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The Effect of 5E Learning Cycle Model Assisted with Mind Mapping on Students' Science Process Skills and Academic Achievement in the Respiratory System Subject Matter

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***Abstract*—The this study aimed to determine the effect of the 5E Learning Cycle model assisted with mind mapping on Science Process Skills (SPS) and Students' Academic Achievement of The Respiratory System subject matter. This type of research is Quasi-Experimental, using the Nonequivalent Pretest-Posttest design. The study population was 8th-grade students of State of junior high school (SMP 3 Watampone) as many as 8 classes with 218 students in the 2017/2018 school year. The sampling method was purposive sampling technique. The research sample used 24 students in the experimental class and 19 students in the control class. The experimental class was taught by using the 5E Learning Cycle model assisted with mind mapping, while the control class was taught by the conventional learning model. Data collection uses the science process skills test (SPST) and academic achievement test (AAT). Descriptive statistical analysis results show that the average SPS score and students' academic achievement in the experimental class are higher than the control class. Based on the results of hypothesis testing using the t-test, it shows that the 5E Learning Cycle model assisted with mind mapping has a higher effect on students' SPS and academic achievement compared to conventional learning models on the respiratory system subject matter.**

Keywords—5E learning cycle model, science process skills, academic achievement

I. INTRODUCTION

Science is an organized body of knowledge about nature. It is the product of observations, common sense, rational thinking, and (sometimes) brilliant insights [1]. Therefore it needs a model and method to teach science. Teaching is the process of using an appropriate method, staff, and material in order to reach in the most effective manner to the predetermined goals [2]. The results of observations on science learning at SMP Negeri 3 Watampone indicated that learning involving science process skills had been carried out, but the results were still low. It can be shown from the practicum score of students generally still below the average. Likewise, with the completeness of learning in grade VIII students at SMP Negeri 3 Watampone in the 2017/2018 school year on respiratory system material, only 39% of students were completed from 43 students with the score of minimum completeness criteria was 78

The low learning completeness of students was possible because of the use of models and methods of learning that were not appropriate. For example, science learning in SMP Negeri 3 Watampone generally used a direct teaching model even though the school has implemented the 2013 curriculum. The direct teaching model is a teacher-centered learning model and is easy to use by teachers. With this learning model, students are not trained in the process of discovery and learning tends to be passive and do not develop the science process skills of students.

In the recent years, many countries put emphasis on the scientific thinking and the science process skills in their curricula; the science process skills involve means and methods to reach scientific information and thus allow the pupils to think scientifically [3]. The Objectives involving the improvement of science process skills in curricula is to help understand how scientists form scientific knowledge, what processes this knowledge undergoes and how it is used in new researches, and adopting the science process skills and scientific research approach and finding solutions to the problems faced in the process of exploring the nature and understanding human-environment relations. According to [4], Science process skills consist of basic science process skills and integrated science process skills. Basic science process skills, including 1) observing, 2) communicating, 3) classifying, 4) measuring metrically, 5) inferring, 6) predicting. And the integrated process skills, including 7) identifying variables, 8) constructing a table of data, 9) constructing a graph, 10) describing relationships between variables, 11) acquiring & processing your own data, 12) analyzing experiments, 13) constructing hypotheses, 14) defining variables operationally, 15) designing investigation, and 16) experimenting.

One of the strategies that can develop a student's science proses skills is Learning Cycle 5E. The model based on constructivist approach help increases students' critical thinking skills and also targets at the discovery and the students' acquaintance with previous knowledge of new concepts [5] 5E learning cycle as opined by [6] motivates students through several phases of learning, to explore a subject, to have a given definition for their experiences, to obtain more detailed information about their learning and to evaluate it. Learning using the learning cycle method is an active cognitive process, in which the student goes through various, explorative educational experiences which enable him to explore the knowledge intended to be taught. The learner engages in a mental activity represented by the re-organization, rearrangement, and alternation that the learner introduces to the learning material.

The 5E instructional model, or the 5Es, consists of the following phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. Each phase has a specific function and contributes to the teacher's coherent instruction, as well as the learners' formulation of a better understanding of scientific and technological knowledge, attitudes, and skills [7]. The first phase, Engagement, is used to motivate students by creating some mental disequilibrium or tapping into familiar real-life situations. The interest generated leads students into the second phase, Exploration, in which they use direct, concrete experiences to make observations, collect data, test predictions, and refine hypotheses. This information enables them to begin answering questions initiated in the Engagement phase. During the Exploration stage, the teacher facilitates safe, guided or open inquiry experiences and questioning so students might uncover their misconceptions about the concept. During the third phase, Explanation, the teacher uses students' observations and data to create a scientific explanation for their results. At this time, appropriate scientific vocabulary is introduced and is related to the students' experiences. The fourth phase, Elaboration, is designed to give students additional problems, which allow them to apply their new knowledge, propose solutions, make decisions and/or draw reasonable conclusions. This is often in the form of another inquiry activity or extension of the Exploration phase. Finally, the fifth phase, Evaluation, is essential to determine if students obtained a scientifically correct understanding of the concept and if they were able to generalize to other contexts. This may be done formally or informally [6].

