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Synergetic Teaching Learning Strategies On Students' Mathematical Problem-Solving Abilities

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Abstract

This research aims to evaluate the effect of learning strategies *Synergetic Teaching* on students' mathematical problem-solving abilities in trigonometry material. The method used is by *desain post-test only control group*. The research subjects consisted of class X students at a vocational high school, who were divided into two groups: group *experiment* who use learning strategies *Synergetic Teaching* and a control group that uses conventional learning. The research instrument is a validated mathematical problem solving test. Research shows differences between students' mathematical problem solving abilities using learning *Synergetic Teaching* compared to using conventional learning. Implementation of this strategy resulted in a significant increase in student test scores, showing a strong positive effect compared to conventional learning. Overall, students taught with the Synergetic Teaching strategy show better problem-solving abilities than those taught with conventional learning. This can be seen from the higher average student scores with the implementation of the Synergetic Teaching strategy. These results indicate that strategy *Synergetic Teac*hing can improve students' mathematical problem solving abilities *significant*. Therefore, it is recommended that strategy learning *Synergetic Teaching* plan learning in advance with clear times for each activity and create a classroom atmosphere that supports collaboration and active participation.

Keywords : Education, mathematics, problem solving, synergetic teaching, trigonometry.

1 INTRODUCTION

Education is a process of learning and self-development aimed at achieving progress and success. Through education, individuals can develop the skills and knowledge needed in life. According to Indonesian Law No. 20 of 2003 concerning the National Education System, education is a conscious and planned effort to help students develop their potential, spirituality, intelligence, morality, and skills. Education plays a vital role in creating an intelligent, competitive, and morally sound generation to advance the nation in the future (Ahdar Djamaluddin, 2019).

Knowledge in education plays an important role in developing students' potential and skills. Learning occurs through interaction between students, educators, and learning resources in a supportive environment. According to (Ahdar Djamaluddin, 2019), learning is assistance from educators to facilitate the acquisition of knowledge, skills, and the formation of students' attitudes and beliefs. The quality of learning is greatly influenced by the motivation and creativity of the teacher. Highly motivated and creative teachers can create a dynamic learning environment, making learning objectives easier to achieve.

Based on the Indonesian Ministry of National Education Regulation No. 08 of 2022, one of the objectives of mathematics education is for students to develop competence in demonstrating flexible, accurate, efficient, and precise attitudes in solving mathematical problems. These skills are essential in life and education. Students with these competencies

are better equipped to face challenges and find solutions. Flexibility helps them view problems from various perspectives, while accuracy ensures correct solutions. Efficient management of time and resources also supports timely problem-solving (Permendiknas RI No 08, 2022).

Mathematics and learning mathematics is studying or understanding ideas or concepts in the form of concepts contained in symbols and the relationships between the ideas contained therein before applying them to real situations (Ma'ruf, 2018). According to (Polya, 2015), mathematical problem-solving involves four stages: understanding the problem, planning a solution, executing the plan, and evaluating the result. These stages require students' active involvement and their ability to integrate various mathematical concepts. However, many studies indicate that students often struggle to apply these steps, highlighting the need for more effective teaching approaches.

According to the 2022 PISA (Programme for International Student Assessment) report, Indonesia's ranking increased by five positions compared to the previous edition. In mathematical literacy, Indonesia ranked 67th out of 81 countries, including 37 OECD countries and 44 partner countries, with a score of 366, down from the previous score of 379 (Lubis, 2024). PISA questions are developed based on four main content areas: shape and space, change and relationship, quantity, and uncertainty and data (Direktorat Guru Pendidikan, 2024). The "change and relationship" content relates to algebra, which is part of the vocational high school curriculum.

Observations in Class X TKJ 1 at SMK Plus PGRI 01, involving 35 students, revealed a low understanding of mathematical concepts in trigonometry. This was reflected in test results, with an average score of 64.28. Observations and interviews with teachers uncovered several factors hindering the learning process, such as a lack of student engagement and motivation. Students often felt embarrassed to ask questions or express their opinions, resulting in ineffective communication between the teacher and students, as well as among students. The absence of good communication negatively impacted the learning dynamics, hindering collaboration and reducing the effectiveness of the teaching-learning process. Therefore, strategies must be found to increase student motivation and encourage them to be more active and confident in participating in learning.

