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AN INTENSIVE STUDY OF TEACHING MODEL OF QUANTUM PHYSICS AT STUDY PROGRAM OF PHYSICS EDUCATION IN UNIVERSITY

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ABSTRACT

Learning outcomes expected from quantum physics course in study program physics education at the university is the knowledge, skills and attitudes.The teaching model of quantum physics to the achievement of the learning outcomes of knowledge, skills and attitudes has been widely researched researchers and researchers published in various journals. Need to do an intensive study of the teaching models of quantum physics published in various journals to get a teaching model of quantum physics suspected effectively improve learning outcomes in the form of knowledge, skills and attitudes. Effective teaching models in learning quantum physics help lecturers improve student learning outcomes. Based on the findings it can be concluded that the research on the application of empirical learning model to achieve the learning outcomes of knowledge, skills or attitudes and rarely, even when there is no source tracking study this article, published in the journal on the internet.

Keywords: *Empirical Teaching Model, Quantum Physics; Constructivism; Learning Outcomes.*

INTRODUCTION

Basically forms of learning outcomes are: knowledge, skills and attitudes. Thus quantum physics learning outcomes expected of students in university physics education courses are knowledge, skills and attitudes. Learning outcomes are formulated in the form of Basic Competence quantum physics course. So, learning quantum physics to achieve basic competence that the shape of the knowledge, skills and attitudes. The question that arises is: What is the guarantee effective learning quantum physics achieve the learning outcomes in the form of basic competencies that are formulated in the form of knowledge, skills and attitudes? The answer, in learning quantum physics, lecturer MUST use effective learning model achieving the desired basic competencies. Effective learning model is empirical learning model. Empirical learning model is a model of learning that have been studied, which have empirical foundation, which has proven effective in achieving learning outcomes that can be achieved the learning model.

Bodner (1986: 873) states "Teaching and learning are not Synonymous, we can teach, and teach well, without having the students learn" in the United States (US). Moreover, in the same tone, van den Berg (editor) (1991: 17), based on some of the results of their research, suggests that in some high schools, even at several universities in Indonesia, the conception of learners on the concept of science concepts contain misconceptions.

Based on the results of the second study education observer that alone, it can be concluded that teaching does not pay attention to aspects of learning theory does not cause the pupil / student learning. In fact, believed to be a good teaching (teach well) in the United State often do not produce learning. Worse yet, in teaching (teaching even considered good) often lead to misconceptions (in Indonesia see van den Berg (editor) (1991: 17)). Hestenes and Halloun (in van Heuvelen, 1992: 56) at the University of Arizona (Arizona State University) find that the style (style) lecturer does not affect the results of a qualitative study of student understanding. They also found that the learning outcomes of students who are taught by professors, the same as learning outcomes of students who were taught a new lecturer (minimum teaching experience), who taught with reference to the textbook closely. Based on the research results, it seems pointless to hire a professor is higher than the salary of a new lecturer in the study was conducted.

Based on the above it can be concluded that one can teach well without learners learn. Teaching is not attain competency. Teaching is supposed to happen is the teaching that cause learning for competence achievement. In other words, learning (teaching that cause learning) is desirable for effective learning for the achievement of competence. Teacher / lecturer / tutor / instructor or effective expert or professional is a teacher / lecturer / tutor / instructor who has the competence: personal, professional, social pedagogic and able to carry out effective learning for the achievement of competence. In the following section described how to implement effective learning for the achievement of competence. Based on the following description, it will be clearly illustrated that the expected learning are: learning using learning models appropriate to the attainment of competence. If learning does not reach the defined competence, it is not effective learning. Teachers and lecturers do not have pedagogic competence in competency-based education. The principle of competence-based learning through the implementation or otherwise measurable competencies.

At the beginning of the twenty-first century, the quantum theory has been formulated quite complete. The students stay just studying the results of the formulation. However, for the study, the students can not be treated the same quantum physics with classical physics. Basically, wherever people began to study quantum physics, at the moment it would seem that the study of quantum physics "heavier", in the sense of requiring the brain, body, and bounce higher, than the study of classical physics. So, anywhere in the world people began to study quantum physics (ie, people of any nation who study quantum physics), that person will feel that feeling heavier it would appear, a minimum of a little taste of what felt like a surprise physicists when they know that the concept of classical physics can not be used to explain the results of experiments on atomic and sub-atomic. Bohr put: Prepare for a shock, advises Bohr, one of the founding fathers of the subject: "Those who are not shocked when they first come across quantum theory can not possibly have understood it." (Bohr in Chester, 1987: 1).