The respiratory system subject is consists of many readings and needs to be memorized by students. The use of 5E learning cycle models can be equipped with mind mapping. According to [8] the mind-mapping, when used as part of an instructional approach, is potent at increasing students' achievement score, knowledge, and retention. Mind Maps are useful for brainstorming, summarizing information, and note taking, thinking through complex problems.

Based on the description, research has been conducted on the Effect of the 5E learning cycle model assisted with mind mapping on science process skills and learning achievement of class VIII SMP Negeri 3 Watampone on respiratory system material.

II. Research method

This type of research is quasi-experimental. This research was carried out in junior high school SMP Negeri 3 Watampone in the 2017/2018 academic year consisting of 8 classes with 218 students. Sampling was done by purposive sampling and obtained two classes were an experimental class consisting of 24 students and control class consisting of 19 students. The experimental class was taught using the 5E learning cycle model assisted with mind mapping, and the control class was taught using conventional learning models.

The instrument used was a science process skills test (SPST) consisting of 20 items and 25 items of multiple choice for academic achievement test (AAT) that had been examined by 2 expert validators. The research design used was nonequivalent control group design as shown in Table 1 [9].

TABLE I. Nonequivalent Control Group Design

Experiment	O1	X	O2
Control	O3	-	O4

III. Result and Discussion

A. Result

The result of science process skills at the experimental class and control class showed in Table 2.

TABLE II. Statistical Data of Science Process Skills

Statistical data	Experimental class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Samples	24	24	19	19
Ideal score	20	20	20	20
Highest score	13	19	13	18
Lowest score	3	15	4	15
Average score	6.92	17.21	8	16
Deviation standart	2.72	1.25	2.67	0.88

Table 2 shows that the results of the pretest of science process skills in the experimental class obtained an average score of 6.92. The highest score obtained was 13, and the lowest score was 3 with the highest total score of 20. Posttest results of science

Process skills in the experimental class obtained an average score of 17.21 students. The highest score obtained is 19, and the lowest score is 15 with an ideal score of 20.The pretest score of the science process skills of the control class obtained the average students SPS score is 8. The highest score obtained was 13, and the lowest score was 4 with an ideal score of 20. The posttest results of science process skills in the control class obtained the average score of participants students is 16. The highest score obtained was 18, and the lowest score was 15 with the highest total score of 20. The result of students' academic achievement is shown in Table 3.

TABLE III. STATISTICAL DATA OF STUDENTS' ACADEMIC ACHIEVEMENT

Statistical data	Experimental class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Samples	24	24	19	19
Ideal score	25	25	25	25
Highest score	11	24	11	22
Lowest score	3	10	3	19
Average score	7.54	21.67	6.89	19.94
Deviation standart	2.13	2.81	2.67	0.84

Table 3 shows that the average pretest score of students' academic achievement in the experimental class was 7.54. The highest score obtained was 11, and the lowest score was 3 with an ideal score of 25. The average posttest score of science academic achievement in the experimental class was 21.67. The highest score obtained is 24, and the lowest score is 10 with an ideal score of 25. The average pretest score of students' academic achievement in the control class of students is 6.89. The highest score obtained was 11, and the lowest score was 3 with an ideal score of 25. The posttest results of science academic achievement in the control class obtained an average score of 19.94 students. The highest score obtained was 22, and the lowest score was 19 with an ideal score of 25. The description of the improvement of students' SPS is shown in Table 4, and the description of an improvement of the science process skills indicators in the experimental class and control class is shown in Table 5.