In learning activities, teachers often do not use effective strategies, leading students to become passive and focused on receiving material from the teacher. To improve student learning outcomes, it is necessary to apply varied strategies that make the learning process more enjoyable and beneficial. One active learning strategy that can be implemented is Synergetic Teaching. This strategy involves students working together in pairs to solve mathematical problems using different approaches. By allowing students with different learning experiences to compare notes and share experiences, this strategy can enhance students' understanding and facilitate discussions that help solve problems (Silberman, 2014). Based on this, the researcher conducted a study entitled "The Effect of Synergetic Teaching Strategy on Students' Mathematical Problem-Solving Ability in Trigonometry" to evaluate the impact of this strategy on students' mathematical problem-solving skills in trigonometry.

2 RESEARCH METHODS

This research is an experimental study using a quasi-experimental design, which is considered as actual research. This type of experiment was conducted in two classes using a comparison class. The research design employed is the "post-test only control design," involving two groups that were each randomly selected. The first group received treatment (X), while the other group did not receive any treatment (Sugiono, 2010).

The population in this study includes all students of SMK Plus PGRI 01. A population is a generalization area consisting of objects or subjects with certain qualities and characteristics determined by the researcher to be studied and from which conclusions are

drawn. Thus, the population does not only include people but also objects studied, encompassing all characteristics or traits possessed by the subjects.

A sample is a part of the population that possesses the same characteristics. The sample must be clearly defined, and the sampling technique must be disclosed to illustrate that the selected sample represents the characteristics of the population. The sample in this study consists of Class X TKJ and X AKL, with 35 students each. The total number of samples is 70 students from Class 10 of SMK Plus PGRI 01.

The sampling technique is a method to obtain a sample that truly represents the existing population. This study used the cluster random sampling technique, where the researcher created several clusters by selecting individuals from the population who have homogeneous characteristics (Sugiono, 2013). Sampling was assisted by the mathematics teacher by forming clusters from the population of 10th-grade students SMK Plus PGRI 01.

3 RESULT AND DISCUSSION

3.1 RESULTS

Before the research was conducted, the initial step was to pilot test the problem-solving test instruments for students. In this phase, the test items that had been developed were trialed to evaluate several important aspects, including validity, reliability, and the difficulty level of each question. Validity refers to the extent to which the test instrument measures what it is supposed to measure, specifically the students' mathematical problem-solving ability. Reliability pertains to the consistency of test results, ensuring that the instrument used can be trusted to produce accurate data. Additionally, analyzing the difficulty level of the questions is essential to ensure that the items presented are appropriate for the students' capabilities.

Once the instruments were confirmed to be valid and reliable, the next step was to conduct research involving hypothesis testing. Before the hypothesis could be tested, several conditions had to be met, namely that the data to be analyzed must be normally distributed and homogeneous. The normality test was performed to ensure that the data obtained from the pretest and posttest met the assumptions of normal distribution, which is a requirement for certain statistical analyses. Furthermore, a homogeneity test was necessary to confirm that the variances of the compared groups were equal, thereby making the analysis results more reliable.

The level of students' mathematical problem-solving abilities was analyzed through data obtained from the pretest and posttest. The pretest was administered before the implementation of the Synergetic Teaching strategy to assess the students' initial abilities, while the posttest was conducted after the intervention to measure the students' improvement. The test results will be analyzed to determine whether there is a significant difference in mathematical problem-solving abilities between students who received instruction through the Synergetic Teaching strategy and those who were taught using conventional methods. The following are the steps and explanations of the research results:

3.1.1 Instrument Validation Test

Tabel 1. Instrument Validation Test

score	Item				
	1	2	3	4	5
$r_{calculated}$	0,405	0,683	0,537	0,675	0,678
r_{Tabel}	0,329	0,329	0,329	0,329	0,329
Description	Valid	Valid	Valid	Valid	Valid

Table 1 presents the validity analysis results for each test item, from numbers 1 to 5, with the calculated value ($L_{calculated}$) obtained being greater than the table value (L_{Tabel}), which is 0.329. The determination of validity is based on the criterion that if L_{Hitung} is greater than L_{Tabel}, the instrument is declared valid. In the context of this research, the validity of the instrument is crucial to ensure that each question posed accurately measures students' mathematical problem-solving abilities.

