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The Effect of the Discovery Learning Model Assisted by Mind Mapping on Students' Metacognition Ability

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ABSTRACT

This study aims to determine the influence of the Discovery Learning model assisted by Mind Mapping on students' metacognition ability in Biology subjects. This study is a quantitative research with a quasi-experimental design. The sampling method employed was the cluster random sampling technique. The data collection techniques were the test and questionnaires. The data analysis techniques used were the t-test and N-Gain test. The t-test obtained a significance value (sig) of 0.000 > 0.05 (less than 0.05). It means that H_1 was accepted and H_0 was rejected. Based on the average N-Gain scores, the test and questionnaire results indicated that metacognitive ability was higher in the experimental class (60.58) with an "effective" category and 45.50 with a "moderately effective" category, compared to the control class (26.89) with an "ineffective" category and 30.94 with a "less effective" category. These findings demonstrate that the Discovery Learning model, assisted by Mind Mapping, significantly enhances the metacognitive abilities of Senior high school students.

Pengaruh Model Pembelajaran Discovery Learning Berbantuan Mind Mapping terhadap Kemampuan Metakognisi Siswa

ABSTRAK: *Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran Discovery Learning berbantuan Mind Mapping terhadap kemampuan metakognisi peserta didik pada mata pelajaran Biologi. Penelitian ini merupakan jenis penelitian kuantitatif dengan menggunakan metode kuasi eksperimen dan pengambilan dengan teknik Cluster Random Sampling. Teknik pengumpulan data berupa soal tes dan angket. Teknik analisis data yang digunakan adalah Uji t-Test dan N-Gain. Hasil uji t-Test diperoleh nilai signifikansi (sig) yaitu 0,000 > 0,05 (lebih kecil dari 0,05) yang berarti H_1 diterima dan H_0 ditolak. Berdasarkan hasil nilai rata-rata N-Gain hasil tes dan angket Kemampuan metakognitif lebih tinggi di kelas eksperimen sebesar 60,58 dengan kategori efektif dan sebesar 45,50 dengan kategori cukup efektif dibandingkan dengan kelas kontrol yaitu 26,89 dengan kategori tidak efektif dan 30,94 dengan kategori kurang efektif. Hasil ini menunjukkan bahwa pengaruh model pembelajaran Discovery Learning berbantuan Mind Mapping secara signifikan mempengaruhi kemampuan metakognisi siswa SMA.*

INTRODUCTION

Education is the main element in the development of Indonesian people (Hulu & Telaumbanua, 2022). Education plays a role in influencing students' thinking activities and how students act in all things. Therefore, education is very important in the development of knowledge and in shaping student behavior (Li & Xue, 2023).

Giving problems to students can help them hone their thinking skills, process all the information they get, and control a critical and systematic mindset (Wulansari et al., 2022);(Haka et al., 2021). The control of this thinking process is closely related to metacognition skills that help students to plan, sort, and monitor their learning process so that the learning outcomes obtained are better (Sholihah & Sofiyana, 2022);(Hasan et al., 2023).

Metacognition is a process in attracting a person's curiosity because it uses cognitive processes in thinking about our own cognitive processes (Syafrudin, 2021) ;(Darwati et al., 2024). Metacognition ability makes students plan to follow developments and monitor the learning process so that the learning carried out becomes better. Metacognition skills are necessary for students in learning (Raditia et al., 2022);(Ayanwale et al., 2023).

Teachers provide learning so that there is a process of acquiring knowledge, skills, mastery, proficiency, forming attitudes and confidence, and improving students' physical and psychological development (Haka et al., 2020). The role of teachers in the learning process is very large, therefore in improving to improve students' metacognition skills, changes are needed in the learning process, such as the use of more interesting and varied learning models and media (Handoko et al., 2024). One way to do this is to use the discovery learning model assisted by mind mapping.

Discovery learning is done through observation, classification, measurement, and prediction, called cognitive processes. According to Bruner, a person's cognitive development occurs through three stages: 1) In the enactive stage, a person performs activities in an attempt to understand the surrounding environment; 2) In the Iconic stage, a person understands his objects or world through images and verbal visualizations, 3) In the symbolic stage, a person has been able to have abstract ideas or ideas that are greatly influenced by their ability to speak language and logic (Yolida et al., 2022);(Usman et al., 2022).