TABLE IV. IMPROVEMENT OF STUDENTS' SCIENCE PROCESS SKILLS

Interval	Category	Experimental Class		Control Class	
		Freq.	(%)	Freq.	(%)
$0.70 \leq g \leq 1.00$	High	19	79.2	9	47.4
$0.30 \leq g < 0.70$	Medium	5	20.8	10	52.6
$0.00 \leq g < 0.30$	Low	0	0	0	0
Total		24	100	19	100

TABLE V. N-GAIN OF SCIENCE PROCESS SKILL INDICATORS OF STUDENT

Science Process Skill Indicators	N-*gain*			
	Exp. Class	*Category*	*Cont. Class*	*Category*
Observation	0.7	High	0.8	High
Identifying problems	0.9	High	0.8	High
Hypothesizing	0.8	High	0.7	High
Designing investigations	0.7	High	0.5	Medium
Communication	0.8	High	0.7	High
Decision making	0.8	High	0.6	Medium

Table 6 shows the achievement of N-gain indicators of science process skills in the experimental class higher than the control class except the indicator observed in the control class is higher, which is 0.8 compared with the experimental class is 0.7.

TABLE VI. IMPROVEMENT OF STUDENTS' ACADEMIC ACHIEVEMENT

Interval	Category	Experimental Class		Control Class	
		Freq.	(%)	Freq.	(%)
$0.70 \leq g \leq 1.00$	High	23	95.80	16	84.20
$0.30 \leq g < 0.70$	Medium	1	4.20	3	15.80
$0.00 \leq g < 0.30$	Low	0	0	0	0
Total		24	100	19	100

N-gain result of learning achievement indicators at experimental and control class shown in Table 7. The results of the normality and homogeneity test data show that the data of science process skills and students' academic achievement of both classes are normal and homogeneous. The results of the t-test calculation show that $t_{calc.} = 3.7591 > t_{table} = 2.0195$. It means H_0 is rejected and H_a is accepted. So that it can be concluded that the 5E learning cycle model assiested by mind mapping has a positive effect on science process skills of students VIII Grade of SMP 3 Watampone in respiratory system material

The results of the analysis showed that learning using the 5E Learning Cycle model assisted with Mind Mapping had an effect on improving the students' science process skills. Results of descriptive statistical analysis using the N-gain formula obtained for the class taught using 5E Learning Cycle learning assisted with Mind Mapping classified as a high category with a score of 0.78 and for the class taught using conventional learning models classified as medium categories with a score of 0.68.

TABLE VII. N-GAIN OF STUDENTS' ACADEMIC ACHIEVEMENT

No	Academic Achievements Indicators	N-gain			
		Exper. Class	Category	Cont. Class	Category
1	Identify respiratory organs	0.3	Medium	0.8	High
2	Explain the influence of air pressure in the breathing process	0.7	High	0.5	Medium
3	Analyze the mechanism of chest breathing and abdominal breathing	0.9	High	0.7	High
4	Explain the mechanism of transporting oxygen throughout the body	0.8	High	0.8	High
5	Identify the volume of air in the lungs	0.8	High	0.6	Medium
6	Describes the process of exchanging O_2 and CO_2 compounds in the respiratory system	0.9	High	0.8	High
7	Investigate the effect of smoking on human health	0.9	High	0.7	High
8	Classifying harmful chemicals contained in cigarettes	0.8	High	0.8	High

B. Discussion

Nida et al. [10] conclude that implementation of the 5E Learning Cycle model assisted mind mapping more effectively than without mind mapping to increase science process skills. The 5E learning cycle model assisted with mind mapping make the learning process more efficient and the student easy to memorize concepts and to increase science process skills [11], [12].

Mind maps are one of the great organizational thinking tools, creative, effective ways of recording and literally mapping thoughts very simple — steps for making mind mapping [13].

Step 1: Brainstorm: 1. Write the topic in the center of a blank page. 2. Use colors, pictures, words, and symbols to record any ideas, topics, researchers, or theories that are associated with the topic. You can place these anywhere on the page. Associate freely and do not filter out ideas at this point; anything and everything is okay.

Step 2: Organization: 3. Map the relationships between the ideas or key points using lines, arrows, colors, and words to link them. 4. Identify the type of relationship between ideas or points, such as contrasts, similarities, cause, and effect. Write these relationships along the linking lines.

Step 3: Mind Map: 5. Once you are comfortable with the associations and organization in your brainstorm, then use the ideas that you have developed to draw out your final mind map. The mind map of the respiratory system can be seen in Fig. 1.

