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The Effect of Scientific Inquiry Learning Model Using Mind Mapping and Critical Thinking Ability toward Student's Science Process Skills in Senior High School

Widya Suryani[1]; Mara Bangun Harahap[2] ; Karya Sinulingga[3]
[1](Post Graduate, State University of Medan, Medan, Indonesia)
[2](Lecturer, State University of Medan, Medan, Indonesia)
[3](Lecturer, State University of Medan, Medan, Indonesia),
Corresponding Author: Widya Suryani

Abstract: *This study aims to analyze: science process skills taught with scientific inquiry model using mind mapping better than students taught with conventional learning, physics science process skills students who have the ability to think critically using scientific inquiry model above average better than students who have the ability to think critically using conventional models above average, and the interaction of scientific inquiry learning model using mind mapping media with students 'critical thinking ability in improving students' physics science process skills. This research is a quasi experimental research with two group pretest-posttest design design. The research population is all students of grade X SMA Gajah Mada Medan first semester of academic year 2017/2018. The sample in this study was taken by cluster random sampling. The instruments used are tests of science process skills and critical thinking ability tests. The resulting data were analyzed using two-way ANOVA. The result of the research shows that: science process skill of students taught with scientific inquiry model using mind mapping better than students taught by conventional learning, physics science process skill of students who have critical thinking ability using scientific inquiry model above average better than students who have the ability to think critically using conventional models above average, and there is the interaction of scientific inquiry learning model using mind mapping with students 'critical thinking ability in improving students' science process skills.*

Keywords: *Scientific inquiry learning model using mind mapping, Critical thinking ability, Science process skills*

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I. Introduction

The era of globalization today, encouraging a tight competition between nations in the world. This competition is called free competition. Nations capable of mastering a number of knowledge, technology, and skills will be the winner **[1]**. Qualified human resources who master the science, technology and a number of skills are absolutely necessary in order to win the competition in the global era. In addition, quality human resources are also needed to drive the industrial sectors of our country. Preparation of qualified human resources can be done through quality education. In Law no. 20 of 2013 on the national education system states that education is a conscious and planned effort to create an atmosphere of learning and learning process so that learners are actively developing their potential to have religious spiritual power, self-control, personality, intelligence, noble character, as well as the necessary skills himself, society, nation and state. Achieving quality human resources should be explored in all aspects of the field of study including the field of physics studies.

Physics has an important role in meningktkan quality of human resources are strong, creative and able to adapt to follow developments that occur in society. The success of physics teaching can not be separated from the quality of teachers as physics lecturers, but the facts seen in the field in physics learning, learning is still centered on the teacher, where students appear passive without involving students to learn to develop the skills of the science process. Science learning activities not only calculate or use the formula, but the learning of physics will be more meaningful if the learning is done in accordance with the nature of science.

Learning physics is essentially a product, a process and a scientific attitude. The nature of physics as a product includes facts, concepts, principles, theories and laws. In terms of process, physicists determine the variables under study, by observing, questioning, hypothesizing, predicting, finding patterns and relationships, communicating, designing and creating, planning and conducting investigations and measuring and counting. These activities are part of the science process skills **[2].**

Scientific process skills emphasize the formation of skills and communicate to gain an understanding of concepts. So to familiarize students into physics, it can be stated that students need to be equipped with the skills of the process of science. Implementation of science process skills will shape students' thinking skills such as critical thinking skills. According to **[3]** critical thinking is a reflective and reasoned way of thinking that is focused on making decisions to solve problems. Essentially critical thinking skills are developed into indicators of critical thinking consisting of five groups according to Ennis: 1) providing elementary clarification, 2) building basic skills, 3) inferencing, and 4) make further explanations (anvanced clarification), and 5) implement strategies and tactics **[3].**

But in fact based on interviews with physics teacher colleagues in SMA Negeri 2 Binjai in the academic year 2015/2016, obtained information that on teaching and learning in schools, physics teachers emphasize that teacher-centered learning. Teachers tend to emphasize mathematical equations in solving physics problems and not training students in science process skills. The conclusion is reinforced by the statement through the results of interview researchers with some students in SMA Negeri 2 Binjai, that they rarely practice, whereas in school there are laboratories (physics, biology, chemistry, and computers). How students' science process skills can develop if students never do practicum. In fact, if students are accustomed to practicum, the skills of students' science process can increase because students are used to observing, grouping, hypothesizing, designing experiments, interpreting data, predicting, communicating, applying concepts and concluding, which activities are indicators of the science process skills.

