IMPLEMENTATION OF MIND MAPPING-BASED DISCOVERY LEARNING MODEL IN ONLINE LEARNING ON COLLOID MATERIALS

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Abstract. Research has been conducted on the implementation of the discovery learning model based on mind mapping in online learning on colloid materials. This study aims to determine the difference in knowledge learning outcomes, attitudes, and student responses to the discovery learning model based on mind mapping in online learning on colloid materials. The method used is a quasi-experiment using a "non-equivalent control group design" design. The research sample was students of class XI MIA 1 as the experimental class and class XI MIA 2 as the control class at MAN 2 Tabalong. Data collection used test and non-test techniques. Data analysis techniques used descriptive analysis and inferential analysis. The results showed (1) there was a significant difference in knowledge learning outcomes between the experimental class and the control class where the t-value > t-table (α = 0.05) with an average value for the experimental class of 86.67 with an average N-gain value of 0.74, while for the control class it was 77.56 with an average N-gain value of 0.60, (2) the attitudes of students' learning outcomes had different average values where in the experimental class it was 78.59 higher than the control class which was 72.30, (3) student responses to the discovery learning model based on mind mapping in online learning on colloid materials were in the good category.

Keywords*: discovery learning models, mind mapping, online learning, learning outcomes, colloids*

INTRODUCTION

Learning is the process of interaction between students, educators, and learning resources in a learning environment. A crucial component of learning is the teacher. During the Covid-19 pandemic, distance learning has been implemented in primary and secondary schools (Suantara & Prabawati, 2021).

The learning process for both primary and secondary education must be enjoyable, challenging, and motivating. Alternative online learning applications can be adapted to the situation and conditions. It is hoped that through the utilization of technology, it can assist in online learning processes, especially in chemistry learning.

Chemistry, as part of science, is an important and inseparable field of study in life. One of the chemistry topics taught in high school level XI is colloids. According to Maimunah (2022), there are still students who have difficulty understanding colloid material, although it is not difficult for students to learn it. The abundance of concepts and examples in the colloid topic makes it difficult for students to learn meaningfully. Students are only taught to memorize concepts, principles, laws, and formulas when understanding is applied. Mawaddah & Martini (2022) state that the science of chemistry not only involves concepts but also requires independent discovery. Students are asked to develop thinking skills rather than memorize material. In fact, dominant teacher-led online learning presents material, and students tend to be passive. Students only listen to the material taught by the teacher. Additionally, according to Maghfiroh et al., (2021), learning has not yet used interactive and

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effective learning models and media because online learning is conducted unidirectionally with tasks assigned via class WhatsApp (WA) groups. This has an impact on suboptimal learning outcomes.

The discovery learning model can be used to address these issues. The discovery learning model can make students more active in the learning process, improve cooperation, and foster learning motivation. It can train students to learn independently according to the current Covid-19 pandemic conditions, increase curiosity, build student knowledge by discovering concepts themselves, and student activities in discovering concepts make concepts easier to understand than just receiving concepts from books (Agusriyalni et al., 2021).

Learning models accompanied by appropriate and innovative learning media will make learning more meaningful. Learning media that can support the discovery learning model is mind mapping media. Mind mapping is an easy way to obtain information through creative, effective notes, and therefore students will seek information and record it using mind mapping media to remember it longer in memory (Buzan, 2005). The results of Setyaningsih et al., (2019) research state that there is a significant effect using mind mapping and obtaining positive learning outcomes improvement. Other research also conducted by Seda et al., (2019) states that the discovery learning model based on mind mapping can improve learning outcomes.

This research was conducted online through the WA application. The WA application has several features to facilitate communication interactions, such as a gallery for inserting photos and videos, contacts for inserting or sending other people's contacts, a camera for taking pictures, audio for sending voice messages, maps or locations for sending coordinates of our position, and documents for inserting file documents in pdf, word, power point (PPT) formats and others (Harahap et al., 2021). In its implementation, teachers not only assign tasks but also apply learning models and media by utilizing the features available in the WA application.

