Model of Project Based Learning with Computer Simulations to Improve Conceptual Understanding of Prospective Science Teachers

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Model of Project Based Learning with Computer Simulations to Improve Conceptual Understanding of Prospective Science Teachers

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Abstract- Conceptual understanding is one of the important things in learning science in the 21st century. Various innovations were made to motivate and make science learning more interesting. Among the difficulties in learning, science has many abstract concepts. Abstract concepts need to be visualized so that they are easily understood by students. The combination of innovative learning models with computer simulations is needed to get better learning outcomes. The purpose of this study is to examine the effectiveness of project-based learning modelwith computer simulations toward the conceptual understanding of prospective science teachers. This study involved three groups that were treated with project-based learning assisted with computer simulations. The conceptual understanding was measured using multiple-choice tests. The results showed an increase in the conceptual understanding of prospective teachers in science concepts. The use of computer simulations has been proven to help students visualize concepts so that they are easily understood.

Keywords: project based learning; computer simulations; conceptual understanding; prospective science teachers

Introduction

Studying in 21st-century places more emphasis on academic achievement in the form of high-level skills. Good mastery of skills will provide a better future for the next generation. However, there is one thing that is the key and the main source of this skill, and we call it conceptual understanding. A good conceptual understanding will produce the skills needed by students. Geary et al. [1] stated that conceptual understanding is very influential on the quality of student competencies quantitatively. Even conceptual understanding is very influential on other skills such as argumentation skills [2].

Constructivist thinkers believe that good conceptual understanding comes from good learning. In the 21st century, learning is required to focus on students in most processes, namely student-centered learning and learning centered on direct activities [3]. In addition, the purpose of physical education has evolved to be able to adapt to the pace of development of the application of scientific discoveries in everyday life. Riveros [4] stated that the most effective learning to meet the demands of the 21st century is student-centered learning.

Project-based learning is the closest learning proses to the daily life of students. The definition of project universally refers to unit of work [5]. That is, project-based learning will produce a product by studentsbased on some works in a project that is done individually or in groups. In the process of finding ideas, planning designs, and developing products, students are required to master specific concepts because the products will work properlyif the conceptual principle of the product is able to be understood and taken from good concepts. Students are the main actors in project-based learning because most of the activities are carried out by students, this is what makes project-based learning truly student-centered learning.

Project-based learning is student-centered learning. In general, students in their daily lives are familiar with tasks such as making posters, dioramas, and models. All of these assignments are categorized as a project, but in their implementation, they do not produce meaningful learning because they prioritize cognitive processes and final products [6]. Project-Based learning should focus on the project process, not only promoting the good and bad outcomes of the project. Larmer also provided two meaningful project-based learning criteria, namely, students must generate interest in the given project, and the project must be in accordance with the learning objectives.

Meaningful project-based learning requires the media as an information transfer tool to motivate students. Computer simulation media is very suitable to carry out the task. Computer-based learning media are media that is on the rise in millennial education. There are many types of computer-based media, for example virtual laboratories [7], animation media [8] and computer simulations. Computer simulation is an imitation of a

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phenomenon or conceptual and its environment in the form of a computer program. Computer simulations have been known to increase student motivation in learning [9], [10], [11]. Computer-based and simulation media are able to provide an increase in students' understanding of concepts [12] and creativity[13]. These studies proved that computer simulations support project-based learning into more meaningful learning, which is able to motivate students and improve their understanding of concepts as learning objectives.

In addition,conceptual understanding has become a popular theme in educational research. Even in general, the achievement of conceptual understanding is the main thing in learning. The combination of various methods, models, media, and learning techniques influences students' conceptual understanding differently. Material differences also require different treatments. Moreover, for a prospective teacher, a good understanding of the concept is important because it is the main asset that will be used in undergoing the future teaching profession.

Several factors influence the increase in the conceptual understanding of prospective teachers, such as the use of instructional media. Rakhmawan et al. [14] stated that the use of laboratory-based learning could improve conceptual understanding of prospective teachers; however, real laboratory cannot be done at any time. Problems that often encountered, such as lack of facilities and infrastructure, abstract concepts, security issue, and high costs. Laboratory activity can still be fulfilled with the help of virtual laboratories as studies by Finkelstein et al.[15], and Gunawan et al. [16] found that the application of virtual laboratories can help improve the quality of learning and increase student creativity. Better student creativity will make it easier for students to find and understand the concepts that they have been learning.