This can be seen based on data obtained that the average value of physics exam of class X students is still low when viewed from the value of Minimum Exhaustiveness Criteria is 75. Average value on TP. 2015/2016 is 65 and on TP. 2016/2017 average value 68. This data indicates that the average value of physics examination class X SMA Negeri 2 Binjai for both lesson years is still relatively low. One of the factors is the low learning outcomes of physics because the learning of physics is taught by conventional learning which consists of lecture, demonstration, and presentation methods. Teachers tend to transfer the knowledge they have to the students' minds, the teacher is concerned only with results rather than the process.

Responding to the above problems need a model that involves active learning of students to improve the science process skills and student learning outcomes in the form of concept understanding, one of which is the scientific inquiry learning model. According **[4],** on the results of his research indicates that the model of scientific inquiry learning to improve the student's so that there are differences in student learning outcomes by using conventional learning model. In addition, **[5]** also concluded on the results of his research that learning with scientific inquiry can improve students' science process skills compared with conventional learning.

The Scientific Inquiry learning model is a learning model that involves students in truly original research problems by confronting students in the field of investigation, helping to identify conceptual or methodological issues. The phases in this model are (1) the students presented a field of research, (2) the students make the problem, (3) the students identify the problem in the study, (4) the students speculate to clarify the problem **[6]**

1.1 Model of scientific inquiry study

The scientific inquiry learning model is designed to bring students directly into the inquiry process. Through scientific inquiry model the student is expected to actively ask the question why something happened then search and collect and process the data to determine the answer of the question. The application of scientific inquiry instructional model in teaching and learning activities aims to develop a deeper understanding of science concepts and shape students' scientific knowledge. Through experimental activities students can try various ways to complete experiments conducted so as to develop the ability to think it has. Students are expected to be responsible for conducting investigations in identifying problems, hypotheses, designing methods to prove hypotheses, analyzing them and making final conclusions. The scientific inquiry learning model is a learning model that involves students in truly original research problems by confronting students in the field of investigation, helping to identify conceptual or methodological problems. The phases in this model are (1) the students presented a field of research, (2) the students make the problem, (3) the students identify problems in the study, (4) the students speculate to clarify the problem **[7]**.

The nature of the scientific inquiry approach is to teach students to process information with techniques once used by biological researchers, for example, identifying problems and using methods to solve the problem. The following explanation of the syntax of scientific inquiry learning model according to **[7]** are: 1) In the first stage students presented the field of research, which includes the methodologies used in the study. 2) In the second stage, the problem begins to be organized so that the student can identify the problem in the research. 3) In the third stage, students are asked to speculate about the problem, so that students can identify the difficulties involved in the research. 4) In stage four, students are asked to speculate on ways to clarify the difficulty, by designing Re-test, process data in different ways, generate data, develop constructs and so on. Teacher's job is to guide, train, and educate research by emphasizing the research process and persuading students to reflect on the

process. Teachers should be careful that identifying facts is not the main issue that should be emphasized in research. Furthermore, the most important thing in this regard is how teachers can encourage students to deal with complex and well-researched research questions.

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1.2 Critical thinking ability

According to **[3]** the ability to think critically is a reflective and reasoned way of thinking focused on decision-making to solve problems. This mental process will raise the critical thinking ability of students to be able to master physics in depth. Critical thinking allows students to analyze their thoughts in making choices and draw conclusions intelligently. When children are given the opportunity to use higher-level thinking at each grade level, they will eventually be used to distinguish between truth and lies, appearance and reality, facts and opinions, knowledge and beliefs.

Understanding the material of physics requires thinking and reasoning in order to solve physics problems. Critical thinking is not the only material to understand the teaching materials but a process or activity that should be incorporated in the learning of any material at a certain level of education. Physical problem solving requires logical thinking and procedural thinking because the physics problem is sourced from natural phenomena and complex material requires the stages of thinking from basic thinking to high-level thinking.

Critical thinking ability are developed into indicators of critical thinking consisting of five groups according to Ennis: 1) providing elementary clarification, 2) building basic skills, 3) inference, and 4) make further explanations (anvanced clarification), and 5) implement strategies and tactics (strategies and tactics). This thinking framework generates thought processes when extracting information and applying the best criteria to decide how to act from different perspectives **[8]**

1.3 Skills of the science process

The skill of the science process is a complex capability device commonly used in conducting scientific inquiry into a series of learning processes **[2].** Science process skills in this study refers to **[2]** are as follows 1) obseving, 2) asking question, 3) Formulate hypotheses, 4) Find patterns and variable relationships, 5) Communicate effectively, 6) Designing an experiments,7) conducting an experiments ,8) Make a conclusion.

