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The development of physics module oriented generative learning to increase the cognitive learning outcomes and science process skills of the students

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Abstract. This study aims to develop a physics module oriented generative learning. The research and development design were modified into three stages: preliminary study, development, and trial. The preliminary study consists of literature studies and preliminary surveys. At the development stage, the module validation results are obtained with the criteria of "good". The stages of the trial were confined to the learner obtained N-gain values for cognitive learning outcomes and science process skills in the "moderate" category. The result of difference test of mean of control and experiment class is found that there is a significant difference with the average of experiment class higher than control class. Based on the questionnaire, learners respond positively to the module.

1. Introduction

The use of teaching materials in the form of modules is one of the uses of media in a learning process. The use of teaching materials in the learning process becomes an alternative teacher so that it is easier to teach material to students. Learning to use modules effectively will change the conceptions of students towards scientific concepts so that in turn their learning outcomes can be optimally improved both in terms of quality and quantity [1].

Learning modules that have been developed are very varied, including the physics module with a scientific approach [2], PBL modules [3], project-based modules [4], and generic science modules [5]. Each type of module has special characteristics. The important thing to get in learning besides cognitive learning outcomes is one of them is science process skills. The application of generic science learning is effective learning to be applied [6].

Learning physics is not only seen from the end result but also in the learning process that takes place. This is in line with the 2013 curriculum which is currently starting to be applied with the concept of providing learning experiences for students in developing attitudes, skills, and knowledge.

Science process skills in physics lessons can be easily measured if the teacher packs learning with interest and innovation. One model that can condition science process skills and student learning outcomes is well measured, namely generative learning models [6].

Generative learning model consists of four phases, namely the phase of exploration, concentration, challenges and application. This learning model is suitable for developing science process skills in physics learning. Generative learning can optimize the science process skills of students [7]. It's caused the generative learning syntax corresponds to aspects of science process skills.

Availability of quality textbooks is still lacking. This can be seen from the books used only emphasized on the knowledge delivery mission [8]. The principles of learning psychology and design theories of a textbook are still not applied in the preparation of textbooks so that students find it difficult to understand the books they read. Overcoming these limitations, one solution that can be used is learning by using teaching materials in the form of modules.

The application of module-oriented teaching materials to generative learning models is very suitable to be applied to physics material. This is because physics materials will be more easily absorbed by the students through direct observations presented in the form of simple experiments in modules that have been adapted to the phases of generative learning. Learning using modules is also one alternative in delivering learning materials because these teaching materials can make the learning atmosphere more adaptable to the abilities of students. In addition, students can also communicate through discussion forums to solve problems in physics concepts. The learning experience of students directly through experimental activities and discussions contained in modules and generative learning models can later make students better understand concepts, principles, or facts so that they can help develop science process skills that exist in students.

Referring to the theory and results of the research already mentioned, researchers are interested in developing modules as supporters of generative learning in optimizing science process skills and student learning outcomes. In this study, the use of modules and generative learning models is packaged into one in the form of generative learning-oriented modules which can be one of the innovations in learning

2. Methods

This study uses a research and development approach. Research and Development is a research method used to produce certain products and test the effectiveness of these products [9]. The research was carried out through three stages, namely the preliminary study phase, the product development stage, and the product trial stage. In the preliminary stage a library study and initial survey were conducted. In the product development stage, the initial draft module was made and continued with the making of modules. The modules developed were then validated by material experts and media experts. There are three components of assessment, namely content, language, and presentation. Content evaluation includes material coverage and good material accuracy, conformity with the development of science, stimulating curiosity, developing life skills and contextual insights. The language used must be in accordance with student development, communicative, dialogical, interactive, straightforward, and in accordance with Indonesian rules. The module presentation technique must be consistent, systematic, have sample questions, practice questions in each learning activity, answer key, glossary, and bibliography.

The study continued with product testing. During the product testing phase, there were limited trials for 10 students and field trials. The research instruments used were ski native instruments and quantitative instruments. Qualitative instruments consist of four questionnaires, namely preliminary research questionnaires to obtain initial data on learning conditions and teacher needs for instructional media, questionnaire module experts and material experts to collect data relating to expert assessment of generative learning-oriented modules produced, student response questionnaires and questionnaire on teacher responses to modules developed. Student questionnaire responses consist of students' opinions about module components, learning to use modules, the difficulty level of questions in the module, and the ease of using modules. Questionnaire for teacher response includes quality of content, objectives, technical, and the quality of learning using modules. While quantitative instruments consist of cognitive learning instruments and science process skills instruments.

Qualitative data obtained through questionnaires were analyzed by calculating the average of each component in the questionnaire given. In the limited test data the normalized N-gain score (g) was used to obtain the criteria for increasing cognitive values and students' science process skills (KPS). The normalized N-gain score formula is shown in the equation below [10].

$$g = \frac{(Spost - Spre)}{(Smax - Spre)} \tag{1}$$

Analysis N-gain can be classified as follows: g > 0.7 (high); $0.3 \leq g \leq 0.7$ (moderate); and g < 0.39 (low). Data from the field trial results were analyzed using the parametric comparison test (t-independent test) and nonparametric comparison test (Mann-Whitney test).

