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Mind Mapping in Science Learning: Deepening Understanding of the Human Digestive System

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Abstract

This study aims to examine the effect of the Mind Mapping method on the understanding of the Human Digestive System concept among fifth-grade students at Public Elementary School 79 Ambon. The students' understanding of science concepts at this school is low due to the selection of ineffective methods. For this reason, the mind mapping method was chosen because it is effective in enhancing students' conceptual understanding, memory, and active engagement. The research employed a proper experimental design, specifically a pretest-posttest control group type. The sample in this study consisted of 33 respondents, with random sampling used as the sampling technique. The main instrument was a short essay test to measure seven indicators of concept understanding. The data were analyzed using the ANCOVA test, and the results showed that the mind mapping method was much more effective. The average post-test score of the experimental group (65.33) was significantly higher than that of the control group (36.50). The ANCOVA test results proved that 0.001 < 0.05. The most significant improvement was observed in higher-order thinking skills, including comparing and summarizing. Thus, mind mapping has a significant and superior effect compared to conventional methods, as it effectively helps students organize, connect, and visualize information more efficiently.

Keywords: Mind mapping; Conceptual Understanding; Human Digestive System

1. Introduction

Many students are falling behind in an education system that some believe is in crisis (Souley & Abubaka, 2025). Improving education requires efforts from various parties. One solution to help students manage their learning more effectively is through the use of effective learning methods (Dunlosky et al., 2013). Because learning methods vary in terms of the conditions they can create, and different types of learning objectives require different conditions to achieve them, the premise guiding this framework is that the selection of learning methods should be based primarily on the type of learning objective (Lacoe, 2020). In line with the need for effective methods, one of the main objectives in science learning in elementary school is conceptual understanding, which is crucial because it enables students to absorb the content of the lesson as a whole and apply it in their daily lives (Hussein & Csíkos, 2023; Jäder & Johansson, 2025). Furthermore, according to Prediger et al. (2023), conceptual understanding refers to a person's ability to comprehend, absorb, and understand information that is experienced directly or indirectly. In this case, students are not only required to memorize facts but also to master the meaning of the concepts being studied (Zou et al., 2024). Students are considered to understand a concept if they have grasped the meaning or significance of that concept and can explain it using their own words (Anderson et al., 2014). Poor conceptual understanding can hinder students' ability to solve problems, especially in science subjects, where many teachers still struggle in use teaching methods that are appropriate for the material being taught (Chen et al., 2020). This often results in teacher-centered learning, where the dominant method prevails, causing students to become inactive or passive (Treve, 2024).

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These specific challenges cannot be overcome by merely emphasizing the importance of general science learning, but also require a comprehensive strategy to assess the extent of conceptual understanding possessed by elementary school students. In recent years, students have struggled to understand a number of basic concepts in science (Akram et al., 2022). Conceptual difficulties can be defined as obstacles in connecting and building concepts logically. According to Falloon (2019), many students are reluctant to answer questions they consider difficult. These conceptual problems have been a major concern for science educators (Ozmen, 2004). Various studies in science education have shown that most elementary school students face difficulties in understanding fundamental science concepts. These findings indicate that students come to class with their own experiences and preconceptions. These preconceptions often cause conceptual difficulties with common science concepts (Korpershoek et al., 2013). Additionally, it has been found that elementary students often hold unscientific views because they acquire knowledge from mythological sources rather than scientific approaches, leading to obstacles in learning science (Fetherstonhaugh & Treagust, 1992). In general, it is believed that conceptual difficulties arise when science learning is presented in an unengaging way, or when teachers themselves struggle to understand basic concepts and fail to motivate students to question the paradoxes and conflicts arising from their non-scientific perceptions and views. In an attempt to overcome confusion, students sometimes make incorrect assumptions, which further worsen their understanding of a particular concept. Moreover, students often misinterpret terms with different meanings in different contexts or get trapped in factual misconceptions that have been formed since the early stages of education and persist into higher levels (Batlolona et al., 2024; Batlolona, 2025).

