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The Influence of Scientific Approach with the Socratic Method on Learning Outcomes and Students' Mathematical Critical Thinking Dispositions

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Abstract- This research is based on the low learning outcomes and critical thinking disposition of students at MTsN 7 Tanah Datar. The purpose of this study was to determine the differences in the acquisition of students' mathematics learning outcomes after using the scientific approach with the Socrates method with the acquisition of students' mathematics learning outcomes with conventional learning, to find out how students' mathematical critical thinking dispositions after using the scientific approach with the Socratic method. This type of research is quasi-experimental research. The instruments used were tests of students' mathematics learning outcomes, observation sheets, and questionnaires. Based on the results of data analysis, the acquisition of students 'mathematics learning outcomes after using the scientific approach with the Socrates method is better than the acquisition of students' mathematics learning outcomes using conventional learning. Meanwhile, students' mathematical critical thinking disposition in mathematics learning using a scientific approach with the Socrates method is classified as a successful category.

1. Introduction

According to Hudoyo (2003: 151), mathematics subject is a tool to develop human thinking. Thinking is a process of interaction that occurs in the brain so that a link appears that gives rise to knowledge. A good thinking process can develop the potential of students to become knowledgeable, competent, creative, and independent humans. Students are expected to optimize intellectual development, so that students have quality abilities in solving various problems.

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In critical thinking, it is not only the ability that is considered, but there are other aspects that are rarely noticed by the teacher, namely critical thinking disposition. Kwon, et.al (in Sulistiowati, et al, 2015: 2) defines critical thinking disposition as an internal motivation to think critically so that it can decide what it believes to be true and what to do if there is a problem, idea, or issue. Students need a critical thinking disposition to survive and be resilient in facing complex problems, are willing to take responsibility, and develop good work habits in learning mathematics (Yunarti, 2016: 5). Indicators of mathematical critical thinking disposition according to Sholihah, et al (2017: 4), namely: 1) truth-seeking, 2) open-minded, 3) systematic, 4) analytical, 5) self-confidence, 6) curiosity.

The phenomenon that often occurs is that the teacher pays more attention to the students 'final grades without knowing the students' attitudes when finding out a truth, students 'curiosity about new things, and students' thought processes when solving a problem. Observations have been carried out by researchers at MTsN 7 Tanah Datar class VIII, by observing the activities and responses of students in the learning process and the midterm test scores that have been held by the teacher. Some students are classified as active both in asking and answering but most students are passive during the learning process. There are still many students who seem less focused or less analytical, lack self-confidence and lack of student curiosity. This can be seen from the attitude of students who often chat with their classmates about things outside the subject matter, pay less attention when the teacher explains, when asked if they already understand the material explained they answer they understand it but when given the questions they have difficulty doing it, even though already having difficulty working on the questions given they are also less diligent in thinking about solving the difficulties at hand.

Furthermore, it can also be seen from the number of students who lack confidence in class. Only a few students who want to ask questions when they do not understand the material or answer the teacher's questions, the rest are just silent, even though most of them do not know the answer. Student responses when the teacher provides the opportunity to ask questions are not as desired because only a few students ask questions and also when students are asked to solve questions in front of the class or present the results of their work. This is an indication that the students' critical thinking disposition is still low.

In addition, the thing that is of concern is that the learning outcomes achieved by students are still low. Learning outcomes are one indicator in seeing the extent to which the competency standards have been established. In fact, there are still many students who get low scores. This condition is also evident in class VIII of MTsN 7 Tanah Datar. This can be seen from the low percentage of students completing mid-semester mathematics test results, where there are still many students who do not complete compared to the number of students who did.

In this case, what the teacher must do is apply a learning method that emphasizes class participation as a whole and individually to develop the potential of students in order to get satisfying mathematics learning outcomes. One of the learning methods that improve mathematical critical thinking dispositions and student learning outcomes is applying the Socrates learning method.

According to Redhana (2014: 28) the use of the Socrates learning method has been reported to be effective as active learning that can improve student learning outcomes and critical thinking skills. This learning method provides opportunities for students and teachers to participate in learning. Students have a forum to articulate and organize understanding, reasoning, and communication skills, while teachers can reflect on student understanding.

According to Dianita (2017: 26) the Socrates method is indeed good to use to train students' mathematical critical thinking skills, but by giving questions continuously in this method it can create a frightening atmosphere for students. This can be overcome because it uses a scientific approach, making the learning process more interesting. Scientific learning is learning that adopts scientific steps in building knowledge through scientific methods. When Socrates' questions are asked in a scientific approach, there are things such as observing, questioning, reasoning (associating), experimenting and communicating (networking) in them. This will increase students' interest in learning so that the learning process will run better. Students can develop their mathematical critical thinking disposition when students feel that the material provided is related to everyday life.

