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THE IMPLEMENTATION OF INNOVATIVE THEMATIC MODULE TO IMPROVE STUDENTS' LOGICAL THINKING ABILITY

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Abstract

The purpose of this study was to developing an innovative thematic module on basic physics course and improving students' logical thinking ability especially in the subject of Basic Physics II. The assessment developed in this study is an inquiry-based assessment to determine the ability to think logically by the students in learning science theme "light and vision." The research's results and discussions are a module on the theme of light and vision developed by the eligibility requirements in very decent achievement category. The results showed that 56.66% students are in the stage of formal thinking, capable of abstract thinking and can analyze the problem scientifically and then resolve the issue, to acquire knowledge based on logical reasoning. The implementation of an innovative thematic module can improve students' logical thinking ability.

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INTRODUCTION

Innovative thematic learning is mandatory for science learning based on the curriculum in Indonesia (MoEC, 2013). Through thematic and integrative learning in science, the students can get direct experience to increase the strength for receiving, saving, and applying the concept that has been learned. Therefore, the students are trained to discover the concept by themselves holistically, meaningfully, authentically, and actively (Listyawati, 2012). However, this policy is not supported by the availability of thematic module. The expectation of innovative thematic learning can improve the students' logical thinking skills, especially in the subject of Basic Physics II in theme "light and vision".

Based on the national education system in Indonesia, the learning materials for science cover physics, biology, chemistry, and earth science (Widiyatmoko & Nurmasitah, 2014), which is intended to develop students' knowledge, understanding, and analytical thinking towards natural surroundings and environment. The aim of the curriculum is promoting students' ability in applying knowledge in real life situations. Through this curriculum, it is hoped that students will be able to acquire scientific skills, thinking skills, and apply knowledge for problem-solving in daily life activity.

Logical thinking abilities should be given new emphasis in the teaching and learning of science in the effort to improve students' science achievement at all levels of schooling (Fah, 2009; Samadovna, Narzullayevna & Ergashevna, 2020). With logical thinking skills, learners solve the problem by doing various mental practices or reach principals or rules by doing some abstraction and generalization (Yaman, 2005). Usdiyana (2012) states that the better the ability of students in logical thinking, the better the ability of students in analyzing a problem so that students can forming the knowledge. As the application of the ability to think logically important in science learning, thus the teacher must provide assessments that can form students' thinking patterns of memorizing, remembering and understanding to apply, analyze and interpret, evaluate, and create a form of thinking patterns logical.

Thematic innovative module in this study is a module that used thematic integration model and based on inquiry learning. This model reflects the connection between contents of some subjects integrated through certain competence standards (Leasa et al., 2016; Perwitasari & Djukri, 2018). The theme in the module which flow thematically with the theme of light and vision. Thus, some of the relevant theme concepts does not need to be discussed repeatedly in different fields of study, so the use of time is more efficient for discussion and learning objectives achievement are also expected to be more effective (Puskur, 2008). In addition, module is systematical teaching material with understandable language by learners, appropriate with their knowledge and ages, to learn independently with the minimalized teacher's help (Prastowo, 2012). Based on this background, the problems in this research are: (1) How to develop innovative thematic module based on the theme of light and vision? (2) Whether the implementation of innovative thematic module on the theme of light and vision can improve students' logical thinking ability?

METHODS

This study was designed as a Research and Development (R & D) which is a research method used to produce a particular product, as well as test the effectiveness of these products (Sugiyono, 2012). The steps of the research and development method can be seen in Figure 1.

The first step for developing module is the identification of potentials and problems. The problems were identified by observation in a class of Basic Physics II. The problem is the learning was not supported by the availability of thematic module and also not supported by science assessment based on the inquiry on the theme of light and vision. The

theme of "light and vision' are covered physisc (properties of light, mirror and lense, optical instruments), and biology (human eye and eye disorders). Based on the situation, it can be developed an inquiry-based science assessment that can measure students learning outcomes on the cognitive aspect and can improve students' cognitive abilities that initially only memorized and comprehended towards the stage of applying, analyzing, interpreting, evaluating and creating, and think logically.

The next step is module design and revision process. Five characteristics of innovative thematic module are as follows: (a) the module should fit the interest of the students and can help students to improve logical thinking ability; (b) the module should permit students to work independently; (c) the module should connect to the knowledge and interest of the teacher; and (d) the module should include materials and facilities that are easy to obtain; and (e) the module should have a high-quality teacher's guide (Visser, et al., 2010). To analyze the effectiveness of the module, an assessment was developed in the form of multiple-choice questions based on the inquiry that consists of 30 questions.

