

Preliminary Study On The Development Of Physics Book And Workseet Based On Inquiry Reviewed From Thinking Ability of Prospective Teachers

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Preliminary Study On The Development Of Physics Book And Worksheet Based On Inquiry Reviewed From Thinking Ability of Prospective Teachers

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Abstract. This research is a preliminary study of the development of physics books and worksheets based on inquiry to improve the thinking ability of physics education students FMIPA State University of Medan. This research is a research R & D (Research and Development) covering three stages of research are: 1) Preliminary Study, 2) Development of books and Worksheet, and 3) Book trials and Worksheet. Preliminary studies were conducted a) library analysis and b) questionnaire sheets. Library analysis to study the basic syllabus of wave, electric and magnetic and about inquiry learning, thinking ability. The questionnaire sheets were given to student of physics education program of class of 2017/2018 and field survey of lecturers of wave, electrical and magnetic by giving questionnaires to 3 lecturers. The results showed that the concepts of electrical and magnetic wave base courses have an indicator of logical thinking ability. Inquiry based physics teaching improve the quality of learning physics and thinking ability, particularly for prospective teachers of physics.

1. Introduction

When the Indonesian National Qualifications framework based curriculum is valid at the State University of Medan, most of the names of courses also experience changes such as General Physics II, the name of which is the magnetic electrical wave base of one of the courses taught in all MIPA study programs. This is done on the basis of changes, development and innovation in each study program that is required to clarify the "graduate profile" which is expected through the activities of tracking studies, feasibility studies and needs analysis in the community. The graduate profile reflects the minimum ability that students must master after graduation which refers to four aspects of needs. The material at the base of magnetic electric waves are: 1) Vibration, 2) Waves and Sounds, 3) Optical Geometry, 4) Electricity, 5) Alternating Current and Voltage, and 6) Quantum Symptoms [1].

So far, some lecturers teach general physics material II with lecture, discussion, assignment and rarely use a student centered approach (student-centered learning) which causes students difficulties in understanding physical symptoms. The results of the preliminary study showed that the results of general physics learning II in an LPTK in the last six years were still relatively low, namely not graduating in groups of 61 (2010), 64 (2011), 64 (2012), 64 (2013), 64 (2014) , 65 (2015), on a scale of 1-100. The low results of general physics learning II were partly due to the tendency of lecturers to emphasize more on the mathematical aspects of the lecture [2].

In order for concept of general physics II to be understood by students, there needs to be innovation in lectures. One of the innovations in the lecture was the availability of textbooks based on



inquiry-based of magnetic electricity waves. Inquiry learning innovation improves the character and ability to think, mastery of knowledge, concepts, and physical principles, skills to develop knowledge, skills and self-confidence can be applied in everyday life and as a provision for continuing higher education is one of the goals of physics learning listed in the curriculum [3].

In inquiry learning there is the formulation of hypotheses and verification namely physics experiments. In the laboratory work there are many benefits obtained [4,5]. Transferable skills can be developed through science learning processes or practicum in laboratories. Practicum is important to (1) generate motivation for science learning, (2) improve basic skills of experiment, (3) apply scientific approach and (4) support mastery of learning materials [6]. The main purpose of physics practicum is to increase physics knowledges, improve practicum skills, arouse interest, develop creative thinking and problem-solving skills, improve scientific thinking skills as well as apply methods of experiment [7]. In addition, practicum also offers context-rich learning experiences, enhance conceptual understanding, develop practical skills [8] and the best way to learn the nature of science [9, 10].

Inquiry-based physics learning can improve critical thinking skills. Critical thinking based on basic of magnetic electrical wave material content is given to students of physics education programs. According to Walker, 1998 and Şener, 2015 [11, 12] critical thinking skills are a process that allows students to acquire new knowledge through a process of problem solving and collaboration. Critical thinking skills focus on the learning process rather than acquiring knowledge. Critical thinking skills involve activities such as analyzing, interpreting, assuming, interpreting information. Reducing, and arguing [13]. Critical thinking skills are very important in the teaching and learning process because these skills provide opportunities for students to learn through discovery.