3. Result and Discussion

3.1. Introduction Stage
The products developed in this study are generative learning oriented modules. The first stage of development is a preliminary study. There are two activities carried out at this stage, namely the initial survey and literature study. The initial survey was conducted to obtain an overview of the conditions of learning physics in schools. To find out the conditions of physics learning, the aspects examined in the initial survey, namely: 1) teaching preparation, 2) learning activities, 3) the use of modules, and 4) assessment of physics learning. The survey results are taken into consideration for developing generative learning oriented modules.

3.2 Product Development Phase
The module developed in this study is a generative learning oriented module. The main feature of this module is the existence of stages of generative learning in the delivery of material and equipped with worksheets in the form of simple experiments to train students' Science Process Skills (SPS). In the worksheets there are descriptions of the types of science process skills that students must master in each step of the experiment. At this focusing stage, it is hoped that it can develop students' science process skills faster. At the challenge stage, students are given the opportunity to discuss in groups and classically about the results of the experiments that have been carried out.

In addition to the assessment conducted by material experts and media experts, the assessment was also carried out by three teachers in one of the high schools in West Lombok. Assessment indicators include the quality of the content, objectives and technical aspects; and the quality of learning and instructional with an average score of 5 on the criteria strongly agree.

The module in this study was tested for its feasibility by three validators. The validated component of the module includes content eligibility, language feasibility, and presentation feasibility. The results of the validation module oriented to generative learning with indicators of the components of eligibility content, language, and presentation in good categories with an average score of 3.72, 4.00 and 3.96, respectively.

3.3 Trial Phase
The limited trial was conducted on 10 students of class X3, one of the Public High Schools in West Lombok. The results of the N-gain calculation obtained data on cognitive learning outcomes and science process skills of each student with a score of 0.50 included in the criteria of being.The results of data analysis of science process skills are more clearly represented in Figure 1. It can be seen that the percentage of mastery of the final data on science process skills of students is higher than the percentage of initial data on science process skills of students.
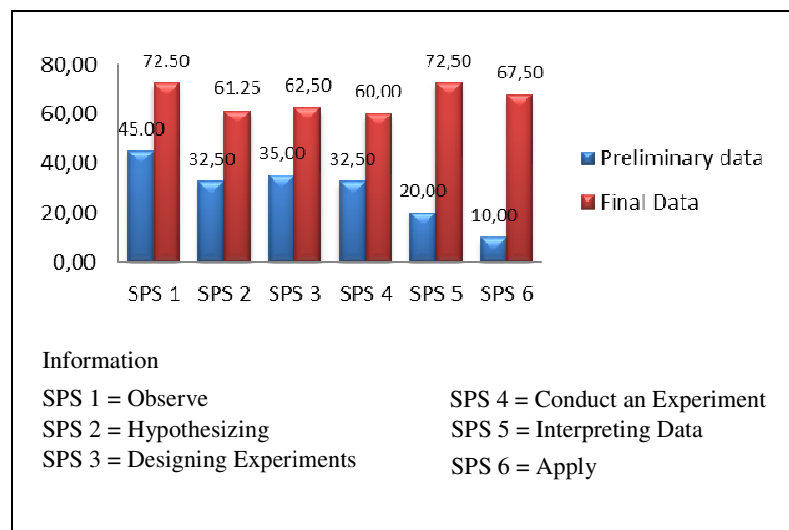
Figure 1. Percentage of Mastery of Students' Science Process Skills (SPS) in Limited Tests

3.4 Field Trial

Increasing students' cognitive learning outcomes shows that the modules developed are effective to apply. This is in line with previous studies that learning with modules is more effective and able to improve mastery of student concepts [11]. Differences in cognitive learning outcomes between experimental class and control class prove that students crave focused and measurable learning resources, using concrete examples in daily life and providing opportunities for students to learn independently.Based on the description above, this reinforces the conclusion that the generative learning oriented module influences the cognitive learning outcomes of class X students at Gunungsari 1 Public High School

3.5 Data on Science Process Skills (SPS)

Figure 2 shows that the percentage of mastery of science process skills of class X1 students is higher than that of class X2 students. It's mean that modules can train SPS through a series of experiences that students actually do and the active involvement of students in learning, so students can practice the skills they have [7].

Based on the learning model adopted, the generative learning model at the exploration and focusing stage supports to train aspects of students' science process skills. Empirically generative learning can optimize students' science process skills. This is because the generative learning syntax conforms to aspects of science process skills.

3.6 Learners Response to Modules Oriented Generative Learning

Questionnaires were given to students in class X1 as an experimental class using generative learning oriented modules. The purpose of the giving of the questionnaire is to find out the response of students to generative learning oriented modules used by students.