In the implementation phase in the class, evaluation of the module effectiveness is done by using quantitative methods, namely through the test of the validity of the expert's judgment, to test the effectiveness by using the pre-post experiment to uncover the improvement of the students' ability to think logically.

The sources of research data is an expert's, professors, students, and the sampling technique used was purposive random sampling. The type of data in this study includes: (1) expert response data module; (2) data on the logical thinking ability of students is measured by the test.

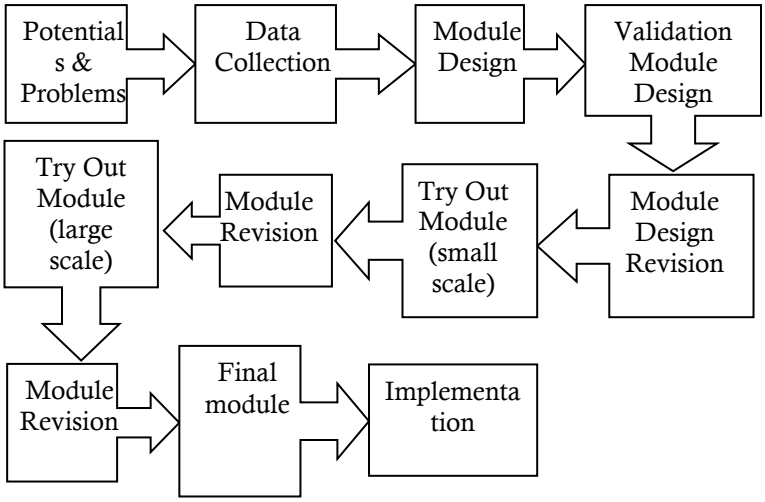

Figure 1. Research and Development Design

Methods of data collection are carried out as follows:

1. The questionnaire method, to determine the expert opinion of the module to determine the quality of innovative thematic module are developed.
2. The test method, to get data on the students' logical thinking ability who follow the Basic Physics II course.

According to Valanides (1997), Test of Logical Thinking (TOLT) consists of 10 questions for middle school students. TOLT scoring can be used as a reference phase according to Piaget's theory of intellectual development criteria (Valanides, 1997) in Table 1.

Table 1. Logical Thinking Ability Stages Criteria

Score	Criteria
0 – 1	Students' thinking phase at the concrete stage
2 – 3	Students' thinking phase at the transition stage
4 – 10	Students' phase at the formal thinking stage

This study is using a score list to determine the result of students' logical thinking ability. Data were collected after the questionnaire obtained the expert analysis module. The data were analyzed descriptively by counting the mastery learning percentage (N).

$$N = \frac{\text{obtained score}}{\text{maximum score}} \times 100\%$$

The results of logical thinking ability are classified according to the criteria in Table 2.

Table 2. Logical Thinking Ability Stages Criteria

Score	Criteria
2 % - 34 %	Students' thinking phase at the concrete stage
35 % - 67 %	Students' thinking phase at the transition stage
68 % - 100%	Students' phase at the formal thinking stage

RESULTS AND DISCUSSION

The innovative thematic module is designed to improve students logical thinking ability. There are three parts to the module design; the lecture program, the experiment and the evaluation to measure logical thinking skills (see Table 3). The test of logical thinking was developed in the form of 30 items multiple choice questions, adjusted for inquiry indicators and logical thinking, as well as the level of students' cognitive abilities.

Table 3. Parts of The Innovative Thematic Module

Lecture Programme	Experiment	Evaluation
Map concept of "light and vision theme"	Investigating the properties of light	Self reflection
The properties of light The formation of shadows on mirrors and lenses	Analyzing the formation of shadows in mirrors and lenses.	Test of logical thinking (30 multiple chioce questions)
Human eye and eye disorders Optical instruments	Designing optical instruments: magnifying glass, periscope, and simple microscope	

The research results on development of an innovative thematic module on the "light and vision" theme include the results of a feasibility assessment by expert and data of students' logical thinking ability. Based on the data collection and research that has been done, obtained the following results.

Assessing the feasibility of innovative thematic module of the theme "light and vision" includes two components, namely the content and feasibility. The recapitulation of the first stage assessment by experts of the module is shown in Table 4.

