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The Effect of Mind Mapping and Learning Style on Concepts Mastery and Students' Representation Skills

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Abstract— **This study aims to explore the effect of 1) students' mind mapping towards concepts mastery; 2) students' learning styles towards concepts mastery; 3) interaction between mind mapping and learning styles towards concepts mastery and 4) students' mind mapping towards students' representation skills on the respiratory system. The sample of this study was 86 students of class VIII MTs N 1 Pesawaran, which is the selected technique randomly. The research instrument used the pretest-posttest to know the students' mastery concepts and representation skills improvement and questionnaires to identify students' learning styles. The design used was a nonequivalent pretest-posttest control group design. Data of students' concepts mastery and representation skills in the form of pretest-posttest and n-gain analyzed using ANCOVA and Least Significant Difference Test (LSD). The results showed 1) students' mind-mapping has a significant effect on students' concept mastery. 2) student learning styles have a significant influence on mastery of concepts. 3) there is no significant interaction between mind mapping and learning styles on the mastery of concepts. 4) there is a significant interaction between mind mapping and learning styles on representation skills.**

Keywords: mind mapping, learning styles, concepts mastery, representation skills

I. INTRODUCTION

Visualization of the abstract concepts can strengthen learners' memory of the concepts learned [1]. Visual thinking can be a bridge from abstract-verbal to clear form so that there is a development of thinking and understanding of concepts related to problem-solving [2]. The key to success in facing the challenges of the 21st century, namely problem solving is to "literate science" because individuals who are literate in science can use the scientific information they have to make decisions when facing problems in life. The idea of modern education, namely literacy used as learning to understand ideas through the media of words that arise from the subject of reading and writing [3].

Learners can be said to master learning when students can construct the meaning of learning messages, both oral, written, and graphic. In the respiratory system, the material can be delivered orally, both with lectures, discussions, and presentations. Also, the characteristics of the respiratory system material require writing in the form of notes, graphics, and images because they are related to organs and respiratory mechanisms. Mastery of the concepts and structure of matter makes a material comprehensively understood for students easier to remember the material. The optimal mastery of concepts by students will have enhancing students' achievement [4].

To master a concept, students are asked by educators to take notes to facilitate students remembering the knowledge learned. Observations from students' notes show that their ability to take notes is still diverse, which can be seen from their notes only in long written form without pictures or symbols with irregular sentence placement. Few students take notes using images, but the image is not following the concept of the subject matter. The ability to take notes can help students build concepts and make it easier to develop their abilities. Ineffective note-taking can cause the learning process to be less meaningful, and the mastery of students' concepts of subject matter becomes low.

Questionnaires and researcher interviews were conducted at MTs that have implemented the 2013 curriculum. Respiratory system material is in basic competencies 3.9, so the competencies that must be achieved by students are analyzing and understanding. Also, the material characteristics of the Respiratory System in humans are abstract and related to the processes that occur in the body. And many terms that make it difficult for students to understand the material. To master the concepts needed an effort to note which can contain a picture, symbols, and writing that can connect the concept comprehensively. During the learning process science, material only focuses on students 'ability to memorize the lecture learning method. It does not consider students' ability to take notes, causing students not to be actively involved in obtaining

learning information. So that in this material, students get an average score of 60. This value does not meet the minimum completeness value standard, which is 75.

The mind mapping method is a creative note-taking method that makes it easier for individuals to remember a lot of information by forming a pattern of interrelated ideas, with the main topic in the middle, while subtopics and details become branches. The mind mapping note-taking method allows educators to communicate reciprocally with students. The method of mind mapping is also unique because something unique is easier for students to remember [5].

The use of mind mapping note-taking methods can make students not only hear explanations from educators but also take an active role in the learning process to understand and master the material. The method of note-taking mind mapping in learning is used because the characteristics of students at middle school age are the formal operational stage where students can think abstractly and logically. At this stage, intelligence is shown through the logical use of symbols related to abstract concepts [6]. Bruner recognized three modes of representation that must be present at all stages of development. These three modes of representation (enactive, iconic, and symbolic) are not necessarily hierarchical, but some learning can only be achieved by passing through each type in a specific developmental order [6].

