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The Implementation of Mind Mapping as an Effective Learning Method in the Mathematics Class

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ABSTRACT
The research describes the effectiveness of Mind Mapping method in the class of mathematics, which is defined explicitly by students' activities, responses, and mathematics learning outcomes. The subjects of this study were grade X Sciences students of Bosowa School Makassar. The instruments used were observation sheets of students' activities, questionnaires of students' responses, and mathematics learning test form. The data of observations and responses were analyzed by percentages, while the students learning outcomes were analyzed by descriptive test and one-sample t-test. The analysis showed that (1) Students' activities are in the good category (3.38 out of 4), (2) Students' responses are at positive category (3.49 out of 4), (3) The average score of learning outcomes (80.83 out of 100) is more than the subject minimum passing grade (75) with a 95% confidence level ($t = 1.865$, $p = 0.0445$), and the standard deviation is 10.84. Therefore, the results demonstrate mind mapping Learning Method is one of the effective learning methods to be applied in Mathematics class.

Keywords: *Mind Mapping, Learning Model, Effectiveness, Students' Activities, Students' Responses, Mathematics Learning Outcomes.*

1. INTRODUCTION

The Programme for International Student Assessment (PISA) is a worldwide study by the Organisation for Economic Co-operation and Development (OECD) in member and non-member nations intended to evaluate educational systems by measuring 15-year-old school pupils' scholastic performance on mathematics, science, and reading. It was first performed in 2000 and then repeated every three years. It aims to provide comparable data to enable countries to improve their education policies and outcomes. It measures problem solving and cognition.

Among all students who participated in PISA 2018, Indonesia was ranked the bottom 6th in the reading ability category, the bottom 7th in the mathematics category, and the bottom 9th in the science performance category out of 79 countries worldwide. From the report, Indonesia experienced a decline in performance compared to the previous PISA assessment results in 2015. Reading ability scores decreased from 397 to 371, math skills decreased from 386 to 379, while science performance skills decreased from 403 to 396.

In 2022 OECD states that PISA will focus on mathematics, with an additional test of creative thinking. Meanwhile, as one of PISA competencies, mathematics is still a difficult subject for Indonesian students. In 2018, the mathematics performance of Indonesian compared to all participating countries was also very low in all PISA events. Even in PISA 2012, this performance is in the second-lowest rank. These results indicate that education practitioners still need a big effort to improve students' mathematics achievement at primary and secondary schools.

Many factors, including the teachers, influence students' achievement. According to [1], the teacher's presence in the learning process still plays an important role. Therefore, teachers need to have skills in choosing the right method when delivering material to their students to make it more interesting, not bored, and accept the material quickly, which will support their learning achievement.

Creative thinking (creativity) is one of the skills that are billed in the 21st century, in addition to critical thinking skills (critical thinking), collaboration (collaboration), and communication (communication).

Creative thinking needs to be possessed to create new ideas, develop, be open, responsive, have creativity, and contribute to national development [2]. In addition, based on research conducted by [2], creativity is an important key to success for students to face a changing world. Many methods can be chosen by teachers in their mathematics class, significantly to improve creative thinking skills. Also, the covariance analysis test of students' creative thinking skills showed a significant difference between the experimental and control classes assisted by mind mapping [3].

This is in line with [4], which states that mind mapping techniques are considered more effective than traditional methods. Also, in [4], Liu advocates that Mind Mapping potentially promotes teaching efficiency and improves students' practical application ability. Students tend to cultivate a good habit of thought, aiming at applying mind mapping in learning. The mind map has been proven to help students build knowledge through steps to organize several topics related to the problem. Furthermore, a mind map can also accommodate students to construct knowledge and activate the brain's work steps. Students are free to create color, writing, shape, and size [5]. Moreover, combining the RMS Learning model and the concept mapping model can increase students' HOTS. Therefore, based on the benefit of mind mapping, this study shows the effectiveness of the mind mapping method in the class of mathematics [6].