Based on the background above, the researcher is interested in examining and researching the implementation of the discovery learning model based on mind mapping in online learning of students on colloid materials. From the problem formulation, the research objective is to determine the difference in knowledge learning outcomes, attitudes, and student responses to the discovery learning model based on mind mapping in online learning on colloid materials.

METHOD

This research method utilizes a quasi-experimental design using the "non-equivalent control group design" research design (Ati & Setiawan, 2020). In this study, the experimental group receives learning using the discovery learning model based on mind mapping, while the control group uses the discovery learning model. The research sample consists of students from class XI MIA 1 as the experimental group and class XI MIA 2 as the control group at MAN 2 Tabalong.

The research instruments consist of test and non-test instruments. The knowledge learning outcomes test instrument used multiple-choice questions. Non-test instruments in this study included mind mapping assessment rubrics, attitude observation sheets, and response questionnaires.

The data analysis techniques used in this research are descriptive analysis and inferential analysis. Descriptive analysis is used to analyze learning outcomes, mind mapping results created by students, and student responses. Meanwhile, inferential analysis for knowledge learning outcomes aims to test the hypotheses that have been proposed. This analysis uses a difference test. Before conducting the difference test, normality and homogeneity tests for pre-test and post-test data are conducted. If the data is normal and homogeneous, then a difference test, namely the t-test, is conducted.

RESULTS AND DISCUSSION

The research results obtained data on students' knowledge learning outcomes, assessments of mind mapping created by students, attitudes of students' learning outcomes, and student responses in the experimental class applying the discovery learning model based on mind mapping and the control class applying the discovery learning model on colloid materials. Data on knowledge learning outcomes were obtained through pre-tests and post-tests, which were then analyzed descriptively based on N-gain and then analyzed inferentially through normality tests, homogeneity tests, and t-tests. The assessment results of mind mapping created by students, attitudes of student learning outcomes, and student response questionnaires were analyzed descriptively.

The implementation of learning in the experimental and control classes was conducted for three meetings. In the experimental class, the discovery learning model based on mind mapping was applied, while in the control class, the discovery learning model was applied. The post-test was conducted after 3 meetings of learning activities. Before conducting the learning, all the necessary materials for learning were prepared in both the experimental and control classes. These preparations include material preparation, preparation of lesson plans, and exercises.

Stimulus provision is the first step where students are given stimuli in the form of images and questions related to colloid materials. By observing these images, students begin to feel curious and pay attention to their learning. This fosters students' desire and interest to investigate and find out things related to the images to understand the material. This can motivate students to learn and increase curiosity because students are interested and want to know more about colloidal materials in daily life. According to Mustofa et al., (2020), with positive responses and high learning motivation from students, they will eventually find it easier to achieve maximum learning outcomes.

The second step is problem identification, where the teacher starts by giving students the opportunity to identify as many relevant problems as possible in the learning material in the form of questions. With these questions, it is expected to stimulate students to think and formulate hypotheses (temporary answers). This will be used as students' initial knowledge. The teacher directs students to what they already know and connects it to what they will learn.

The third step is data collection, which is done by distributing worksheets (*Lembar Kerja Peserta Didik*/ LKPD) files through a WA group. In this step, students are given the opportunity to collect various information obtained through the internet, observing objects, experiments, and relevant sources related to colloid materials to answer the questions in the worksheets. According to Maulina (2022), the consequence of the data collection step is that students actively learn to discover something related to the problems they face, thus unintentionally connecting problems with the knowledge they already have.

The fourth step is data processing, where students are guided to discuss with group mates to answer the questions in the worksheets. If there are students or groups experiencing difficulties during group discussions in answering the questions, the teacher assists students by providing the information needed to complete the answers to these questions.

The fifth step is verification, where students are guided by the teacher to check the correctness of the results of group discussions about colloids through presenting the results of discussions. This step brings out critical attitudes, confidence because they dare to present the results of discussions without fear of being wrong, willingness to change views on answers because evidence from information (material) that has been learned is revealed, so students will gain an understanding of a concept that has been learned.

