# Implementation Of Metacognitive Approach To Self-Regulated Learning And Mathematical Problem-Solving Skills Of Grade X Students

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**Abstract**
This study aims to describe the achievement of mathematical problem solving ability and learning independence of class X students of SMAN 1 Angkola Barat with a metacognitive approach. This type of research is a quasi-experiment with class X1 as the sample. The research instruments used were problem solving ability tests and learning independence questionnaires. The results of the study showed that using the Mann-Whitney U test, it was found that the problem solving ability of the experimental class had an average of 40.37 and the control class with an average of 30.63 and a sig. value of 0.0215. This means sig. <0.05. The conclusion is that the problem solving ability of students who use a metacognitive approach is better than the problem solving ability of students who use conventional learning. The learning independence of students in the experimental class obtained an average of 43.20 and the control class 27.80 and a sig. value. <0.05 or 0.001 <0.05, it is concluded that the learning independence of students taught with a metacognitive approach is better than the learning independence of students taught with conventional learning.

## INTRODUCTION

Many intellectual endeavors require mathematical problem-solving. (Hendrycks et al., 2021) Overall, mathematical problem-solving skills are important skills that contribute to success in students' lives and education (Yapatang & Polyiem, 2022) Problem-solving skills are also necessary in other sciences as well as in daily life. (Lusiana et al., 2022). Through problem-solving, students can solve problems freely and creatively. (Hutchinson, 2022). "Students' problem-solving skills are

still relatively low because many students have not been able to determine indicators of understanding problems, planning solutions, implementing solutions, and re-checking answers".(Hilyani et al., 2020).

The polya steps that must be applied to students, including solving mathematical problems, are complex cognitive processes that involve a series of steps. These steps typically include understanding the problem, drawing up a plan, executing a plan, and looking back (examining the solution). Lilonga & Ogbonnaya, (2023), (Rachmawati et al., 2021). In addition to the importance of problem-solving skills in mathematics, the attitude of appreciating the usefulness of mathematics in daily life is also very important, one of which is developing an independent attitude in learning or self-regulated learning of students.

Learning independence is an effort made to carry out learning activities in an independent way on the basis of their own motivation to master a certain material so that it can be used to solve problems. (Asmar & Delyana, 2020). Based on a journal study conducted by the researcher, it is known that SRL in schools is still in the low category. (Kurniyawati et al., 2019),(Friskilia & Winata, 2018), (Rinanda et al., 2019). Likewise, the results of observations made by researchers show that students' problem-solving skills and learning independence are still in the low category.

The approach and preparation factor of educators in teaching is the main factor to grow and develop the success of students. One approach to improving students' SRL and mathematical problem-solving abilities is the metacognitive approach. (Çetin, 2017)(Susantini et al., 2021). The metacognitive approach applied in this study consists of 3 stages, namely initial discussion (planning), independence (monitoring), and conclusion/reflection. (Putri et al., 2020). (Artzt & Armour-Thomas, 1998)

Learning and a metacognitive approach guide students to become independent learners who understand where and when to get the expected results and focus on work and learn from mistakes (Sanober & Cheema, 2024). With the application of learning based on a metacognitive approach, it is hoped that it will be able to improve students' problem-solving skills and learning independence.

## METHODS

The study employed a quasi-experimental approach with a randomized control only design. The population consisted of Grade X students from SMAN 1 Angkola Barat in the academic year 2024/2025. Using simple random sampling, two classes were selected: X1 as the experimental group and X2 as the control group. Data collection included administering a Problem-Solving Ability Test comprising four essay questions, scored based on a rubric. Additionally, a Learning Independence Questionnaire was utilized, validated for reliability using statistical analyses like Pearson's correlation coefficient and item analysis. Data were analyzed using SPSS software, assessing hypotheses through tests for normality, homogeneity of variances, and hypothesis testing to determine differences in problem-solving abilities and learning independence between the experimental and control groups.

## RESULT AND DISCUSSION

After the analysis prerequisite test was carried out, a hypothesis test was carried out where hypotheses 1,2,3,5,6,7, using the Mann-Whitney U. test for hypotheses 4 and 8 only used interaction graphs because the analysis condition testing was not met.