II. Method

2.1 Population and sample

1 Population and sample

The research was conducted on the students of SMA Gajah Mada Medan Year Academic 2017/2018, consisting of two classes X-1, X-2 with 70 students. Each class consists of X-1 class of 35 people and X-2 class of 35 people. The sample is a portion of the population that is considered to represent the population to serve as a source of information or data sources in a study. The sampling technique is done by total sampling technique that is from two existing classes overall set as sample. Thus the sample is defined as class X-1 and class X-2 totaling 70 people

2.2 Data collection techniques

This type of research is a quasi experimental research is research that aims to determine the effect of something imposed on the subject of the student. The study involved two different sample classes treated. The experimental class is treated in the form of learning using scientific inquiry model. Control class is treated in the form conventional learning. The variables of this study consist of three types of independent variables, moderator variables and dependent variables. This research will use experimental method with 2x2 factor design.

The study involved two different treatment classes. To know the result of student learning done by giving test in both class before and after given treatment. The experimental design of quasi experiments was design: two group pretest -postest design. These variables will be included in the research design.

Table 1. Research design

Learning / **critical thinking ability**	**Model Pembelajaran**		
	***Scientific Inquiry models* (A_1)**	**Conventional learning (A_2)**	**Average**
Above average (B_1)	$A_1 B_1$	$A_2 B_1$	μ_T
Below average (B_2)	$A_1 B_2$	$A_2 B_2$	μ_R
	μ_A	μ_k	

III. Results

Testing of normality of postes data for control class and experiment class assisted by SPSS 18 software with significant level 0,05 and test requirement if significant value on kolmogrof-smirnov column is greater than 0,05 then data is considered normal distribution. Normality test results are shown in Table 2.

Class		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Value_postes	Control class	0,15	35	0,06	0,94	35	0,04
	Experimental class	0,14	35	0,09	0,95	35	0,10

Homogeneity test results are shown in Table 3.

		Levene Statistic	df1	df2	Sig.
Nilai_postes	Based on Mean	2,89	1	68	0,09
	Based on Median	2,70	1	68	0,11
	Based on Median and with adjusted df	2,70	1	59,29	0,11
	Based on trimmed mean	2,94	1	68	0,09

Based on the homogeneity test, the significant value is 0,09. These results indicate that the significant value is greater than the significant level of 0.05, it can be concluded that the control class students and the experimental class come from populations that have the same variance or both classes are homogeneous.

Table 4. Skills of Science Process Based on Critical Thinking ability

Critical Thinking ability Above Average			**Critical Thinking Ability Below Average**		
Value	**Frequency**	**Average**	**Value**	**Frequency**	**Average**
77,5	3	84,79	60,00	1	73,31
80,00	4		67,50	5	
82,50	12		70,00	5	
85,00	7		72,70	5	
90,00	4		75,00	9	
92,50	2		77,50	8	
95,00	3		80,00	2	
Amount	35		Amount	35	

IV. Discussion and Conclusions

4.1 Discussion

4.1.1 Skills of Student Science Process Using Scientific Inquiry Model Using Mind Mapping Is Better Than Student Process Skills by Using Conventional Models

The findings in this study indicate that there is a difference of science process skill between students taught by scientific inquiry and Conventional learning model, the average value of pretest skills of conventional class process is 43,00 and the mean value of postes is 75,14. While the average pretest grade of scientific inquiry is 44.50 and the average posture is 82.93**. [5]** in his research found there are differences in the science process skills between students who were given a model of scientific inquiry learning with students who were given a conventional learning model. The average student process skill given scientific inquiry study was 64.13, and the average for students with the conventional model was 70.07. The same is also obtained by **[9]** which in his research found that the experimental class students with scientific inquiry model has an average value better than students who get conventional learning.

The scientific inquiry model involves students in truly original research issues by confronting investigative areas, helping them identify conceptual or methodological issues in the field and inviting them to devise ways of solving problems. Through it, they can see how a knowledge is created and built into a

community of scientists, students will value knowledge as a result of the grueling research process and will learn the limitations and benefits of today's knowledge **[6].** Implementation of scientific model inquiry learning combined with mind mapping facilitate researchers in conveying information to students so that the teaching and learning process becomes innovative and not boring. This is in accordance with the results of research conducted by **[10]** concluded that the implementation of inquiry learning model assisted mind mapping laboratory included in the category of good sangan that is 85.67%.

Implementation of scientific inquiry learning model using mind mapping makes students more active in learning, fostering attitude to dare to express opinions, think critically, interact with friends and ask the less understood. The pattern of learning becomes more innovative compared with conventional learning, because in this study students in scientific inquiry class using mind mapping can analyze directly and think critically of abstract events and can only be seen using the media. For example students on hooke legal materials, teachers displaying mind mapping related to the style of restorers will entice students to think critically that students will basically provide simple explanations (ask questions, analyze arguments), build basic skills (observe), conclude (create and consider value of decisions), and provide further explanation according to the critical thinking indicator, thus raising students' science process skills to formulate hypotheses, asking predicting questions, communicating effectively, conducting experiments and finding patterns and relationships between the two objects can increase.