The study had been able to show that mind mapping is more effective in improving the academic performance of students in Physics when compared with mastery learning approached and conventional teaching methods [7]. Also, some findings emphasize that having knowledge represented in mind mapping would significantly affect learners' understanding level and speed. Such knowledge representation methods have positively affected students' perception of the understanding of key concepts implicit in challenging texts in an easy and better way than the traditional ways [8]. This finding motivates researchers to research with the title "The Effect of Mind Mapping and Learning Style on Concepts Mastery and Students' Representation Skills." The purpose of this study is to determine the effect of mind mapping on mastery of concepts, learning styles towards mastery of concepts, the interaction between mind mapping and learning styles towards mastery of concepts, and students' mind mapping towards students' representation skills on the respiratory system.

II. METHODS

This research was conducted in the Academic Year 2018/2019 at MTs Negeri 1 Pesawaran. The population in the study was all class VIII MTs Negeri 1 Pesawaran, which amounted to 317 students divided into nine classes. The sample of this study were two experimental classes and one control class, amounting to 86 students.

This research is quasi-experimental research, with the research design is a pretest-posttest non-equivalent control group design, which can be seen in Table 1 below.

TABLE I. PRETEST-POSTTEST NON EQUIVALENT CONTROL GROUP DESIGN

Class	Pretest	Treatment	Posttest
Experiment	O1	A1	O2
Control	O3	A2	O4

A1 = Mind mapping method

A2 = Lecture method

O1, O3 = Pretest

O2, O4 = Posttest

The procedure in this study consists of three stages, namely the preparation, implementation, and final stages. At the preparation stage, researchers conducted a preliminary study, study literature, study the curriculum, compile learning tools, compile research instruments, and validate instruments by the supervisor, and test the validity, reliability, level of difficulty, and the power of different test instruments on students.

In conducting research, the first step is to provide questionnaire sheets to identify student learning styles. Provide pretest to measure students' mastery of concepts and representation skills and provide training to students in making mind maps before being given treatment. Then apply the mind mapping method in learning. After being given treatment, a post-test was conducted to measure the increase in students' mastery of concepts.

The final stage of the research is processing data from the identification of students 'learning styles, measuring students' skills in making mind mapping with rubric adaptation from Ohassta. Processing the pretest and posttest data, then comparing the results of test data analysis before treatment and after being treated to determine whether there is a difference in the mastery of concepts students between learning with the method of mind mapping with the common note-taking method.

The type of data in this study is quantitative data. Data collection uses test instruments in the form of multiple choices to measure mastery of students' concepts refers to aspects of concept mastery indicators according to explaining, comparing, exemplifying, summarizing, classifying, inferring, and interpreting. To evaluate the ability of student representation, using a rubric with five grading levels is used. One form of a rubric to assess students' representation ability, according to Hwang is shown in table 2. Questionnaire identification sheets for learning styles. Before being used in research, the test instrument first tests the validity, reliability, difficulty level, and power differences.

TABLE II.   REPRESENTATION RUBRIC

Score	Criteria
5	Correct answers, correct explanations, and representation elements such as icons, symbols, labels, graphics, or tables are true and complete
4	Correct answers, inaccurate explanations, and representation elements such as icons, symbols, labels, graphics, or tables are true and complete
3	Correct answers, incorrect explanation, and representation elements such as icons, symbols, labels, graphics, or tables are incorrect and incomplete
2	Incorrect answers, incorrect explanations, and representation elements such as icons, symbols, labels, graphics, or tables are incorrect and incomplete
1	Incorrect answers, incorrect explanations, and representation elements such as icons, symbols, labels, graphics, or tables are incorrect and incomplete

The analysis technique is carried out for quantitative data in the form of pretest, posttest, and n-gain using the ANCOVA statistical hypothesis test. Before the hypothesis testing is carried out, a prerequisite test is conducted, namely, the normality test using the Kolmogorov Smirnov test and homogeneity test using the Levene's Test of Equality of Error Variances. The N-gain score is interpreted according to the interpretation in table 3.