3.1.2 Instrument Reliability Test

Tabel 2. Reliability Test

Total Variance	Item Variance	Cronbach's Alpha Value	Standard	N	r11	Description
6,7683	3,7349	0,5518	0,6	5	0,5602	Reliabilitiy

Table 2 illustrates the reliability analysis results of the instrument, with a Cronbach Alpha value of 0.5518. This value indicates that the instrument possesses a moderate level of reliability, although it falls slightly below the commonly accepted threshold of 0.6. Additionally, the item-total correlation (r11) value of 0.5602 further supports this assessment, reflecting a reasonable degree of consistency among the items within the instrument.

3.1.3 Difficulty Test

Tabel 3. Difficulty Test

Statistics	Item				
	1	2	3	4	5
Mean Score	3,25	3,03	2,94	2,44	2,78
Maximum Score	4	4	4	4	4
Difficulty Test	0,8125	0,7569	0,7361	0,6111	0,6944
Description	Easy	Easy	Easy	Medium	Medium

Tabel 3. Based on the analysis of validity, reliability, and difficulty level of the instrument used to measure students' problem-solving abilities, 5 test items were selected. To draw conclusions in this study, the researcher will conduct a hypothesis test using the t-test. Before conducting the t-test, the researcher will first perform a normality test and homogeneity of variance test on the two samples.

3.1.4 Normality Test Results

Tabel 4. Normality Test

Classes	N	L_{obs}	L_{Tabel}	Test Decision	Conclusion
Experimental	25	77,40	7,79	Ho is Accepted	Normal
control	25	69,80	6,69	Ho is Accepted	Normal

Tabel 4. shows the results of the normality test conducted on the data of students' mathematical problem-solving abilities. For the experimental class, with a total of 25 students (N), the Lobs value is 77.40, and the L_{Tabel} value is 7.79. Since the Lobs value is greater than the L_{Tabel} value, the test decision states that Ho is accepted. This means that the data distribution for the experimental class is normal. For the control class, with a total of 25 students (N), the Lobs value is 69.80, and the L_{Tabel} value is 6.69. Since the Lobs value is greater than the L_{Table} value, the test decision also states that Ho is accepted. This indicates that the data distribution for the control class is also normal. Therefore, the data from both classes (experimental and control) are normally distributed, meaning that the normality requirement for the subsequent hypothesis testing has been met.

3.1.5 Homogeneity Test Results

Tabel 5. Homogeneity Test

Variance Value	Experimental	Control	$F_{calculated}$	F_{Tabel}
S^2	61	44,75	0,7376	1,9838
N	25	25		

Based on the results of the variance analysis, a $F_{calculated}$ of 0.7376 was obtained, which was compared to a F_{Tabel} of 1.9838. This result indicates that $F_{calculated}$ is less than the F_{Tabel} (0.7376 < 1.9838). Therefore, it can be concluded that the variances of the groups tested in this study are homogeneous.

3.1.6 T-Test Results

Tabel 6. T-Test

Classes	Mean	$T_{calculated}$	T_{Tabel}	Description
Experimental	77,40	3,7011	2,0106	Ho is rejected
Control	69,80			

Based on Table 6, decision-making is conducted by comparing the value of $T_{calculated}$ with T_{table}. The criteria used in this analysis are as follows: if If $T_{calculated} > T_{table}$, then the alternative hypothesis Ha is accepted, and the null hypothesis Ho is rejected. Conversely, if $T_{calculated} \leq T_{table}$, then Ha is rejected, and Ho is accepted.

