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THE INFLUENCE OF PROBING QUESTION TECHNIQUE USAGE IN TEACHING-LEARNING ACTIVITIES ON STUDENTS' CRITICAL THINKING ABILITY

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Abstrak: *Tujuan dari penelitian ini adalah untuk membandingkan bagaimana pembelajaran konvensional dan strategi pertanyaan probing mempengaruhi perkembangan kemampuan berpikir kritis matematis siswa. Sebuah sekolah menengah pertama menjadi tempat penelitian ini. Desain penelitian kuasi-eksperimental dengan desain kontrol post-test only diadopsi sebagai metodologi penelitian. Teknik cluster random sampling digunakan dalam penelitian ini. Penilaian kemampuan berpikir kritis matematis dilakukan dengan menggunakan instrumen deskriptif dalam penelitian ini. ANOVA dua arah adalah metode analisis data yang digunakan. Hasil penelitian menunjukkan bahwa peserta didik yang belajar menggunakan teknik pertanyaan probing dan peserta didik yang belajar secara konvensional memiliki tingkat kemampuan berpikir kritis matematika yang berbeda; kategori kemampuan awal matematika tinggi, sedang, dan buruk menunjukkan adanya variasi pada kemampuan berpikir kritis matematis siswa; kemampuan berpikir kritis matematis siswa tidak terpengaruh oleh teknik pertanyaan probing atau pengetahuan matematika yang mereka miliki.*
Kata kunci: kemampuan berpikir kritis, probing question, siswa, pengetahuan

Abstract: The aim of this study was to compare how conventional learning and probing question strategies affected students' development of their mathematical critical thinking skills. A junior high school served as the site for this study. A quasi-experimental study design with a post-test only control design was adopted as the research methodology. Cluster random sampling techniques were used in this investigation. An assessment of mathematical critical thinking abilities was conducted using a descriptive instrument in this study. A two-way ANOVA is the method of data analysis employed. The outcomes revealed that learners who learned using the probing question technique and those who learned conventionally had different levels of mathematics critical thinking abilities; the categories of high, medium, and poor prior mathematical knowledge show variances in the pupils' mathematical critical thinking abilities; students' mathematical critical thinking abilities are not affected by the probing question technique or their existing mathematical knowledge.
Keywords: critical thinking skills, probing question, student, knowledge

Introduction

Education is all about valuable experiences that last throughout life and grow in all spheres of life and influence individual growth. Education is one of the efforts made by the government to educate a nation. Through education, it is hoped that it can produce the next generation of a nation that is qualified and able to compete with other countries (Arief, 2021). The next generation of a quality nation can be realized with a quality education that is able to develop the positive potential that is hidden in students (Ichsan, 2023). This

is indicated by the continuous change of curriculum to find the best curriculum for education in Indonesia, because the curriculum has an important role in education. With the improvement of the curriculum from time to time, education is considered to be one of the benchmarks for the success of a nation. The way that lessons are taught and students are taught in a classroom is one of the important variables in education. The process of learning, we are required to have the ability to think (Kadir., 2014). According to previous researcher, thinking is a process formed by new mental representations through the transformation of information that includes reasoning, depiction, logical problem solving, and the formation of concepts of creativity, intelligence, consideration, and abstraction. In another sense, thinking can also be said to be the ability to re-analyse information that has been received. In everyday life, the ability to think is important to use to solve life's problems (Lestari., 2017).