TABLE III.   N-GAIN CRITERIA

Gain	Interpretation
$0,7 \le g \le 1,0$	High
$0,3 \le g < 0,7$	Moderate
$0,0 < g < 0,3$	Low

III. DISCUSSION

The learning styles of students obtained from the distribution of questionnaires identifying the learning styles of 86 students, it is known that in the experimental class, the visual learning styles were 25 students, auditory as many as 12 students, and kinesthetic as many as 11 students. While in the control class, it was known that visual learning styles were 14 students, auditory as many as 11 students, and kinesthetic as many as 13 students. The visual and auditory learning style in the experimental class based on Figure 1. is more than the kinesthetic learning style. Whereas in the control class, the visual and kinesthetic learning style is more than the auditory learning style.
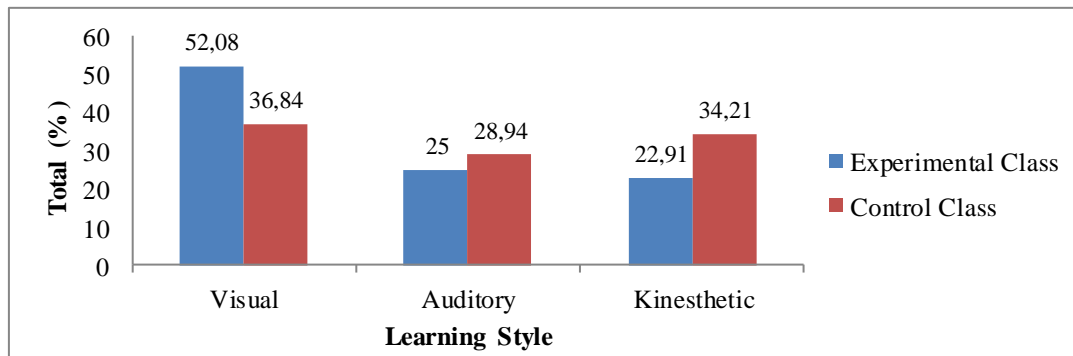

Fig. 1.   Comparison of Learning Styles of Students

The effect of the method of mind mapping note-taking on mastery concepts, learning styles on mastery of concepts, the interaction between mind mapping and learning styles towards mastery of concepts, and interaction between mind mapping and learning styles towards representation skills in this study were tested with ANCOVA. Before testing using ANCOVA, prerequisite tests were carried out, namely variance normality and homogeneity, which can be seen in table 4.

TABLE IV.   NORMALITY AND HOMOGENEITY TEST RESULTS

Data	Method	Normality Test (*Sig.*)		Homogeneity Test (*Sig.*)	
		Pretest	*Posttest*	*Pretest*	*Posttest*
Concepts mastery	*Mind mapping*	0,363	0,282	0,226	0,146
	Common note taking	0,069	0,321		
Representation skills	*Mind mapping*	0,098	0,271	0,698	0,463
	Common note taking	0,244	0,332		

The data from the experimental class for concept mastery and representation skills pretest normality tests were obtained by sig. 0.363 and 0,098, the posttest was obtained by sig. 0.282 and 0,271. The normality test the control class for concepts mastery and representation skills pretest was obtained sig. 0.069 and 0,244, the posttest was obtained sig. 0.321 and 0,332. The results of the normality test data mastery of both pretest and posttests concepts in the two sample classes indicate that the data are normally distributed (sig.> 0.05). The homogeneity test of the pretest and posttest mastery concept data has a significance value of 0.226 and 0.146. Furthermore, pretest and posttest representation skills data have a significance value of 0.698 and 0,463, which indicates that the data of mastery concept and representation skills are homogeneous (sig.> 0.05). After fulfilling the prerequisite test,

a statistical test using ANCOVA was performed, which showed the results as in table 5.