Table 4. Summary of Results Assessment by Experts

Components	Number of Experts	Scoring Answers Item		Score (%)
		Yes	No	
The Contents	2	6	0	100
Feasibility	2	6	0	100
Average				**100**

Data assessment results in Table 4 shows that all of the scoring items received a positive response and got "Yes," so it can be concluded that the module criteria is qualified and can be used to the implementation stage. The implementation of module feasibility assessment is intended to test the feasibility of the product and gaining input from experts. After the feasibility assessment is completed, then obtained the initial product revision which presented in Table 5.

Table 5. Module Performed Revision

No.	Suggestions	Revisions
1.	Include list of reference	Completing a bibliography and list them in the module
2.	The module is equipped with alignment chart	Completing the integration module by adding a chart on the home page
3.	Made the pictures larger and given a description of a more comprehensive and functional	Enlarge the images to help the students to see the images and increase interest in the attitude like reading, captions made more comprehensive and functional
4.	The material is more expanded	Extending the material by adding more forms of activities that make the students more active

The implementation assessment is carried out to obtain the data of the students'

logical thinking ability in working on the logical thinking problems, as the analysis of empirical evidence assessment developed logical thinking can measure the stages of logical thinking ability of students or not. The implementation test is carried out by taking a sample of 30 students to work on the problems that have developed. Data obtained in user trials with 30 students, the result can be seen in Table 6.

Table 6. Stages of Students Logical Thinking Ability Recapitulation

Logical Thinking Stages Criteria	f	Percentage
Concrete Thinking Stage	2	6,67%
Transition Thinking Stage	11	36.67%
Formal Thinking Stage	17	56.66%
Total number of Students	30	100%

The analysis results of implementation testing showed that 56.66% students are in the stage of formal thinking, capable of abstract thinking and can analyze the problem scientifically and then resolve the issue, to acquire knowledge based on logical reasoning.

This research resulted in two main data, i.e., data feasibility of the module and data of the students' logical thinking abilities. The initial stage of the preparation of the module is through the relevant data collection. After the data collection phase is completed, then proceed to the stage of preparation of the initial product (module) with collecting materials and combine them, so that the resulting draft module. Then after the draft module is ready, the assessment from the experts to validate of the feasibility of the module.

Validation is an essential thing before the draft module used in this lecture. This step is in line with government recommendations on National Education Standards, which stated that the feasibility of the content, language, presentation, and images in the textbooks rated by the National Education Standards set by Regulation (Government Regulation number 19 the year 2005). Based on the regulation, then the module assessment refers to the assessment instrument textbooks that are the result of the adaptation of the National Education Standards. An assessment conducted by two experts consisting of two lecturers of mathematics and natural sciences Faculty, Universitas Negeri Semarang. Experts election tailored to the assessment needs of each component and are from the institution concerned. Based on National Education Standards Agency (2006), experts are selected based on the fields of science and related institutions.

The feasibility assessment module includes a cover or module completeness. The results of the expert assessment received a positive response (Yes) from the experts on the module developed. Based on the results of such evaluations can be concluded, that the module developed is passed with the acquisition of an average score of 100% so that it can proceed to the implementation phase of the module.

The implementation assessment carried out to obtain students' logical thinking ability data to work on the 30 items of logical thinking test. The implementation assessment results used in the analysis of empirical evidence developed assessment can measure the stages of logical thinking ability of students or not. Students' logical thinking ability data were analyzed using descriptive analysis which summarized in Table 5 and the usage test analysis calculation showed that students are grouped into 3 phases logical criteria, namely (a) 2 students (6.67%) were in the stage of concrete thought; (b) 11 students (34.375%) in the transition thinking stages, and (c) 17 students (56.66%) in the stage of formal thinking of the total 30 students who attending lectures Basic Physics II.

Based on the research that has been conducted, showed that students who took a Basic Physics II course, as many as 17 students are already in the stage of formal logical thinking, which means that 17 people have been able to form the knowledge gained by analysis, abstracting, and drawing the conclusions scientifically. This is consistent with the theory of the mental development of Piaget who said that the lifespan of 12 years -

an adult, a child is capable of formal thinking (Catharina, 2009). The stage of formal logical thinking is a thinking stage in dealing with a problem or establish knowledge-based ability to create abstract, test and make conclusions that are controlled by logical reasoning (Valanides, 1997). A student who is at this stage is capable of abstract thinking and can analyze the problem scientifically and then resolve the problem. The formal thinking stage is experienced by humans when 12 years old to adults because there is a natural human intelligence system that is fully capable of forming the capacity to think up in the stage of formal thinking.

