Student Creativity in Learning of Physics Experiments

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ABSTRACT

Experimental physics courses are one of the courses of excellence. Students need to be trained on the process of designing school physics practices with creative thinking learning patterns on the courses they gained during their studies. the purpose of this article is emphasizing the aspects of creative thinking skills towards the preparation of future physics teachers. The problems that can be identified are: 1) the creativity of the physics teacher has not been able to convince students of the physical product; 2) the applied curriculum has not emphasized the development of aspects of creative thinking skills. The approach used to cultivate creativity is inquiry with a practical approach. The results of this research are able to differentiate reasons, analyze arguments, analyze possibilities and uncertainties, solve problems and make decisions. The students should be developed based on the need for practical models that can support the achievement of goals. The essence of physics is a process of thinking in constructing and applying abstract ideas and their logical interrelationship. Research reveals that creativity is mostly a decision about what or who should do. The creative thinking skills in experimental physics classes need to be possessed by potential physics teachers so that they can understand the basic concepts, and are skilled in finding other solutions. Creative thinking skills can't develop them well if they're not trained.

Keywords: experiments, creativity, inquiry, problem solving

INTRODUCTION

The results of research on the ability of teachers of physics in designing and conducting school physics practicum activities in some regions appear to be not optimal (Al-Abdali & Al-Balushi, 2016). Despite the problems of laboratory facilities and equipment, physics teachers were less creative in designing practices or developing equipment. The study suggests that teachers of physics have not been able to solve problems in organizing practical activities, as a result of the learning experience of being a student. This condition is in line with McDermott's (1999) explanation that one of the important factors affecting the poor performance of physics teachers is their inadequate preparation when becoming prospective teachers. The various program of preparation of prospective teachers that are applied through courses in the curriculum of study program, have always been the basis for preparing future teachers of physics.

Although efforts to improve the curriculum are always being made, the performance of physics teachers must always be monitored through a conscious effort to learn independently and creatively in self-development (Sinambela, 2013). Preliminary

studies of the maintenance of a school physics practice of 40 physics teachers in Maluku show that their responsibility in organizing physical practice activities in schools is still at a low level. The results are based on questionnaires and interviews compared to observations. Physics teachers' reasons for the importance of organizing practicum activities were only 37.5 per cent; while 62.5 per cent did not match the observation results. The practicum activity that led to the creativity of physicist teachers according to the observations was only 25 per cent, while 75 per cent had not yet matched the questionnaire results. The attitude of teachers in organizing physical practice activities to develop students' creativity was only done by 32.5% of the teachers; while 67.5% did not match their reasons in the questionnaire (Budaeng et al., 2017).
The results of the preliminary study conducted show that the experimental physics course is one of the courses of expertise most teachers rely only on their cognitive abilities without being mixed up with high-level thinking skills. This condition is characterized by a learning process that tends to evaluate student learning outcomes on the basis of classroom evaluations, without involving laboratory learning evaluations. The results of interviews with students in the preliminary study showed that they had difficulty designing physics practicums that could generate creativity in experimentation, because the lectures have not emphasized the development of aspects of creative thinking skills. This indicates that students need to be trained on the process of designing physical practicums in schools through the courses they have acquired over the years, with creative thinking learning patterns (Adhiriyanthi et al., 2021; Pratiwi et al., 2019; Sujito & Liliasari, 2020). Students have also not been able to identify physical practice equipment kits for use in practice activities.

Their ability to identify characteristics of physical concepts that can be practiced or demonstrated, too, has not been performed optimally. The application of practicum methods to be used in physical practicum activities, related to the problem of the availability of equipment and the purpose of learning established, also has not been understood by students. In relation to that, the main ideas underlying this writing are: (1) can train students in generating their creative ideas through kit exploration activities, developing a range of practicums, and developing physical practicum designs; (2) can help students in designing school physics practicum activities based on their creative ideas, which refers to classroom activities with creative learning patterns through general explanation activities, modeling, group discussions, individual tasks, and group tasks; (3) can train pupils to enhance their creativity in design physical practice activities; which is known through the assessment of aspects of creative thinking skills against each indicator of activity in experimentation.