The sixth step is drawing conclusions. In this step, students are guided to summarize the learning material based on the results of group discussions. The appropriate way to summarize the material is by giving students the task of creating a summary in the form of mind mapping.

Students who create mind maps are able to map out the materials they have understood, allowing them to understand the relationship between one material and another and facilitating students in determining the key points regarding the main material discussed while they draw conclusions so that the learning process can be meaningful to students. According to Mukaromah et al., (2020), the presence of mind mapping indicates that students are more active in seeking related information, organizing their own concepts, and connecting important concepts so that learning becomes more meaningful because new information becomes easier to understand.

Learning activities using the discovery learning model based on mind mapping applied in the experimental class can improve students' learning outcomes in colloid materials. This is because students can discover their knowledge concepts independently, and creating mind maps helps students better understand and remember the taught material. This is supported by Deporter et al., (2008), stating that mind mapping can help us remember words and readings, enhance understanding of the material, help organize the material, and provide new insights because it contains key words in a topic.

In the control class, students receive learning using the discovery learning model with not too bad learning outcomes. Meanwhile, learning activities using the discovery learning model based on mind mapping applied in the experimental class can improve students' learning outcomes in colloid materials. This is because students can discover their knowledge concepts independently, and creating mind maps helps students better understand and remember the taught material. Based on the research results of Kadir et al., (2018) the experimental class using the discovery learning model based on mind mapping showed better learning outcomes in learning than the control class using the discovery learning model. This indicates that learning applying the discovery learning model based on mind mapping has a greater and more effective opportunity to improve learning outcomes.

The post-test results in both classes showed improvement, but the knowledge learning outcomes in the experimental class showed an average higher than the control class. The average pre-test and post-test scores are presented in Table 1.

Table 1. Average student knowledge outcomes

Score	Experimental Class		Control Class	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
The lowest	13	67	7	53
The highest	73	100	73	100
Average	**42,89**	**86,67**	**40,27**	**77,56**

Table 1 shows the average pre-test scores in the experimental class were 42.89, while in the control class, it was 40.27. All students had knowledge learning outcomes in the low category. This indicates that students in both classes had similarly low initial knowledge. After undergoing the learning process, students were given a post-test. The post-test results showed improvement, but the knowledge learning outcomes in the experimental class had a higher average score compared to the control class. The average post-test score in the experimental class was 86.67, while the average post-test score in the control class was 77.56. The difference occurred due to the implementation of different learning media, which influenced the achieved scores.

Students who are below the Minimum Completeness Criteria (Kriteria Ketuntasan Minimum) are considered incomplete, while students who are at the minimum KKM and maximum KKM boundaries are considered complete. The completeness percentage of students, both in the experimental and control classes, can be seen in Table 2.

Table 2. Teaching and learning completeness standards

Score	Experimental Class	Control Class
< 75 (Failed)	3	8
≥ 75 (Passed)	27	22
Class Completeness (%)	**90**	**73**

Table 2 shows that the percentage of learning completeness in the experimental class is higher, at 90%, compared to the control class, which is 73%. This indicates that students in the experimental class achieve more completeness compared to the control class. This is because of the different learning approaches; the experimental class uses the discovery learning model based on mind mapping, while the control class only uses discovery learning.

In the control class, based on observations during the learning process, many students were still confused in finding and solving problems. This made the learning atmosphere boring because many students were not actively asking questions or expressing opinions. As a result, students lacked understanding of the taught material, and during the final evaluation (post-test), students often forgot the material taught, affecting their learning outcomes. This is what caused the learning outcomes in the control class to be lower than in the experimental class.

The N-gain analysis results also show differences in students' knowledge learning outcomes between the experimental and control classes. The N-gain values for the experimental and control classes can be seen in Table 3.