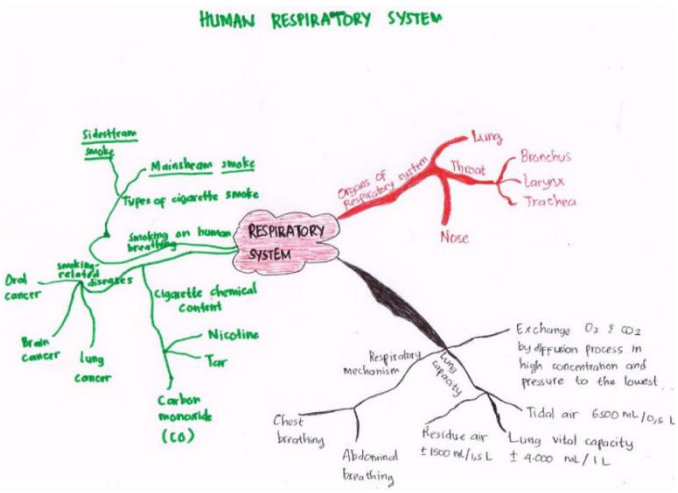

Fig. 1. Mind Map of Respiratory System

Factors that influence the differences in the results of science process skills are learning that combines hands-on and minds on. Through the 5E cycle model, students have the opportunity to conduct investigations to find knowledge to answer what has been proposed. the investigation process trains science process skills to students. Starting from how to make observations, identify problems, submit hypotheses, plan experiments, conduct experiments, and communicate the results of experiments. According to another finding of the research, the basic science process skills are emphasized more in the curricula compared to integrated science process skills [3].

Science process skills are needed to solve problems, find answers or make systematic decisions in real-world contexts [3]. This is a mental process that encourages students to think critically, creatively, analytically and systematically. By mastering, science process skills and better understanding with the right attitude towards science will ensure students think effectively. Nonetheless, the reality is that science process skills have not been optimally developed in several schools. It is indicated that there are still many teacher-centered learning activities. One way that can be used to activate students in learning science process skills is to use learning strategies that involve students interacting directly in conducting exploration, knowing and applying concepts and one of them is the 5E learning cycle model.

The 5E learning cycle model allows students to learn new concepts or try to understand concepts that have been known in depth. Through the 5E learning cycle, students are trained in skills and activities that increase curiosity, fulfill student expectations, and make students focus and active in gaining information and understanding. Students use their knowledge in discovering new concepts to get more meaningful concepts. In other words, theoretically, the learning cycle 5E is learner-centered learning where students actively observe and explore to construct concepts. Construction of concepts can occur because students gain knowledge through scientific activities that encourage students always to find out or prove a truth. Balci studies show that the learning cycle 5E helps students activate their prior knowledge and overcome their misconceptions [6].

The results showed that cycle learning 5E had a positive effect on science process skills. This is because the learning of the 5E learning cycle model assisted with mind mapping integrate one material that is different from the material to be studied so that students are active and motivated to take part in learning, whereas in the control class is applying direct learning, the educator performs, shows and explains a process learning. So the students were not able to improve student academic achievement because they were not fully involved in the learning process.

Improving the science process skills of students taught with 5E learning cycle assisted with mind mapping is also caused by the active participation of students in the teaching and learning process, especially during worksheets. This is due to the work of worksheets of students together with their group friends, posing a problem then make a hypothesizing followed by designing the experiment then arrive at the stage of drawing conclusions and learning models that guide students to develop their science process skills where they are guided to find and investigate themselves about a scientific concept so that students' knowledge and skills are not the results of remembering facts but their own findings.

The results of descriptive statistical analysis in the experimental class showed the highest value of 0.95 while in the control class it was 0.82. This value indicates that the value obtained by the experimental class is higher than the value obtained by the control class. This means that the experimental class is more active or more interested in participating in the learning process than the control class. This is because the experimental class is assisted with mind mapping where mind mapping is more increasing the motivation and interest in learning because it can facilitate students to understand the relationship between the materials being taught

The lowest learning outcome score in the experimental class is 0.67, and the control class is 0.57. The experimental class average score is 21.67 while the average score of the control class is 6.89. The academic achievement of students in the experimental class was higher than the control class because the students in the experimental class had higher learning enthusiasm compared to the control class.

The results of inferential analysis using the t-test obtained a value of t_{count} of 4.99 higher than the value of t_{table} of 2.02. These results indicate that t_{calc} is in the area where Ho is rejected and Ha is accepted. It can be stated that there

is a positive influence on the learning cycle 5E learning model assisted with mind mapping on the academic achievement of grade VIII students of SMP 3 Watampone on the respiratory system subject. This is in line with the study results of the [13] that the use of the 5E learning cycle model along with mind map has a significant effect on students' academic achievement of grade VIII of SMP Negeri 5 Karanganyar.

IV. CONCLUSION

There is the effect of the 5E learning cycle learning model assisted with mind mapping on science process skills and learning achievement of grade VIII students of SMP 3 Watampone in the subject matter of the respiratory system.

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