The problem can be identified based on the above description, namely: (1) the creativity of physics teachers in organizing the physical practicum activities of the school has not been able to convince students of the physics products studied. This is not consistent with the purpose of science/physics education aimed at convincing students in studying the products of science / physics; and provide them with an understanding of the methods used in learning the products (Nurdyani et al., 2018; Sahida & Zarvianti, 2019); (2) the experimental physics curriculum applied does not emphasize the development of aspects of creative thinking skills of future teachers; although such aspects are the needs of learners in global competition, and can be trained through the process of learning. Such a condition suggests that the preparation program of candidate teachers organized through experimental physics lessons, need to be reinforced to provide candidate teacher in developing his creativity as one of the competences required in the current and future global competition (Ariswan, 2019; Ratnaningtyas et al., 2019); (3) creative thinking skills in experimental physical lessons have never been credited, whereas such competences are required students so that they will be able to solve the fundamental problems associated with the maintenance of physical practicum activities; either concerning the problem of the minimum of practicum equipment, developing methodologies diversely, or the need to develop design (Klein et al., 2021; Palmgren & Rasa, 2022).

Referring to the above issues and educational purposes of science teachers, the purpose of writing this article emphasizes the aspects of creative thinking skills towards the preparation of future physics teachers. A science-oriented learning program of creative thinking skills for prospective physics teachers. This article develops creative thinking skills in experimentation characterized by accommodating creative learning patterns, and developing basic experimentation skills through a variety of activities.

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METHODS

The research method uses the study of the library by conducting a study, explanation and analysis of the results of previous research (Gifford & Finkelstein, 2020; Li & Singh, 2021). This study examines several journals that are relevant and in accordance with the theme of the study develops the creativity of students through practical activities to train the skills of the 21st century. This research works based on data, codes data, analyzes data, and displays data. The purpose of this step is to gather data and scientific information of theories, methods, or approaches that have developed and have been documented in the form of books, journals, manuscripts, records, historical records, documents, etc. The study was conducted on reputable scientific journals with quartiles Q1, Q2, Q3 and Q4 that have relevance and proximity to objects. This method researchers use to obtain research that has the strongest relevance between variables in research. Journals that have high relevance to research themes are grouped according to research variables. The results are then tabulated in the form of tables. This step is to facilitate in finding the theory, coding, and analyzing the data obtained (Boa et al., 2018; Creswell, 2017). Modeling through tabulation is further analyzed with descriptive analysis.

RESULTS AND DISCUSSION

Physics Experiments

Research is divided into several categories, namely revealing reasoning, testing hypotheses, analysis of arguments, probability and uncertainty analysis, problem solving and decision-making (Ismayani, 2016; Tiruneh et al., 2017; Tiruneh & Cock, 2018). The internship is one of the learning strategies that can attract the interest of the student with the aim of giving the student the opportunity to test and implement effectively on the things he has learned theoretically. In science learning, including physics, the laboratory has become a very important aspect because it is a place used for practical learning (Yuliana, 2020).

Physics practice at a school aims to demonstrate the basic basic principles of physics, introduce students to experimental tools so that they can use them for a specific purpose, learn about how to conduct scientific experiments, and develop certain practical attitudes (Zohar & Cohen, 2016). Physics practices in the laboratory should involve students to gain experimental experience, including experience in designing research; assist students in developing a number of basic skills and tools to undertake experimental physics and data analysis; help students in mastering concepts of physics; help learners to understand the role of direct observation in physics, and differentiate theoretical inference from experimental inference, and help students develop collaborative learning skills that are vital to (Eshach & Kukliansky, 2018; Malmia et al., 2019; Ratnaningtyas et al., 2019).

Although the role and function of the physics labs in schools is important, the intensity of practicum-based physics learning in the labs at schools is very low. This is due to several factors, among them the minimal availability of facilities (tools and materials) practicum, still there is a physics laboratory room used as a classroom, and the absence of laboratory or technicians, so the process of preparation of practicum activities in the laboratory takes a lot of learning time (Ye, 2018). Meanwhile, the physical practicum equipment that is available in high school is KIT, basic measurement tools, and physical security tools with minimal availability and poor condition, so the number of physics practicum completions in high schools is in the category of less good.

Physics practices also face problems, including expensive laboratory equipment, limited laboratory facilities, and difficulties in practicing abstract physical concepts. In the abstract concepts of physics, there is a difficulty in presenting the physical processes directly through laboratory activities that result in low levels of mastery of physical concepts and creative thinking (Young et al., 2019). The existing conditions of the implementation of physical practice activities in high school need to be sought its solution, so that the process of learning physics can experience improvement of quality. Some of the following research results on technology-based physics practices can serve as a basis for developing better practices that are acceptable and implemented in school learning (Shana & Abulibdeh, 2020).