Based on the results of a literature review, it was found that at the basic education level, there is still a tendency to understand the digestive process as merely a physical activity, namely the breakdown of food to separate what is considered good and bad. The chemical aspect of digestion, where food is converted into substances that can be absorbed by the body, is often overlooked (Cakici, 2005). Logically, a more accurate explanation should be found at higher levels of education, namely that digestion involves mechanical and chemical processes that convert food into compounds that can be absorbed by the organism. However, many definitions are still incomplete because they ignore the stage of absorption and distribution of nutrients into the bloodstream and body tissues (Özsevgeç et al., 2017). Additionally, a common understanding among students is that the stomach is the main organ in the digestive process, where the entire process of nutrient breakdown and absorption occurs. They assume that digestion begins in the mouth and ends in the stomach, so the role of the intestine is only considered as a container for storing food residue without significant digestive activity (Gul et al., 2024). On the other hand, the function of the mouth is often narrowed down to its role in mechanical processes, while saliva is considered only to moisten and help move the food bolus, without realizing that the fluid also plays a role in the chemical process of digestion. Similar misconceptions also arise with other digestive fluids, which are often considered only to facilitate the movement of food without understanding their chemical role in the breakdown of substances (Tapia et al., 2023)

One effort to improve conceptual understanding is learning using the mind mapping method, which can improve students' mastery of concepts (Wang et al., 2025). In addition, mind mapping also provides an effective approach to improving understanding in learning (Alkhazaleh & Abu, 2024). Mind mapping is a visualization tool used in instruction that students can apply to generate ideas, take notes, organize thoughts, and develop concepts (Shi et al., 2022). Mind mapping can also be a fun method that helps students engage in activities that involve both the right and left brain, while developing writing skills, and is considered effective in improving students' ability to remember material (Fang & Chiu, 2025). Mind mapping is a learning aid that utilizes tools to describe and analyze content or material, facilitating the learning process. The use of mind mapping in learning has a positive impact on students' academic achievement, attitude, conceptual learning, and critical thinking (Guo et al., 2024). Tony Buzan developed the basic concept of Mind Mapping in the early 1960s after studying the notes of thinkers such as da Vinci, Galileo, Picasso, Darwin, and Einstein, and then comparing them with principles from psychology, neuroscience, neurolinguistics, semantics, creative thinking, memory, mnemonic techniques, and perception (Buzan, 2002). Since then, Buzan has published over 100 books that have been translated into 33 languages and are available in more than 150 countries. In 2008, the American Creativity Association awarded him the Lifetime Achievement Award. The concept of Mind Mapping has also gained support from various large international institutions such as De Beers, Disney, Boeing, Microsoft, NASA, and the University of Oxford (Buzan & Buzan, 2010; Buzan, 2014). Although recently, neuroscience has been increasingly discussed in the counseling literature (Ivey et al., 2018) and the use of Mind Mapping has increased in various other fields such as medicine, engineering, and education (Kernan et al., 2017), the application of Mind Mapping is still relatively rare in the mental health counseling literature. To fill this gap, the authors provide an overview of Mind Mapping along with a step-by-step guide to creating a Mind Map, with the aim of enabling counselors to explore Mind Mapping as a creative approach that can be integrated into their counseling skills (Pillay et al., 2020). Mind Mapping is considered a tool that essentially enables the development of knowledge understanding through active engagement generated by learners. Constructing maps allows learners to build their knowledge through graphical representations that make sense to them. This structure highlights how learners connect central concepts and ideas (Gavens et al., 2020)