One of the subjects that teaches students to have thinking skills is mathematics. The following dimensions of math skills are having thinking and action skills: (1) creative, (2) productive, (3) critical, (4) independent, (5) collaborative, and (6) communicative, according to the attachment to the Minister of Education and Culture Regulation No. 20 of 2016. This shows that mathematics is a subject that sharpens thinking skills (Mahmuzah, 2015). Usually, students who have good abilities in mathematics will also have good abilities in other subjects. This is due to the fact that mathematics imparts the thinking process, including critical thinking skills. According to earlier studies, the ability to think critically when solving mathematical problems which involves mathematical reasoning, mathematical knowledge, and mathematical proof is known as mathematical critical thinking (Mokodenseho, 2023). According to earlier researchers, the capacity to generalize, demonstrate, or evaluate mathematical circumstances in a given setting requires prior knowledge, mathematical reasoning, and cognitive techniques (Mohzana, 2023). Critical thinking does not only involve logic; there are also broad intellectual readiness criteria such as clarity, credibility, precision, relevance, accuracy, breadth of meaning, depth, and balance. Therefore, to reach the stage of critical thinking, high-level thinking skills are needed (Murcahyanto, 2022).

According to Bloom's taxonomy, thinking tasks requiring a high hierarchical cognitive level are referred to as high-order thinking skills, which in their development, analysis, and evaluation are categorized as critical thinking (Naim, 2022). In its application, to hone higher-order thinking skills, teachers usually confront students with non-routine questions at their school, which in turn will hone students' mathematical critical thinking skills. Higher-order thinking skills are primarily intended to enhance students' higher-level thinking abilities, particularly those that relate to the capacity to think critically when receiving various types of information, to think creatively when solving problems using prior knowledge, and to think critically when making decisions in complex situations (Neyarasmi, 2017). In actuality, however, pupils' critical thinking abilities at school are still generally low due to a variety of reasons. According to an interview with a teacher at one school, one of the questions supplied by the teacher is routine, therefore it is unable to gauge students' critical thinking abilities (Husna, 2018). The Program for International Student Assessment (PISA) research findings, which place Indonesia at the lowest position out of the 70 participating nations, demonstrate this (Sucipto, 2017). The share of top performers in at least one topic (level 5 or 6) when testing the math abilities of 15-year-old students in the science, reading, and mathematics categories is just 0.8% of the PISA standard, which is 15.3%. This data shows that the mathematical ability at level 5 or 6, which can measure the critical level of students' mathematics in Indonesia, is still below the average PISA score. The critical thinking ability referred to by PISA at level 5 or 6 is that students can determine strategies for solving problems, reason, communicate actions, reflect on their findings, interpret, and possess argumentative skills.

The teacher-centred learning (traditional), as it has been utilized frequently in schools thus far, where the teacher's position is more dominating and students tend to be passive, is another factor contributing to the low ability of students' mathematical critical thinking. This is consistent with the findings of the researchers' interviews, which showed that the majority of the learning that was implemented in the classroom was centred on the teacher because there were several obstacles, such as limited media or not being allowed to carry communication tools, so students could only reason through books. The teacher had given worksheets, but still, if it's not explained, students still don't understand, and the questions given by the teacher are more for the ability to understand concepts, so critical thinking skills are rarely given. Therefore, everyone, especially math teachers, needs to pay serious attention to students' mathematical critical thinking skills as they learn mathematics. By using student-centred learning, students can become active and explore their own knowledge (Syahbaba, 2012).

Then, apart from these problems, prior knowledge of mathematics is one of the factors supporting achievement. This is consistent with the findings of earlier study, which came to the conclusion that procedural information, such as preliminary knowledge of mathematics, which calls for advanced cognitive abilities, accurately predicts final achievement and is also strongly correlated with prior learning success. In

other words, pupils who start off strong will likewise do well. Providing students with questions to follow, specifically linking with the concepts they already have, is one of the finest ways to teach them to build thinking skills, one of which is critical thinking. Among the "characteristics" of teaching critical thinking are: (1) fostering student interaction as learners; (2) posing open-ended questions; (3) giving students enough time to reflect on the questions or problems presented; and (4) teaching for transfer (teaching students to be able to apply the skills they have just learned to other contexts and on their own experiences) (Widodo, 2015).