1.1. Mind Mapping

Mind mapping represents a thought process written in images with diagrams, colors, symbols, and words [7]. This learning model can improve students' learning outcomes since it requires students to memorize the whole material, conceptualized more systematically and structured. Buzan further explains that Mind mapping leads to the left and right brain activity by evoking critical thinking that leads to the reflection and function of the human brain. It is in line with the research study; it is mentioned that not optimal brain functions cause students' low learning and thinking interests. During inputting memory process, the human requires to activate right and left hemisphere functions. Thus, there is brain equilibrium in receiving each information. Such character learning could be implemented into the Brain-based learning model, which offers an adjusted learning concept to the brain's work and learning scientifically. Hence, it provides a mathematics learning impression for students who usually memorize. They will turn such habits into meaningful learning [8].

Pearson (2010) describes that a mind map consists of a central topic placed in the middle of the page. It has categories and subcategories that radiate peripherally and are usually pictorial and use color [9]. In [1], Alamsyah (2009) also explains that each mind map has the following elements:

1) The center of the mind map is the main idea or idea.
2) The main branch or basic order ideas (BOI), the first-level branch that radiates directly from the center of the map. Thoughts.
3) Branches, which are emanations from the main branch, can be written in all directions.
4) Words, using only keywords.
5) Pictures, using pictures they like.
6) Colors, using attractive colors on the map.

The steps for making a mind map: 1) Starting from the middle of a blank paper whose long side is placed vertically or horizontally. 2) Determining the central topic to be made using the mind mapping method, the central topic is usually the title of the book or chapter title that learned and must be placed in the middle of the paper and cultivated in the form of pictures. 3) Make basic order ideas (BOI) for the central topic that has been chosen, use a different color for each item. Risk BOI is usually the title of the chapter or subchapter of the book to be studied, or it can also be done by using 5WH (what, where, why, who, when, and how). Buzan (2009) in [1] explains that the BOI line is made thicker than the lines of the following branches after the main branch (BOI), and all the main branch lines (BOI) must be connected to the central topic. 4) Complete each BOI with branches containing data-d supporting data related to the second, third, and subsequent branch lines thinner than the main branch line (BOI). The colors of the second, third, and subsequent branch lines follow the respective BOI colors. 5) Complete each branch with pictures, symbols, codes, lists, graphs so that more interesting, easy to remember, and reach. If necessary complete with more connecting lines if there are BOIs that are related to one another and write only the keywords for each line. Windura (2008) in [1].

2. METHODOLOGY

This study is quantitative research of pre-experiment type to know the effectiveness of learning mathematics by applying the mind mapping method. The population in this study were students of class X IPA SMA Bosowa School. The research design is one group whose learning is carried out using an online learning adaptation.

This learning process that applies the mind mapping method is done via virtual applications such as Google Meeting, WhatsApp Group, Google Classroom, and Quizizz. The students firstly learn in the main room of google meet, which is then divided into several small googles meet rooms to discuss in a group issues related to the topic and summarize the case learned using mind mapping. After that, the students returned to the main room to present the results of their discussion. This study

was conducted 4 times, including the post-test in the last meeting.

2.1. Research Instrument

The instruments used to collect data were student activity observation sheets, student response questionnaires to learning, observation sheets on the implementation of mind mapping learning methods, and learning outcomes tests in the online form using the Quizizz application.

2.2. Data Collection Technique

The criteria of effectiveness are related to (1) Students Mathematics Learning Outcomes, Student Activity, dan (3) Student Responses [10]. The data collection techniques that researchers used in this study were following steps:

1) Student Activities

Student activities data was collected using observation sheets related to process skills during online learning, including mind mapping. The activities measured are personal and collaboration activities of students in each small group.