The discovery learning model can regulate students' learning activities by involving mental processes. The students can observe, digest, understand, classify, make guesses, measure, and draw conclusions to solve problems systematically and obtain previously unknown knowledge (Aryani & Wasitohadi, 2020);(Lim et al., 2023). This idea is supported by research conducted by Rosmala et al. (2023) entitled The effect of discovery learning on the problem-solving ability and science learning outcomes in elementary school students.

Learning using the discovery learning model can increase students' cooperation and learning achievement. Students also do not always depend on the teacher because, during the process, teachers are only facilitators, and students are required to learn actively through information discovery, problem-solving, cooperation, and discussion (Pertiwi, 2021).

The metacognition ability of the tenth-grade students at SMA Negeri 15 Bandar Lampung was relatively low, at 40%. The low ability was due to several factors, one of which was students' unawareness of studying something they did not know. Students depended on the teacher's explanation. Therefore, they could not independently solve problems in learning activities, and learning outcomes were relatively low.

Learning media can make it easier for students to remember lessons and solve problems in learning activities (Rahim et al., 2022). Mind mapping is one of the appropriate learning media used in the application of the discovery learning model. Mind mapping is an interesting and creative record because it is created with interesting colors and images. This mind mapping contains short, concise, and clear material notes with the core title in the middle to help students remember the learning material (Hamad & Ahmed, 2021). According to Meryansumayeka et al. (2022), this technique has been used to improve problem-solving skills, overcome certain weaknesses of traditional teaching, and improve methods of recording material (Shi et al., 2023).

Mind mapping has both advantages and disadvantages. Its advantages include being a tool to freely express an understanding of the material, presenting notes in a more concise and clear format, making it easier to locate notes when needed, and providing a clear overview of the material (Fearnley, 2022).

Based on the alternative solutions proposed by the researcher, the researcher was interested in conducting research on the influence of the discovery learning model assisted by mind mapping media on facilitating the learning process, producing effective learning, and affecting students' metacognition skills.

METHOD

This study employed the quantitative method with a quasi-experimental pretest-posttest control group design. In this design, the experimental and control classes were selected by cluster random sampling.

The population of this study was all tenth-grade students consisting of 8 classes (275 students) of Senior High School for the 2023/2024 academic year. The samples used in this study were taken from the population using the cluster random sampling technique because the object to be studied or the data source was diverse. From eight population classes, two classes were obtained, namely class X.5 (35 students) as an experimental class and class X.8 (35 students) as a control class.

The data collection techniques are metacognition ability test questions and metacognition ability questionnaires to determine students' metacognition ability levels. The research instruments are tested using the instrument validity test, reliability test, difficulty test, and discriminating power test. This study uses the data normality and homogeneity test as the prerequisite test for data analysis. The hypothesis test uses the t-test, namely the independent sample test and the normality gain or n-gain test.

RESULTS AND DISCUSSION

Metacognition Ability Data

Measurement of metacognition ability Students are tested and surveyed using test and questionnaire techniques. After the treatment was applied, measurements were carried out in both the experimental class and the control class. Table 1 shows the results of the analysis of the metacognition ability test and questionnaire.

Table 1. Comparison of Metacognition Ability Test Scores

Class	Highest Scores	Lowest Rate	Ave rage
Eksperimen	94	75	87
Control	85	65	76

Based on these values, it can be seen that the metacognition ability between the experimental and control classes is different. The average score of metacognition ability of students in the experimental class was 87, with a maximum score of 94 and a minimum of 75, while in the control class, the average score was 76, with a maximum score of 85 and a minimum score of 65 so that the ability of metacognition in the experimental class with the treatment of the discovery

learning model is higher than that of the control class that uses the direct instruction learning model.

Table 2. Comparison of Metacognition Ability Questionnaire Scores

Class	Highest Scores	Lowest Rate	Ave rage
Eksperimen	100	70	82
Control	85	65	74

The data in Table 2 shows that the answer value of the metacognition ability questionnaire of the experimental class is greater than that of the control class. The average score of the experimental class questionnaire is 82, with a maximum score of 100 and a minimum score of 70. Meanwhile, the average score of the control class questionnaire is 74, with a maximum score of 85 and a minimum score of 65. The experimental class score was higher than that of the control class, meaning the experimental class had higher metacognition ability than the control class.