TABLE V.   TEST RESULTS FOR ANCOVA MASTERY CONCEPTS

Source	F	Sig.
Corrected Model	10,152	0,000
Intercept	18,701	0,000
Metodh	10,434	0,002
Learning Styles	9,089	0,003
Metodh*Learning Styles	1,753	0,189

The effect of the note-taking method on mastery of concepts based on the results of statistical tests in table 5. obtained a significance value of 0.002 (sig. <0.005). And also, following the BNT test (see in table 6), the mastery of concept values in the two note-taking methods obtained a significance value of 0,000 <0,005. And supported by data on the achievement of mastery of concepts in students who learn by using the method of mind mapping note taking higher than students who learn with the common note-taking method that can be seen in Figure 2.

TABLE VI.   RESULTS OF THE LSD TEST OF MASTERY CONCEPTS ON BOTH NOTE TAKING METHODS

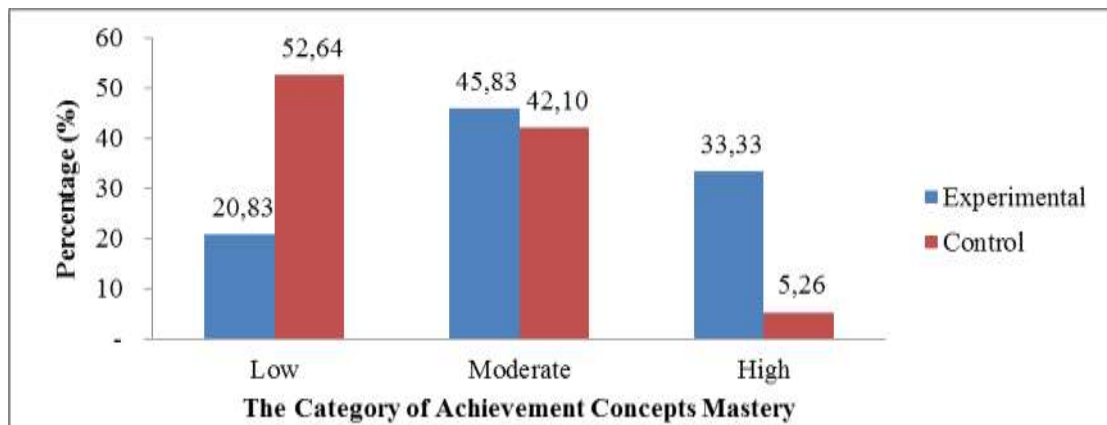| (I) Note Taking Method	(J) Note Taking Method	Sig.[a]	95% Confidence Interval for Difference*	
			Lower Bound	Upper Bound
Mind Mapping	Common Note Taking	0,000	0,140	0,339
Common Note Taking	Mind Mapping	0,000	-0,339	-0,140

Fig. 2. Differences in Achieving Mastery of Concepts

Mastery concepts of students who learn by using the mind mapping note-taking method are higher than the common note-taking method because students in making mind mapping are required to be able to determine the main topic and connect between concepts. Also, the use of symbols, images, and the use of many colors make it easier for students to remember interconnected concepts. The students with common note-taking do not connect between concepts and do not use images, symbols, and many colors, so students are less able to integrate the concepts that are recorded. Supported by the opinion of Paivio, which states that external representation will activate verbal and non-verbal systems in the human memory system [9]. The verbal system specifically acquires knowledge related to language. Non-verbal systems are responsible for processing knowledge involving images. The formation of visualization concepts requires a number of information, data, concepts, or objects that are arranged to provide meaningful understanding [9].

Students learning styles influence the mastery of students' concepts; this is based on the results of the analysis using ANCOVA statistical tests in table 5. In Figure 3. shows that students' mastery of concepts in the experimental class with visual learning styles is higher than kinesthetic and listening learning styles. Whereas in the control class that uses the general method of taking notes, the highest achievement of mastery of concepts is students with listening learning styles.