Cultivate Creativity

A learning method that can be used to cultivate this creativity is to use an inquiry with a practical approach. This was done as an attempt to prepare students for future physics teachers in organizing physical practice activities in high school (Hyland et al., 2021; Parker et al., 2022). Students should be grounded in development based on the need for practical models that can support the achievement of goals through accommodation of creative thinking skills aspects in experimenting for students of prospective physics teachers. Mixed methods research through embedded design, is characterized as a phase of collecting quantitative and qualitative data at a time. The model is carried out by collecting mutually complementary, qualitatively and quantitatively complementary data to be defined through the stages of quality and quantity research (Creswell, 2017).

Physics learning using a practical approach will work well if it is followed by practical activities and carried out based on scientific methods comprehensively. The essence of physics is a process of thinking in constructing and applying abstract ideas and their logical interrelationship. Regarding hands-on labs, Piaget emphasized that students who study science should actively do (hands-on), because the process is sufficiently convincing when introduced to self-found experiments (Hackemann et al., 2022; Odden et al., 2019; Pakpahan & Saragih, 2022) Students' hand-on and mind-on activities are important to generate their creative behavior; so students do not consider the result as a failure of conceptual knowledge, the result of a learning process that focuses only on cognitive aspects.

In line with that explanation, they have argues that the high of a person without being accompanied by an increased ability to think at a high level, is not enough to compete in today's global era; because life's challenges cannot be solved by cognitives alone, but requires creative thinking patterns (Sahida & Zarvianti, 2019). According to Hackemann et al., (2022), hands-on physics experiments lead more to the process of demonstrating a phenomenon in order to trust students. According to Sutaphan & Yuenyong, 2023, creative thinking is one of the high-level thinking skills, which occurs through the process of cognitive operation, and can be trained in learning. A creative thinker will be able to generate many ideas, make many relationships, have many perspectives of something, be imaginative, and care about the results he achieves. According to (Adhiriyanthi et al., 2021) that creative thinking is characterized as knowledge and attitude.

Thinking creatively as a trait of knowledge is called aptitude fluency, flexibility, originality, elaboration; whereas attitudes are like curiosity, honesty, rigour, and responsibility. Thinking creatively is also meant as creativity. But the ability to create completely new things is almost impossible; so creative thinking is a combination of previous knowledge. Thus, the ability of a person to create new combinations based on the information acquired, will make sense in sparking his creativity. In line with that, Nurdyani et al., 2018, states that creative thinking and creativity have different meanings. Creative thinking brings a person to a new idea whereas creativity is the real essence of the idea. So, the important meaning of creative thinking will benefit a man competitively if he can develop his skills and knowledge to come up with new ideas in the environment where he works. Various aspects of creative thinking skills have been recommended to be developed in learning (Bahri et al., 2021). These include: problem sensitivity, fluency, flexibility, originality, elaboration, and evaluation. It is generally explained that these aspects of creative thinking skills have different characteristics. The explanation of the qualities of creativity has been studied by Gosper & Ifenthaler (2014).

The results reveal that creativity is mostly a decision about what or who to do. It is described that everyone has the ability to develop their creativity. However, the scientific meaning of creativity must be understood so that what is done conforms to the purpose of development. The creative thinking skills in experimental physics classes need to be possessed by potential physics teachers so that they can understand basic concepts, and are skilled in finding other solutions. It is in Costa, 1991 opinion that teaching by thinking creatively means providing an opportunity for students to train in the use of basic concepts. Students' experience of this process can give them an opportunity to be skilled in thinking in different ways for understanding a particular concept.

CONCLUSION

The conclusion that can be drawn from the article is that the practical approach in addition to improving student understanding in the study of physical phenomena, can also improve skills. The evolving essence of physics is the process of thinking in constructing and applying abstract ideas and their logical interrelationship. Therefore, it is necessary to practice in students as an effort to prepare future physics teachers in organizing physical practice activities in high school. However, the scientific meaning of creativity must be understood so that what is done conforms to the purpose of development. Creativity in experimental physics lessons needs to be possessed by future physics teachers so that they can understand the basic concepts, and are skilled in finding other solutions. The limitation of this research is the use of one focus variable, namely creative thinking, whereas there are still many other aspects of thinking that support physics learning. In the future, the results of this research can be used as a basis for designing learning that can foster student creativity.

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