On the basis of this, it is necessary to apply suitable learning in order to enhance students' mathematical critical thinking. The probing question technique is one of the lessons that is thought to be appropriate for improving critical thinking abilities. A probing question is one that takes into account the factual, guiding, and probing question types. In order to stimulate pupils' thinking, probing questions play a part in this. The following are some guidelines for identifying probing questions: (1) ask students to expound on or explain their reasoning; (2) ask students to connect prior knowledge to current issues or concepts; and (3) ask students to support or verify their theories. In this explanation, learning with the probing question technique can provide a stimulus for students to explain their ways of thinking by asking them to use the knowledge they have and prove an idea that will explore their critical thinking skills. Seeing the problem of students' low critical thinking on indicators of building basic skills, the probing question technique is one solution to be able to improve this (Widyatiningtyas, 2015). The probing question technique originates from the probing technique, which has now developed into seven categories of questions: the probing method or investigative methods; probing reasoning or reasoning investigations; probing causes or causal investigations; probing meaning or meaningful investigations; probing arguments or investigating arguments; probing extension or extension investigation; unfocused probing or unfocused probing.

Method

This study employed a quasi-experimental methodology. Quantitative research is part of this study. The participants in this study were split into two groups: the experimental group and the control group. The experimental class and the control class both took a final test as part of the study's randomized post-test only control group design. All students made up the population for this study. The cluster random sampling technique was used to collect samples from eight courses for two classes. The method of gathering data for this study is through test results. At the last meeting, the test was administered to both the conventional group and the group that received probing questions. The test was administered by the researcher in the form of a description of the subject matter with a pattern of seven questions. The findings of the post-test will provide information on the students' scores on mathematical critical thinking from both the conventional group and the group with probing questions. In this study, the instrument took the form of essays that were used as a post-test to gauge students' levels of mathematical critical thinking. Seven item description questions based on numerical pattern material make up the test. The goal of the research instrument employed in this study was to compare the mathematical critical thinking abilities of experimental and control group pupils. The same instrument was handed to the two groups. Before the research instrument was employed, validity, reliability, and tests to ascertain the differential power and level of difficulty of the questions were conducted on the test instruments. The researcher examined how students' mathematics critical thinking abilities were affected by probing questions and PAM learning strategies. In order to classify students into PAM groups, initial test results on previously studied content are used as the basis for the data collection, whilst post-test results on number pattern material are used to assess students' development of mathematical critical thinking skills. This study's data analysis methods made use of SPSS. The normality test and homogeneity test, which are required tests for inferential analysis, can be performed first. After carrying out both tests, the data obtained was then tested against the hypothesis.

Findings and Discussion

The average improvement in students' mathematical critical thinking abilities as a result of studying the probing question technique is 52.21, which is higher than the average improvement in students' mathematical critical thinking abilities as a result of conventional learning, which is 37.17. From the standard deviation value of the probing question, students scored 17.42, compared to conventional students' scores of 12.90. From the standard deviation data, it can be seen that the diversity of student answers is found in classes that receive probing question learning. The average value of critical thinking abilities as a whole differs by 15.04. The class that employed the probing question technique achieved the highest score 83 while the pupils who received standard instruction received the lowest 14. The class that received conventional instruction received a score as high as 64, and the class that used the probing question technique received a score as low

as 22. Conclusion: Students in the class that learned about probing question technique had better mathematical critical thinking skills than students in the class that learned about conventional methods. This demonstrates that students who acquire the probing question technique have increased mathematics critical thinking abilities that are superior to those of those who got traditional instruction.

The average score for students with high PAM in the class using the probing question technique is 74.63, while the average score for students with high PAM in the control group is 52.33, with a standard deviation of 12.87. At high PAM, there is an average difference of 22.3 in students' mathematical critical thinking abilities. From these data, it was found that the diversity of students' answers at high PAM lay with conventional learning students. Students with high PAM in the class that received probing question technique learning had a higher average than the conventional class, even so, children who got traditional instruction had a wide range of responses. This is due to the nearly identical responses provided by children that learn using the probing inquiry technique at high PAM.