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a. First Hypothesis Test

This hypothesis test was used to find out whether the problem-solving ability of students who use metacognitive approach learning is better than the problem-solving ability of students using conventional learning. The results of this hypothesis test calculation can be seen in table 1:

Table 1. Results of the First Hypothesis Calculation

| Class | N | Average | Sig. |
|---|---|---|---|
| Experiment | 35 | 40,37 | 0,0215 |
| Control | 35 | 30,63 | |

From the table, it can be seen that the problem-solving ability has a sig value of 0.0215. This means sig. < 0.05 then minus H0 thus it can be concluded that the problem-solving ability of students who use a metacognitive approach is better than the problem-solving ability of students who use conventional learning.

b. Second Hypothesis Test

This hypothesis test was used to determine the problem-solving ability of students with high initial ability who were taught with a metacognitive approach better than students with high initial abilities taught with a conventional approach. The results of the calculation of this hypothesis test can be seen in table 2:

Tabel 2. Results of the Second Hypothesis Calculation

| Class | N | Average | Sig. |
|---|---|---|---|
| Experiment | 21 | 22,43 | 0,03 |
| Control | 17 | 15,88 | |

From the table, it can be seen that the problem-solving ability has a sig value of 0.03. This means that the sig value < 0.05 (Sugiyono, 2018) thus it can be concluded that the problem-solving ability of students with high initial ability taught with a metacognitive approach is better than students with high initial ability who are taught with a conventional approach.

c. Third Hypothesis Test

This hypothesis test was used to find out whether the problem-solving ability of low-skilled students taught with a metacognitive approach is better than that of low-starting ability students taught with a conventional approach. The test results can be seen in table 3:

Table 3. Results of the Calculation of the Third Hypothesis

| Class | N | Average | Sig. |
|---|---|---|---|
| Experiment | 14 | 21,93 | 0,0015 |
| Control | 18 | 12,28 | |

From the table, it can be seen that the problem-solving ability has a sig value of 0.0015, meaning that the sig value < 0.05, thus it can be concluded that the problem-solving ability of students with low initial ability who are taught with a metacognitive approach is better than students with high initial ability who are taught with a conventional approach.

d. Fourth Hypothesis Test

The interaction between the learning approach and the initial ability to influence problem-solving skills can be seen in the picture 1.
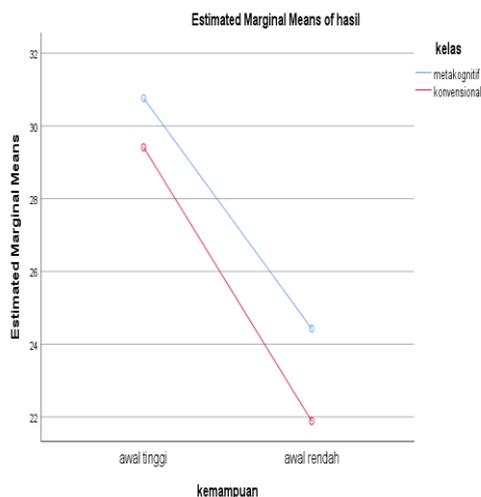
Figure 1. The interaction between approach and initial ability in influencing problem-solving abilities

Based on the image, it can be seen that there are no intersecting lines but two parallel lines. Therefore, it can be concluded that there is no interaction between the metacognitive approach and the initial ability to influence problem-solving ability. In other words, the metacognitive approach is suitable for students with high and low initial abilities.

d.   Fifth Hypothesis Test

This hypothesis test was used to see the learning independence of students taught with a metacognitive approach better than students taught with a conventional approach. The results of the hypothesis test calculation can be seen in table 4 :

Table 5. Results of the Calculation of the Fifth Hypothesis

| Class | N | Average | Sig. |
|---|---|---|---|
| Experiment | 35 | 43,20 | 0,001 |
| Control | 35 | 27,80 | |

From the table, it is obtained that student learning independence has a sig value. $< 0.05$ or $0.001 < 0.05$, then in other words, the learning independence of students taught with a metacognitive approach is better than the learning independence of students taught with conventional learning.

e.   Sixth Hypothesis Test

This hypothesis test was to determine the learning independence of students with high initial ability who were taught with a metacognitive approach better than students with high initial abilities who were taught with a conventional approach. Testing this hypothesis using Mann-Whitney U because it is known that the data are not normally distributed and have inhomogeneous variance. The results of the hypothesis test calculation can be seen in table 6:

Table 6. Results of the Sixth Hypothesis Calculation

| Class | N | Average | Sig. |
|---|---|---|---|
| Experiment | 21 | 25,60 | 0,000 |
| Control | 17 | 11,97 | |

From the table, it is obtained that students with high initial ability have a sig value. $< 0.05$ or $0.000 < 0.05$, then in other words, the learning independence of students with high initial ability taught with a metacognitive approach is better than the learning independence of students with high initial ability who are taught with conventional learning.