Table 3. Interpretation of student knowledge N-gain

Class	<g>	Categori
Experimental Class	0,74	High
Control Class	0,60	Medium

Table 3 shows that the experimental class has a higher average N-gain value compared to the control class. This indicates that the experimental class achieved a higher increase in knowledge learning outcomes compared to the control class, which achieved an increase in knowledge in the moderate category after receiving colloid learning by applying the discovery learning model based on mind mapping in the experimental class.

A t-test was conducted on the pre-test and post-test data of students' knowledge learning outcomes in the experimental and control classes, which had been tested for normality and homogeneity. Pre-test and post-test data must be declared to be normally distributed and homogeneous. The t-test results for the pre-test and post-test data of knowledge learning outcomes are depicted in Table 4.

Table 4. t-test results for pre-test and post-test data

Results	Class	df	$\bar{X}$	SD^2	t_{value}	t_{table} 5%	Conclusion
Pre- test	Experimental Class	58	42,90	296,37	0,610	2,00	There is not any significant difference
	Control Class		40,27	244,75			
Post- test	Experimental Class	58	86,67	57,25	3,626	2,00	Significant difference
	Control Class		77,56	159,28			

Table 4 shows that both the experimental and control classes obtained $t_{value} < t_{table}$ (0,610 < 2,000), before treatment. This value indicates that the t_{value} is smaller than the t_{table} (0,610 < 2,000), so it can be concluded that H0 is accepted, and H1 is rejected, meaning there is no significant difference between the knowledge learning outcomes obtained by students in the experimental class and the control class before treatment.

After being given different treatments, based on the table, it can be seen that the $t_{value} > t_{table}$ (3,626 > 2,000). This value indicates that the t_{value} is greater than the t_{table} (3,626 > 2,000), so it can be concluded that H0 is rejected, and H1 is accepted, meaning there is a significant difference between the knowledge learning outcomes obtained by students in the experimental class and the control class after treatment.

The difference in achievement results is because the experimental class applied the discovery learning model based on mind mapping, while the control class only used discovery learning. This is consistent with Soleha et al., research (2019) which shows that learning outcomes using mind mapping instructional media are better compared to not using mind mapping instructional media.

Variani & Agung (2020) stated that learning using the discovery learning model with mind mapping can have a positive effect on improving science learning outcomes and can encourage students to participate actively and make it easier to remember the lessons learned. Moreover, it provides opportunities for students to find information and build their knowledge of the material creatively by taking notes and summarizing the essence of the material learned. The research results of Yonelda et al., (2022) show that student learning outcomes using the discovery learning model with mind mapping are higher than those of students using the discovery learning model because of the high level of active student participation in the task of creating mind maps. Hence, students are motivated to actively understand the material, and they are more enthusiastic during learning.

The attitude learning outcomes during the 3 meeting sessions show that the average attitude score in the experimental class is higher than that in the control class. This is because the experimental class used the discovery learning model based on mind mapping. The research conducted by Sari et al., (2016) shows that the discovery learning model with mind mapping affects students' knowledge, attitude, and psychomotor learning outcomes regarding cell materials in high school. The observed attitude aspects are curiosity, cooperation, and responsibility.

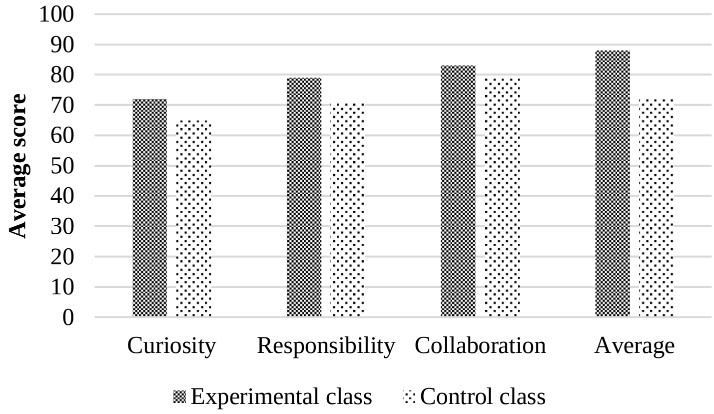

Figure 1. Student attitude learning outcomes

Figure 1 shows that during the learning process in 3 meetings, the average attitude learning outcomes in the experimental class are higher than those in the control class. The students' attitudes are reflected in the activities carried out during the learning process.