In this case, learning using a scientific approach with the Socrates method means learning that connects the five components of the scientific approach by giving Socrates questions to build concepts and is expected to bring up students' mathematical critical thinking dispositions in mathematics learning and improve student learning outcomes.

Based on what has been described above, this article examines: 1) Is the acquisition of student

mathematics learning outcomes after using the scientific approach with the Socrates method better than the acquisition of students' mathematics learning outcomes using conventional learning? 2) How are students' mathematical critical thinking dispositions after using the scientific approach with the Socrates method?

2. Methods

In accordance with the problems under study, this type of research is a pretest-posttest control group design. The population in this study were students of class VIII MTsN 7 Tanah Datar in the academic year 2018/2019 which consisted of three classes, namely class VIII.1, VIII.2, VIII.3. Sampling was done by using simple random sampling technique. The research instrument was a test of students' mathematics learning outcomes, the observation sheet of mathematical critical thinking disposition and a questionnaire.

Student mathematics learning outcomes test data were analyzed using the t-test. Before doing the t-test, first look for the N-gain to see how much student learning outcomes. To calculate N-gain, the Lestari and Yudhanegara formula can be used (2015: 235):

$$N - gain = \frac{posttest\ score - pretest\ score}{SMI - pretest\ score}$$

Information:
SMI: ideal maximum score

Table 1. Criteria for Normalized Gain

The amount of N-Gain	Interpretation
0,7 ≤ g ≤ 1	High
0,3 ≤ g < 0,7	Moderate
0 ≤ g < 0,3	Low

After obtaining the N-gain of the two classes, the normality and homogeneity tests of the N-gain data were then carried out. Furthermore, hypothesis testing is carried out, the formula for testing the hypothesis is:

$$t = \frac{\overline{x_1} - \overline{x_2}}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \text{ with } s = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

Where:
$\overline{x_1}$: average N-gain of the experimental group
$\overline{x_2}$: average N-gain of the control group
n_1 : the number of students in the experimental group
n_2 : number of control group students
S_1^2 : the N-gain variance of the experimental group students
S_2^2 : the N-gain variance of the Control group students

With criteria:
H0 is accepted if $t_{table} > t_{count}$ or $t_{count} < t_{(1-\alpha)}$ with $d_k = n_1 + n_2 - 2$ otherwise
H0 is rejected (Sudjana, 2005: 239-240).

The observation sheet of students' mathematical critical thinking dispositions was analyzed using the percentage formula as proposed by Sudjana (2014: 131), namely:

$$P = \frac{f}{N} \times 100\%$$

Information:
P : percentage number
f : frequency for which the percentage is being sought
N : number of frequencies / individuals

The criteria that have been obtained are determined. The criteria stated by Dimyati and Mudjiono (2009: 125) are as follows:

Table 2. Criteria for Success Level of Students' Mathematical Critical Thinking Disposition

Criteria	Success Rate	Percentage (%)
Very Slightly	Unsuccessful	1-25
Slightly	Less Unsuccessful	26-50
Many	Successes	51-75
Very Many	Very Successful	76-100

Data on students' mathematical critical thinking dispositions in mathematics learning was also obtained through a mathematical critical thinking disposition questionnaire. The scale used to measure students' answers to the mathematical critical thinking disposition questionnaire is a Likert scale which is arranged in the form of a statement. The filling out of the questionnaire is made in the form of a checklist by giving a mark on the available column. The questionnaire was also analyzed using the percentage formula, namely:

$$P = \left(\frac{f}{N} \times 100\%\right)$$

Information:
P: percentage
f : the frequency of each questionnaire answer
N : the ideal number of scores

3. Research and Discussion

(a) Learning Outcomes

Before the hypothesis is tested statistically, first calculating the normalized gain score (N-gain), it is obtained that the normalized Gain test of the experimental class students' mathematics learning outcomes is in the high category, namely 0.73; Meanwhile, the normalized gain in the control class students' mathematics learning outcomes is in the moderate category, namely 0.55. Then the normality test and homogeneity test were carried out on the two samples, namely the experimental class (VIII.3) and the control class (VIII.1). Based on the normality test, it was found that the two classes were normally distributed, while the homogeneity test found that the two sample classes had homogeneous variances. After the normality test and homogeneity test of the sample class with normal distribution results and homogeneous variance, then the hypothesis test was carried out, the results showed $t_{count} > t_{tabel}$ that it was concluded that H0 was rejected at a real level α=0,05, which means that the acquisition of student learning outcomes after using the scientific approach with the Socrates method is better rather than the acquisition of student mathematics learning outcomes with conventional learning.