Based on Bohr's statement revealed that the study of quantum physics is not as light as studying classical physics. Or rather, not as heavy as studying classical physics studying quantum physics, but the study of quantum physics is much heavier than studying classical physics. Morrison (1990: 12) stated that there are three reasons why the study of quantum physics is more severe than in the study of classical physics. First, humans grow in and become familiar with the macroscopic world. Thus, when studying quantum physics, which obviously is the most powerful theory for the world microscopic (atomic and sub-atomic) people often experience conflict in understanding quantum phenomenon that is clearly different from the classic symptoms are commonly used in everyday life. Second, quantum physics work in the area above the level of reality, namely quantum physics is more abstract than classical physics. For example, anyone who has ever seen an electron with the sense of sight or with the aid of a tool that sharpens vision? No, but we can talk about electrons within the abstract, the real (not imaginary) but are in mind. Third, quantum mechanics is inherently mathematical. Sharper, mathematics is the language of quantum physics. In the following paragraphs describe the role of mathematics in quantum physics.

Physics can generally be classified into classical physics and modern physics. Classical physics, are all known and unknown physics before Einstein (Albert Einstein [1879-1955]; leading physicist and well-known not only in the famous physicist but in all walks of life, regarded as the most famous scientist of the 20th century, physicists bloody Jews, was born in Germany, an American, won the Nobel Prize of Physics), proposed the theory of relativity and Planck (Max Karl Ernst Ludwig Planck [1858-1947]; German physicist, received the Nobel physics prize, the initiators of quantum theory) introduced the concept of quantum. Modern physics is physics known and unknown since when Einstein introduced his theory of relativity and quantum theory Planck submit up to everything related to the physics associated with the theory of relativity and quantum theory put forward people today. The most revolutionary in the development of modern physics is the development of quantum theory.

Quantum theory, known and unknown today can be regarded as having three phases of development, namely: Phase One, which is known today as the development of the old quantum theory (the old quantum theory) which was developed primarily by Planck (quantum theory), Einstein (quantum theory of light), Bohr (Niels Henrik David Bohr [1885-1962]; Danish physicist, received the Nobel physics prize, develop the quantum theory of the hydrogen atom), Sommerfeld (Arnold Johannes Wilhelm Sommerfeld [1868-1951]; German theoretical physicist, developed the theory of atomic spectra) and Compton (Arthur Holly Compton (1892-1962), an American physicist, developed the Compton Effect); The second phase, which is known today as the development of quantum mechanics (quantum mechanics: When quantum mechanics was developed (1925-1927), many developers are still young (approximately [22-30] years), so that physics developed at that time famous as a young child physics (Knaben Physik or Boy physics)) which was developed primarily by de Broglie (Louis Victor Prince de Broglie (1892-1987); theoretical physicists French nationality, received the Nobel physics prize, hypothesize matter-wave), Schroedinger (Erwin Schroedinger [1887-1961]; physicists Austrian nationality, won the Nobel Prize physicist, developed the wave mechanics), Heisenberg (Werner Heisenberg [1901-1976]; German physicist, received the Nobel Prize physicist, developed the matrix mechanics), Pauli (Wolfgang Pauli [1900-1958]; Austrian-born US physicist, developed the exclusion principle in quantum mechanics), Dirac (Paul Adrien Maurice Dirac [1902-1984]; theoretical physicist, received the Nobel Prize physicist, developed the quantum mechanics), and born (Max Born [1882-1970]; British physicist, was born in Poland, won the Nobel Prize physicist, developed the interpretation of the wave function); and most recently was the third phase, known as the development of relativistic quantum mechanics (relativistic quantum mechanics) or more popularly known as quantum field theory (quantum field theory) that is being developed physicists today, and the results of the present development is led to theories such new theory of 'grand unified theory (GUT)' and even expected that someday will produce a unified theory called 'theory of everything (TOE)'.

Morrison (1990: pp. 3-4), stating that the relationship of mathematics to physics can be categorized as 'mathematical relationship with classical physics' and 'relationship with the mathematics of quantum mechanics and relativistic quantum mechanics'. According to Morrison, a mathematical relationship with classical physics are: mathematics is a tool (tools) for classical physics to implement (apply, implement) ideas (design, idea) theory of classical physics. That is, in classical physics we use mathematical methods, especially for implementing the ideas of classical physics in explaining natural phenomena are very complex. Furthermore, Morrison stated that we still might understand the idea of classical physics (in the form of concepts, models, laws and theories) without understanding the math (high). That is, if the students just want to understand about the idea of classical physics (eg Newton's law), so without mastering high math students are still able to understand the physics. However, if the student wants to implement the ideas of classical physics then inevitably the students have to wear math, even the need to understand and master the higher mathematics. Thus, the ability of students to apply the ideas of classical physics in solving problems related to natural phenomena which are usually quite complex, highly dependent on the ability of the students in bermatematika. According to Morrison, a mathematical relationship with quantum mechanics and relativistic quantum mechanics is: mathematics is the language of quantum mechanics and relativistic quantum mechanics. Thus, without mastering math may not understand quantum mechanics and relativistic quantum mechanics.