Students with visual learning styles have a higher level of mastery of concepts than hearing and kinesthetic (Figure 3) because students can pay attention to presentations by students and educators. And making mind mapping thoughts that help students visually see relationships and patterns of new information. Through mind mapping, students can make connections, see patterns, access related memories that have been stored before, and develop memory paths [10]. Students with visual learning styles will easily receive information using two-dimensional assistance, such as images, graphics, models, and others [11].
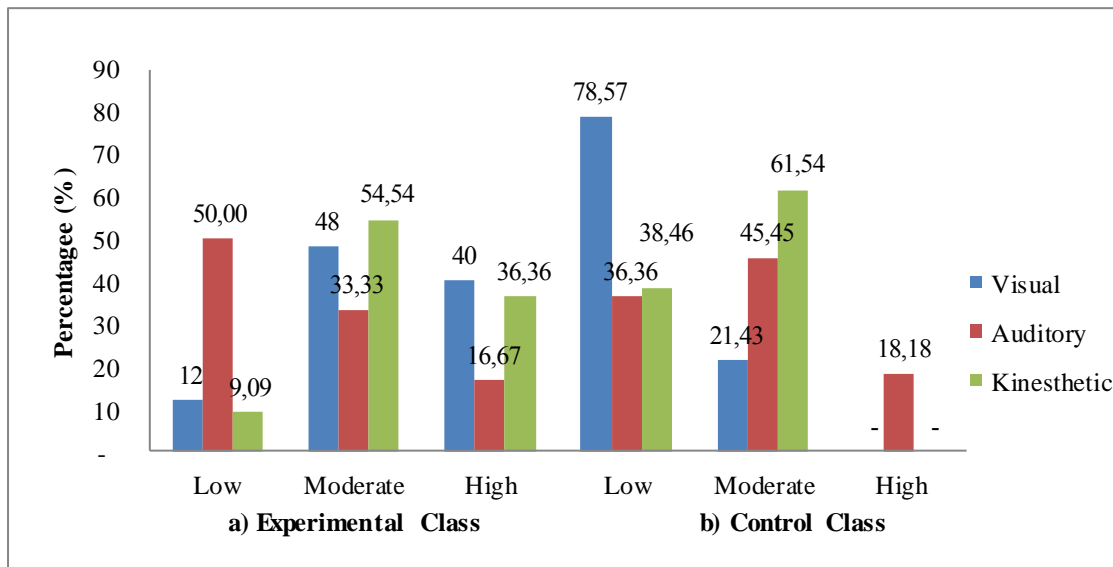
Fig. 3. Comparison of Achievement of Mastery Concepts with Different Learning Styles

In the experimental class, the achievement of mastery of the concept was mostly in the high category by visual and kinesthetic students while in the control class by auditory students. It can be because students during learning do mind mapping activities that are following their creativity. This mind-mapping activity involves hand movements to make maps, paths, and connections between concepts. It is the following states that a continuous process to connect concepts can improve brain work [12]. The development of representation capabilities is carried out in each phase of learning through reading activities, implementing, translating from phenomena to images, complex process charts, and diagrams, concept maps and mind maps [9].

Students with auditory learning styles have the lowest level of concept mastery achievement in the experimental class (Figure 3) because students during learning are focused on listening to the educator's explanation, listening to the discussion, and presenting the mind mapping that has been made. It is following the opinion that students with auditory learning styles at the time of presentation in front of the class, causing long-term memory storage that affects the ability to connect concepts [10]. However, during the learning process, the educator does not explain too many concepts in detail to the students. And only a few students present the results of the mind mapping that has been made.