According to Krulik and Rudnick [14] critical thinking is a way of thinking that test, connect, and evaluate all aspects of a problem situation, including the ability to gather information, memorize, analyze the situation, to read and understand and identify things required. Ennis [15] states there are six basic elements that need to be considered in critical thinking, namely: focus, rationale, conclusions, situations, clarity and overall examination. Facione and Facione [16] defines critical thinking as a make reflective decisions and resolve what is believed and done wisely. Halpern [17] argues that critical thinking is "cognitive skills and strategies that may enhance the desired result of thinking, i.e., purposeful, reasoned, and the actual destination - Miscellaneous think includes resolve the problem, formulate a conclusion, taking into account the possibility, and make a decision".

2. Methods

This research includes research and development. This type of R & D research is a process used to develop and validate educational products [18]. In this study will be developed a product an inquiry-based physics learning book. In general, the research was carried out in 3 stages, namely: preliminary study phase, development of inquiry-based physics learning book design phase, and validation and evaluation of model phase.

At present the research is still in the preliminary study stage. At this stage the method is used is descriptive method, to describe existing phenomena systematically, factually, accurately, and as they are and collect information that is considered important as a basis for development. Researchers can directly relate to respondents and other objects related to the problem under study. Respondents who were involved at this stage were prospective lecturers and lecturers of basic electrical and magnetic waves. For the preliminary study, studies were carried out with field studies and literature studies. Through literature studies can be carried out an analysis of the competence of a physics lecturer and the role of lecture on basic magnetic electric waves. That is the understanding of concepts, and the theories and research findings. Field studies are carried out by observation, interviews and questionnaires. Through observation and interviews can be analyzed the practice of lecture of basic magnetic electrical waves which have been carried out and the learning facilities available

3. Result and Discussion

This stage is carried out by applying a qualitative descriptive approach. At this stage a number of information was collected regarding physics laboratory facilities and the process of teaching basic electric and magnetic waves. This information includes the availability, quality and quantity of supporting infrastructure facilities up to the frequency of routine and ever conducted experiments. Observation results show that the physics laboratory equipment in the physics education program is in adequate condition, with good experimental support equipment. Generally the available equipment consists of several experimental kits such as waves, optics, electricity and magnets. Interviews were also conducted with lecturers, and prospective lecturers to find out some of the problems related to physics teaching and to know their responses about the research plan to be conducted. In addition to interviews, questionnaires were also given about some physics learning problems. Students generally will be better able to solve calculation problems than questions that test mastery of theoretical concepts, especially those related to physical process problems which should be observed or experimented in the laboratory.

At this stage also carried out media analysis that can be developed, to the analysis of relevant physical concepts. In addition, some literature and the results of current research are analyzed to get an overview of development opportunities. A number of findings and results of the analysis are then made into consideration in developing the basic book of magnetic power waves. Based on the analysis carried out on concepts in physics it can be seen that physics consists of abstract concepts, concepts based on principles, and abstract concepts with concrete examples. Research to develop the book in the basic course of electric waves and magnetism requires analysis of these concepts carried out with a concept analysis table. The results of concept analysis are shown in Table 1. Based on the analysis of the concept, the types of concepts obtained from the basic concepts of wave, electricity and magnetism are obtained.

Table 1. Analysis of the basic concepts of magnetic electric waves

No	Type Concept	Label Concept	No	Type Concept	Label Concept
1	Concrete	Simple harmonic Vibration	15	Abstract	Curved Mirror Formula
2	Concrete	Simple harmonic vibration	16	Abstract with concrete examples	Refraction of light Refraction on thin lenses
3	Abstract with concrete example	Simple Harmonic Motion Equation	17	Abstract with concrete examples	Special rays on the lens Lens strength Combined Lens
4	Concrete Simple	Harmonious Motion (GHS)	18	Concrete	Optical Tools
5	Abstract with concrete examples	GHS graph and phase difference	19	Concrete	Refraction in prisms Refraction on planparal glass
6	Abstract with concrete examples	Restoration style on GHS	20	Concrete	Electric Charge Coulomb's law Electricity Style Electric field Electricity Potential Capacitor

