Need analysis in the development of teaching materials with problem solving-collaborative models in quantum physics courses

Hidayati¹*, Elizar², and Festiyed¹

¹Department of Physics, Universitas Negeri Padang, Padang 25131, Indonesia
²Department of Physics, Universitas Negeri Padang, Padang 25131, Indonesia

*hidayati@fmipa.unpad.ac.id

Abstract. This study aims to analyze preliminary data on the conditions of quantum physics lectures as a necessity in developing teaching materials. This research is the initial stage of research and development, namely preliminary research. Data collected using interviews with lecturers, questionnaires to students and study documentation. Data analysis techniques used in the form of descriptive statistical analysis. From the data analysis that has been done it can be stated that the available quantum physics teaching materials have not varied. Second, the assignments given in lectures on quantum physics have been able to help students understand the material. Third, students have sufficient potential in understanding the material, but the percentage of students who have ideas in solving problems and who are able to correct answers from friends, want to work collaboratively and who actively ask questions is still low. For this reason, it is necessary to develop media and teaching materials to improve the lecture and collaborative processes of students.

1. Introduction

Implementation of lectures aims to prepare graduates to be able to deal with the 21st century well. Graduates of educational study programs are expected to have sufficient ability to be able to exist in the 21st century. There are four abilities that educational graduates need to have in the 21st century: ways of thinking, ways of working, tools for work, and skills for life. For this reason, lectures carried out by lecturers should be able to equip students with the four abilities needed in the 21st century [1].

Based on the 21st Century National Education Goals, the learning that is held must be able to realize quality graduate resources that have global competitiveness. In addition, the National Education Standards Agency in Indonesia (BSNP) [2] has formulated the 21st Century National Education Goals namely "21st Century National Education aims to realize the ideals of the nation, namely a prosperous and happy Indonesian people, with respectable and equal position with other nations in the world globally, through the formation of a society that consists of quality human resources, namely an independent, willing person and has the ability to realize the ideals of his people". The aim of the 21st Century National Education is to enable educators to design the learning they will carry out so that they can prepare generations who are able to develop their skills and abilities in mastering information and communication technology so that they can face the challenges of globalization in the future.
This is in line with the 21st century learning framework proposed by Trilling & Fadel [3], that the need for learning skills in this globalization era is future-oriented, which is increasingly challenging and can be successful with the 4C criteria; Critical thinking and problem solving, Communication, Collaborative, and Creativity.

The implementation of this lecture should also be adjusted to the description of the qualifications levels of the KKNI (Indonesian National Qualification Framework) in which learning outcomes are arranged (Learning Outcomes-LO). This LO must be possessed by students in order to meet the performance standards required in KKNI and be elaborated and prepared by the Study Program. Every element that must be possessed by students in meeting their learning achievements are: Attitudes and values, mastery of knowledge, work skills and authority and responsibilities [4].

In the Quantum Physics course, the lectures refer to the objectives of lectures based on the Indonesian National Qualification Framework (KKNI) in Higher Education. The intended purpose is lectures that require students to have abilities that meet criteria in terms of attitudes and values, work skills, mastery of knowledge, and responsibilities. To fulfill these four criteria a strategy is needed in the right lecture process. In the Quantum Physics course the strategy chosen should make lectures meaningful to students, produce a change of attitude towards a better direction, be able to hone the ability to solve problems and be able to work in groups and teach students to be responsible for making the right decision. The lecture process also needs to be adapted to the development of education in the world, that is, not only learning by using conventional methods but also trying various methods of learning and supported by learning media that increase the effectiveness of learning.

The distribution of material from lectures on quantum physics includes an overview of old quantum physics, the Schrodinger Equation, the application of the Time Free Schrodinger Equation in the case of constant potential, Simple Harmonic Oscillators and Hydrogen Atoms.

Observation results indicate that students' understanding of quantum physics material is still quite low. In addition, data is also obtained that most of the material in quantum physics is material that is mathematical and abstract and in the lecture process is not yet supported by suitable media.

Because of the various obstacles that arise in the implementation of quantum physics lectures that are still not in accordance with the demands of learning as set out in the 21st Century National Education Objectives, it is very necessary alternative solutions to overcome these obstacles and problems.

The results of the short discussion with the team of lecturers in quantum physics in order to feed back to this lecture, it is known that the quantum physics lecture process carried out, needs to be updated and developed. This development is needed so that students are trained to think critically and be more creative in developing their own potential, and can collaborate well, during lectures and after graduating. For this reason, it is necessary to find alternative alternatives for the solution so that the learning achievements of students in quantum physics lectures meet the demands of 21st Century learning. Before looking for good alternatives for quantum physics lectures, a preliminary study of this quantum physics lecture is conducted in order to obtain actual data.

2. Research Method

The research conducted is descriptive research. Descriptive research is a research method that seeks to describe and interpret objects as they are. In general, descriptive research has two main objectives, namely to systematically describe the facts and characteristics of the object being studied appropriately [5].

In this preliminary study, three objects were investigated, namely Quantum Physics lecturer, Quantum Physics syllabus and teaching materials, and students who attended Quantum Physics lectures. Quantum Physics lecturer is used to get information about Quantum Physics lectures in the Physics Department. Two physics majors were interviewed to get this information. Teaching material is the second object to get information about Quantum Physics material. Students majoring in Physics who take Quantum Physics courses are used to get lecture information that includes assignments. The number of students involved in gathering this information is 97 students.
Data collection techniques used in this preliminary study consisted of three parts, namely interviews, questionnaires, and documentation. Interviews are used to get data about the implementation of quantum physics lectures by lecturers. The instrument used was the interview guide sheet. The questionnaire is used to get an overview and input into the implementation of lectures in Quantum Physics. The instrument used was the lecture questionnaire sheet. Documentation is used to get data about lectures on Quantum Physics. Documents used include syllabi, textbooks. The instrument used was the document evaluation sheet.