The PAM class receiving traditional instruction had an average of 36.95 and a standard deviation of 8.94, whereas the class being taught the probing question technique had a mean of 48.52 and a standard deviation of 12.18. In intermediate PAM, there is an average difference of 11.57 between students' mathematical critical thinking skills. From these data, the diversity of student answers in moderate PAM lies in students learning the probing question technique. This shows that learning with the probing question technique has a greater contribution than classes that receive conventional learning. The two low PAM courses, the class that learned probing question method and the class that learned conventionally, had average mathematical critical thinking abilities of 31.6 with a standard deviation of 8.08 and 21.2 with a standard deviation of 6.46, respectively. At low PAM, there is an average difference of 10.4 between pupils' mathematical critical thinking abilities. From these data, the diversity of student answers at low PAM lies in students learning the probing question technique. This shows that in the low category of PAM, learning with probing questions gets higher results than conventional learning.

The students' mathematical critical thinking ability based on the PAM category concluded that both the high, medium, and low PAM categories got higher scores in the class that received the probing question technique. From the standard deviation, the diversity of students' answers in medium and low PAM was found in students who received probing question technique learning, while the diversity of students' answers in high PAM was found in conventional classes because the answers of students in this study were different. Students who receive probing question technique learning answer almost uniformly, and this causes the standard deviation of students learning the probing question technique to be lower than students who receive conventional learning. From the description above, it shows that the PAM category affects students' mathematical critical thinking abilities.

The class receiving conventional learning receives a lower average score per class indicator than the class using the probing question technique. The indicator for analysing arguments was greater in the class that learned how to ask probing questions, at 54.17, compared to the class that learned conventionally, at 32.60, a difference of 21.57. The indicator concludes that the class that receives probing question technique learning gets higher results, namely 38.24, than the class that receives conventional learning, namely 20.96, with a difference of 17.28. In the indicators of building basic skills, both classes that received probing question technique learning and conventional learning obtained results that were not much different, with a difference of 4.93. The class learning the probing question technique was still superior with a score of 84.93, while the class teaching conventional learning had a score of 80.00 on this indicator. Finally, the indicator for making further explanations has the lowest score of the two studies. In the class that received the probing question technique, the score was 30.52, while in the class that received conventional learning, it was 17.65.

The best indicators of students' mathematical critical thinking skills are found in indicators of building basic skills. In this indicator, both learning the probing question technique and conventional learning get results that are not much different, or both get good results. This is because the probing question technique and conventional learning are learning techniques that both ask questions, so in this indicator of building basic skills, both students who receive probing questions and conventional learning techniques get good results. The average student's critical thinking ability is the highest after the indicator of building basic skills, namely the indicator of analysing arguments. Furthermore, the average critical thinking ability of students with the lowest two indicators is in the indicators of concluding and making further explanations. The ability to think critically mathematically on the indicators of analysing arguments, concluding, and making further explanations when viewed from the value of completeness is still very far away, different from the indicators of building basic skills, although in these three indicators the highest average score is found in students who receive probing question technique learning. This is possible because learning the probing question technique was only carried out in six meetings, so maximum results were not obtained.

The results of the study revealed that there was a significant difference in mathematical critical thinking skills between groups of students taught by the probing question technique and groups of students taught by conventional learning. Likewise, with students in the low, medium, and high PAM categories, students in the high PAM category had higher post-test results than students in the medium and low PAM categories, and students in the medium PAM category had higher post-test scores than low PAM category students. Students with low, medium, and high PAM categories who received probing question technique learning also got higher results compared to students with low, medium, and high PAM categories who received conventional learning. With this, it can be concluded that students' PAM categories have an impact on their mathematical critical thinking. A statistical test a 2-way ANOVA with a significance level of 0.000 confirms this. When scores on each indicator are taken into account, the probing question method class outperforms the traditional class on each measure of mathematical critical thinking ability.