TABLE VII.   TEST RESULTS FOR ANCOVA REPRESENTATION SKILLS

Source	F	Sig.
Corrected Model	33.686	0.000
Intercept	32,244	0.000
metode * gayabelajar	33,686	0,000

The method of note-taking with learning styles has an interaction with students' representation skills based on the results of the analysis using ANCOVA statistical tests in table 7. The average N-gain of the experimental class representation skills is higher than the control class with a moderate increase in interpretation. In contrast, the control class is a low increase (Figure 4). Representative skills of students can be predicted based on ways of disclosure through oral, written in the form of symbols, images, graphics, or tables [13]. The results of this study are following the results of the study, which concluded that by using the mind mapping method, students' skills in integrating knowledge into multi-representation subjects developed [14].
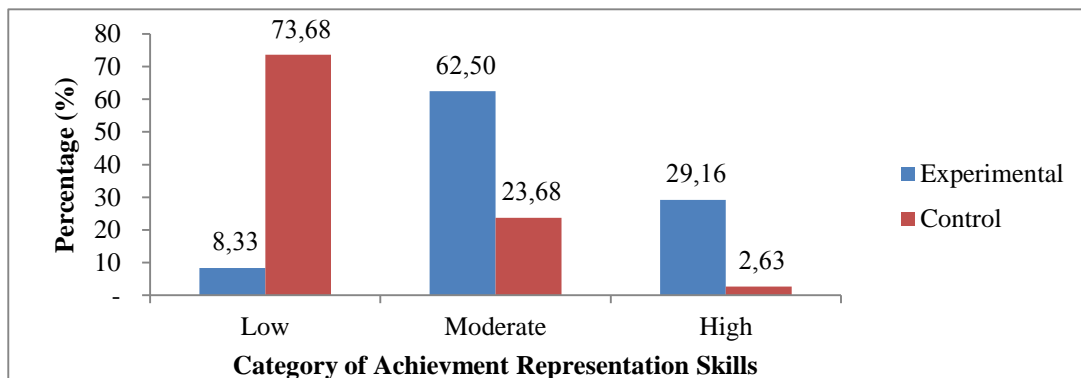

Fig. 4. Differences in Achievement of Representation Skills

The level of representation skills that can be achieved by students can be seen in table 8. It shows that the highest level (level 5) in the experimental class is found in the concept of respiratory organs and disorders, and efforts to maintain the health of the respiratory system. In the control class, the highest level of skill representation can be achieved by students is level 4. Achievement of the highest level on the concept because students have had prior knowledge of the concept before learning is given. Achieving this highest level also shows that students are able to make a comparison table to answer the problem. It is following the opinion of Schulman that students build an understanding of their initial knowledge [15]. New knowledge relates to the things that already known to students by applying initial knowledge with new experiences and ideas [15]. According to Brow, preliminary knowledge is arranged in a scheme where initial mental representations obtained from old experiences help students understand new things [15].

The level of representation skills in Table 8 below shows that the level most achieved in the experimental class is level 3; meanwhile, the control class is level 2. While students using mind mapping are required to summarize the material and projecting into a map such as symbols, images, and other elements of representation. It following by the opinion of Solso, which states that external representation will activate verbal and non-verbal systems in the human memory system [9]. Verbal systems are related to language, and non-verbal systems involve images/images. In addition, Hill states that images and words function as impulses received through the senses. It is stored in memory and sent to working memory, which organizes words, sentences, and images as verbal representations. Processed in long-term memory which will be easier to remember if the information is represented in two ways [9].