2) Student Responses

To measure student responses to learning, the data collection used student response questionnaires via Google Form. This questionnaire is given after giving the learning outcome test using a Likert scale with four alternative answers, namely strongly agree, agree, disagree, and strongly disagree:

Table 1. Scoring criteria for student responses

Alternative answer	Score item
Strongly agree	4
Agree	3
Disagree	2
Strongly disagree	1

3) Learning Outcomes

For measuring student learning outcomes, data were collected using student learning outcomes tests through the Quizizz application. This test is given in the last meeting after the completion of all learning processes.

2.3. Data Analysis Technique

The analysis mainly used a descriptive quantitative technique with the descriptions below:

1) Student Activities

The observation sheets of student activities data will be processed using descriptive statistics by comparing means of all activities in all meetings.

Table 2. Student response category

Category	Score item
Very good	Average ≥ 3.5
Good	$2.5 \leq$ average < 3.5
Fair	$1.5 \leq$ average < 2.5
Bad	average < 1.5

2) Student Response

The student response questionnaires also will be processed using descriptive statistics by comparing means of all questions in the questionnaires.

Table 3. Student response category

Category	Score item
Really positive	Average ≥ 3.5
Positive	$2.5 \leq$ average < 3.5
Negative	$1.5 \leq$ average < 2.5
Really negative	average < 1.5

3) Learning Outcomes

The learning outcomes will be analyzed through descriptive and inferential statistics. The descriptive analysis will be categorized by comparing average student learning outcomes to KKM (minimum passing grade of mathematics subject = 75). The research was categorized as successful if total students who achieve at least the minimum passing grade (KKM) or have a learning outcome score ≥ 75 are at least 80% of the total students.

Besides, through inferential statistics analysis, the average of students learning outcomes will be shown more than KKM. However, this hypothesis needs to be tested. Therefore, the collected data will be analyzed with a one-sample t-test (one-way test), using SPSS application with the conclusion:

a) If *p-value* > α, then Ho is accepted, and H_1 is rejected. It means the average of students learning outcomes is the same as KKM.
b) If *p-value* < α, then Ho is rejected and H_1 accepted. It means the average of students learning outcomes is more than KKM.

3. RESULT AND DISCUSSION

3.1. Student Activities During Learning by Using the Mind Mapping Learning Method

The following is student activities data obtained based on observations through student activity observation sheets at Virtual Meetings using Google Meetings consisting of 3 (three) small groups of Google meeting rooms. This data is collected when the mind mapping method is applied in the class of mathematics. The summary of learning outcomes after being observed for 3 meetings is presented in table 4.

Table 4. Category of student activities

Aspects	Meetings			Average of each aspect	Categories
	1st	2nd	3rd		
1	3	3	3	3	Good
2	4	4	4	4	Very good
3	3	3	3	3	Good
4	3	3	4	3.33	Good
5	3	3	4	3.33	Good
6	3	3	3	3	Good
7	4	4	4	4	Very good
8	3	3	4	3.33	Good
Average of all aspects				3.38	Good

Explanation:

1. Listening/paying attention to teacher's explanation - (main room of Google meet)
2. Observing student activity sheets – (main room of Google meet)
3. Gather appropriate information, carry out experiments/discussions to get explanations and problem-solving in groups - (Google meet group)
4. Discuss together with their group friends about the results of their respective answers (ask and respond) (Google meet group)
5. Create a Mind Map (Mind map of solutions related to the material) - (Google meet group)
6. Present the results of their discussion to the class - (main room of Google meet)
7. Presenting his Mind Mapping in front of the class - (main room of Google meet)
8. Make a summary of the material studied and send it in the form of mind mapping - (WhatsApp / Google Classroom)

From three meetings, about 8 activities were observed in the class related to applying the mind mapping learning method. There are two activities considered very good achievements from the observation done, and the other 6 activities are considered good, with the average total achievement is 3.38.