f.   Seventh Hypothesis Test

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This hypothesis test was to determine the learning independence of students with low initial ability taught with a metacognitive approach better than students with high initial abilities taught with a conventional approach. Testing this hypothesis using Mann-Whitney U because it is known that the data are not normally distributed and have inhomogeneous variance. The results of the hypothesis test calculation can be seen in table 7:

Table 7. Results of the Calculation of the Seventh Hypothesis

| Class | N | Average | Sig. |
|---|---|---|---|
| Experiment | 21 | 21,14 | 0,0065 |
| Control | 17 | 12,89 | |

From the table, it is obtained that students with high initial ability have a sig value. $< 0.05$ or $0.0065 < 0.05$, then in other words, the learning independence of students with low initial ability taught with a metacognitive approach is better than the learning independence of students with low initial ability who are taught with conventional learning.

g. Eighth Hypothesis Test

The interaction between the metacognitive approach and the initial ability to influence the independence of mathematics learning can be seen in the following figure 2.
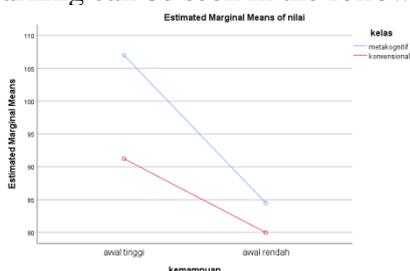


Figure 2. The interaction between approach and early ability to influence independence

Based on the picture, it can be seen that there are no intersecting lines but that two lines are parallel. Therefore, it was concluded that there was no interaction between the metacognitive approach and the initial ability to affect students' learning independence. In other words, the metacognitive approach is suitable for students with both high and low initial abilities.

Discussion

1. Student Problem-Solving Ability of Experimental Classroom and Control Class

The learning process carried out with a metacognitive approach starts from the first stage of initial discussion, the teacher explains the purpose of the topic being studied, the cultivation of concepts takes place by answering basic questions. The teacher guides students to instill confidence and awareness by asking themselves questions when answering each question in the teaching material or the question asked by the teacher, so that the student has confidence that the problem can be solved, and has the intuition that the problem can be solved in certain ways.

The second stage students work independently or in groups to complete the practice questions given. The teacher provides an individual reciprocal influence, going around guiding students in solving problems. By providing stimulus in the form of metacognitive questions, for example, questions to control and monitor students' thinking processes. The influence of metacognitive reciprocity leads students to focus on mistakes and provide clues to students so that students can correct themselves, can control and monitor their thought processes, and can store and reuse the ideas that have been found to be able to solve the given problems.

The third stage is reflection and summarizing. Reflection is carried out by teachers and students. Teacher reflection leads more to consolidation and application that leads to greater consolidation and application so that students get more meaningful learning. A student's reflection is more directed to what he or she has understood from learning as well as the possible application in a broader problem. Next, make a summary done by the students themselves which is a recapitulation of what has been done in class by answering questions asked by the teacher.

At the time of completing the final test on problem-solving ability, students are required to be able to achieve the set problem-solving ability indicators. Indicators of problem-solving ability that must be achieved are understanding the problem, developing a solution plan, implementing a solution plan and checking again. In the experimental class, problem-solving skills have increased.

2. Student Learning Continuity Experimental Classes and Control Classes

In the study, it was concluded that learning with a metacognitive approach has a huge impact on being able to increase students' learning independence both in terms of motivation, initiative and responsibility. This can also be seen from the higher average learning independence of students taught with a metacognitive approach compared to the average learning independence of control class students taught with a conventional approach.

## CONCLUSIONS

Based on the data analysis presented in Chapter IV, it can be concluded that students taught using the metacognitive approach demonstrated higher problem-solving abilities compared to those taught using conventional methods. This was consistent across students with both high and low prior abilities, as those in the metacognitive group outperformed their peers in the conventional group. However, there was no interaction between the learning approach and prior ability in influencing students' problem-solving skills. Similarly, students taught with the metacognitive approach showed higher learning independence than those in the conventional group, regardless of their initial ability level. Yet again, there was no significant interaction between the learning approach and prior ability in affecting students' learning independence.

## CONFLICTS OF INTEREST STATEMENT

Regarding this study, the author declares that there is no conflict of interest.

## AUTHOR CONTRIBUTIONS

Study concept and design: Diah Maya Fitrih Hrp. Acquisition of data: Arnellis Arnellis. Analysis and interpretation of data: Yerizon Yerizon. Drafting the manuscript: Diah Maya Fitrih Hrp. Critical revision of the manuscript for important intellectual content: Yulyanti Harisman. Statistical analysis: Diah Maya Fitrih Hrp.

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