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ANALYSIS OF STUDENTS' CRITICAL THINKING SKILLS IN SOLVING TRIGONOMETRIC PROBLEMS

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Abstract. The thought processes practiced in school are limited to cognition, memory, and convergent thinking, while divergent thinking and evaluation are less noticed. Learning activities focused on recording, memorizing, and recalling, learning is concentrated on exercises that are procedural and mechanistic. This research aims to find out the critical thinking skills of students in solving trigonometric problems in grade XI of SMA Negeri 6 Medan. The type of research used is qualitative descriptive. The subjects in this study amounted to 1 person who was selected using the purposive sampling technique, which is the highest score of student test results. The instruments used are tests to find out the student's learning results as the basis for subject selection and interviews are used to find out the student's critical thinking skills. Data analysis used is qualitative data analysis consisting of data reduction, data presentation, and conclusion withdrawal. The results of data analysis obtained that the subject in the learning process and the process of solving the problem of trigonometric material has the ability to think critically. Subjects have three indicators of critical thinking skills used in this study, namely trying to know information well, providing reasons for problem solving, and looking for alternative solutions.

Keywords: Critical Thinking, Problem Solving, Trigonometry

Abstrak. Proses berpikir yang dilatihkan di sekolah terbatas pada kognisi, ingatan, dan berpikir konvergen, sementara berpikir divergen dan evaluasi kurang diperhatikan. Kegiatan pembelajaran terfokus pada mencatat, menghafal, dan mengingat kembali, pembelajaran terkonsentrasi pada latihan yang bersifat prosedural dan mekanistik. Penelitian ini bertujuan untuk mengetahui kemampuan berpikir kritis siswa dalam menyelesaikan soal trigonometri di kelas XI SMA Negeri 6 Medan. Jenis penelitian yang digunakan yaitu deskriptif kualitatif. Subjek dalam penelitian ini berjumlah 1 orang yang dipilih menggunakan teknik purposive sampling yakni nilai tertinggi hasil tes siswa. Instrumen yang digunakan yaitu tes untuk mengetahui hasil belajar siswa sebagai dasar pemilihan subjek dan wawancara digunakan untuk mengetahui kemampuan berpikir kritis siswa. Analisis data yang digunakan yaitu analisis data kualitatif yang terdiri dari reduksi data, penyajian data, dan penarikan kesimpulan. Hasil analisis data diperoleh bahwa subjek dalam proses pembelajaran dan proses penyelesaian soal materi trigonometri memiliki kemampuan berpikir kritis. Subjek memiliki tiga indikator kemampuan berpikir kritis yang digunakan dalam penelitian ini yaitu berusaha mengetahui informasi dengan baik, memberikan alasan untuk dalam penyelesaian masalah, dan mencari alternatif penyelesaian

Kata Kunci: Berpikir Kritis, Penyelesaian Masalah, Trigonometri

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INTRODUCTION

The development of Science and Technology, information that will be more diverse, both the source and the essence of information, to deal with rapid technological changes, the ability to think critically is an aspect that needs to be emphasized in teaching (M. Arifin, 2012). In this context, education also undergoes renewal over time and never stops (As'ari et al., 2017). Education as a process that is realized to develop the potential of individuals so that they have the intelligence of thinking, emotional, alert and skilled to be ready to live in society.

Mathematics should be a fun lesson, because it relates to everyday life (Erdogan, 2019). But what to expect is generally different from reality. This happens because of the use of inappropriate methods by teachers in teaching. Teachers give many lessons on aspects of memory and understanding. Learning like this will of course create a static, monotonous and boring classroom atmosphere. Thus the role of the teacher is needed in determining the right methods that can improve students' learning outcomes and skills (Bădescu & Stan, 2019). A teacher must be able to direct and explore the potential that is in students, so that students are able to develop certain skills including critical thinking skills.

Math learning in high school is generally done by teachers more emphasis on aspects of knowledge and understanding (Arisoy & Aybek, 2021; Setiana et al., 2021), but applications, analysis, synthesis, and even evaluation are only a fraction of the learning undertaken. This causes students to develop less reasoning in solving problems and applying concepts that have been learned in real life (Sadikin et al., 2019). The phenomenon that occurs today is that so many students are passive, they tend to sit still listening without being able to develop the information obtained or discussing. The situation should be taken seriously by educators to look for learning alternatives regarding appropriate learning methods and how to motivate students to be creative and confident and encourage critical thinking (Arisoy & Aybek, 2021).