7	Concept based on the principle	Definition of Wave	21	Abstract with concrete examples	Electric Current Electrical resistance Ohm's Law Kirchoff's 1st Law Kirchoff's 2 nd Law Electrical Energy Electricity Power	and
8	Abstracts with concrete examples	Walk Wave Equations.	22	Abstracts with concrete examples	Magnetic Properties Magnetic field Style	
9	Concepts based on the principle	Upright Wave	23	Abstract with a concrete example	Electromagnetic Induction	
10	Concrete Vibration Strings Get. In the air column Resonance Konkrit	Vibration Strings In the air column Resonance	24	Concept based on principles	Current and alternating current voltage	
11	11 Concept based on the principle	Upright Wave	25	Abstract based on concrete	Effective Value	
12	Concepts based on the principle	Wave (Pelayangan) Waves Wave Energy Wave Intensity Sound Intensity Level	26	Concrete	Series of Resistance (R), Inductors (L) and Capacitors (C) Power in alternating current	
13	Concrete	Doppler effect				
14	Concrete	Reflection on a flat mirror and Curved Mirror				

Based on questionnaire data that has been disseminated to find out the initial perception of prospective lecturers about learning and book development plans, it can be seen that most (83%) think that concepts in physics are difficult and difficult to understand. So that the physical concepts that will be outlined in the book must be understood by students with contextual teaching that can be faced in everyday life. All respondents supported the idea of developing inquiry-based electric and magnetic wave books to support physics learning in class. According to respondents the use of inquiry-based books can also help understanding the concepts of physics, thinking skills, and enhancing students' character skills.

Based on a questionnaire analysis of student needs regarding student needs for books obtained an average score range in percentage, if 0-50% answered "Yes" then there is no need to develop inquiry-based physics learning textbooks, if 51-100% it is necessary to develop a learning-based module inquiry. In the student needs analysis questionnaire, it was found that the average percentage score of answering "Yes" was 72.25% with a total of 40 students. Questionnaire for analyzing the needs of five

lecturers in the basic magnetic and wave courses that the average percentage score answered "Yes" is 72%. Based on the results of the analysis of the needs of students and lecturers, the development of textbooks on inquiry-based learning on the material of basic magnetic and electric waves.

In the preliminary study phase an empirical study was carried out in the form of observations of lectures and analysis of the ability profile of prospective lecturers and theoretical studies on the basic material of electric and magnetic waves. Observations were made on basic lectures of magnetic and electric waves. This course is one of the subjects that plays a strategic role in improving the professionalism of prospective lecturers. Through this lecture, students are equipped with the ability to process basic magnetic and electric wave material so that they can be taught well in high school.

The results of observations on the lecture, showed that: 1) The main methods used were lectures, practicums and assignments; 2) Learning tends to be more strengthened in the discussion of formulas and solving problems, namely in the form of practicum, development of learning materials, LKS, solving physics equations and calculations related to practical materials; 3) The dominant mode of representation is used: decryption (verbal, graph, table), (practicum) and mathematical; 4) Lack of interaction between students-lecturers or students in constructing knowledge 5) Assignments given to students are related to the development of worksheets for practicum, making practicum reports and solving questions in reference textbooks.

From the results of the evaluation type analysis used to test the ability of mastering the concept of students it is known that the questions generally test the ability of students to remember, solve physics equations and calculation questions. Based on the results of interviews with lecturers, the problems faced for the development of students' abilities are: 1) The depth of material that must be developed by prospective lecturers is not balanced with the time available; 2) Having difficulties in developing standard lecture models that are suitable for needs; 3) Practically, there is no difficulty in developing the ability of students through practicum, especially on the topic of waves and electricity, because the tools and practicum materials used are available. For the topic of alternating current of electricity is rather difficult to practice it appropriately, 4) Feeling that you have not maximally developed the mastery of the concept of students, because prospective lecturers have not been able to interpret the results of the lecture.

From the results of the understanding profile analysis of prospective lecturers on the basis of the magnetic electrical and waves is found, that: 1) It is very difficult to understand the abstract wave equation; 2) Most students have difficulty giving explanations to the wave equation; 3) Students have not been able to understand the role of models / images to explain physical phenomena and transform them into symbolic representations. Thus, there is a tendency for students to solve the questions given only by using physics formulas.

Critical thinking skills help students to learn. Without critical thinking, students forget what they learn, because they rarely internalize ideas well [19]. Cosgrove, 2009 [20] states that there are 6 parts of thinking skills, namely inference, assumption, interpretation of information, deduction, analysis, and argument. Table 2 shows the sections and indicators of critical thinking skills.