Creativity plays a very important role in the process of completing student projects. Computer-based simulations have the opportunity to increase student creativity. Students with good creativity will naturally produce better project ideas. In the process of making a project, students can improve their conceptual understanding by understanding the working principles of each product that they design. Hocevar [17] stated that creativity is directly proportional to one's level of intelligence. It means that someone creative has a good level of understanding. If creativity can be trained through project-based learning, the student's conceptual understanding will be more easily enhanced.

This research is very important to know the impact of project-based learning aided by computer simulations in creating meaningful learning. In theory, computer simulation is effective learning. However, there are still many specific data are needed to understand the process in it. Therefore, this research was held to answer all related questions.

Methods

The effect of project based learning with computer simulations on increasing conceptual understanding of prospective teachers is a quasi-experimental based study. This quasi-experimental research was a pretest-posttest design, with three experimental groups. The experimental groups were given project-based learning with computer simulations. The study population was students at one of university in Mataram, West Nusa Tenggara. The research sample consisted of three groups in different study programs and different subjects. Three lecturers in the three sample groups used project-based learning with computer simulations in their classes.

Research instrument used a multiple-choice test with 30 questions designed to evaluate e level of students' conceptual understanding. Students' conceptual understanding was evaluate based on each subject. The instrument was developed according to the level of difficulty. The data analysis was used is the N-gain test. N-gain test results provide an overview of the increase in students' conceptual understanding in the three groups. The emerging trends describe the conditions of each different group but apply the same thing, namely project-based learning with computer simulations.

Result and Discussion

Based on the analysis of the development of conceptual understanding between groups, the results are presented in Figure 1.

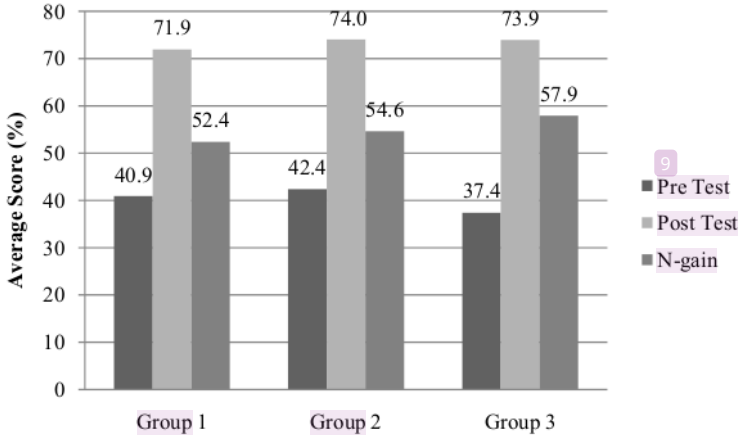

Figure 1. The Improvement of Students' Conceptual Understanding

Based on Figure 1, there are several things that can be understood. Overall, the three groups had almost the same increase. All three groups have the same level of improvement, which is moderate. If we look at the ranking, group 3 is the group with the highest increase, which is 57.9% and the lowest in group 1 which is 52.4%. Group 3 has the lowest pre-test score but has a fairly high post-test score of 73.9.

The Improvement students' conceptual understanding can be observed based on pretest and posttest scores. The increase is based on the results of the N-gain test. The results show that the three groups have good enhancement. Group 1 increased by 52.4%, group 2 increased by 54.6%, and group 3 increased by 57.9%. It can be understood that the improvement of each group is not significantly different,that is, the effect of applying project-based learning to the three groups is the same.

In group 1, the increase was 52.4%. This increase was based on differences in the pre-test results of 40.9 and post-test of 71.9. The improvement experienced in group 1 was due to the implementation of project-based learning, providing valuable experience for each student. The experiences gained by these students are in the form of the process of finding ideas, applying ideas, building ideas into real objects, solving problems when applying ideas to design, and presenting ideas. When students try to find ideas for learning media to be developed, they must read and understand various literature related to the media they want to develop. Mueller et al. [18] stated that the idea discovery process influences the decision making process and execution of future plans. This means that a good idea is not just a thought without a clear direction, but it contains a good understanding of the concept along with an understanding of the full procedure of how to apply the idea.