TABLE VIII.   ACHIEVEMENT OF STUDENT REPRESENTATION SKILLS IN EXPERIMENTAL AND CONTROL CLASSES

Concepts	Level	Number of Students (%)							
		Experimental Class				Control Class			
		Learning Styles			Total	Learning Styles			Total
		V	A	K		V	A	K	
Respiratory process	1	8.0	8.3	0.0	6.3	21.4	0.2	15.4	19.4
	2	36.0	25.0	9.1	27.1	71.4	0.7	38.5	58.3
	3	40.0	50.0	54.5	45.8	7.1	0.1	38.5	19.4
	4	16.0	16.7	36.4	20.8	0.0	0.0	7.7	2.8
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Respiratory organs	1	4.0	8.3	9.1	6.3	0.0	12.5	0.2	8.6
	2	8.0	33.3	0.0	12.5	78.6	50.0	0.8	71.4
	3	44.0	50.0	45.5	45.8	21.4	37.5	0.1	20.0
	4	36.0	8.3	36.4	29.2	0.0	0.0	0.0	0.0
	5	8.0	0.0	9.1	6.3	0.0	0.0	0.0	0.0
Disorders and efforts to maintain the health of the respiratory system	1	4.0	16.7	9.1	8.3	35.7	10.0	15.4	21.6
	2	8.0	0.0	0.0	4.2	21.4	30.0	38.5	29.7
	3	52.0	33.3	18.2	39.6	42.9	40.0	38.5	40.5
	4	24.0	41.7	27.3	29.2	0.0	20.0	7.7	8.1
	5	12.0	8.3	45.5	18.8	0.0	0.0	0.0	0.0
Respiratory volumen	1	4.0	16.7	0.0	6.3	21.4	0.0	15.4	13.5
	2	24.0	16.7	27.3	22.9	35.7	0.0	23.1	21.6
	3	60.0	50.0	63.6	58.3	42.9	100.0	61.5	64.9
	4	12.0	16.7	9.1	12.5	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

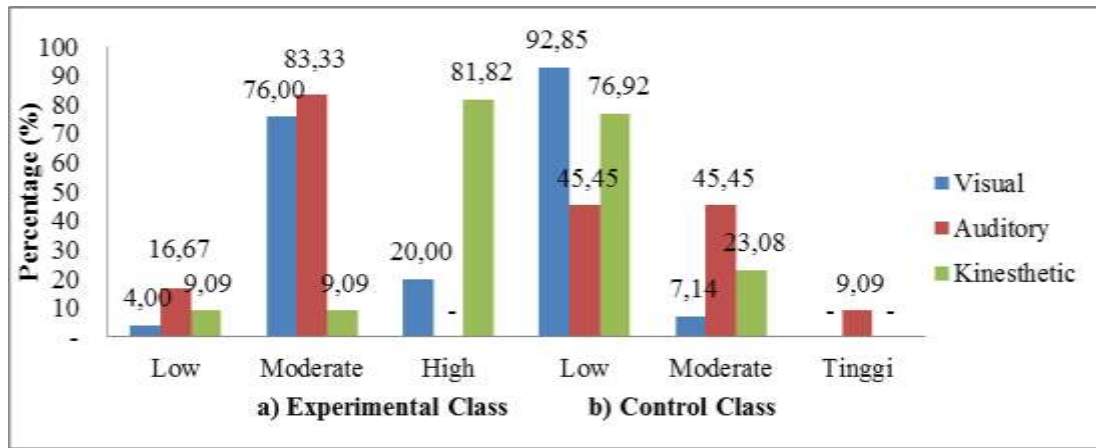a. Description: V (visual); A (Auditory); K (Kinesthetic)

Fig. 5. Comparison Chart of Achievement of Representation Skills

In Table 8. and Figure 5. show that students achieve the highest level of student representation skills in the experimental class with kinesthetic and visual learning styles. Whereas in the control class by students who have auditory learning styles and kinesthetic learning styles. It shows that the achievement of the representation skills of students with auditory learning styles is better than visual and kinesthetic learning when learning with common note-taking because the use of lecture methods accompanies it. The best way to learn for students is to learn from verbal lectures or through class discussion or listening to others. The tones of voice, pitch, speed, etc. are important to them. If a lesson is given to them in the written form, it may not be that much beneficial to them until they don't read it aloud or use a tape recorder. Written information may have little meaning until it is heard [16]. Students with kinesthetic and visual learning styles can improve representation skills by making mind mapping (Figure 5) because of hand movements in making mind mapping. This is in accordance with the opinion, which states that body cues and body movements can stimulate the increase of pathways for information storage [12]. The development of representation capabilities is carried out at each phase of learning through reading activities, implementing, translating from phenomena to images, complex process charts, and diagrams, concept maps and mind maps [9].