No.	Indicator Section	Indicator critical thinking
1.	Inferences	Select criteria to consider possible solutions
2.	Assumptions	Considering and making decision
3.	Interpreting Information	Apply acceptable principles

4.	Deductions	Draw conclusions or formulate hypotheses
5.	Analysis	Identify or formulate criteria to consider possible answers
6.	Arguments	Identify the reasons stated

Information about the use of inquiry stages in magnetisme, electricity and wave, lectures according to prospective teachers is shown in Table 3. How many percent answered about inquiry-based physics learning.

Table 3. Analysis of student needs about inquiry-based learning

		Percentage of Student Answers	
		Well	No
1	Have you ever heard of inquiry?	40	60
2	Has the lecturer ever conducted inquiry learning in learning?	20	80
3	Do you know the nature of inquiry correctly?	10	90

Only 40% of students have ever heard about inquiry, and only 20% of students say that lecturers have conducted inquiry in learning. Only 10% of students know the nature of inquiry correctly.

Pembelajaran inkuiri mengikuti langkah-langkah seperti yang ditunjukkan oleh Tabel 4.:

Table 4. Stages of inquiry-based learning steps of lecturers and students		
Stages of Learning	Student Activity	Lectures Activity
Stage of problem presentation.	Divide students into groups Focusing student attention on a material through a series of demonstrations. 3. Provide problems to students. 1. Sit together with a group of friends. 2. Pay attention to demonstrations conducted by lecturers and answer questions posed by lecturers. 3. Formulate temporary answers to problems given by the lecturer.	Sit together with a group of friends. 2. Pay attention to demonstrations conducted by lecturers and answer questions posed by lecturers. 3. Formulate temporary answers to problems given by the lecturer
Data collection and verification stage.	1. Asking students to collect information related to the proposed problem	Gather information related to the problem given. 2. Make a temporary answer.
Data collection stage through experiment.	1. Divide the worksheet experiment in each group. 2. Guiding students in conducting experiments. 3. Travel around each group to guide students to experiment..	1. Receive worksheet experimental. 2. Listen to lecturer guidance. 3. Conducting real experiments in accordance with the instructions and guidance of lecturers

Table 4. Stages of inquiry-based learning steps of lecturers and students

Stages of Learning	Student Activity	Lectures Activity
Data formulation and processing stage.	<ol style="list-style-type: none"> 1. Providing opportunities for students to process and analyze experimental results data and answer discussion questions contained in LKS. 2. Ask students to formulate the results of the experiment. 	<ol style="list-style-type: none"> 1. Processing and analyzing experimental results data. 2. Formulate the results of the experiment conclusions.
The analysis phase of the inquiry proc	<ol style="list-style-type: none"> 1. Guiding students to understand the patterns of discovery that have been made. 2. Guiding students to analyze the stages of inquiry. 	<ol style="list-style-type: none"> 1. Pay attention to and understand the patterns of findings that have been made. 2. Analyzing the stages of inquiry

In connection with the learning method, from the results of interviews and observations, the lecturers of the basic magnetic electrical wave basic subjects mostly be used the lecture and question and answer method in an explaining order, gave examples of questions, asked questions, practiced, and gave assignments. The reason why the lecturer uses this learning method is because this method is very easy to do for a large number of classes, lots of material and can be followed by students. Several other lecturers reported that they used a variety of learning models, namely problem-based learning, cooperative learning, group discussion and assignment learning. None of them use inquiry-based learning. When asked further why not use the learning, most of them said that if using such learning would require quite a lot of time so the material was not overtaken, the learning was not suitable for the class with a large number of students and some reasoned that the learning model was still poorly understood .

The problem given by the lecturer in the form of the questions in the source book emphasizes more on mathematical manipulation, not the contextual problems that exist in everyday life. Students who are weak in the field of mathematics will be very difficult to be able to solve the problem. Almost no concept or problem presented departs from direct experience through investigations in the laboratory.