In group 2, the increase was 54.6%. At the pre-test, the average score of group 2 only had a score of 42.4, but in the post-test, it was able to increase the concept mastery score to 74. This provided information that in group 2, project-based learning with computer simulations was also able to increase the level of conceptual understanding and learning outcome [19].

In group 3 the increase occurred by 57.9%. At the time of the pre-test, the score of group 3 was only 37.4, but in the post-test, it was able to increase the average score of concept mastery to 73.9. This provides information that in group 3, project-based learning with computer simulation is also able to increase the level of mastery of students' concepts. Group 3 is the group with the highest increase. Increased mastery of their concepts can also be observed in the results of their project product development. If it is observed that group 3 is a group with relatively better product development compared to groups 1 and 2. This indicated that in the process of developing ideas and the execution of ideas, students in group 3 are superior to other groups. The implication, at the time of the post-test, group 3 were better than groups 1 and 2.

Project-based learning emphasizes processes and products. The process that occurs when developing a media must have a good understanding of the concept or vice versa.In the process of developing media, students develop mastery of the concepts that they have as a result of developing ideas, problem-solving and discussions among friends in the group. Anderman et al. [20] stated that project-oriented learning could increase the level of mastery of concepts well. Additionally, Fauzia et al. [21] stated more clearly that project-based learning supports increased understanding of concepts in students. This is because project-based learning supports the development of various kinds of skills[22], [23], [24]. These skills are included in the skills needed in the 21st century, and all these factors could ultimately make students easier to improve their understanding of concepts in the end.

The use of computer simulation media also provides positive support for the development of conceptual understanding of prospective teacher students. Husein et al. [25] stated that the use of interactive media could be supported by problem based instruction and produces positive results on understanding student concepts. The use of computer simulations as support for project based learning is very appropriate. Project based learning is more

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meaningful because of computer simulation media. The existence of computer simulations makes it easier for lecturers to convey learning objectives interactively and provides more motivation to students by showing various potential computer simulations that they can develop. Leow & Neo [26] showed that the use of interactive media could positively influence motivation and learning interest. Moreover, the application of computer-based media can be used repeatedly and providing direct feedback to users, thenit gives strongly supportsfor effective learning process [27]. All these advantages are the main supporters for the development of good conceptual understanding.

The implementation of learning in the three groups went quite well. Students can complete each project well planned. In the process of developing and completing projects, students show a positive attitude, good motivation, and the development of supporting ideas. The supportive environment provides good learning for every student in developing every idea they propose. To this point,, the conceptual understanding that exists in each student is observed to continue to develop in line with the process of completing their project. Susilowati et al. [28] said that the application of project-based learning was proven to improve conceptual understanding because it provided an active, but inefficient learning environment. The role of computer simulations is to make the learning process more effective.

Computer simulations play a role in providing additional motivation and knowledge for lecturers in showing media that can be developed. Hermansyah [12] showed that the use of media computer-based not only makes learning effective but also proves to be able to increase conceptual understanding. The combination of project-based learning with computer simulation is the right thing because the two complement each other so that it becomes more effective and efficient.

Furthermore,the three groups come from different study programs. The study programs involved are physics education, chemistry education, and biology education. Figure 1 shows that the improvement of each student group did not differ significantly. That is, the use of project based learning aided by computer simulation has the same effect in all classes. Although each class has a different character applying a combination of project based learning and computer simulations, it shows consistent results. In other words, this learning method is good for applying across different class characters. This is supported by several studies that showed the application of project based learning both in all class characters, such as biology classes [29], chemistry [30], and of course physics [31].

Thus,conceptual understanding in all groups was spread evenly. This is evidenced by the average final score of students in each group showing almost the same results. Because the sample is homogeneous and normal, it can be understood that the application of project-based learning aided by computer simulation influences all students in each group. Although each group originates from a different scientific background, project-based learning turns out to have a good effect on all group characters, meaning that project-based learning aided by computer simulations can be applied to all characters of science classes [32], [33], [34].

Conclusion

Project based learning using computer simulation can improve conceptual understanding of prospective teachers. The combination of these two things creates an effective and efficient learning ecosystem. This is because project based learning provides space to express ideas and develop conceptual understanding. In addition, computer simulations also provide opportunities to supplement deficiencies in project based learning, namely by increasing the efficiency of learning time and the motivation of prospective teacher students.

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