According to the explanation provided by the researchers in the previous discussion, the way in which the conventional class and the class using the probing question technique are taught results in disparities in the students' capacity for mathematical critical thought. The probing question technique is applied to each type of technical question when studying it, which promotes the development of mathematics critical thinking skills more effectively than traditional learning methods, such as asking techniques. In contrast to conventional learning, which had an average score of 37.17, probing question technique learning had an average score of 52.21 on the exam of mathematical critical thinking. After the hypothesis is tested, a significant value of 0.000 is found. As a result, it can be argued that students in the class using the probing question technique are better able to think critically about mathematics than students in the traditional class. This study identified four indications of mathematical critical thinking abilities: analysing arguments, drawing conclusions, developing fundamental skills, and providing additional explanations. Learning with the probing question technique is superior than traditional learning in all four metrics. The researcher discusses students' mathematical critical thinking abilities on each indicator from the post-test results of students in the regular class and the class using the probing question technique in order to be more specific.

The post-test findings revealed that the average for each indicator of the class using the probing question technique was 52.21, compared to the average for the conventional class of 37.17. According to the explanation given above, it is clear that students in the class that uses probing questions perform better than those in the traditional class. The statistical test that was conducted, namely the t test between learning the probing question technique and traditional learning with a sig 0.000 < 0.05, or H0, which is rejected, serves to support this. Therefore, students who learn using the probing question technique have better mathematical critical thinking skills than those who learn using traditional methods. This explanation suggests that studying with the probing question technique aids in the growth of mathematical critical thinking abilities. Students in the probing question engineering class perform on average better on indicators of their mathematical critical thinking abilities than students in the traditional curriculum. According to the study's findings, teaching pupils how to ask probing questions strengthens their capacity for mathematical critical thought. This is consistent with a 2017 study by Hahkioniemi Markus titled "Student teacher's types of probing questions in inquiry-based mathematics teaching with and without GeoGebra," which claims that the use of the probing question technique will improve students' capacity for deliberation, argumentation, and exploration. One of the indicators in this study is analysing arguments, where clear and precise reasons are needed to analyse arguments. The answers of students who received probing question technique learning had the right and correct answers in reasoning, while students who received conventional learning did not analyse correctly, even though the answers were correct.

Furthermore, on other indicators such as concluding based on generalizations, some students who received probing question technique learning could conclude perfectly, while students who received conventional learning according to post-test results to make conclusions by generalizing were still not correct. In the indicators of building basic skills, both learning using the probing question technique and conventional learning are equally good, and many students answer correctly. The difference is that students learning the probing question technique can explain the method that has been built during learning, namely using the remainder theorem, while almost all conventional classes use the manual method, which is counted one by one. Likewise, with the indicators of making further explanations, the class that received the probing question technique had a higher average score compared to students who received the conventional class.

The next test, namely the 2-way ANOVA test, found that students' prior knowledge of mathematics (PAM) obtained a significance value of 0.000 $\leqslant$ 0.05, or H0 was rejected, which means that there was an influence from the students' PAM category as a whole on mathematical critical thinking abilities. To strengthen these results, a t test was carried out on the low PAM category learning probing question

techniques and conventional learning, moderate PAM learning probing question techniques and conventional learning, and high PAM learning probing question techniques and conventional learning, and it was found that all sig < 0.05, which indicates that learning the probing question technique is more effective when using each PAM category than when using traditional learning methods. The presentation demonstrates that for each level of PAM students in both learning styles, there is an average difference in their capacity for mathematical critical thought. This demonstrates how pupils' mathematics critical thinking abilities might be impacted by their PAM level.

the outcome of the interplay between PAM and learning approaches. A 2-way ANOVA test was used to analyse it. H0 is accepted, which indicates that there is no influence of the interaction of learning techniques and PAM on mathematical critical thinking abilities. The interaction of learning techniques and PAM achieves a significance value of 0.211 > 0.05. To strengthen these results, it has been explained that the t test for the low PAM category is learning probing question techniques and conventional learning, moderate PAM is learning probing question techniques and conventional learning, and high PAM is learning probing question techniques and conventional learning, getting sig < 0.05, which means that all learning with each PAM category in learning the probing question technique is higher than conventional learning.

