teaching materials is adjusted to the Minimum Completeness Criteria and is also based on the results of assessing student learning outcomes. Cognitive assessment is taken from student test results after practical activities are carried out. Psychomotor and affective assessments are taken when practicum activities are carried out. The data analysis technique used to process the development data is qualitative descriptive analysis.

RESULTS AND DISCUSSION

This development research starts from analysis activities. This activity is intended to analyze the development needs for the teaching materials that will be developed. The types of analysis used are context analysis and development needs analysis. As a result of this analysis activity, the researcher decided to develop a practical guidebook based on inquiry laboratory activities intended for students and accompanied by a guide for teachers regarding the guidebook developed.

After the analysis stage is complete, the researcher begins to prepare the design of the practical guidebook that will be developed. What researchers do is prepare a schedule, team, teaching material specifications, material structure, and evaluation form. Making this teaching material product took 1.5 years with a work team consisting of researchers as product developers, a team of experts to assess the product and teachers and students as users and as product assessors. The specifications for the teaching materials developed are (1) teaching materials in the form of practical guidebooks, which are made in such a way that the material is interesting, easy to learn, and adapted to students' needs and refers to the Education Unit Level Curriculum; (2) the presentation of the content of learning materials is designed using an inquiry laboratory activity approach; (3) the development product consists of a practical guidebook intended for students and teachers; and (4) The physical form of the practical guidebook in the form of printed media is made in such a way that the description of its physical form has a size of 21 cm x 29 cm. The language used is attempted to be communicative between the practical guidebook and students or teachers.

The material structure in the development of this teaching material for the presentation of practical guidebooks for students is directed from Study Instructions; Tool Introduction; Competency Standards and Basic Competencies; Practical Topics; Practicum Objectives; Formulation of the problem; Hypothesis Formulation; Tools and materials; Practical Preparation; Practical Steps; Observation result; Question; Conclusion; and Follow-up. Meanwhile, the presentation of practical guidebooks for teachers is directed from the Syllabus; Practical topics; Practicum Objectives; Introduction to Activities; Time Allocation; Theoretical basis; Learning Tips; and practice questions.

After the design was completed, the researchers began drafting the physics teaching materials that would be developed. In drafting this teaching material, the researcher consulted with the thesis writing supervisor. In this development stage, researchers pay attention to the following things: (1) the principles of preparing teaching materials, namely the principles of relevance, consistency and adequacy; (2) steps for preparing printed teaching materials; (3) learning theory that underlies the development of teaching materials; (4) principles of physics learning; (5) principles and steps for learning using an inquiry laboratory activity approach; and (6) characteristics of practicum guidebooks.

After the draft of teaching materials was completed, the researcher then carried out expert validation, namely material validation (content) and design validation (learning technology). Material and design validation is carried out by experts in their respective fields with predetermined requirements. Based on the validation results, the developer makes revisions to the teaching materials developed. And revisions are carried out in an iterative cycle, meaning they are carried out repeatedly until the product is said by experts to be suitable for testing in the field.

According to content experts, the overall assessment of teaching material products is good, but there are several inputs or suggestions from material experts. From the aspect of the accuracy of the content of the learning message, after revision, it can be concluded as follows: (1) the description of the material in the teaching materials is in accordance with the competency standards/basic competencies in the Education Unit Level curriculum; (2) The material is easy for students to understand; (3) Terms are used in accordance with physical concepts and principles; (4) this teaching material is able to foster students' interest in learning. From the aspect of the accuracy of the aspects developed with the characteristics of the inquiry laboratory activity approach, after revisions have been carried out, it can be said that the presentation of the material in the teaching materials is in accordance with the phases of the inquiry laboratory activity approach used and students can be guided to carry out the phases or steps of the approach used. well. Meanwhile, from the aspect of the relationship between student and teacher practicum guidebooks, after revisions have been carried out, it can be said that: (1) the description of the material in the teacher practicum guidebook can help teachers to carry out the practicum activities presented in the student practicum guidebook well; (2) material descriptions are presented in language that is easy for teachers to understand and implement; and (3) the form of assessment recommended by the developer is in accordance with the practicum objectives and has been validated.

According to learning technology experts, the overall assessment of teaching material products is good, but there are several inputs or suggestions from material experts. From the aspect of the accuracy of the learning design after revision, it can be said that: (1) The illustrations/examples/pictures presented are presented correctly; and (2) the overall design of the teaching materials is attractive because it is presented with attention to user-friendliness. From the aspect of the accuracy of the sequence of components, after revision it can be said that the components of the practical guidebook are complete. Meanwhile, from the aspect of accuracy of text design, after revisions have been made, it can be said that the text design as a whole is good.

After the development stage was completed and the teaching material product was deemed suitable by experts to be tested in the field, the researchers conducted product trials starting with colleagues and teachers with a background in physics education. The physics teacher gave good marks to the product being developed. The physics teacher gave a very enthusiastic assessment of the product being developed because so far there have been no teaching materials made by physics teachers themselves at school. Apart from that, according to the physics teacher, these teaching materials can improve students' thinking abilities and processing skills so that they are suitable for use as learning resources in schools because apart from being in accordance with the curriculum, they are also suitable for school conditions. However, there are several suggestions and input from colleagues regarding the product being developed. These suggestions and input are (1) The picture needs to be made clearer so that it attracts more students' interest in learning, and (2) The components in the problem formulation need to be further detailed so that it makes it easier for students to formulate the problem. Based on suggestions and input from colleagues, the developer carries out revisions in an iterative cycle until the teaching material is deemed suitable for testing on students.