One scientific concept that is contextual to students is the digestive system. The digestive system is an crucial concept because it enables students to understand better how digestion occurs in their bodies (Mack et al., 2023). Gul et al. (2024), argue that the digestive system is a crucial process in a person's life. However, digestion is physically hidden inside the body, making it difficult for students to understand and learn about in class. To overcome this, the mind mapping method has a significant influence on science learning, particularly in the context of the human digestive system. Mind mapping indicates that learning involves visual and creative elements, which can increase students' interest in the learning process so that students can be actively involved in the learning process (Liu et al., 2018). It is in line with similar research conducted by Buran & Filyukov (2015), which shows that the mind mapping method is an effective and enjoyable method to stimulate student activity, thereby improving the quality of the learning process. It indicates that mind mapping can enhance students' performance, memory, creativity, and cognitive thinking skills. Because this technique adheres to the principle of learning while working, it also fosters independent learning habits (Balim, 2013). In addition, mind mapping helps students approach problems systematically, following steps such as identifying the problem, creating a plan, implementing the plan, and checking back, which ultimately leads to a solution. It can help students understand abstract science concepts such as the human digestive system (Ormancı & Ören, 2011). This research is novel because it focuses on the application of the mind mapping method and students' conceptual understanding in a fifth-grade elementary school setting, utilizing material on the digestive system. This differs from previous research conducted at the elementary school level using science materials and in various locations. This research will investigate the impact of mind mapping on students' conceptual understanding of the human digestive system, focusing in fifth-grade students at Ambon State Elementary School 79, where no prior research has been conducted. Based on the above description, the purpose of this study is to investigate the impact of the mind mapping method on the comprehension of concepts related in the human digestive system. The results of this study can contribute to the development of more effective science learning methods.

2. Method

2.1. Type of Research

This study employs an experimental design with a pretest-posttest control group. This type of study is used to determine the effect of a variable on other variables (Capili & Anastasi, 2025). The study was conducted in two classes: the experimental class and the control class. In the experimental class, the treatment employed was the mind mapping method, whereas in the control class, it was not used. This experimental method is also a research approach that tests hypotheses in the form of cause-and-effect relationships by manipulating independent variables and assessing the changes resulting from such manipulation (Chester & Lasko, 2021); Al-Sinani et al., 2022). The variables in this study are independent: the mind mapping method, and the dependent variables are the understanding of science concepts.

2.2. Population and Sample

The population in this study was all fifth-grade students, with a total of 131 students at Public Elementary School 79 Ambon in the 2025/2026 academic year. The sample in this study will be selected using simple random sampling. Simple random sampling is a technique for selecting members of a population randomly, without regard to existing strata (Singh, 2003; West, 2016). Two classes from the three existing classes will be selected randomly *(simple random sampling* or *cluster random sampling).* After randomizing the three classes, the two classes selected as samples were class V-A, designated as the experimental group, and class V-B, designated as the control group.

2.3. Research Instrument

The main instrument used in this study was a science concept comprehension test on the digestive system. This test consisted of short essay questions designed to measure indicators of concept comprehension. The test was administered twice: before the treatment (pretest) and after the treatment (post-test). The pretest and post-test questions have been adjusted to the indicators of conceptual understanding based on Anderson and Krathwohl in (Novanto et al., 2021), which include: 1) interpreting, 2) exemplifying, 3) classifying, 4) summarizing, 5) concluding, 6) comparing, and 7) explaining.

2.4. Data Analysis Techniques

The research data were analyzed and tested descriptively and statistically using the ANCOVA test in the SPSS 22 Windows computer program to test the research hypothesis.

3. Results

Data collection on student learning outcomes was conducted using pretests and post-tests on the control group and the experimental group. The pre-test and post-test data for both groups can be classified in Tables 1 and 2.

3.1. Experimental Group

The application of the mind mapping method has proven highly effective in enhancing students' conceptual understanding. The most dramatic improvement was seen in the Comparing and Summarizing indicators. In the Comparing indicator, the percentage of students in the Poor category dropped sharply from 45.45% to only 3.03%. In comparison, the percentage of students in the Good and Very Good categories jumped to 96.97%. Similarly, on the Summarizing indicator, the percentage of students in the Poor category dropped from 93.94% to 18.18%, with most students moving to the Good and Very Good categories.

This significant improvement demonstrates that mind mapping is effective in enhancing students' understanding of concepts. Through the mind mapping method, students can be actively involved and develop an interest and motivation to learn, which is expected to improve their understanding. In the Conclusion indicator, although there was a slight decrease in the percentage in the Fair and Good categories, the percentage of students in the Very Good category actually increased from 3.03% to 24.24%. It shows that the mind mapping method helps some students to achieve the highest level of conceptual understanding.