According to the results of this study, the two variables, namely learning techniques and PAM, do not mutually influence each other, or there is no simultaneous interaction between learning techniques and PAM. This is caused by several factors: first, the learning activities, especially in the probing question class, are treated with reasoning questions and require students to reason, while conventional learning is only given ordinary questions that do not require students to explain more. This can be seen from the value obtained by probing question learning, which is superior both at high PAM, moderate PAM, and low PAM. The effect of learning is thought to be greater than the effect of prior knowledge of mathematics. Second, learning that continues to use LKS in every meeting result in students getting bored, both in probing question learning and conventional learning, so that student enthusiasm seems to diminish over time. Third, physical condition, motivation, and anxiety are also factoring that influence critical thinking skills. However, in this study, researchers only measured critical thinking skills on the cognitive aspects, while the affective and psychomotor aspects were not measured.

This means that in order to develop mathematical critical thinking skills, learning the probing question technique is effectively used in groups of students who have high PAM, medium PAM, and low PAM. Learning the probing question technique can be used at various levels of PAM, presumably because learning with the probing question technique includes learning that starts from the category of questions that explore student knowledge, namely the probing method, probing reasoning and cause, probing meaning, probing argument, and probing extension, and is unfocused so that it can be received at both high, medium, and low PAM levels.

Experimental learning carried out by researchers uses a scientific approach with the probing question technique. This research was conducted with the help of worksheets, which contained categories of probing questions. This probing question technique requires students to find concepts independently and be able to think and reason about the questions given. This technique also encourages students to reason and argue clearly. Here the teacher becomes a facilitator for students, namely directing and stimulating them if there are students who still do not understand the intent of the questions on the probing question worksheet. Conventional learning carried out by researchers involves a scientific approach with questioning techniques. This research was conducted with the help of worksheets that contained simple questions so that students could build their own concepts with the help of the simple questions in this worksheet. Here the teacher becomes a facilitator for students, namely directing and stimulating them if there are students who still do not understand the intent of the questions on the LKS.

Conclusion

Overall, the learning of probing question technique and normal learning differs in how well students can use mathematical critical thinking. those who employ the probing question technique have greater mathematical critical thinking skills than those who learn through traditional methods. Overall, there is a gap between the students' prior mathematical knowledge and their capacity for mathematical critical thought. In both studies, there is an average gap in the levels of students. Students in the high group had greater mathematical critical thinking skills than students in the moderate category, and students in the medium category had greater mathematical critical thinking skills than students in the low category. Overall, the use of probing questions had no impact on students' PAM or their capacity to think critically about mathematics. Because each PAM category yields better results for students who receive the probing question technique, learning with this approach can benefit students with high, medium, and low categories. Instead of studying

mathematics, students with high, medium, and low PAM scores can learn the probing question approach, which can help them strengthen their mathematical critical thinking abilities. Teachers who want to use probing question technique learning should first design student worksheets (LKS) as best as possible so that they will produce optimal results, and then in preparing LKS, they should adjust the time allocation so that learning can run effectively and finish on time. In carrying out this probing question technique, schools can provide training for teachers and provide facilities appropriate to learning. Learning with the probing question technique to develop the ability to think critically mathematically is still not optimal. Research on the probing question technique is carried out using test instruments only, so it cannot yet assess student behaviour, which can be seen through non-test instruments. This research was carried out on the subject of number patterns, so the results of this study cannot be generalized to other subjects.

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