Basically students have critical thinking skills in learning such as question skills, hypotheses, classification, observation and interpretation. But these skills sometimes do not develop properly, so there is a need for methods that are able to develop students' critical thinking skills in math learning. In this study, choosing mathematics in trigonometric material, where this material is considered appropriate to measure the ability to think critically of students, because in solving the problem students must be able to use their reasoning in the process of solving problems.

At this time there is still a gap between the learning system offered and the expected learning outcomes with the implementation of learning and learning outcomes achieved by students (As'ari et al., 2017; Kolar & Hodnik, 2021). The gap above, among others, is because students still have difficulty in solving routine problems, especially non-routine problems such as critical thinking in math learning. The thought processes practiced in schools are limited to cognition, memory, and convergent thinking, while divergent thinking and evaluation are less so noticed, learning activities focused on recording, memorizing, and recalling, concentrated learning on exercises that are procedural and mechanistic (Karanja, 2021; Widyatiningtyas et al., 2015; Yildiz, 2017). Based on the results of observations in students of grade XI of SMA 6 Medan it is known that teachers in the learning process are only oriented to learning outcomes in the form of high grades, while students' critical thinking skills are not considered. Teachers always emphasize to students to get high grades this is certainly a problem in students (Erdoğan & Gül, 2020; Kamsurya & Saputri, 2020).

Medan State High School was chosen as a research location, because the learning process that takes place at the school is not oriented to students' critical thinking activities. Teachers in the learning process only focus on learning outcomes in the form of grades, while students' critical thinking activities are less of a concern, so with this research is expected to describe students' critical thinking skills in math learning, especially in trigonometric materials. This research aims to find out the critical thinking skills of students in solving trigonometric problems in class XI of SMA Negeri 6 Medan.

METHOD

The type of research used in this study is qualitative descriptive, which is research that aims to obtain data and describe (Creswell & Creswell, 2018; Sugiyono, 2013) about students' critical thinking skills in solving trigonometric problems. The subject in this study was a student of grade XI of SMA Negeri 6 Medan. The process of determining the subject using purposive sampling (Arikunto, 2012; Sukmadinata, 2012), which is the process of determining subjects using certain goals or criteria, namely student test results. Based on the results of the test students were taken 1 person to be a subject in this study, namely students who obtained the highest grades in the test implementation process.

Critical thinking indicators used in this study are (1) trying to know information well, (2) providing reasons for problem solving, and (3) looking for alternative solutions. The instruments used in this study are (1) researchers, because in the implementation of research researchers are directly involved in the research process, namely researchers plunge directly

into the field in conducting observations and interviews, (2) tests used in the form of a blurb test that aims to find out students' critical thinking skills in solving problems in trigonometric materials, and (3) unstructured interview guidelines (Arifin & Retnawati, 2017). The questions used in the interview guidelines are developed based on the student's test results as well as the answers the student delivers in the interview process. The data analysis technique used in this study is qualitative data analysis following the concept developed by Miles and Huberman, namely data redution, data display, and conclusion drawing (Cohen et al., 2018; Miles & Huberman, 1994).

RESULTS

An interview with a subject is an interview that is conducted in an unstructured manner. This means that the questions used in the interview process are developed based on the results of the interview, but still based on the critical thinking indicators used in this study. This is intended to be able to know more about students' critical thinking skills in the learning process and problem solving in trigonometric materials. The results of the subject's work in completing test problem number 1 during the interview are as follows.