In learning using a scientific approach with the Socrates method, the teacher divides students into 4 groups then the teacher provides problems regarding the topic to be studied, namely the two-variable linear equation system with the substitution method, and students are instructed to observe and understand the problems given, from these problems the teacher will ask students with Socrates questions, namely "how do you solve the problem?", "try to determine the system of two-variable linear equations formed from the two pictures!", "What SPLDV method do we use to solve these problems in accordance with our learning goals today? "," how much is the price of one pair of glasses and one pair of pants? ".

From these questions the students answered almost simultaneously, namely: "make the problem into a mathematical form first, we suppose the price of the glasses with x, the price of pants with y", "the system of linear equations that is formed is x+2y=500.000, 3x+y=500.000,", "we will use the substitution method", "The price of one pair of glasses is Rp. 100,000.00, while the price of one trouser is Rp. 200,000.00 ". After the problem is resolved, the teacher provides the opportunity for students to ask questions about the two-variable linear equation system with the substitution method, and asks students to give examples of similar problems.

Next, the teacher invites students to reason from the following question "Does solving a two-variable system of linear equations using graphs provide the same solution as the substitution method? Explain

your reasons. Then the teacher provides worksheets that will be discussed by students in groups that have been formed, the worksheets given contain problems related to the topic of the two-variable linear equation system with the substitution method. The purpose of giving worksheets is so that students can more easily understand the material being studied.

After the discussion in the group is complete, students are asked to cross-check the work by asking each group to correct the work of another group. Next, one group is asked to present the results of the discussion or the report they have made, and the other group asks, responds to or provides an explanation that is different from the group presenting. To strengthen the confidence of students' answers, then the teacher asks the socratic question to the student group, namely "did your friend work on the problems in the worksheets correctly?", "Why can you say that your friend's solution is correct? What is the reason?". After the discussion is complete, the teacher and students make conclusions from the material being studied.

Paraskevas and Wickens (in Redhana, 2014: 34) state that the Socrates method involves the use of systematic questions, inductive thinking, and the formulation of general definitions. Students are presented with scenarios and the teacher asks a series of questions in a systematic manner. Questions are designed to guide students in constructing their knowledge. Students need to use their experience and knowledge to solve simple and complex problems or issues raised through questions. Next, inductive techniques are used to help students learn the material more broadly. Once generic ideas and concepts are understood, the teacher uses questions to help students develop a rational or more universal definition of a concept. In this way, students have the opportunity to show a comprehensive understanding of the material being studied.

In learning with a scientific approach with the Socrates method there is no competition between groups. Because in learning with a scientific approach with the Socrates method it is governed by several principles, such as: (1) students should not interrupt when other students are talking; (2) all participants listen carefully to what other students say; (3) opinion must be based on strong evidence; and (4) the discussion process must be in a dialogical atmosphere, not a debate (Redhana, 2014: 36).

Meanwhile, the direct learning model applied to the control group has not been able to actively optimize the role of students. Even though students have been given the task of studying the material before learning begins, this does not guarantee that students have actually learned. If students are only given the task of studying the material in the book by reading without any questions that spur students to think, then it is possible that students only read without trying to understand the material in more depth. The teacher only explains and gives examples to students. In this process, students only accept the teacher's explanation and the opportunity for students to find and build their own understanding is very lacking. The material explained by the teacher is only used for memorization so that students' understanding is still lacking. When given exercises, students tend to apply more methods or procedures based on memorization, not understanding. Students find it very difficult to apply the concept if students face problem situations that are different from those exemplified by the teacher.