The activity of creating mind maps can increase students' curiosity and make them more active in asking questions and expressing opinions. This is evident during the process of creating mind maps, where students actively discuss with their groupmates in creating mind maps, and they are not hesitant to ask questions about things they do not understand, whether to the teacher or to their groupmates, about things that can help them complete the mind maps. According to Casmini (2020), creating mind maps can stimulate students' curiosity about a subject because in learning, students are guided to discover their own concepts and express them in the form of mind maps.

The task of creating mind maps also makes the experimental class more responsible for their work. In line with the research conducted by Jannah et al., (2021), the implementation of learning with mind mapping shows better student responsibility attitudes compared to without mind mapping. This is because in the experimental class, students are more responsible in completing group tasks and submitting assignments on time.

In the experimental class, students assigned to create mind maps can increase cooperation and a sense of freedom in expressing ideas or opinions. This is consistent with the research of Hartinawati et al., (2022), where mind mapping makes students skilled and brave enough to propose ideas or opinions during the learning process, creating a sense of joy in attending classes, and fostering good cooperation among students in groups.

Mind maps that have been assessed according to predetermined criteria can be seen in Figure 2.

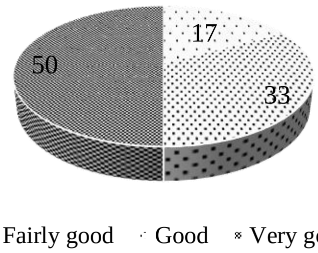

Figure 2. Percentage of the quality level of student-made mind maps

Figure 2 shows that some students' mind maps have excellent quality, accounting for 50%. Meanwhile, those with good quality account for 33%. The learning activity using mind mapping implemented in the experimental class attracts students' attention, leading to most students being enthusiastic and motivated to participate in the learning process.

The ability of students to create mind maps with fair quality is 17%. Based on the assessment using the mind mapping assessment rubric, some students do not meet one of the criteria out of the six indicators, namely keyword creation, main branch connections to other branches, design (color and images), depth of concept, concept accuracy, and concept breadth. However, the mind maps with good and fair criteria do not deviate in concept accuracy, thus maintaining alignment between creativity and the actuality of the learning material concepts discussed.

The deficiencies that cause their mind maps not to meet the criteria in the assessment rubric could be because students also do not enjoy the ideation technique. This is because their intelligence level in logic, the students also do not have a reading culture and do not make synopses/summaries of readings, so they are not accustomed to summarizing the essence. Old habits in note-taking techniques influence the new note-taking technique. Students' old habit of relying on long conventional notes makes it difficult to extract the key points. According to Harahap & Harahap (2019), groups of students categorized as fair and poor in making mind maps are due to students not being accustomed to note-taking with mind mapping techniques, and old note-taking techniques affect mind mapping note-taking techniques.

The comparison between mind map scores and the average post-test scores of each group in the experimental class can be seen in Figure 3.

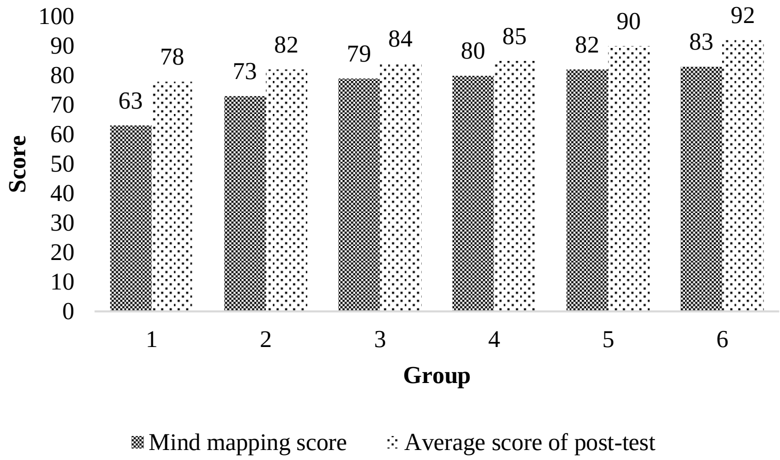

Figure 3. Comparison of mind map scores with average post-test scores of each group