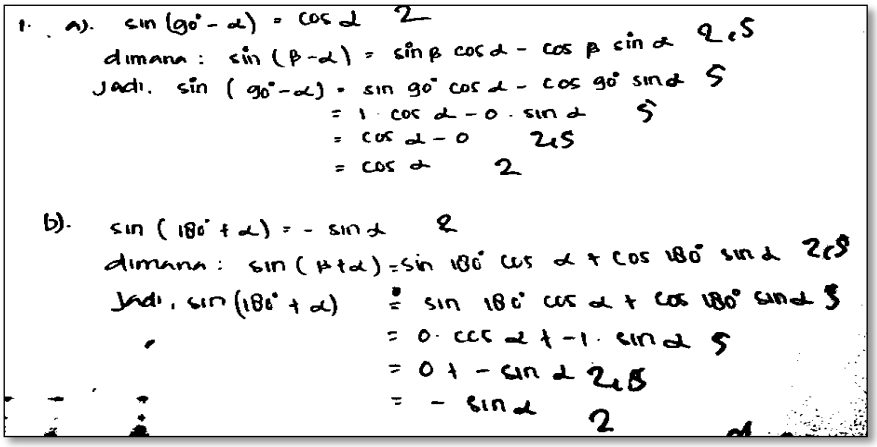

Figure 1. The subject's work on problem number 1

R : Can you explain the answer you got in question number 1?

AW : In the part (a), prove that sin (90^o - ∝) = cos $∝^o$. So from the form it is known that the shape is the formula of the difference in sinuses. So to solve the problem, you can use the sine difference formula that is sin (∝ – β) = sin ∝ cos β - cos ∝ sin b. Using the difference formula, the description of sin (90^o - ∝) will be sin 90^o cos ∝ + cos 90^o sin ∝, spelled back then the final result will be obtained, namely cos ∝. Similarly, in part (b), the problem is a form of the difference formula of the sinuses. So the process of completion is the same as part (a).

R : Where do you get the results of 90^o cos operation ∝ is cos ∝?

AW : This is derived from the result of the simplification of sin 90^o. At special angles it is known that sin 90^o is 1, so 1 is multiplied by cos $\propto$ the result is cos $\propto$.
R : Where do you get the value of 0 x sin $\propto$?
AW : If 0 x sin $\propto$ obtained from the result of simplification of cos 90^o sin $\propto$. Because in special corners of cos 90^o the result is 0.

Excerpts from the interview above, it is known that the subject in the process of solving the problem when the interview seeks to be able to get good information from the given problem. The subject before solving the problem tries to understand the given problem and then find a solution or solution to the given problem. This is evident from the way the subject solved the problem at the time of the interview. The subject first analyzes the problem well then uses known formulas in the process of solving the problem.

In addition to being able to do the problem well through a conceptual approach, the subject can explain again simply the process of solving the problem obtained. The subject is able to defend the arguments they have, based on scientific evidence and explanations logically and precisely. If observed from the way of completion and the way the explanation is conveyed it is known that the subject includes students who understand well about trigonometric material and have sufficient ability to analyze the questions given during the interview. To further deepen the data obtained about critical thinking skills, the researcher asked the subjects to re-solve problem number 2. The result of solving problem number 2 done by the subject is as follows.

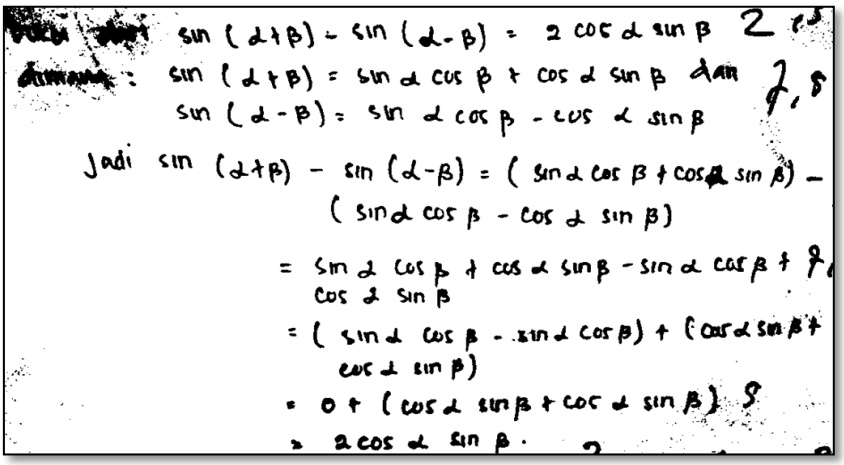

Figure 2. The subject's work on problem number 2

P : Can you explain how to get the problem number 2?
AW : In question number 2 is told to prove that sin ($\propto$ + β)- sin ($\propto$ - β) = 2 cos $\propto$ sin β. If you consider the shape of the problem consists of the shape in the formula of the number and angular difference of the sinuses. So if I think to solve problem number 2 using the formula of number and angle difference of sinuses.
P : Where do you get $\propto$ β cos + cos $\propto$ β?