Table 1 Classification of concept comprehension indicator results based on pretest and post-test in the experimental class

Indicator	Number of Students Pretest	Pretest Percentage	Category	Number of Post-test Students	Post-test Percentage
Interpreting	0	0	Very Good (Score 4)	7	21.2
	0	0	Good (Score 3)	9	27.2
	3	9.1	Fair (Score 2)	5	15.2
	30	91.9	Insufficient (Score 1)	12	36.4
Exemplary	1	3.0	Very Good (Score 4)	9	27.3
	1	3.0	Good (Score 3)	8	24.2
	2	6.1	Fair (Score 2)	12	36.4
	29	87.9	Insufficient (Score 1)	4	12.1
Classify	0	0	Very Good (Score 4)	7	21.2
	6	18.2%	Good (Score 3)	10	30.3
	6	18.2	Fair (Score 2)	10	30.3
	21	63.6	Insufficient (Score 1)	6	18.2
Summarizing	0	0	Very Good (Score 4)	12	36.4
	0	0	Good (Score 3)	12	36.4
	2	6.1	Fair (Score 2)	3	9.1%
	31	93.9%	Insufficient (Score 1)	6	18.2%

Conclusion	1	3.0	Very Good (Score 4)	8	24.2
	6	18.2	Good (Score 3)	3	9.1
	8	24.2	Fair (Score 2)	3	9.1
	18	54.5	Insufficient (Score 1)	19	57.6
Comparing	1	3.0	Very Good (Score 4)	10	30.3
	2	6.1	Good (Score 3)	22	66.7
	15	45.5%	Fair (Score 2)	0	0
	15	45.5	Insufficient (Score 1)	1	3.0
Explaining	3	9.1	Very Good (Score 4)	7	21.2
	12	36.4	Good (Score 3)	11	33.3
	10	30.3	Fair (Score 2)	13	39.3
	8	24.2	Insufficient (Score 1)	2	6.1

3.2. Control Group

In contrast, the post-test results in the control group showed inconsistent and limited improvement. Although there was a slight increase in several indicators, such as Exemplifying and Classifying, where the percentage of students in the Insufficient category decreased, the increase was not comparable to that of the experimental group.

In the Interpreting and Concluding indicators, there was even a significant decline. The percentage of students in the Poor category on the Interpreting indicator increased from 75% to 81.25%, and on the Concluding indicator, it rose from 37.50% to 62.50%. It suggests that conventional learning methods are less effective in enabling students to interpret and draw conclusions independently.

Table 2 Classification of concept understanding indicator results based on pretest and post-test of the Control class

Indicator	Number of Students Pretest	Pretest Percentage	Category	Number of Post-test Students	Post-test Percentage
Interpreting	0	0	Very Good (Score 4)	0	0
	0	0	Good (Score 3)	0	0
	8	25.0	Sufficient (Score 2)	6	18.8
	24	75.0	Insufficient (Score 1)	26	81.3%
Exemplary	0	0	Very Good (Score 4)	4	12.5
	0	0	Good (Score 3)	10	31.3%
	2	6.3	Fair (Score 2)	8	25.0
	30	93.8	Insufficient (Score 1)	10	31.3
Classify	0	0	Very Good (Score 4)	4	12.5
	4	12.5	Good (Score 3)	9	28.1
	13	40.6	Fair (Score 2)	7	21.9

	15	46.9	Insufficient (Score 1)	12	37.5
Summarizing	0	0	Very Good (Score 4)	4	12.5
	0	0	Good (Score 3)	5	15.6
	6	18.8	Fair (Score 2)	5	15.6%
	26	81.3%	Insufficient (Score 1)	18	56.3%
Conclusion	0	0	Very Good (Score 4)	4	12.5
	3	9.4	Good (Score 3)	5	15.6
	17	53.1	Fair (Score 2)	3	9.4
	12	37.5	Insufficient (Score 1)	20	62.5
Comparing	0	0	Very Good (Score 4)	6	18.8
	3	9.4	Good (Score 3)	16	50.0
	12	37.5	Fair (Score 2)	4	12.5
	17	53.1	Insufficient (Score 1)	6	18.8
Explaining	0	0	Very Good (Score 4)	6	18.8
	5	0	Good (Score 3)	2	6.3%
	19	0	Fair (Score 2)	17	53.1
	8	25.0	Insufficient (Score 1)	7	21.9

Overall, this data analysis supports the argument that the mind mapping learning method is significantly more effective in enhancing students' conceptual understanding than conventional methods. The drastic improvement in the experimental group in almost all indicators, particularly in higher-order thinking skills such as comparing and summarizing, proves the superiority of mind mapping as a student-centered and innovative learning strategy.