(b) Mathematical Critical Thinking Disposition

Based on the results of observations made in class VIII.3 (experimental class), the percentage of students' mathematical critical thinking disposition was obtained using a scientific approach with the Socrates method for each meeting in table 3 below:

Table 3. Percentage of Students' Mathematical Critical Thinking Dispositions Using the Scientific Approach with the Socratic Method

Indicator	Percentage per Meeting				Average (%)	Success Rate
	1	2	3	4		
Truth Seeking	29,41	47,06	58,82	70,59	51,47	Successful
Open Minded	41,18	47,06	58,82	70,59	54,41	Successful
Systematic	35,29	41,18	64,71	58,82	50,00	Less Successful
Analytical	35,29	35,29	52,94	58,82	45,59	Less Successful
Self Convidence	38.24	55,88	67,65	73,53	58,83	Successful
Curiosity	35,29	52,94	64,71	76,47	57,35	Successful

From the table above, it can be seen that the success rate of students' mathematical critical thinking disposition in learning mathematics uses a scientific approach with the Socrates method based on observations that some are classified as successful and some are classified as less successful.
Meanwhile, based on the questionnaire filled out by students, the scoring data from the mathematical critical thinking disposition questionnaire of students who take part in learning use a scientific approach with the Socrates method for each indicator can be seen in table 4 below:

Table 4. Scoring Results of the Students' Mathematical Critical Thinking Disposition Questionnaire Experiment Class

DBKM Indicator	Number of Statement	Score	Average	Criteria
Truth Seeking	1	72	85,49%	High
	2	79		
	13	67		
Open Minded	3	72	85,49%	High
	4	73		
	14	73		
Systematic	5	72	85,49%	High
	6	72		
	15	74		
Analytical	7	75	87,84%	High
	8	71		
	16	78		
SelConvidence	9	73	86,47%	High
	10	72		
	17	72		
	18	77		
Curiosity	11	75	88,24%	High
	12	75		
	19	73		
	20	77		

Based on the table above, it can be seen that the percentage of student opinions for each indicator is in the high score range.
Truth Seeking, based on the results of observations, the truth-seeking indicator is already at the level of success with the category of success. Meanwhile, based on the questionnaire filled out by students, this indicator is at a high criterion. Because, in learning when students find steps to solve a problem they do not understand, they try to find the correct information, namely by asking their friends who understand the problem solving or directly asking the teacher. When the teacher asks various Socrates questions to validate the correctness of the answer, students are able to provide answers to each question and are able to defend the answer to be able to provide conclusions from a series of questions given by the teacher.
Open-minded, based on the results of observations, the open-minded indicator is already at the level of success with the success category. Meanwhile, based on the questionnaire filled out by students, this indicator is at a high criterion. The success of this indicator is shown by students when group discussion activities solve the problems that the teacher gives. They want to teach other students who do not understand and respect the opinions of other students even though they are not quite right. In addition, students are willing to change their answers after the teacher provides instructions for finding the correct answer and are willing to explain to other students who do not understand.
Systematic, based on the results of observations, systematic indicators are at the level of success with the less successful category. This is because in learning students are not accustomed to using the scientific approach with the Socrates method, besides that there are still many students who have not used regular

steps according to the procedures that have been studied, there are still many students who cannot solve problems with different types of questions from the example given by the teacher. Meanwhile, based on the questionnaire filled out by students, this indicator is at a high criterion.

Analytical, based on the results of observations, analytical indicators are at the level of success with the less successful category. This is because in learning students are not used to using reasoning and providing reasons for the answers given. Many students have not been able to provide answers to the questions that the teacher gave and choose and use criteria with logical reasons in accordance with the answers given. Students have not been able to account for their opinions, because students are afraid and doubt the answers. Because when you have answered the question given, the teacher will ask again what is the reason for choosing the answer, asking if you are sure of the answer.

This is in line with the opinion of the American Psychiatric Association (in Yulisa, et al, 2015: 12) which states that someone who is under pressure will reduce the ability to think, concentrate, and have difficulty making decisions. In addition, Eric Jensen (in Yulisa, et al, 2015: 12) argues that, when under pressure or threat the human brain decreases its ability to be creative, remember previous learning, and communicate effectively. Meanwhile, based on the questionnaire filled out by the students, this indicator is in the high criteria, because the questionnaire was filled out by the students themselves.

Self-Confidence, based on the results of observations, the indicators of self-confidence are already at the success level with the success category. Meanwhile, based on the questionnaire filled out by students, this indicator is at a high criterion. The success of this indicator was shown when students had group discussions, even though at the first meeting they were still afraid to express their opinions and present the results of the discussion in front of the class, but for the next meeting there were many students who dared to express their opinions, even many groups wanted to present their discussion results in front of the class. , without being appointed by the teacher and having fear. According to Warman (2013: 13) that students who have self-confidence will try hard in carrying out learning activities, and students who lack self-confidence judge that they lack the ability so that students do not carry out an activity with all their abilities. This is in line with the advantages of the Socrates method according to Lammendola (in Fisher, 2010: 4), namely "Socrates method to force nonparticipating students to question their underlying assumptions of the case under discussion, and constand feedback", meaning that the Socrates method fosters the courage of students in expressing opinion when discussing, and fostering confidence in yourself.