The assessment results showed that the use of logical thinking phase transition is owned by 11 students, which means that 11 people are already capable of forming knowledge through analysis of the problem but has not been fully able to take the conclusions to establish knowledge or solve problems by testing and concluded. The transitions logical thinking phase which is the transition from concrete to formal logical thinking is a stage in which students can form knowledge through analysis of the problem but has not been fully able to leave the concrete reasoning based on the empirical experience he has gained. Based on Piaget's theory of cognitive development, adolescence is a stage of transition from the use of concrete thought operationally to formal operational thinking. Therefore, the changing thinking phase from the transition to formal acquired when it is supported by the influence of maturity, experience physical, logical-mathematical experience, the social experience or the environment, and self-organization (Catharina, 2009).

The concrete logical thinking phase in this study show that the two students still in the stage of concrete logical thinking. Concrete thinking stage is the stage of logical thinking through reasoning about knowledge acquired based on empirical experience that has been acquired, but not yet able to think abstractly (Valanides, 1997). This is contrary to Piaget's theory which says that children aged 12 years old to adult, should have been able to think formal, although there are some who think the transition. The implementation assessment results in this study can be used as empirical evidence in the field and as supporting evidence expert judgment. The implementation assessment results, and validation experts showed that the assessment of inquiry-based science that has been developed can measure students' ability to think logically.

The advantage of the assessment was developed inquiry-based and aims to measure the ability to think logically in the Basic Physics II course with the theme "light and vision." According to Ariesta & Supartono (2011), the inquiry is not a new approach to learning, but it always used in the learning science, so that strategies can be applied in the process of inquiry learning and assessment, for the inquiry application purpose is to develop the ability to think in a systematic, logical, and critical. The assessment of learning science should not as simple as memorizing theories and concepts but can encourage students to think further, logical, and systematic. The students' ability in a further and logical thinking in science learning can be stimulated with the assessment that specifically assesses the students' logical thinking ability.

The assessment process is a systematic process of collecting, interpreting, and using the information to improve the quality of student learning (Bekiroglu, 2008). The assessment developed in this study is an inquiry-based assessment to determine the ability to think logically by the students in learning science theme "light and vision." The assessment in this study contains 30 multiple-choice items that are adjusted to the indicators of inquiry and logical thinking. Based on Lunetta et al. (2007) inquiry processes are often taught as a set of steps, like defining questions and formulating hypotheses; designing and planning experiments; collecting and analyzing data; summarizing results and reaching conclusions; and communicating the findings. Assessment based inquiry in this study can stimulate students to identify,

formulate questions, make predictions, analyze and interpret the data, communicate the results and draw conclusions based on logical reasoning, so the result of the work on this matter, a student is trained to work on the problems that are not merely rote and understanding, but who are trained to work on the problems that are to apply, analyze and interpret data and draw conclusions to solve the problem. Also, students can form logical thinking skills possessed.

Assessment developed in this study is an inquiry-based assessment applying the indicators in the assessment inquiry in the questions. Indicators of inquiry used in the development of inquiry-based assessment in this study were (1) to formulate the question; (2) evaluate books and other critical resources; (3) make predictions; (4) planning inquiry or investigation; (5) review the material already known; (6) to analyze and interpret data; (7) communicate the results (Balim, 2009).

According to van Rens, et al. (2012), one of the objectives of the using of inquiry strategy is to develop the ability of students to think in a systematic, logical, and critical. The experiments part of the innovative thematic module can help students to think about how students can develop their thinking ability to solve the problem in science learning. Modul also contributes to a greater understanding of how to support the students in developing their need to cope with science in their lives (Klop et al., 2010). Modul can also increase the interests of the students to learn science (Yeoman et al., 2015). By these advantages of using the module in the learning process, it can help students to improve their logical thinking ability.

Students' logical thinking should not only have improvement for learning, but also can be developed in the assessment of learning science by using the assessment tool that specifically measures the ability of students' logical thinking, so that development-based assessment inquiry in this study, using two indicators, which is an indicator of inquiry and logical thinking, with the aim that can develop assessment stimulate and measure the students' logical thinking ability.

CONCLUSION

Based on the research results and discussion the conclusions of this study are:

a. The innovative thematic module on the theme of light and vision in very decent category.
b. The implementation of innovative thematic lecture module and conservation based on the theme of light and vision can measure student ability to think logically.

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