3.2. Student Responses Related to Learning Mathematics Using the Mind Mapping Method

The following is student responses data obtained from online questioners from google form. The responses are related to learning mathematics using the mind mapping given in table 5.

Table 5. Category of student responses

Aspects	Average	Category
1	3.58	Very Positive
2	3.58	Very Positive
3	3.83	Very Positive
4	3.67	Very Positive
5	3.33	Positive
6	3.25	Positive
7	3.50	Very Positive
8	3.50	Very Positive
9	3.25	Positive
10	3.42	Positive
11	3.50	Very Positive
12	3.50	Very Positive
13	3.58	Very Positive
14	3.42	Positive
15	3.42	Positive

Total	**3.49**	**Positive**

Explanation:

1. Students are happy with the learning done by the teacher.
2. Students are more motivated to learn mathematics delivered by the teacher.
3. Students have a better understanding of mathematics subject through learning conducted by the teacher.
4. Activity sheets and learning steps support student learning processes to improve mathematics learning outcomes.
5. Students have more opportunities to express their opinions to other students or the teacher during learning time.
6. Students can make a mind mapping related to the material well.
7. Mind mapping helps students classify the material of mathematics better.
8. Mind mapping helps students understand and remember the material and formulas of mathematics more efficiently.
9. Mind mapping gives a complete summary of the material.
10. Mind mapping helps students learn mathematics in an efficient and structured way.
11. Learning with mind mapping gives students more learning experiences.
12. Students agree that mind mapping can help them learn mathematics.
13. Learning in groups, including answering questions and mapping the material, allows students to discuss and exchange ideas and thoughts with groupmates.
14. Students feel an improvement after learning with the mind mapping method
15. Students agree to use the mathematics learning method for the next topic.

After the class mathematics was done with applying the mind mapping method, teachers gave application forms to know student responses. From the response data above, about 10 out of 15 responses are considered very positive for reaching the percentage of average ≥ 85% of the total score (4). After analyzing the 15 responses, the final average is 3.49, which means all student responses were very positive after this learning method.

3.3. Mathematics Learning Outcomes of Students Who are Taught Using the Mind Mapping Learning Method

3.3.1. Descriptive Statistical Analysis Results

Student learning outcomes are described based on the analysis of post-test results in class X sciences at SMA Bosowa School Makassar for vector material (Mathematics with specialization in sciences). This analysis uses descriptive statistics to make the summary. The following are the details descriptive of student learning outcomes data presented in table 3 and distribution of students' mathematics learning outcomes completeness in table 6.

Table 6. Recapitulation of student learning outcomes test

Descriptives

			Statistic	Std. Error
posttest	Mean		80.8333	3.12815
	95% Confidence Interval for Mean	Lower Bound	73.9483	
		Upper Bound	87.7184	
	5% Trimmed Mean		80.9259	
	Median		85.0000	
	Variance		117.424	
	Std. Deviation		10.83625	
	Minimum		60.00	
	Maximum		100.00	
	Range		40.00	
	Interquartile Range		10.00	
	Skewness		-.449	.637
	Kurtosis		.504	1.232

Table 7. Distribution of student mathematics learning outcomes completeness

Descriptive	**Categories**		**Total**
	Finished (≥ 75)	**Unfinished (< 75)**	

Numbers of Participants	10	2	12
Percentage of Learning achievements	83%	17%	100%

Table 6 shows that all students learning outcomes are around 80,83, with the student's minimum achievement is 60 and the highest score reaches 100 (the ideal score). It also shows that the standard of Deviation around 10 means that student achievements only differ by about 10 points from the student's overall average.

In addition, the numbers of students whose mathematics learning outcomes reach at least the minimum passing grade (75) shown in table 7 are 10 out of 12 students. This data means the percentage of learning completeness is 83% from all students in the class.

