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Improving Students' Mathematical Disposition in Applied Graph Learning through the Knowledge Sharing Strategy

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Abstract

Applied Graph is a compulsory course in the Informatics Engineering study program at Pamulang University that many students still perceive as difficult. This study aimed to examine differences in students' mathematical disposition between those taught using the knowledge sharing learning strategy and those taught using the expository strategy. A quantitative approach with a quasi-experimental design was employed, involving a sample of 59 students. Data were collected using a mathematical disposition questionnaire consisting of 29 valid items, which was validated on 136 students and demonstrated very high reliability (Cronbach's alpha = 0.992). Data analysis was conducted using an independent samples t-test, yielding a p-value of 0.005. The findings indicate a significant difference in mathematical disposition between students taught using the knowledge sharing strategy and those taught using the expository strategy.

Keywords: mathematical disposition, knowledge sharing Learning, learning strategy

1. Introduction

Applied graph theory is a course that introduces concepts, algorithms, and real-world applications of graph theory, a branch of discrete mathematics that studies network structures composed of vertices connected by edges (Hendy et al., 2025). Mastery of applied graph concepts requires students not only to understand abstract mathematical ideas but also to develop strategic thinking and problem-solving skills applicable to complex real-world situations. Consequently,

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learning in applied graph courses should address not only cognitive outcomes but also affective dimensions, particularly students' mathematical disposition.

Mathematical disposition refers to students' tendencies to think and act positively toward mathematics, encompassing self-confidence, perseverance, responsibility, curiosity, interest in challenges, and reflective thinking (Kusmaryono et al., 2019; NCTM, 1989). This affective aspect plays a crucial role in successful mathematics learning and the development of critical and creative thinking skills (Fitrianna et al., 2018; Kamid et al., 2021). However, numerous studies indicate that Indonesian students' mathematical disposition remains relatively low, as many perceive mathematics as difficult and abstract, leading to negative attitudes, low confidence, and a tendency to give up when facing challenging problems (Dina & Ikhsan, 2019; Fitriya et al., 2023; Almerino et al., 2019). This condition is also reflected in international assessments such as PISA and TIMSS, which consistently position Indonesian students below the global average in mathematics-related outcomes (OECD, 2023; Provasnik et al., 2012).

Previous research has demonstrated that mathematical disposition is positively associated with mathematics achievement, communication skills, and representation abilities (Dina & Ikhsan, 2019; Fitrianna et al., 2018; Kamid et al., 2021), highlighting the need for instructional approaches that actively engage students and support collaboration and reflection. One such approach is active learning based on knowledge sharing, which emphasizes the exchange of ideas through discussion, collaboration, and presentation. Knowledge sharing enables students to deepen conceptual understanding, enhance communication skills, and develop positive mathematical dispositions through social interaction and mutual reflection (Johnson & Johnson, 2009; Sari, 2020; White et al., 2012).

Despite its potential, empirical studies examining the effectiveness of knowledge sharing in mathematics learning—particularly in improving students' mathematical disposition—remain limited. Most existing studies in Indonesia have focused on discovery learning or problem-based learning models, primarily targeting cognitive outcomes rather than affective development through sustained social interaction and collaborative knowledge construction (Dina & Ikhsan, 2019; Kusmaryono et al., 2019). Moreover, research suggests that changes in mathematical disposition require long-term learning experiences that promote positive interaction and continuous reflection, which are not sufficiently addressed in conventional instructional models (Lin & Tai, 2016).

Therefore, this study addresses this research gap by applying a knowledge sharing learning strategy in an Applied Graph course to examine its effectiveness in improving students' mathematical disposition. The novelty of this study lies in integrating knowledge sharing as an active learning strategy within the context of applied graph learning, a domain that demands both abstract reasoning and real-world problem-solving. This approach is expected to strengthen the affective dimension of mathematics learning by fostering collaborative reflection, social support, and active engagement, enabling students to develop not only conceptual understanding but also positive attitudes, confidence, and perseverance in tackling challenging mathematical problems.

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2. Methods

The research method used in this study was a quantitative method with a quasi-experimental design, using a nonequivalent group posttest-only design (Handayani & Noviana, 2021). The study involved two intact groups that received different instructional treatments: the experimental group was taught using the knowledge sharing learning strategy, while the control group received instruction through the expository learning strategy. By comparing posttest outcomes between the two groups, the design allowed for an evaluation of the effectiveness of the knowledge sharing strategy relative to conventional instruction, while maintaining the natural conditions of the learning environment.

The purpose of this study was to determine whether there was a difference in mathematical disposition between students taught using the *knowledge sharing* strategy and students taught using the *expository* strategy, as well as to describe the achievement of mathematical disposition indicators in each group.

The population in this study was Pamulang University students in the Computer Science study program in the third semester of the 2024/2025 academic year. Sampling in this study was conducted using multistage sampling (Siregar & Nababan, 2021). The research sample consisted of 59 students, including 30 students in the experimental group and 29 students in the control group. This sampling technique ensures sample representativeness and adequate control in the implementation of the experiment (Handayani & Husnul, 2025).

