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Research Article

Application of practice-based learning in graph theory

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ABSTRACT

Learning graph theory is an important topic in the world of mathematics and computer science. However, students often face difficulties in understanding the concepts and practical application of graph theory. Therefore, this study aims to apply practicum-based learning methods in teaching graph theory to students. The method used in this study involves the application of practical work through the use of maple. Students are given the opportunity to interactively run experiments, analyze results, and relate them to graph theory concepts. Apart from that, they are also given assignments that focus on the practical application of graph theory in real-world contexts. This study was conducted on students of the Mathematics Education Study Program IKIP PGRI Pontianak, totaling 1 class using an experimental approach. The collected data were analyzed quantitatively to evaluate the effectiveness of practicum-based learning methods in increasing students' understanding of graph theory. The results of the study show that the application of practicum-based learning in graph theory has a positive impact on student understanding. Students show a significant increase in their understanding of graph theory concepts and their ability to apply the theory to real-world situations. In addition, students also provide positive feedback regarding interactive and fun learning experiences.

Keywords: Practice-Based Learning; Graph Theory; Experiment; Using Maple; Mathematics Learning

1. INTRODUCTION

Learning graph theory is an important aspect in mathematics and computer science. Graph theory is used to analyze the relationship between connected objects and has become the basis for many important applications in everyday life, such as social networks, transportation, communication, and optimization. Even though graph theory has broad implications, students often experience difficulties in understanding the concept and applying it practically. Based on the research and opinions of experts, the application of practicum-based learning in graph theory is a feasible effort to do. Smith (2018) explains that practicum-based learning can help students internalize graph theory concepts in a more tangible way and strengthen their understanding through direct experience with practical applications.

In line with this opinion Jones et al. (2019) revealed that based on the results of the research conducted, it shows that students who are involved in practicum-based learning in graph theory have better abilities in solving complex problems involving graph structures and applying graph theory concepts in real-world situations. The results of this study provide strong evidence that practicum-based learning methods have the potential to improve students' understanding and skills in mastering graph theory. Johnson (2019) states that the application of practicum in learning graph theory provides opportunities for students to interact with real graph objects, which can strengthen their concepts and skills. In addition to strengthening concepts and skills, research conducted by Lee (2017) states that students who are involved in practicum-based learning in graph theory have higher motivation, more active involvement, and better achievement in understanding concepts and applying them. In addition, the application of practicum in learning graph theory is also consistent with the theory of constructivism put forward by Piaget (1970). According to this theory, effective learning occurs through direct experience and students' active participation in the construction of their own knowledge. In the context of learning graph theory, practicum provides opportunities for students to interact directly with graphs, run experiments, and explore the relationship between concepts and practical applications.

Based on the reasons above, this research is proposed to apply a practicum-based learning method to graph theory. This research will examine the effectiveness of this method in improving students' understanding and their ability to apply graph theory in real-world contexts. It is hoped that the findings from this study will make a significant contribution to the

development of more effective learning methods in studying graph theory.

2. RESEARCH METHOD

This study aims to apply practicum-based learning methods to graph theory and see an increase in pretest and posttest scores as an indicator of learning effectiveness. In accordance with the objectives to be achieved in this study, the research method used is by using a quantitative approach using a one group pretest-posttest design. The main step in this study is that students in one class will take a pretest before practicum-based learning, then take a posttest after learning is over. The difference in pretest and posttest scores will be used to evaluate the increase in understanding of graph theory after the application of practicum-based learning.

The population in this study were all students taking graph theory courses in the mathematics education study program at the IKIP PGRI Pontianak which consisted of 3 classes with a total of 82 students. Based on the results of the homogeneity test that was carried out that the data from the population was homogeneous, then one class was randomly selected to be the subject of this study. Based on the randomization results, Class A was chosen which consisted of 28 students. The instrument used in this study is a test instrument consisting of pretest and posttest questions. Two knowledge tests on graph theory were developed to measure students' pretest and posttest understanding of students. The test covers basic concepts, graph properties, and practical applications in various contexts. In addition to these instruments, supporting instruments are also made in the form of structured and detailed practicum guidelines designed to guide students in carrying out practicums and applying the concepts of graph theory in real-world situations.