3.3. Normality Test

After obtaining the descriptions of the pretest and post-test scores for the control group and the experimental group, the next step is to conduct a normality test on the pretest and post-test scores of both groups to determine whether the data are typically distributed. The results of the Kolmogorov-Smirnov and Shapiro-Wilk tests indicate that both data sets are normally distributed if the significance value is greater than 0.05. It indicates that the normality assumption is satisfied.

The significance values (sig) for all data (pretest and post-test) in both classes are greater than 0.05. Specifically, the sig value for the control group's pretest is 0.307, the control group's post-test is 0.067, the experimental group's pretest is 0.129, and the experimental group's post-test is 0.282. Since all of these values are above 0.05, it can be concluded that the data tested in both classes is valid for further analysis. The normality test is important to ensure that the data distribution is in accordance with the assumptions required for further statistical analysis. With good normality test results, the pretest and post-test data meet the assumptions of normal distribution, making them valid for t-test analysis and comparison of results.

3.4. Homogeneity Test

After conducting a normality test and obtaining normally distributed data, a homogeneity test was then conducted on the sample classes. The hypothesis for the homogeneity test of post-test scores is as follows:

- Ho = both sample classes have the same/homogeneous variance
- Ha = the two sample classes have different/non-homogeneous variances

The homogeneity test ensures that the variance (or data distribution) of both groups (experimental and control) is not significantly different, indicating homogeneous variance. This is also a requirement for statistical tests such as ANCOVA. The Levene test results show that the significance value (sig) obtained is 0.843, which is greater than 0.05, indicating that the variance of the two groups is homogeneous. In other words, the difference in initial learning outcomes between the groups is not significant, so that further comparisons will focus on the effect of the learning method.

The Levene test results show a significance value (Sig.) of 0.843. Since this value is greater than 0.05, it can be concluded that the variance (or diversity) of the two groups (Post-test Control and Post-test Experiment) is homogeneous, meaning they are the same. With these two conditions (normality and homogeneity) fulfilled, we can proceed to the primary analysis test, namely the *ANCOVA* test.

3.5. ANCOVA Test

Because the sample classes are normally distributed and have homogeneous variance, an *ANCOVA* test was conducted to determine the effect of the *mind mapping* method on the understanding of science concepts in the human digestive system material in class V of Public Elementary School 79 Ambon.

This test was used to decide whether the hypothesis is accepted or rejected. The research hypothesis is as follows:

- Ho = There is no significant difference between the learning outcomes of students in the control class and the experimental class after being given treatment.
- Ha = There is a significant difference between the learning outcomes of students in the control class and the experimental class after being given treatment.

Table 3 Descriptive Statistics Data

Dependent Variable: Posttest			
Learning Model	**Mean**	**Std. Deviation**	**N**
Mind Mapping	65.33	15.303	33
Convensional	36.50	7.518	32
Total	51.14	18.855	65

Based on the results of data analysis using the ANCOVA test conducted on the mind mapping method with 33 student respondents, the mean score was 65.33. Meanwhile, in the conventional learning model with 32 student respondents, the mean score was 36.50. There is a significant difference in the effect of using the mind mapping method compared to the conventional method in terms of conceptual understanding in science education, particularly in the material related to the human digestive system.