Curiosity, based on the observation result, the indicator of curiosity is already at the level of success with the success category. Meanwhile, based on the questionnaire filled out by students, this indicator is at a high criterion. The success of this indicator is indicated by the willingness of students to ask the teacher about the solution to the problems given, or to ask the teacher about the material being studied. In addition, students' curiosity is shown through their actions when they come to the teacher to ask the answer to a problem. This condition is in accordance with the opinion of G.A Brown and R. Edmonson (in Yulisa, et al, 2015: 5) which states that asking questions in learning activities can encourage students to think, increase student involvement, and arouse student curiosity.

4. Conclusion

The acquisition of students 'mathematics learning outcomes after using the scientific approach with the Socrates method is better than the acquisition of students' mathematics learning outcomes with conventional learning. The students' mathematical critical thinking disposition using a scientific approach with the Socrates method is classified as a successful category in learning mathematics in class VIII MTsN 7 Tanah Datar.

References

1. Damayanti, Indah, dkk. (2015). Deskripsi Disposisi Berpikir Kritis Matematis Siswa Dalam Pembelajaran Socrates Kontekstual. *Jurnal Pendidikan Matematika* Vol 3, No 4, 11-22
2. Dianita, Rizki Asri. (2017). Deskripsi Disposisi Berpikir Kritis Matematis Siswa Dalam Pembelajaran Socrates Saintifik (Penelitian Kualitatif Pada Siswa Kelas VII-L Semester Ganjil SMP Negeri 20 Bandar Lampung Tahun Pelajaran 2016/2017) (skripsi). Bandar Lampung: UNILA.
3. Dimyati dan Mudjiono. (2009). *Belajar dan Pembelajaran*. Jakarta: Rineka Cipta.
4. Fisher, Craig. (2010). *Discussion, Participation and Feedback in Online Course 2010 ISECON Proceedings v27 n1382*. USA: Nashville Tennessee.

5. Hudoyo, Herman. (2003). *Pengembangan Kurikulum dan Pembelajaran Matematika*. Malang: FMIPA Universitas Negeri Malang.
6. Lestari dan Yudhanegara. (2015). *Penelitian Pendidikan Matematika*. Bandung: PT Refika Aditama.
7. Noor, Juliansyah. (2012). *Metodologi Penelitian*. Jakarta: Kencana Prenada Media Group.
8. Purwanto. (2011). *Evaluasi Hasil Belajar*. Yogyakarta: Pustaka Pelajar.
9. Redhana, I Wayan. (2014). Pengaruh Model Pembelajaran Seminar Socrates Terhadap Hasil Belajar Siswa. *Cakrawala Pendidikan* Th. XXXIII, No. 1, 27-38.
10. Sholihah, Dyahsih Alin, dkk. (2017). Diposisi Berpikir Kritis Matematis Dalam Pembelajaran Menggunakan Metode Socrates. *JKPM* e ISSN: 2339-2444. Volume 4, Nomor 2, 1-9.
11. Sudjana. (2005). *Metoda Statistika*. Bandung: Tarsito Sugiyono.
12. Sudjana, Nana. (2014). *Penilaian Hasil Proses Belajar Mengajar*. Bandung. PT Remaja Rosdakarya.
13. Sulistiowati, Dwi Laila, dkk. (2015). *Analisis Deskriptif Disposisi Berpikir Kritis Matematis Siswa dalam Pembelajaran Socrates Kontekstual (Penelitian Kualitatif Di SMP Al-Kautsar Bandar lampung Tahun Pelajaran 2014/2015)*. Jurnal Pendidikan Matematika. Vol. 3, No. 4, Halaman 1-15.
14. Warman, Dewi. (2013). Hubungan Percaya Diri Siswa dengan Hasil Belajar Geografi Kelas XI IPS di SMA N 1 Bayang Kabupaten Pesisir Selatan (skripsi). Padang: Universitas Negeri Padang.
15. Yulisa, dkk. (2015). Disposisi Berpikir Kritis Matematis Dalam Pembelajaran Dengan Metode Socrates Dan Pendekatan Kontekstual. *Jurnal Pendidikan Matematika* Vol. 3, No. 3, 1-14.
16. Yunarti, Tina. (2016). *Metode Socrates dalam pembelajaran berpikir kritis aplikasi dalam matematika*. Yogyakarta: Media Akademi.