IV. CONCLUSION

The mind mapping note-taking method influences the mastery of students' concepts. This is proofed by the increase in higher concept mastery of students who use mind mapping note-taking methods rather than common note-taking. This implies that Mind mapping has the capacity to help students associate ideas, think creatively, and make connections that might not be achievable in the common note-taking method. Learning styles of students also influence the mastery of students' concepts. Achievement of the highest concept mastery by students with a visual learning style; however, the interaction between the method of mind mapping note-taking with students learning styles does not affect the mastery of students' concepts. It is because the achievement concept mastery of students with higher auditory learning styles uses the common note-taking method. The interaction between the method of mind mapping note-taking with the learning styles of students influences the representation skills of students, and this is proofed by the higher representation skills of students in the experimental class compared to the control class in students with kinesthetic and visual learning styles.

REFERENCES

[1] Ward R E and Wandersee J 2001 Visualizing science Using Roundhouse Diagram Science Scoope. 24(4) p 17-21

[2] Lavy I 2006 Dynamic Visualization and The Case of "Stars in Cages" Procedings 30th Conference of The International Group for The Psychology of Mathematics Education vol 4 p 25-32

[3] Triling B and Fadel C 2009 21st century skilss: learning for life in our times (San Francisco: CA Jossey-Bas)

[4] Wambugu P W and Changeiywo J M 2008 Effects of Mastery Learning Approach on Secondary School Students' Physics Achievement Eurasia Journal of Mathematics, Science & Technology Education 4(3) p 293-302

[5] Budd J W 2003 Mind Maps As Classroom Exercises Journal of Industrial Relations Landgrant Term ProfessorIndustrial Relations Center University of Minnesota 35 (1) p 35-46

[6] Lutz S T and Huitt W G 2004 Connecting cognitive development and constructivism: Implications from theory for instruction and assessment Constructivism in the Human Sciences 9(1) p 67-90.

[7] Blessing O O and Olufunke B T 2015 Comparative Effect of Mastery Learning and Mind Mapping Approaches in Improving Secondary School Students' Learning Outcomes in Physics Science Journal of Education 3(4) p 78-84

[8] Abbas S S, Eldin A S and Elsayed Adel 2018 The Effect of Concept Mapping and Mind Mapping Utilization on Students' Understanding Level: An Empirical Study Proc. of the Eighth Int. Conference on Concept Mapping (Colombia: Medellín)

[9] Lengkana D 2018 Pengembangan Program Pembelajaran Anatomi dan Fisiologi Tubuh Manusia Berbasis Multi Representasi Untuk Meningkatkan Kemampuan Representasi dan Interelasinya Dengan Keterampilan Generik Sains Calon Guru Biologi (Disertasi) Universitas Pendidikan Indonesia

[10] Wilis J 2011 Research-Based Strategies to Ignite Stutdent learning (Translator Akmal Hadrian) (Yogyakarta: Mitra Media)

[11] Meier D 2000 Accelerated Learning Handbook (Bandung: Kafifa)

[12] Sprenger M 2011. How To Teach So Students Remember? (Jakarta: Erlangga)

[13] Gilbert J K 2010 The Role of Visual Representations in The Learning and Teaching of Science: An Introduction Asia Pasific on Science Learning and Teaching 11 (1) p 1-19

[14] Keles O 2011 Mind Maps and Scoring Scale for Environmental Gains in Science Education. International Conference on New York Horizons in Education Conference Proceedings Book

[15] Hasan A, Gushendra R and Yonantha F 2017 The Influence of Prior Knowledge On Students' Listening And Reading Comprehension Indonesian Journal of English education 4(1) p 1-15

[16] Maqbool S, Malik S A, Maqbool S, and Hassan S U 2018 Effects of Traditional Lecture Method and Multi-Sensory Approach on ELT Learners at Graduate Level International Journal of Academic Research in Progressive Education and Development 7(4) p 488–505