Conventional learning is used to convey lessons transformed directly by teachers to students, this learning model is specifically designed to support student learning processes related to declarative knowledge and procedural knowledge taught with gradual, step-by-step pattern of activities **[11]**. This learning management system requires the involvement of students especially in terms of attention, listening, question and answer are planned, resulting in less optimal learning process to improve the skills of science processes because teachers make students become passive in learning. Part of the science process skills that can be examined from the conventional is to ask questions, find patterns and relationships, communicate effectively, measure and calculate. Only a few of the science process skills can be studied conventionally so that this model does not effectively demand students into investigations. Unlike the scientific inquiry model that is almost all

Based on the above description, it can be concluded that conventional learning is less able to improve students 'science process skills, and scientific inquiry learning model is better in improving students' science process skills.

4.1.2 Scientific Process Skills Students with Higher Thinking Ability using Scientific Inquiry Model using Mind Mapping Better Than Students Who Have Critical Thinking Abilities Above Average using Conventional Learning

Based on the tables of critical thinking ability, the average students' critical thinking ability below average in the experimental class is 43.54 and the control class is 35.67. The average students' critical thinking abilities above average in the experimental class were 50.58 and the control class was 49.17. The science-process skills for critical thinking skills below average in the experimental class were 74.00 and the control class was 73.00. The average science-process skills for above-average critical thinking skills in the experimental class were 86.5 and the control class was 80.50. ANOVA test conducted on the difference of physics science process skills that have above average critical thinking ability and critical thinking ability below average as a whole there is a significant difference to the result of learning skill of science process students between students who have critical thinking ability level above average and students who have below average critical thinking ability. This is shown from the significance value of 0.00 <0.05. Based on the test, the skills of science students process based on critical thinking skills below average has a value of 73.31 and above-average critical thinking ability has a value of 84.79, it can be concluded that the skills of science process with critical thinking skills above average better than the science-process skills with below-average science-process skills. Students who have above average critical thinking skills possess high scientific process skills and students with below-average critical thinking skills have low science process skills.

Critical thinking also requires skill in thinking about assumptions, in asking relevant questions, in drawing its short implications, thinking about and debating issues on an ongoing basis **[12]**. **[3]** argues that critical thinking is a rational and reflective thinking that is focused on what is believed and done.

Based on the description above, it can be concluded that the ability of above-average critical thinking using scientific inquiry model will be better than students who have the ability to think critically above average using conventional models.

4.3 Interaction of Learning Model Scientific Inquiry Using Mind Mapping with Student's Critical Thinking Ability In Improving Student's Student Process Skills

Based on the result of hypothesis testing for the interaction between scientific inquiry model using mind mapping with critical thinking (learning model critical thinking) can be seen significant value (sig.) Is 0,04

because sig value. 0.04 <0.05, then Ha is accepted which means there is a significant interaction between the scientific inquiry learning model using mind mapping with the level of critical thinking on the science process skills. The average score of students' science process skills in a conventional class with a critical thinking ability below the average is 73.00 and for the above-average critical thinking level is 80.50. While in scientific inquiry class using mind mapping the average score of science process skill of students who have critical thinking ability below average is 80,50 and for tingat critical thinking above average is 86,50. Based on these data it can be concluded that the scientific inquiry model at the critical thinking level above average is better than conventional learning above average and vice versa for the level of critical thinking below average in scientific inquiry model is better than conventional learning.

This is in line with the research by **[4]** which states that the scientific inquiry teaching model improves the students' science process skills so that there are differences in student learning outcomes using conventional learning model. The learning of scientific inquiry model using mind mapping invites students to criticize starting from problems, temporary answers, collecting and analyzing data and summarizing answers to problems. A good learning structure in scientific inquiry learning model makes students have high thinking skills so they can develop their knowledge.

Based on the above conclusions, it can be concluded that the scientific inquiry learning model using mind mapping and critical thinking skills of students influence each other in creating better students science process skills.

4.2. Conclusion

Based on the results of research and discussion that has been described in the previous chapter it can be concluded:

1. Scientific process skills of students taught with scientific inquiry learning model using mind mapping is better than the students' science process skills taught by conventional learning. The results show that there is an effect of scientific inquiry learning model using mind mapping on students' science process skill.
2. The students 'science-process skills in the above-mentioned critical thinking group are better than the students' science process skills in the critical thinking group below average. The results show that there is a critical thinking effect on students' science process skills.
3. There is an interaction between the learning model and critical thinking in influencing the students' science process skills. These results indicate the interaction that scientific inquiry learning model using mind mapping with critical thinking above average and below average have better science process skills than conventional learning. This means that the scientific inquiry learning model using mind mapping with critical thinking has an effect on science process skill, while conventional learning with critical thinking has no effect on science process skill.

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