Table 4 Results of ANCOVA Test Analysis

Dependent Variable: Posttest						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	16255.981a	2	8127.990	77.579	<.001	.714
Intercept	787.927	1	787.927	7.521	.008	.108
Pretest	2749.560	1	2749.560	26.244	<.001	.297
Learning Model	15152.237	1	15152.237	144.623	<.001	.700
Error	6495.773	62	104.771			
Total	192736.000	65				
Corrected Total	22751.754	64				
R Squared = .714 (Adjusted R Squared =.705)						

Based on the *ANCOVA* test table above, it can be concluded that the sig value is < 0.001. The $F_{calculated}$ value obtained is 0144.623, and the F_{table} value obtained from the data above is 4.00. The value 4.00 is obtained using the formula df2 = n-k, df2 = 65 – (2+1), df2 = 62. To find the result of 4.00, it is found in F_{table} adjusted based on the number of samples minus the number of variables (independent and dependent), so that the result found is 4.00.

After conducting the ANCOVA test, a hypothesis test was performed to see whether the hypothesis was accepted or rejected. According to the calculations using the *ANCOVA* test through Univariate, the results showed a significance of < 0.001. The *ANCOVA* test proved that the F-count was greater than the F-table, with an F-count of 144.623 exceeding an F-table of 4.00, and a significance level of 0.001, which is less than 0.005. This indicates that the null hypothesis (H0) was rejected and the alternative hypothesis (H1) was accepted. Therefore, there is an effect of the *mind mapping* method on the understanding of science concepts related in the human digestive system in grade V of Public Elementary School 79 Ambon.

4. Discussion

An in-depth analysis of the research data reveals that the mind mapping learning method exhibits a significantly higher efficacy in enhancing students' conceptual understanding compared to traditional teaching methods, specifically lectures. The findings indicate substantial improvements across nearly all indicators, particularly in higher-order thinking skills such as comparing and summarizing. These results unequivocally demonstrate the superiority of mind mapping as an innovative and student-centered learning strategy. The remarkable improvement observed in the mind mapping group can be attributed to the method's ability to effectively organize, connect, and visualize information. By utilizing mind maps, students were able to graphically represent complex concepts and relationships, thereby facilitating a deeper understanding of the subject matter. This visualization process enabled students to better comprehend and internalize the information, leading to improved retention and recall. Moreover, the mind mapping method allowed students to identify relationships between seemingly disparate concepts, promoting a more holistic understanding of the subject. By creating a visual framework of the material, students could navigate and explore the concepts more efficiently, fostering a deeper level of understanding and critical thinking. The significant enhancements in higher-order thinking skills, such as comparing and summarizing, are particularly noteworthy. These skills are essential for students to develop a profound understanding of complex concepts and to apply them in novel situations. The mind mapping method's ability to facilitate these skills underscores its value as a pedagogical tool. In contrast, conventional teaching methods, such as lectures, often rely on rote memorization and may not provide students with the same level of engagement and understanding. The findings of this study suggest that mind mapping offers a more effective approach to learning, one that prioritizes student-centeredness, visual representation, and critical thinking. Overall, the analysis of the research data provides compelling evidence for the effectiveness of mind mapping as a learning strategy. By harnessing the power of visual representation and student-centered learning, educators can create an environment that fosters deeper understanding, improved retention, and enhanced critical thinking skills. As such, mind mapping is a valuable tool for educators seeking to innovate and improve student learning outcomes.

These findings are in line with several other findings in the last 5 years that also show the effectiveness of mind mapping in education. A study published in 2024 by Gou et al. found that the use of mind mapping can have a positive impact on students' academic achievement, attitudes, conceptual learning, and critical thinking. Mind maps are the most effective tool for improving students' reading comprehension skills, as students can detect relationships and connections between ideas, images, examples, and details embedded through these maps. (Alkhazaleh & Abu, 2024). The effectiveness of mind maps in enhancing the teaching and learning process lies in their ability to contribute significantly to the development of high-level thinking skills in students (Chaichompoo, 2017; Samonlux & Yimwilai, 2025). By providing a means for students to organize and express their ideas in a flowing and connected manner, mind maps enable the creation of a web of ideas that are linked together through the use of varying connection strengths. This visual and graphic tool has been found to be particularly effective in improving reading comprehension skills, as it facilitates the organization of information and enhances students' understanding of the material (Semilarski et al., 2020). The use of mind maps has been shown to stimulate students' memory and facilitate the retrieval of information from their minds. The process of creating mind maps, which involves the use of keywords, symbols, and visual connections, has been found to strengthen neural connections between concepts and improve recall (Abraha, 2024). As Dhindsa et al. (2011) recommends, mind maps can be a valuable interactive instrument in the teaching process, encouraging students to collaborate and engage with information in a more meaningful way. By providing a means for students to record, organize, and connect information, mind maps can facilitate the storage and retrieval of information, making them a useful strategy in the teaching and learning process (Taha & Dizaye, 2022). Furthermore, the creation of mind maps can empower students to take an active role in their learning, encouraging them to make decisions, identify relationships, and organize information in a way that is meaningful to them. By doing so, mind maps can transform students from passive recipients of information into active learners who are engaged in the process of understanding and learning (Alomari & Alhorani, 2019). Additionally, mind maps can facilitate the teaching of writing skills to students and help teachers organize their practice (Dorota, 2020).