After the teaching materials were tested on colleagues, the next step the researchers took was individual trials on students. Individual trial assessments were given by 3 students representing high, medium and low ability students. The assessment in this individual trial is more focused on the ease and difficulty of using the class X odd semester practical guidebook which is based on inquiry laboratory activities. Based on the interview results, it can be concluded that students are interested and need practical guidebooks developed for learning. According to students, this practical guidebook has never been encountered before in learning because it consists of steps based on inquiry laboratory activities. However, students suggested that the student practicum guidebook be equipped with material explanations regarding the steps of inquiry laboratory activities so that it would be easier for students to carry out the steps contained in the physics practicum guidebook. Apart from that, in several parts of the practical guidebook there are still some symbols in physics that have not been explained so that students have difficulty carrying out the steps of inquiry laboratory activities. Therefore, it is necessary to add or improve the physics practicum guidebook being developed.

After revising the teaching materials based on individual trials, the researchers conducted small group trials. The small group trial assessment was given by 9 students representing high, medium and low ability students. The assessment in this small group trial places more emphasis on the ease and difficulty of using the class X odd semester practical guidebook which is based on inquiry laboratory activities. Based on the interview results, it can be concluded that students are interested and need practical guidebooks developed for learning. According to students, this practical guidebook has never been encountered in their studies and can help students understand physics material and students do not experience difficulties in carrying out the steps of inquiry laboratory activities that are integrated in the student physics practical guidebook.

Based on the results of the small group trial, the developer did not revise the teaching materials developed and the researchers continued by conducting product trials on large groups to test their effectiveness. The large group trial assessment was given to 1 class of 29 students. Assessment in this large group trial places more emphasis on finding the effectiveness of the teaching materials being developed. From the student learning results, it was found that 86% of students received a complete score or met the Minimum Completeness Criteria. Meanwhile, the results of the psychomotor and affective assessments, all students received a complete score or according to the Minimum Completeness Criteria. From these results it can be concluded that this physics practical guidebook is effective for use in physics learning.

Suggestions for using physics teaching materials for teachers (facilitators) in the classroom learning process should be carried out in team teaching because in the learning process there is theory and practice. With team teaching, it is hoped that teachers can guide and direct students in learning in class. In utilizing physics teaching material products in the implementation of learning, learning tools such as study rooms and laboratory equipment need to be prepared. The use of physics teaching materials is not limited to face-to-face activities. Dissemination or dissemination of products can be carried out by researchers themselves, namely by informing physics teachers or directly to students. Dissemination can also be done to colleagues in other schools through the subject teacher deliberation (Subject Teachers' Conference) forum. This physics teaching material can be used in all educational units at the high school level if there are similarities in the syllabus for physics subjects, but it must be adapted to the characteristics of local students.

In connection with the limitations of the development carried out, it is necessary to further develop various class X physics materials which are considered possible to be developed using an inquiry laboratory activity approach. Apart from that, it is recommended that trials be carried out widely. Good teaching materials certainly have an effect on improving student learning outcomes after using these teaching materials.

This research is in line with research conducted by Simanjuntak et al., (2018) regarding the development of web-based instructional media for teaching wave physics on Android mobile. Where the research obtained results that mobile learning using an Android platform based on web services is suitable for use as a physics learning medium. The difference between the research conducted by Simanjuntak et al., (2018) and the research currently carried out by researchers lies in the basis on which the media was developed.

The novelty of this research is that it makes a new contribution by developing physics learning materials that focus on investigation-based laboratory activities, providing an innovative approach to increasing student understanding and engagement at SMAN 1 Muaro Jambi. Through this approach, this research explores new ways to increase the effectiveness of physics learning by emphasizing direct experience and active exploration in the learning process. Carrying out this research has the potential to produce significant positive impacts, such as improving students' critical thinking skills and experimental abilities, as well as increasing their interest in studying physics through direct experiences that are interesting and relevant to the real world. In addition, the application of inquiry-based learning materials can provide a strong foundation for the development of physics curricula that are more interactive and oriented towards active learning in other schools.

CONCLUSION

Based on the results of the development of physics teaching materials based on inquiry laboratory activities in class (2) The teaching materials developed are said to be interesting if the teaching materials are suitable for learning for class Meanwhile, teaching materials are said to be effective if the teaching materials are adjusted to the Minimum Completeness Criteria and are also based on the results of assessing student learning outcomes; (3) the requirements that must be met in order for the development of physics teaching materials to be good include: in accordance with the principles of preparing teaching materials, namely the principle of relevance, the principle of consistency, and the principle of adequacy, in accordance with the principles of preparing teaching materials according to Steffan- Peter Ballstaedt, in accordance with learning theories, namely Jean Piaget's developmental theory, Brunner's cognitive theory, Ausebel's meaningful learning theory, and constructivist learning theory; (4) the way to use physics teaching materials is in scheduled face-to-face classroom learning with the guidance of a teacher (facilitator) or in independent learning where students can work on assignments and questions contained in the teaching materials; (5) this physics teaching material can be used by class X students of SMAN 1 Muaro Jambi in classroom learning; (6) The form of the physics teaching material product based on inquiry laboratory activities is as follows: the teaching material developed is in the form of a practical guide book, the presentation of the contents of the learning material is designed using an inquiry laboratory activity approach, the development product consists of a practical guide book intended for students and teachers , as well as the physical form of the practical guidebook in the form of printed media, made in such a way with a description of its physical form, measuring 21 cm x 29 cm, and the language used is attempted to be communicative between the practical guidebook and students or teachers, (7) The impact of using the practical guidebook based on inquiry laboratory activities for class Practically, this physics teaching material is able to make the learning process more interesting and effective.

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