This research was carried out by giving pretest questions (01) to students before starting practicum-based learning to measure their initial understanding of graph theory. After the pretest, students will be involved in practicum-based learning(X). They will be given practical guidelines that guide them in carrying out experiments, analyzing results, and applying graph theory concepts in real-world situations. After completing practicum-based learning, students will take a posttest (02) to measure their understanding after implementing the practicum. After the posttest, students will have an evaluation and discussion session to strengthen their understanding and provide feedback about the learning experience. In more detail, the research method used can be seen in **Figure 1**.

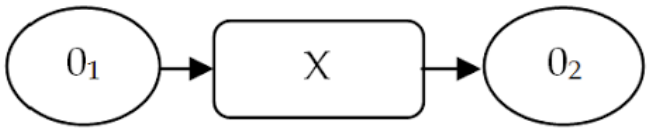

Figure 1. One group pretest posttest design

The pretest and posttest data obtained are then calculated for the average value then the data on the differences in pretest and posttest values will be analyzed using the t-test to see whether there is a significant increase in understanding of graph theory after the application of practicum-based learning.

3. RESULTS AND DISCUSSION

Before starting practicum-based learning, a pretest was conducted to measure students' initial understanding of graph theory. The pretest results showed that the average initial score of students was 58. Most of the students' initial understanding was in the low category. After the pretest, the application of practicum-based learning in graph theory was carried out. Students are involved in carrying out practicums designed to apply graph theory concepts in real-world situations. They use maple software, analyze the results, and relate them to relevant graph theory concepts. After completing practicum-based learning, a posttest is carried out to measure students' final understanding of graph theory. The posttest results showed that the average student final score increased to 86. In more detail, the results of student pretest and posttest can be seen in **Table 1.**

Table 1. Average Scores

Average Scores	Pretest	Posttest
Experiment	58	86

This increase in score indicated a significant increase in student understanding after the implementation of the practicum. Furthermore, to test the significance of increasing student understanding, statistical analysis was carried out using the t-test. The results of the t-test show that the p-value is < 0.05. That is, there is a significant difference between the scores of students' pretest and posttest. This indicates that the application of practicum-based learning in graph theory significantly increases student understanding. The results of this study indicate that the application of practicum-based learning to graph theory is effective in increasing student understanding. The significant increase in students' understanding after the implementation of practicum shows that direct experience in carrying out practicums and applying graph theory concepts in real-world situations makes a positive contribution to learning.

Practical application gives students the opportunity to experience firsthand how graph theory concepts can be applied in real situations. Through direct interaction with graph simulation software, students can run experiments, analyze results, and understand the implications of graph theory concepts. This practical experience can strengthen their understanding and help them connect graph theory concepts with practical implementation. The results of this study are also consistent with previous studies which show the benefits of practicum-based learning in understanding mathematical concepts. In the context of learning graph theory, practical applications provide flexibility for students to think critically, apply their knowledge, and develop analytical skills needed in real-world contexts. As revealed by Brown (2014) that the application of practicum-based learning in graph theory provides an opportunity for students to connect graph theory concepts with practical implementation, which supports a deeper and more relevant understanding.

A significant increase in student understanding after the application of practicum shows that practicum-based learning methods are feasible to be applied in teaching graph theory. This method can be used to strengthen student understanding, facilitate active involvement, and increase the application of graph theory concepts in various contexts. In the context of mathematics and computer science education, the application of practicum-based learning in graph theory can be an effective strategy in preparing students to face challenges in the academic and professional worlds. However, it should be noted that this study has limitations in terms of generalizability. This research was conducted in one class with a limited number of students. Therefore, further research with a larger and more diverse sample can provide a deeper understanding of the effectiveness of practicum-based learning in graph theory

4. CONCLUSION

Based on the results of the data analysis carried out, using the t-test it was concluded that there was a significant increase in students' understanding of graph theory after the application of practicum-based learning. The application of practicum-based learning in graph theory gives students the opportunity to be directly involved in carrying out practicums, applying graph theory concepts in real-world situations, and analyzing results. The results of this study indicate that this hands-on experience significantly improves students' under-standing of graph theory.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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