The dependent variable in this study was Mathematical Disposition, while the independent variable was the Knowledge Sharing learning strategy. The data analysis technique used an independent sample t-test. The data analysis process was carried out in several stages, beginning with a prerequisite test, namely a normality test and a homogeneity test.

The instrument used in this study was a mathematical disposition questionnaire. The research instrument analysis consisted of validity and reliability tests, and trials were conducted to determine which statements were appropriate and suitable for use. The questions were tested on 136 students, and the statements that were categorized as appropriate were used in the study. A total of 30 statements were used, as follows:

Table 1.
Mathematical Disposition Indicators

No	Dimension	Indicator	No. Statement	
			Positive	Negative
1	Self-confidence	The presence of self-confidence in learning and solving problems	1, 2	29
		The presence of confidence of achieving the best results	3, 4	30

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		The existence of trust highly towards their own work results	5, 6	28
2	Tendency	Interest in mathematics	7, 8	23
		Ability to express results	9, 10	25
		The ability to reflect on the results of thinking and performance	11, 12	24
3	Flexible and open	Openness when receiving input from others	13, 14	21, 22
4	Perseverance and	Persistent and diligent, in solving mathematical problems	15, 16	26, 27
5	Awards	The existence of recognition for the role of other sciences alongside mathematics	17, 18, 20	19

3. Result and Discussion

Instrument Analysis

The mathematical disposition questionnaire tested on students consisted of 30 statements that had previously been validated by experts. The mathematical disposition questionnaire was tested on 136 students. The results showed that 29 statements were valid, while one statement was invalid because it did not meet the applicable criteria.

The reliability of the instrument was examined by comparing the calculated r value with the r table at a 5% significance level, and the results of the Cronbach's alpha analysis on 29 statements yielded a value of 0.992, indicating that the mathematical disposition questionnaire is highly reliable. This alpha value far exceeds the minimum reliability threshold commonly used in educational research ($\alpha \geq 0.70$), demonstrating that students' responses across items are consistent and non-contradictory, and that the indicators of mathematical disposition are clearly formulated, relevant, and well aligned with the construct being measured. The exceptionally high reliability may also be attributed to the relatively large number of items and the uniformity of respondents' understanding of the statements, which minimizes variation due to measurement error.

Research Data Description

The research data used for analysis was the Mathematical Disposition Questionnaire completed by students who received treatment using the *Knowledge Sharing* and Expository Learning Strategies. Based on descriptive analysis of the research data, the data was presented in several groups, as follows:

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Table 2.
Research Data Description

Learning Strategy	Number of Students	Min	Max	$\bar{X}$	Mo	Me	Elementary
Knowledge Sharing	30	91	123	108	114	108	9.58
Expository	29	88	127	101	103	102	8.35

Based on the results of the Mathematical Disposition test administered to students who were taught using the *Knowledge Sharing* strategy in the applied graph course, the minimum score was 91, the maximum score was 123, the average score was 108, the mode was 114, the median was 108, and the standard deviation was 9.58.

Based on the results of the Mathematical Disposition test for students who were given treatment with the Expository strategy on material in the applied graph course, the minimum score was 88, the maximum score was 127, the average score was 101, the mode was 103, the median was 102, and the standard deviation was 8.35.

Prerequisite Test

The mathematical disposition score data was described and analyzed based on the learning strategy. The score data was obtained from the post-test mathematical disposition data. The data was obtained from 59 students consisting of 30 students from the experimental class and 29 students from the control class.

The Normality Test was used to determine whether the students' mathematical disposition scores with the *Knowledge Sharing* and Expository Learning Strategy treatments were normally distributed. The results of the calculations for the two data groups are shown in the following table:

Table 3.
Normality Test of Research Data

	Shapiro-Wilk		
	Statistic	Df	Sig
Control	.936	29	.079
Experiment	.943	29	.118

The results of the mathematical disposition score calculations for the classes that were given the *Knowledge Sharing* and Expository Learning Strategies treatments each had a p-value > α = 0.05, meaning that the classes had normally distributed data.

The Normality Test was used to determine whether the mathematical disposition scores of students with the *Knowledge Sharing* and Expository Learning Strategies were homogeneous. The calculation results for the two data groups are shown in the following table:

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Table 4.
Research Data Homogeneity Test

Levene Statistic	df1	df2	Sig
2.333	1	57	.132

Based on the results of the mathematical disposition score calculation, students who were given the *Knowledge Sharing* and Expository Learning Strategy treatment had a p value $> \alpha = 0.05$, meaning that the class was homogeneous, which means that the class had the same variance.