Caregiver lecturers on the magnetic electrical wave basic courses make a mastery test concept to measure the achievement of learning outcomes indicators. Even though they have never made the test of ability to think skills, but they consider it necessary to make these tests specifically to know the ability to think of students. Students' thinking ability needs to be developed during the learning process so that students not only learn to memorize but they can improve their knowledge and understanding and control their own thinking processes so that they can compete in the community. When the lecturer was asked about learning that could develop concept understanding, almost all lecturers stated that they had designed learning to develop conceptual understanding even though not specifically. The results of the analysis of the syllabus and lesson plans used by the lecturers show that the concept of understanding the concept is still very limited in indicators of learning outcomes. An indicator of understanding the concept that is most often used is in terms of representing physics questions into numbers and explaining certain physical concepts. In connection with the test items used by the lecturer, most lecturers admitted that they took several questions from the handbook (dictate) and from other sources, where the questions were in the form of calculation questions that emphasized the use of mathematical formulas rather than understanding physical concept. The physics lecturer should further enhance students' thinking skills and think about their thoughts so that they can provide opportunities for students to be able to control their own thinking processes (thinking ability). The needs of prospective physics lecturers for training in developing thinking skills can be done through magnetic wave elementary elementary lectures. Students who have good thinking skills, enable them to develop an understanding of the concept. Concept understanding needs to be developed because of

the five cognitive processes (understanding, applying, analyzing, evaluating, and creating) that are based on transfer ability and emphasized in schools [21]. One of the main functions of magnetic and electrical wave basic lectures is to equip physics lecturers to develop an understanding of the concept. Students are said to understand if they can construct the meaning of learning messages, both oral, written, or graphic, delivered through teaching, books, or multimedia.

Understanding the concepts in the basis of magnetic and electrical waves, among others, is realized in a number of abilities in terms of: interpreting, giving examples, classifying, comparing, explaining, and concluding. Based on the above analysis, it can be concluded that the ability to think and comprehend concepts is a requirement for physics lecturers of magnetic and electrical waves can play a role in serving those needs. The results of the analysis of the ability of thinking skills that can be developed have been formulated in Table 2, which was adopted from Brown (in Cosgrove) [20].

Based on interviews with 10 students of second-level physics education teacher candidates, the low ability of thinking skills and understanding of concepts is due to the fact that most students experience difficulties in: (1) knowing and associating a concept with other concepts; (2) knowing the steps to be used; (3) predict; (4) planning what will be done; (5) monitoring and assessing what is and has been done, (6) interpreting; (7) read the data and present it in graphical form; (8) give an example; (9) compare; and (10) draw conclusions. Refer to the first step in inquiry learning according to NSES and NRC [22,23], Bybee, 2006 [24], or steps 1 and 2 according to Kauchak & Eggen [25], or the third step according to Arends [26] shows involvement student activities asking. This step should give an idea of how to encourage the activities of productive students to make questions, ask question, choose and set questions so as to produce critical questions. Furthermore, student activities in steps 2 through 5 according to NSES [22] and Bybee, 2006 [24], or steps 3 to 6 [25], or 4 to 6 [26], are activities to answer the previous step questions. In this step it should give an overview of sharing responsibilities by asking each other questions and answering so as to trigger critical thinking in the search for evidence, explanation, evaluation of explanations and justifications as desired by scientific scientific epistemic activities. These skills need to be developed with the efforts of educators to help students learn to ask and think critically [27,28,29]

Relief efforts to encourage students to be able to ask questions and think critically can be done based on Vygotsky's idea of the zone of proximal development (ZPD) [30] (Schunk, 2012), and Scaffolding according to Wood, Bruner & Ross, 1976 in Schunk [29]. ZPD theory, interconnectedness with others gives a role to self-regulation and activity in constructing knowledge. Likewise in asking and critical thinking cannot be done alone but needs to involve others [31] Other people are used as sources and partners to elaborate information, data, facts and opinions through question and answer in order to reach conclusions. Thus, constructivist theory supports students making their own questions and asking questions to friends and lecturers.

Likewise the phase of the inquiry approach according to NSES [22] includes asking and questioning activities in each phase of learning. The types of questions involved are: productive questions, to make (produce) questions; elaboration questions, to direct explanation, analysis and evaluation; Development of the inquiry learning phase refers to scaffolding, question, productive, elaborative and reflective [32].

4. Conclusion

Support students to acquire scientific inquiry skills and fosters creative thinking skill by inovating the physics local material. Inquiry based physics teaching engages students in many activities and thinking processes. Both approaches are encouraging students to design the experiment based on their interest. However, the guided inquiry has different distinguishing features. First, guided inquiry approach explicitly guided the students in designing the experiments which encourages students to construct ideas for finding alternative local materials for protein test and to create the proper material and new experiment. Second, the scientific steps in guided inquiry approach guided students to promote their creative thinking skills through the scientific methods as used by scientist.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11