Data collected through appropriate instruments are analyzed using certain analytical techniques. The data analysis technique used in this study is descriptive statistical analysis. Descriptive statistics are statistics that function to describe or provide an overview of the object under study through sample data or population as they are. On this descriptive statistic without conducting analysis and making conclusions that are applicable to the public. There are several data presentations in descriptive statistics that can be used such as: regular tables, frequency distribution, graphs, and group data explanation through mode, median, average values, group variations and standard deviations [6].

3. Results and Discussion

The first result of preliminary research is the implementation of quantum physics lectures. The interview was conducted with 2 lecturers of quantum physics in the physics department, Faculty of Mathematics and Natural Science, Universitas Negeri Padang. The interview component about conducting quantum physics courses consists of 5 aspects, namely: 1). implementation of quantum physics lectures, 2). quantum physics lecture material, 3). teaching materials for quantum physics, 4). problems faced in lectures in quantum physics, and 5). factors causing problems in.

From the analysis of the results of the interview it can be stated 5 results. The first results of the lecture on quantum physics have not been good. The second result of quantum physics material is the discussion of microscopic physics material whose analysis requires math that is not simple. The third result, teaching materials used so far besides English textbooks, there is a hand out. The fourth result is the examples of the cases discussed are microscopic and the results of the mathematical analysis that have been done have no display that can make it easier for students to understand them. Besides that, it was also found that in implementing lectures, students behaved more independently and could not collaborate. The fifth result is the factors that cause problems in quantum physics lectures is the absence of a learning model that requires students to work collaboratively and also teaching materials have not provided an overview of abstract material. The results of the analysis of the Quantum Physics teaching materials used in lectures can be seen in Figure 1.

![Figure 1. Teaching material analysis results in Quatum Physics course](image)

Based on Figure 1, Quantum Physics teaching materials used include handouts, and textbooks. The
The use of teaching materials is dominated by textbooks with a percentage of 80%. In addition, the use of teaching materials provided by lecturers in lectures is not yet fully attractive and makes it easier for students to learn them. This can be seen from the response of students by 55% stating that this teaching material is interesting to learn independently and 60% states that this teaching material is easy to learn.

The results of the analysis of quantum physics courses are presented in Figure 2. Analysis of assignments includes assignments routinely before and after lectures, the role of the task in helping students understand the material well, clarity and appropriateness of the tasks given to students' thinking abilities and assignments to work collaboratively. Based on Figure 2, it can be seen that assignments have not been routinely done with a percentage of 75% before lectures and 50% of assignments are given after lectures. Assignments given by lecturers can help them understand material with a percentage of about 45% and 50% are in accordance with students' thinking abilities. To work on collaborative tasks only reached 40%.

Furthermore, for the analysis of student characteristics, results such as Figure 3.

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**Figure 2. Task analysis results**

**Figure 3. Results of analysis of student characteristics**
Based on Figure 3, it can be seen that the characteristics of students are the potential and constraints experienced by students in quantum physics lectures. The analysis showed that about 65% of students were enthusiastic about attending lectures and 75% were interested in learning the next material, but only 40% studied quantum physics from various references. Furthermore, 60% of students already know what mathematics should be used in analyzing a case. However, in this quantum physics course, several weaknesses were experienced by students. Only 40% of students who actively ask questions, and 40% of students who have ideas in solving problems and 45% who can work collaboratively and also 45% are able to correct the answers of friends.

From the analysis of the data that has been presented it appears that the teaching materials used have been quite diverse. There are many references that can be used by students in lectures and will help students understand the material being studied. Furthermore, the analysis of the tasks given showed quite good results. The assignments given by lecturers are quite clear and in accordance with students’ thinking abilities, and can help them in understanding learning material.

Based on an analysis of the potential and constraints experienced by students in quantum physics lectures. From the data obtained, students have sufficient motivation to study quantum physics. This is seen from the students’ interest to learn quantum physics material from various references and learn the next material. However, in the lecture, there are seen some weaknesses experienced by students while attending lectures in quantum physics. There are still few students who have ideas in solving problems and students who are able to correct the answers of friends are still lacking. For student activities, it is still low from the willingness to collaborate and also during the learning activity students are still asking questions.

Analysis of some of these aspects shows that the pleasant conditions of lectures accompanied by high understanding and student activities should be able to occur. However, the lack of means to support this makes students’ activities and attitudes still lacking. In order to overcome this, learning is needed that involves students actively and is able to work collaboratively during the quantum physics lecture process. It requires a lecture process that has lecture steps that can improve 21st century skills, especially regarding collaboration and the availability of teaching materials that support it. The results showed that collaborative learning can improve students’ social abilities so as to be able to convey arguments, criticize the opinions of their friends if there are opinions that they think are wrong, listen actively and respect the opinions of others, and be able to equip students to generate new creative ideas as a result of thought by them.

4. Conclusion
From the data analysis that has been done it can be stated three results from this preliminary research. First, the available quantum physics teaching materials have not varied. Second, the assignments given in lectures on quantum physics can help students understand the material. Third, students have sufficient potential in understanding the material, but the percentage of students who have ideas in solving problems and who are able to correct answers from friends, want to work collaboratively and who actively ask questions is still low.

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