3.3.2. Inferential Statistical Analysis Results

The inferential statistics are analyzed by using a one-sample t-test with a one-way hypothesis as bellows:

H_0: the average of student's learning outcomes is the same as the KKM($\mu = 75$)

H_1: the average of student's learning outcomes is more than the KKM($\mu > 75$)

The data will be tested with a significant value of 5%.

Table 8. The result of tests of normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
posttest	.233	12	.071	.927	12	.352

a. Lilliefors Significance Correction

Table 9. The results of the one-sample t-test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
posttest	12	80.8333	10.83625	3.12815

One-Sample Test

	Test Value = 75					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
posttest	1.865	11	.089	5.83333	-1.0517	12.7184

After data is confirmed to be normal by using the normality test through SPSS, the next procedure compares the data to the minimum passing grade (KKM=75) using a one-sample t-test with the result shown in table 6. From the data above, the study gets t = 1.865 with probability (2-tailed) = 0.089 for the category of student learning outcomes. The research uses a one-way hypothesis, so the significance or probability is 0.089/2 or 0.0445. Because the probability (0.445) < significant value set (0.5), it means H_0 is rejected, and H_1 is accepted, or it can be concluded that the average of student's learning outcomes is more than the KKM($\mu > 75$).

4. CONCLUSION AND SUGGESTION

4.1. Conclusion

Based on the results of research and discussion, it can be concluded that student activities while using the mind mapping method were in a good category by reaching an average score of 3.38 out of 4, collected from questioners. Moreover, after the mind mapping learning method was applied, student responses were in the very positive category, reaching an average score of 3.49 out of 4, collected from student responses form.

Also, the average score of students' learning outcomes (post-test) taught using the mind mapping method reached 80.83 from the ideal score of 100 with a standard deviation of 10.84. This average exceeds the

specified minimum passing grade (KKM 75), with 83% of students who reach the score $\geqslant 75$.

Therefore, the mind mapping learning method effectively applies to mathematics classes with learning outcomes, student activities, and student responses as indicators.

The same results are also given in other researches. In other mathematics classes studied, the mean scores obtained for experimental by using mind mapping and control groups are 170.26 and 151.42, respectively. The standard deviation of the scores on Mathematical creativity for the experimental group is 2.37, and that of a control group is 3.9. The calculated t value is 28.98. The hypothesis to be tested is a directional one. A one-tailed test of significance of the difference between two independent samples was employed, and the tabled value for significance of difference of the group means at 0.01 is 2.33. Hence, the experimental group's hypothesis has a higher mean score in Mathematical creativity than the control group is supported [11].

Also, between control and experimental group students who were taught English, two groups were benefited from their respective methods. Even though the control group was benefited, the experimental group was more benefited than the control group. Mind Mapping was more attractive, colorful, self-paced etc., it stuffed the fresh mind of experimental group students very sharply. Mind map creates visual influences in the mind of learners. So, the experimental group might have shown higher performance [12].

The results of the t-test analysis, namely the paired sample t-test in the experimental group in physics class VIII, also found that the mind mapping method had a positive effect on increasing physics learning achievement. The results of the t-test analysis obtained the value of t = -11.006 with p = 0.000 (p <0.01), which means it is very significant [1].

At the pre-test stage obtained in science learning t count $< t$ table with a significance level of 0.05, so H_a is rejected and H_0 is accepted. This means there is no significant difference in pre-test results conducted by the control group and experimental class. Meanwhile, after being given different treatments using Mind Mapping to improve sciences process skills and learning motivation, obtained the post-test data and t-test with t count $> t$ table with a significant level of 5%, then H_a is accepted, which means there is a significant difference between both classes. It shows that the average experiment class is better than the average learning outcomes control class [13].

4.2. Suggestion

Based on the conclusions put forward, it is necessary to conduct further research on mind mapping methods in offline or face-to-face learning, both with the same or different topics of discussion. Also, it needs to be considered to develop a new learning model with the combination of this mind mapping learning method with an effective learning model in the mathematics class to improve students' achievements.

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