Based on the questionnaire given to students it is known that the average percentage of students of 88.90% is interested in the module developed. This is because based on the results of validation by instrument experts and media experts, it is obtained that the material depth is good enough to be adapted to the learning needs at the high school level, good supporting image accuracy, good sample accuracy, using good language rules, there are components that motivate participants students, and there is consistency in the presentation of each good learning activity so that students can more easily

use it. This is also expected to increase the motivation of students in learning. Of the students who were given the questionnaire, an average of 78.00% stated that the module format was new. By default the module format is learning objectives, material, examples, summaries, and formative tests. Modules with generative learning refer to the standard format for modules but with modifications. Modifications made are the presence of Student Worksheets containing simple experiments to support science process skills. In each worksheet a component of science process skills is included. This is expected to help students understand and develop science process skills. In addition to formative tests there is also a test of science process skills to determine the mastery of each component.
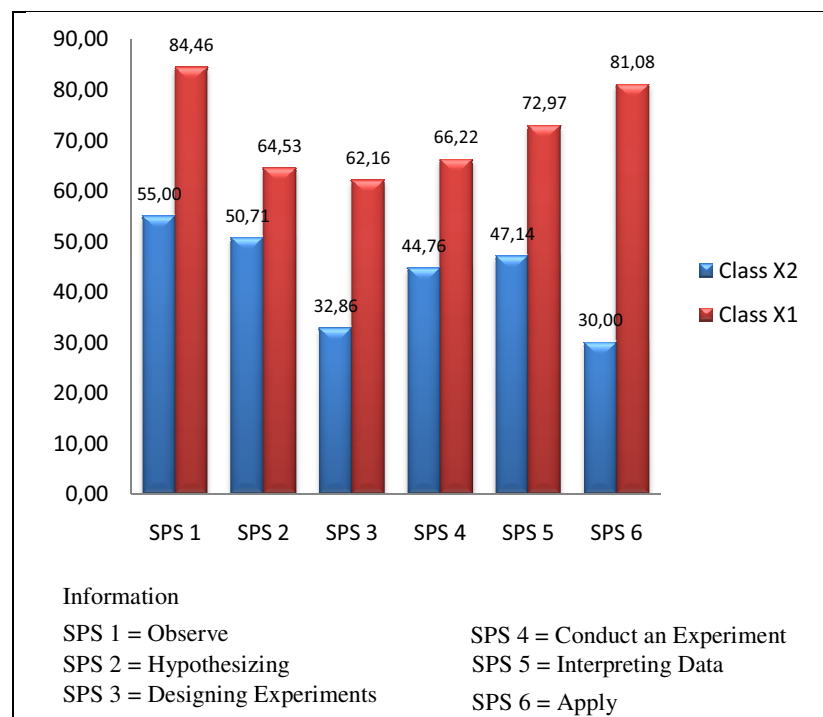

Figure 2. Percentage of Mastery of Science Process Skills (SPS) Class X1 and X2 Learner

There is an average of 74.90% of students who think that module language, module material, sample problems in modules, student worksheets are easy to understand. In terms of language, based on the results of validation get the criteria "Good" in accordance with the development of students. In addition, the language used is communicative, interactive and in accordance with the rules of good Indonesian. The material in the module is not focused on writing, but is accompanied by interesting pictures/illustrations that can make it easier for students to understand the concept. learners' worksheets are not focused on counting exercises but rather on descriptions of experimental results that are tailored to the components of science process skills. Examples and problem exercises in modules are made tiered with the number of questions of the same type made more than one question.

There are 88.20% of students who think that they are interested in participating in learning as in the module in the next teaching and learning activities. Based on the results of validation, generative learning oriented modules get the criteria "Good" in fostering the curiosity of students and encouraging students to look for more information.

For the difficulty level of the problem, 49.00% thought that the questions contained in the module were difficult. This is because the problem is made tiered from easy questions to difficult questions. In

addition, because there are questions that ask many aspects and require analysis, make students think that the questions given are difficult.

Based on the description above, in general it can be concluded that more than 60% of students give a positive response to generative learning oriented modules. Important factors in learning are learning motivation, teacher totality in teaching and the tools or media used in learning. This is in accordance with the research conducted before about the relationship between teacher teaching methods, media, and motivation in improving the quality of learning.

4. Conclusion

Based on the results and discussion, it was concluded that the feasibility of generative learning-oriented modules through expert testing is the average feasibility of content is 3.72 with the criteria "Good". The average language feasibility is 4.00 with the criteria "Good", and average the feasibility of presentation is 3.96 with the criteria of "Good". The results of the trial are limited with the average value of the initial data on cognitive learning outcomes of 42.85 ± 1.16. The average final data on cognitive learning outcomes of 70.28 ± 1.92 obtaining a 0.50 N-gain value in the "moderate" category. The average value of the initial data of science process skills of students is 7.00 ± 3.88 with the mastery criteria of the component "very lacking". The average final data science process skills are 28.50 ± 3.65 obtaining an N-gain value of 0.58 in the "medium" category.

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