Figure 1 An example of a handwritten mind map on the topic of the human digestive system

Additionally, a study by Hanif et al. (2020) also showed that mind mapping provides a practical approach to enhancing understanding in learning, particularly in fifth-grade classrooms. Furthermore, another study conducted by Pangandaman et al. (2024) found that mind mapping techniques improve students' performance, memory, creativity, and thinking capacity. This technique also fosters independent learning habits by following the "learning while working" principle. For abstract materials, such as the human digestive system, mind mapping helps students approach problems systematically, starting with understanding the problem and developing a plan. This can assist students in comprehending complex scientific concepts. These findings are also supported by a study by (Polat & Atış-Akyol, 2021), which demonstrated a significant impact of mind mapping methods on conceptual understanding in elementary school science learning. In contrast, the results in the control class, which used conventional learning methods (lectures), showed inconsistent improvement. This finding is consistent with other studies, which show that dominant lecture methods and a lack of active student involvement in learning can lead in a limited understanding of science concepts (Suryawati & Osman, 2018). This is in line with the opinion of Tao & Robinson (2005), who stated that the lecture method is the least effective in terms of gaining conceptual understanding of the topic at hand, because students can easily lose concentration during the delivery of material.

Overall, these findings reinforce the argument that the mind mapping method is a superior learning strategy for improving conceptual understanding of science material, particularly material on the human digestive system, compared to conventional learning methods. The results of this study can make an important contribution to the development of more effective science learning methods in the future. Based on the study's results, the mind mapping learning method has a significant impact on conceptual understanding in the human digestive system material. The results of this study show that the mind mapping method is far more effective than the conventional method (lecture). It is evident from the drastic increase in students' conceptual understanding in the experimental class, especially in indicators of higher-order thinking skills such as "comparing" and "summarizing." This significant improvement was due to the mind mapping method, which successfully helped students organize, connect, and visualize information, thereby facilitating their construction of a deep conceptual understanding. These findings are also in line with other studies showing that the use of mind mapping can improve students' academic achievement, attitudes, conceptual learning, and critical thinking (Almulla & Alamri, 2021; Shi et al., 2022; Huang et al., 2017). On the other hand, the control class that used conventional methods showed inconsistent improvement. It suggests that lecture methods are less effective in enabling students to interpret and draw conclusions independently.

5. Conclusion

Based on the findings, it can be concluded that the Mind Mapping method significantly enhances students' conceptual understanding of human digestion system material compared to conventional methods such as lectures. The research results show that the average post-test score of the experimental group (65.33) is substantially higher than that of the control group (36.50), with ANCOVA test results indicating a significance value of < 0.001. The most notable improvement was observed in high-level thinking skills, particularly in comparing and summarizing concepts. This suggests that the use of mind mapping helps students organize, connect, and visualize information effectively, thereby strengthening their conceptual understanding and critical thinking skills. Overall, this study confirms that mind mapping is an innovative, student-centered, and effective learning strategy for improving science learning outcomes in elementary schools, especially on the topic of human digestion systems. For future research, it is recommended that this method be applied more broadly to other science materials to enhance the implementation of active and visual learning in elementary schools.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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