In this study, the calculations indicate that $T_{calculated}$ is 3.7011 compared to T_{table}, which is 2.0106 at a significance level of 5%. Since $T_{calculated} > T_{table}$, it can be concluded that Ha is accepted, and Ho is rejected.

Thus, the results of this research show a significant difference in mathematical problem-solving abilities between students in the experimental class using the Synergetic Teaching strategy and students in the control class using direct learning methods. These findings indicate that the implementation of the Synergetic Teaching learning strategy has a positive impact on enhancing students' abilities to solve mathematical problems, emphasizing the importance of active and collaborative learning methods in improving learning outcomes. This research strengthens the argument that innovation in teaching strategies can make a meaningful contribution to the development of students' mathematical skills.

3.2 Discussion

Based on observations during the implementation of the Synergetic Teaching strategy, it was evident that this method was a new experience for both teachers and students, as it had never been applied in the classroom before. The strategy encourages students to be more active in the learning process by asking questions of their peers, engaging in discussions, responding to questions, and interacting directly. This more dynamic activity helps students not only receive material from the teacher but also engage in efforts to deeply understand concepts through interaction with classmates. This highlights that Synergetic Teaching can enhance active participation and student interaction during learning.

The implementation of this strategy requires extra attention from the teacher in managing student engagement. Not all students voluntarily take the initiative to present or share discussion results, so teachers must provide encouragement and motivation to every student. Teachers must also ensure that all phases of the Synergetic Teaching strategy are well-executed to achieve optimal learning outcomes. This challenge includes ensuring that all students are actively involved and understand the material in various ways, tailored to their individual needs.

From the comparison between the experimental class using Synergetic Teaching and the control class applying conventional methods, it was found that students who learned with the Synergetic Teaching strategy had higher average test scores. This difference

confirms that Synergetic Teaching has a significant positive impact on students' mathematical problem-solving abilities. The experimental class showed better improvement in critical and analytical thinking skills, which are essential for solving mathematical problems.

Overall, this study shows that the Synergetic Teaching strategy can improve interaction, participation, and students' ability to solve mathematical problems more effectively. The use of this strategy also emphasizes the importance of active learning, where students engage both collaboratively and individually in understanding the material. Therefore, it is recommended that teachers optimize the implementation of the Synergetic Teaching strategy by managing time and learning stages to ensure that learning objectives are maximally achieved.

4 CONCLUSION

Based on observations in the AKL class, students' mathematical problem-solving abilities remain low due to a lack of understanding of basic concepts, ineffective teaching methods, and limited practice in problem-solving. Teaching that is overly focused on memorization rather than comprehension also contributes to this issue. Other factors, such as a lack of challenging exercises, monotonous teaching methods, and low student confidence, further exacerbate the situation. The Synergetic Teaching strategy, which promotes active and collaborative learning, has proven effective in improving students' mathematical problem-solving abilities. This strategy enables students to share experiences and compare their understanding, ultimately deepening their conceptual comprehension and improving learning outcomes. The application of this strategy resulted in a significant increase in students' test scores, demonstrating a strong positive impact compared to conventional methods. Overall, students taught using the Synergetic Teaching strategy exhibited better problem-solving skills than those taught with traditional methods. This is reflected in the higher average scores achieved by students with the implementation of the Synergetic Teaching strategy.

5 RECOMMENDATIONS

Based on the research findings, several recommendations are provided regarding the implementation of the Synergetic Teaching strategy in the mathematics learning process to enhance students' mathematical problem-solving abilities:

1. Teachers should plan the learning sessions with clear timing for each activity. Implement proactive classroom learning with clear rules, and create a classroom environment that supports collaboration and active participation.
2. Researchers are encouraged to conduct more in-depth studies on classroom teaching strategies applied in the context of Synergetic Teaching and evaluate their effectiveness in increasing student engagement and efficiency.
3. Students are advised to actively participate in every learning activity, contribute to group discussions, and collaborate with peers. Learn to manage time effectively, prioritize assigned tasks, and ensure each learning session is used productively.

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