Metacognition ability test data was used to answer the research hypothesis. The hypothesis test in the study was the independent sample t-test. Before conducting research testing, a prerequisite test was carried out first. The prerequisite tests in the study include normality tests and homogeneity tests. The following are the results of the normality test (Table 3) and the results of the homogeneity test (Table 4)

Table 3. The Normality Test on Metacognition Ability Test

Class	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Pretest Eksperimen X5	.137	35	.092
Posttest Eksperimen X5	.114	35	.200
Pretest Control X8	.123	35	.199
Posttest Control X8	.144	35	.066

The normality test used was the Kolmogorov-Smirnov test with a significance of α = 0.05. The data above shows that the normality test of the test and the metacognition ability questionnaire have a significant value of all data in both the experimental and control classes, as well as the pretest and posttest values > 0.05. So, it can be concluded that the scores of the metacognition ability test are normally distributed.

Table 4. The Normality Test on the Metacognition Ability Questionnaire

Kelas	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Pretes Questionnaire Eksperimen X5	.138	35	.089
Posttest Questionnaire Eksperimen X5	.144	35	.063
Pretest Questionnaire Control X8	.100	35	.200
Posttest Questionnaire Control X8	.133	35	.125

Table 5. Homogeneity Test on the Metacognition Ability Test

	Levene Statistic	df1	df2	Sig.
Based on Mean	.111	1	68	.740
Based on Median	.210	1	68	.648
Based on the Median and with adjusted df	.210	1	67.897	.648
Based on trimmed mean	.179	1	68	.673

Table 6. Metacognition Ability Questionnaire Homogeneity Test

	Levene Statistic	df1	df2	Sig.
Based on Mean	1.524	1	68	.221
Based on Median	1.379	1	68	.224
Based on the Median and with adjusted df	1.379	1	62.02	.245
Based on trimmed mean	1.591	1	68	.211

Based on the table above, the level of significance of the metacognition ability test and questionnaire is higher than 0.05. Therefore, it can be concluded that the data on the test results and questionnaire on students' metacognition abilities are homogeneous.

Hypothesis Test Results

The analysis test was carried out using a computer program, SPSS 23, for Windows, which performed an independent sample t-test at a significance level of 5%. The results of the hypothesis test are shown in Tables 7 and 8.

Table 7. The Results of the Hypothesis Test on Metacognition Ability Test

Independent Samples Test Levene's Test for Equality of Variances	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	.111	.740	8.572	68	.000
Equal variances not assumed			8.572	67.387	.000

Table 8. The Results of the Hypothesis Test on Metacognition Ability Questionnaire

Independent Samples Test Levene's Test for Equality of Variances	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	1.524	.221	5.196	68	.000
Equal variances not assumed			5.196	64.776	.000

The tables above show that the 2-way significance (t-tailed) results are 0.000 < 0.05. Therefore, there is a difference between the experimental and control classes. Based on the data, the experimental group with the discovery learning model scored higher than the control class that used the direct instruction learning model. Therefore, it can be concluded that the discovery learning model influences students' metacognition ability.

N-Gain Test Results

The N-Gain results can be seen in Table 9.

Table 9. The Comparison of the Average Score of the N-Gain Metacognition Ability Test

Class	Pre test	Post test	Average N-Gain	Criterion
Eksperimen	72,97	89,42	60,58	Effective
Control	67,65	76,57	26,89	Ineffective

Table 10. The Comparison of the Average Value of the N-Gain Metacognition Ability Questionnaire

Class	Pre test	Post test	Average N-Gain	Criterion
Eksperimen	69,14	80,57	45,50	Quite Effective
Control	68,42	76,14	30,94	Less Effective

Based on the table above, the experimental class achieved an average N-Gain score of 60.58 for the test, which falls into the effective category, and an average N-Gain score of 45.50 for the questionnaire, categorized as fairly effective. In contrast, the control class obtained an average N-Gain score of 26.89 for the test, which was classified as ineffective, and an average N-Gain score of 30.94 for the questionnaire, which was categorized as less effective. These results indicate that learning through the discovery learning model assisted by mind mapping can enhance students' metacognition abilities on environmental pollution.