Based on the above, allegedly effective learning quantum physics achieve the desired learning outcomes are learning quantum physics that uses empirical learning model, taking into account the properties of the contents of quantum physics itself. In the next section conducted an intensive study of the learning models of quantum physics published in various journals published on the internet to get the learning model of quantum physics suspected effectively improve learning outcomes in the form of knowledge, skills and attitudes. Source study is restricted to the learning models of quantum physics, published on the internet.

METHODOLOGY

The study was conducted on effective teaching quantum physics achieve the desired learning outcomes. Effective quantum physics learning is learning using empirical learning model, taking into account the properties of the contents of quantum physics itself. Intensive studies conducted on the application of research results learning models of quantum physics published in various journals published on the internet to get the learning model of quantum physics suspected effectively improve learning outcomes in the form of knowledge, skills and attitudes. Source study is limited to the results of the study of empirical learning models applied in the study of quantum physics, published on the internet.

Criteria learning model that included in the study are learning models are shaped in accordance with the understanding learning models by Joyce et al. (1992; 2000). Arends (2001: 24) states that the concept of learning model developed by Joyce et al. can be used as a source of design learning process outcomes or results of the implementation of the design of the learning process is a competence that has been formulated.

Joyce et al. (1992: 13) states that the learning model has the following elements: the basic theory, strategy, and implementation measures (use of) models in the classroom or setting (background) other learning. The cornerstone of the theory of a learning model is an explanation of the objectives of models, theoretical assumptions (theoretical Assumptions), and the principles and concepts reaction major (major concepts) underlying the model. Strategy a learning model operationally defined as a description of the model. The description stated in four concepts: syntax, social systems, the principles of reaction and support systems. The description of the activities of what is supposed to happen, and if possible in the order (sequence) of how these activities occur. Syntax or phasing model is an explanation of the operation of the model (the model in action). The syntax is described in the terms of a row of an activity called phase (phase). The social system is an explanation of the role of teachers and learners and connectivity as well as the type of norms are supported. In the reaction of the principles described how teachers should look at learners and how to respond to that performed learners. So, in the support system described what may be required in addition to the model with regard to supporting human skills, capacity and facilities. Step application (use) models in the classroom or other learning settings can be illustrated for various disciplines (subject areas), or guidelines for application at a certain age or a certain curriculum design or suggestions unification of a model with other models. In addition, it can also be a discussion of the important points that seem to be the cause of the difficulty of the model implemented by educators in the classroom or other learning settings. In concept learning models Joyce et al., Main elements harmoniously intertwined. The main elements are: the theoretical foundation, strategies and implementation steps or syntax (use of models in the classroom or setting (background) other learning). In other words, invisible red thread connecting from the theoretical basis to the application in the classroom. Empirical learning models that are Student Active Learning (SCL) on the book Joyce et al. and Arends are based on constructivism. Thus, learning models based constructivism suspected effectively achieve the learning outcomes such as: knowledge, skills and attitudes in learning quantum physics.

RESULTS AND DISCUSSION

Internet search results from November 28, 2014 until December 3, 2014, shows a great many (hundreds, perhaps thousands) of publications on quantum physics learning on the internet. However, unfortunately there are no publications that meet the criteria for a source of study material in this paper. Previously described, which will be studied intensively is the result of research on the application of empirical learning models aimed to achieve the learning outcomes in the form of knowledge, skills and attitudes to learning quantum physics.

CONCLUSIONS

Expected outcomes of the study will be studied intensively in this paper is the result of research on the application of empirical learning models aimed to achieve the learning outcomes in the form of knowledge, skills and attitudes to learning quantum physics.

It turns out that the internet search results have shown no publication of research results that meet the criteria for a source of study materials on this article.

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Based on the above findings it can be concluded that the research on the application of empirical learning model to achieve the learning outcomes of knowledge, skills or attitudes and rarely, even when there is no source tracking study this article, published in the journal on the internet.

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