Research Results

Based on the research problem and hypothesis, the data to be analyzed was first subjected to prerequisite tests, namely homogeneity and normality tests. After the normality and homogeneity tests were conducted, it was found that the data was normally distributed and had the same variance or was homogeneous. Since both prerequisite tests were met, hypothesis testing could be conducted using the t-test. The calculation of mathematical disposition scores using the t-test can be seen in the following table:

Table 5.
t-test for the Difference in Mathematical Disposition of Students in the Experimental Class and Control Class

Learning Model	**t-test for Equality of Means**			**Information**
	T	**Df**	**Sig. (2-tailed)**	
Knowledge Sharing >< Ekspositori	2.927	57	0.005	H0 Rejected

Based on the data in Table 5, the t-test calculation results for the two data groups above show that because p-value < 0.05, H_0 is rejected. This means that there is a difference in the mathematical disposition of students who were given the *Knowledge Sharing* and Expository Learning Strategies. A Cohen's d value of 0.78 indicates a large effect size. This suggests that the Knowledge Sharing strategy provides a strong and practically meaningful contribution in enhancing students' mathematical disposition compared to the Expository strategy.

Discussion

The Knowledge Sharing strategy emphasizes learning through social interaction and collaboration, enabling students to exchange ideas, experiences, and mathematical reasoning in an active learning environment. Through this process, students function not only as recipients of information but also as sources of knowledge for their peers, which activates metacognitive processes, fosters learning responsibility, and strengthens intrinsic motivation (Huffaker & Calvert, 2003). Collaborative interactions create positive interdependence, encouraging students to explain ideas, listen to alternative solutions, and engage in mathematical argumentation, all of which

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contribute to deeper conceptual understanding and more positive attitudes toward mathematics (Johnson & Johnson, 2009; Anthony & Walshaw, 2009).

Beyond cognitive engagement, Knowledge Sharing plays a significant role in developing mathematical disposition, particularly self-confidence, perseverance, responsibility, and reflective thinking. Active peer interaction provides immediate feedback, helping students recognize and correct misunderstandings while strengthening their confidence and persistence in solving challenging problems (Fitriya et al., 2023). Reflective dialogue within collaborative learning environments also promotes self-assessment and evaluation of strategies, supporting the development of the cognitive, affective, and conative dimensions of mathematical disposition (Deal et al., 2025). These findings align with social constructivist theory, which posits that knowledge and dispositions are constructed through dialogue and social interaction (Vygotsky), and are consistent with empirical evidence showing that interactive learning environments enhance curiosity, responsibility, and self-efficacy in mathematics learning (Ulia et al., 2021).

However, while previous studies have demonstrated the effectiveness of collaborative and active learning models in improving mathematical disposition, most have focused on general mathematics instruction or school-level contexts. The findings of this study extend prior research by providing empirical evidence of the effectiveness of Knowledge Sharing specifically within an Applied Graph course, a subject that demands high levels of abstraction, strategic thinking, and real-world problem-solving. This context highlights how Knowledge Sharing not only supports conceptual understanding but also strengthens students' affective engagement in mathematically complex and application-oriented learning environments.

In contrast, expository learning positions students as passive recipients of information, limiting opportunities for interaction, reflection, and shared problem solving. Such conditions restrict the development of affective and conative aspects of mathematical disposition, including confidence, curiosity, and responsibility for learning (Huffaker & Calvert, 2003; Feldhaus, 2014). Previous research has shown that monotonous, teacher-centered instruction often leads to stagnant or declining mathematical disposition, as students lack ownership of the learning process and focus primarily on procedural outcomes rather than conceptual understanding (Fitrianna et al., 2018; Setiawan, 2023). Moreover, the absence of a supportive mathematical community in expository learning limits social reinforcement, which is essential for fostering productive dispositions toward mathematics (Graven, 2012).

Overall, the findings of this study reinforce and extend existing literature by demonstrating that Knowledge Sharing-based learning effectively addresses the research gap concerning the development of mathematical disposition in higher education mathematics, particularly in Applied Graph learning. By integrating collaborative interaction, reflection, and shared responsibility, Knowledge Sharing not only enhances cognitive outcomes but also cultivates confidence, perseverance, and openness to mathematical ideas. These results suggest the need for a paradigm shift from teacher-centered instruction toward student-centered, knowledge-sharing learning environments to promote both mathematical understanding and positive mathematical dispositions.

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4. Conclusion

Based on the results of the data analysis, this study concludes that there is a significant difference in students' mathematical disposition between classes taught using the Knowledge Sharing strategy and those taught using expository learning, with Knowledge Sharing shown to be more effective. Students who participated in collaborative and interactive learning activities demonstrated more positive dispositions toward mathematics, including higher levels of confidence, perseverance, interest, and responsibility. These findings support previous research emphasizing the importance of active, student-centered learning approaches in developing affective aspects of mathematics learning. However, this study is limited by its relatively small sample size and its focus on a single applied graph course, which may limit the generalizability of the results. Future research is recommended to involve broader and more diverse samples, examine long-term effects, and explore the relationship between mathematical disposition and other learning outcomes, such as achievement and problem-solving skills

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