AW : sin ∝ cos β + cos ∝ sin β obtained from the description of sin (∝ + β). Because what the teacher once taught the result of sin (∝ + β) is sin ∝ cos β + cos ∝ sin β.
P : If sin ∝ cos β - cos ∝ β sin, where do you get it from?
AW : Just like the above, it is the description of sin (∝ + β).
P : Where do you get 2 cos ∝ β sin?
AW : It comes from the sum. Because, there is the same tribe that is cos ∝ and sin β. Because the tribe is the same, then the sum of the coefficients remains.

Based on the results of the interview it is known that the subject in solving the problem is done well. This is seen from the stage of solving the problem done by the subject. The subject understands the problem given through the keywords that can be the problem. Furthermore, using various approaches in the problem solving process and being able to explain the process of solving the problem again. This stage shows that the subject is able to think critically, especially in solving trigonometric problems. In general, students' critical thinking skills in solving problems on trigonometric materials based on achievement indicators are detailed as follows.

Trying to Know Information Well

The ability to know information is one of the skills that are very important in the process of learning mathematics. Because in solving problems and math problems, a student should be able to know the information contained in the problem so that it can help for the problem solving process. Based on the results of research conducted, it is known that the subject in solving trigonometric material problems first seeks to understand the information contained in the problem well. This is so that in solving the problem the subject is able to solve it correctly. In solving the problem, the subject is seen to read and understand carefully every detail of the information contained in the matter that helps the subject in solving the problem. This can be seen from the steps of solving the problem by the subject, namely as follows.

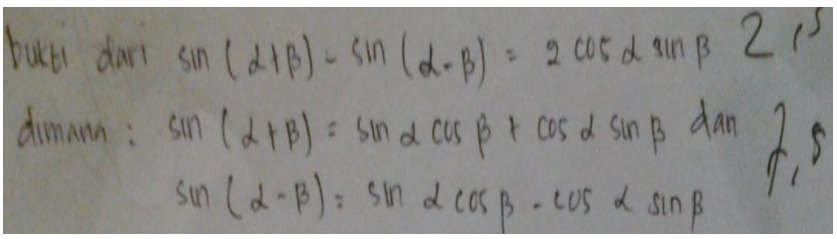

Figure 3. Results of problem solving by subject

Finding alternative solutions

The ability to find alternative problem solving must be owned by students in math learning. Math learning in addition to requiring direct student involvement, problem-solving

skills and finding alternative solutions in the problem-solving process are key objectives in the math learning process. Based on the results of the interview it is known that in the process of solving trigonometric problems the subject is able to find alternative solutions to solve the problems provided by the researcher. Two problems given at the time of the interview, the subject is able to solve it well, the subject uses a conceptual approach in solving the problems. The result of the subject's work in solving the problem is found in the following Image.

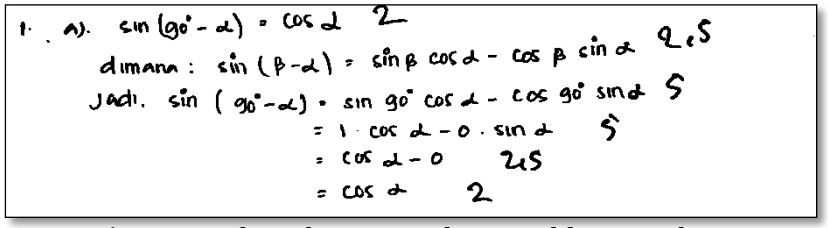

Figure 4. The subject's work on problem number 1

In more detail, students' critical thinking skills on indicators looking for alternative solutions are contained in the following interview excerpts.

R : Please explain the answer that was resolved in question number 1?