The exciting part of the discovery learning model is the practicum activities (Sormin, 2023). Students use theory, direct experience, and new knowledge they gain from real activities (Putri & Mawarnis,

2024). They can also find other examples in daily life that can cause environmental pollution, and students become more confident when conveying new knowledge they have (Purwanto, 2022);(Rasyid et al., 2023). Furthermore, the learning media used was not only textbooks. Mind mapping was also used to give students an impression of enthusiasm and enthusiasm to learn because of its attractive and colorful shapes. It provides examples of how to make interesting summaries to facilitate learning activities (Sari et al., 2021).

The discovery learning model has been proven to improve students' metacognition skills (Susanti et al., 2022), proven by test and metacognition questionnaire data results in experimental classes that use the discovery learning model (Triana et al., 2021). The scores obtained by students in the experimental class were higher than in the control class, namely the average score of metacognition ability. The average score of the experimental class was 87, while the average score of the control class was 76.

The learning process in the experimental class went well, as seen from the enthusiasm and active role of students in participating in lessons, practicums, and discussions by expressing opinions, curiosity, and enthusiasm in solving problems through practicum activities (Prianto et al., 2022);(Amaliyah et al., 2024). Learning using the discovery learning model assisted by mind mapping positively impacts students' learning. Students who previously did not know about the lesson now know this knowledge through direct experience involving students to carry out practicum activities. Park & Kim (2022) said learning becomes active and learning goals are achieved. The knowledge will be remembered longer because it is through real experience.

As revealed by Trauning (2023), the discovery learning model can help students find information by providing direct experience and practical activities. Through these activities, students can conclude from information and understand a concept (Supena et al., 2021). This understanding will last a long time in memory because students can find the information themselves (Lachner et al., 2021).

The learning process in the control class was quite good, although not conducive. The teachers applied the direct instruction learning model or direct learning model (Budiman et al., 2021). This model is more teacher-centered because the learning process is more dominant through lectures. Teachers explained the material and wrote it on the board. During the explanation, students tended to be silent and only listened to the explanation from the teacher (Masriah et al., 2023). Thus, students' curiosity was less provoked. When the teacher asked questions, only active students answered questions. Other students tended to be silent and unfocused (Ho et al., 2023). As a result, students who were active and showed curiosity tended to be active, and those who were passive remained passive. During the question-and-answer process, active students tended to play a role, while passive students only became listeners and lacked an understanding of the subject matter (Ghaleb, 2024).

Based on the explanation, the discovery learning model assisted by mind mapping influences students' metacognition ability. The results align with several relevant previous studies showing that the discovery learning model positively affects the student learning process and outcomes.

The findings are reinforced by Hongsuchon et al. (2022) that interactions influenced by several factors, both internal and external, can make students achieve maximum learning ability. In addition, Usman et al. (2022) and Sawah & Kusaka (2023) argued that the discovery learning model improves students' reasoning skills and the ability to think freely, causing a

sense of pleasure, practicality, and ease in implementing learning.

Based on the research results, supported by previous relevant research and theories, it can be concluded that the discovery learning model assisted by mind mapping significantly influences students' metacognition ability.

CONCLUSIONS AND SEGGESTION

Based on the study results, it can be concluded that the results of learning activities using the discovery learning model influence students' metacognition ability. The hypothesis test with the independent sample t-test showed a significance value of 0.000, less than 0.05. Therefore, H_0 is rejected, and H_1 is accepted, meaning that the discovery learning model influences students' metacognition ability.

This research suggests that schools should improve the quality of education in schools. Teachers should not focus on one way of teaching. They are expected to apply the discovery learning model as one of the learning model options in biology subjects. This model can improve students' metacognition skills to achieve learning goals properly. Students are hoping to play an active role in learning activities because by playing an active role in learning activities, they will certainly improve their learning outcomes and metacognition skills. Hopefully, this research can be used as a consideration and reference for future researchers.

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