Figure 3 shows a linear relationship between mind map scores and student learning outcomes. Students who create good mind maps also achieve good learning outcomes.

The research results indicate that the majority of students' scores fall within the range of 80-90. This indicates that students' learning outcomes are in the good category. The mind maps made by students are also in the good category. Some students whose learning outcomes are in the very good category have mind maps that fall into the very good category as well. Meanwhile, students who are not proficient turn out to have mind maps in the fair category. This indicates that there is a linear relationship between students' knowledge learning outcomes and mind map scores. Asmara (2017) stated in his research that when students create good mind maps, they also have a good understanding of the material they illustrate, so when tested with a post-test, they will also get good results.

The response questionnaire was given to students after the meeting ended. This questionnaire contains 10 statements that can be accessed through Google Form. Overall, the experimental class, which implemented discovery learning based on mind mapping, had a good response to learning with an average score of 39.20. Based on the categories of student responses distributed via Google Form, they consist of strongly agree (SA), agree (A), unsure (U), disagree (D), and strongly disagree (SD). The results of student response questionnaires to discovery learning based on mind mapping on colloidal material can be seen in Figure 4.

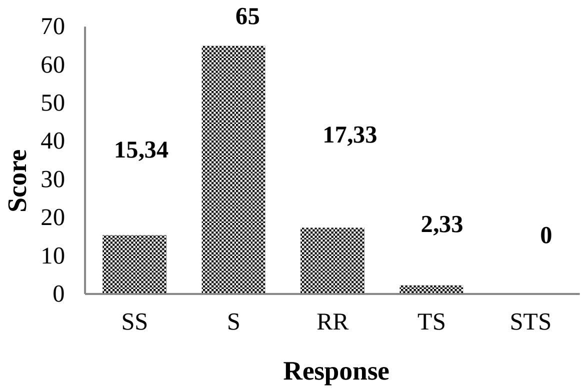

Figure 4. Student response results

Figure 4 shows that overall, the percentage of student responses falls into the strongly agree (SA) category at 15%, agree (A) category at 65%, unsure (U) category at 17.33%, and disagree (D) category at 2.33%.

Students have a positive response to learning using the discovery learning model based on mind mapping on colloidal material. This is evident from the highest percentage of responses being "agree," while no students responded with "strongly disagree." Therefore, it can be said that students are interested in learning using the discovery learning model based on mind mapping, which can help them better understand and remember colloidal material. Research conducted by Muliana et al, (2020) shows that student responses to discovery learning models with mind mapping on algebraic shape material demonstrate positive results. This is because many students responded strongly agree to positive statements and disagree to negative statements.

CONCLUSION

Based on the research results and discussion, it can be concluded that (1) there is a significant difference in knowledge learning outcomes between the experimental class and the control class, where the $t_{value} > t_{table}$ ($\alpha = 0.05$) with an average score for the experimental class being 86.67 with an average N-gain score of 0.74, while for the control class, it is 77.56 with an average N-gain score of 0.60, (2) student attitude learning outcomes have different average scores, where in the experimental class it is 78.59 higher than the control class, which is 72.30, (3) students' response to discovery learning based on mind mapping in online learning on colloidal material is in the good category.

As for suggestions that can be given to future researchers, it is expected to optimize classroom management and use time as efficiently as possible because this model takes up a lot of time. Additionally, before the research begins, researchers should first introduce students to mind mapping and teach them how to create mind maps correctly so that the learning process can proceed smoothly and students become proficient in creating them.

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