AW : In the matter of part (a) prove that sin (90^o - ∝) = cos $∝^o$. So from the form it is known that the shape is the formula of the difference in sinuses. So to solve the problem, we use the formula of the difference in sines that is sin (∝ – β) = sin ∝ cos β - cos ∝ sin b. Using the difference formula, the description of sin (90^o - ∝) will be sin sin 90^o cos ∝ + cos 90^o sin ∝, spelled out again then the final result is obtained, namely cos ∝. Likewise, the part (b) is a form of the difference formula of the sinuses. So the completion process is the same as part (a).

Providing Reasons for Problem Solving

Giving reasons for solving a problem is very important for a student to do. This indicator is owned by the subject in solving trigonometric problems. After completing the problem, the subject can re-explain the answer he got correctly. This is contained in the following interview excerpts.

R : Please explain, why so get the solution of problem number 2 like that?

AW : In the number question is told to prove that sin (∝ + β)- sin (∝ - β) = 2 cos ∝ sin β. So note the shape of the problem consists of the shape in the formula of the number and the difference in the angle of the sinus. So to solve problem number 2 we use the formula of number and angle difference of sinuses.

R : Where do you get ∝ β cos + cos ∝ β?

AW : Sin ∝ cos β + cos ∝ sin β obtained from the description of sin (∝ + β). Because what has been taught the result of sin (∝ + β) is sin ∝ cos β + cos ∝ sin β.

R : Sin ∝ cos β - cos ∝ β, where do you get it from?

AW : Just like the above, it is the description of sin $(\propto + \beta)$.
R : From where Aisa obtained 2 cos $\propto$ sin β
AW : It comes from the sum. Because, there is the same tribe that is cos $\propto$ and sin β. Because the tribe is the same, then the coefficient is summed.

DISCUSSION

Critical thinking is an important level of thinking owned by students, especially in math learning (Taja-on, 2021). By having critical thinking skills will help students in the problem-solving process when learning in the classroom (Bahatheg, 2019; Munawaroh, 2018). But because the potential for creativity requires special help to develop critical thinking skills, the learning process in the classroom should be designed by teachers well so as to help students to think by using their skills in problem solving (Sarıcan et al., 2021; Serin, 2020). With an ideal learning approach, the potential for critical thinking can continue to be honed well. The use of appropriate methods is a learning method that places students as learning subjects so that students can be motivated in carrying out learning and developing students' critical thinking in the learning process (Palavan, 2020). Because by thinking critically students can easily bring problems into the real world, this is also in line with the demands of national education goals that require students to have the ability to think critically so that they can make it easier for themselves to plunge into society. Students' critical thinking should be fostered early with learning habituation that can encourage critical thinking skills (Hermond & Tanner, 2020).

Based on the results of research conducted on students of grade XI of SMA 6 Medan it is known that subjects in the process of solving trigonometric problems use critical thinking skills in the problem solving process. In solving the problem, students try to understand the various information contained in the problem, by then using the various information to find alternative solutions to solve the problem. In addition, when able to find a solution to the problem solving, the subject can explain well the answers obtained directly to the researcher in the interview process.

When viewed from the activity of the subject in the interview process, it can be known that the subject meets 3 indicators of critical thinking used in this study, namely trying to know the information well, providing reasons for problem solving, and looking for alternative solutions. This is clearly apparent when the subject is asked to complete the problem during the interview process. The subject is able to solve the problems well and provide explanations for the solution of the problem, and is able to maintain the arguments obtained.

This is because in the learning process in the classroom, teachers often hone students' ability to think through good, guided, and problem training exercises in the form of independent tasks. By often doing exercises and honing skills by itself students are always accustomed to analyzing various problems and trying to find alternative solutions to these problems. This is in line with the opinion expressed by Mulyanto et al., (2018) that thinking skills are actually a skill that can be learned and taught, both in school and through self-study. Thinking skills are actually skills that can be learned and taught because critical thinking is a directed and clear process used in mental activities such as solving problems, making decisions, persuading, analyzing assumptions, and conducting scientific research (Giselsson, 2020).

CONCLUSION

Based on the results of the study it can be concluded that the subject in the learning process and the process of solving trigonometric material problems has the ability to think critically and meets the three indicators of critical thinking skills used in this study, namely trying to know information well, providing reasons for problem solving, and finding alternative solutions.

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