Proceeding books:
The 2nd International Conference and Innovation Exhibiti on Global Education (ICEGE)

Doi: https://Doi.org/10.22236/ie.v1i1.107

Learning Obstacle Related to the Ability of High School Student Representation to the Trigonometry Concept

Elsa Komala[1*], Didi Suryadi[2], Dadan Dasari[2]

[1]Pendidikan Matematiaka FKIP Universitas Suryakancana, Cianjur, Indonesia
[2]Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Bandung Indonesia
Correspondence email: elsakomala@gmail.com

ABSTRACT

This research is phenomenological qualitative research that aims to identify learning obstacles in the representation ability of high school students on the Trigonomeri concept. This study also revealed how the meanings and experiences of students' meanings regarding the ability of representation in the trigonometry concept. This study involved 36 Class XI students in one of the State High Schools in the Sukabumi Regency and two mathematics teachers as participants. The data in this study were obtained from the analysis of the results of representation ability tests, documentation analysis (curriculum and sourcebooks), student and teacher questionnaires. The results obtained that there are three identified learning obstacle characteristics consisting of Ontogenic psychological obstacle identified in connection with the interests and motivation of students towards learning on trigonometric concepts, conceptual ontogenic obstacle relating to conceptual designs that are too difficult and too fast for students; Didactical obstacle deals with designs that do not represent the interconnectedness of concepts so that they are not aligned with the students' continuous thinking needs (mathematical representation ability); The epistemological obstacle relates to students' knowledge in solving representational ability problems with trigonometric concepts. These characteristics are found in each indicator of the ability of mathematical representation.
Keywords: Learning obstacle, Representation, Trigonometri

INTRODUCTION

In learning mathematics and living everyday life students always deal with multiple problems. Likewise, when students are confronted with a mathematical problem situation in learning in class, they will try to understand the problem and solve it in ways they know. Bruner et al. revealed that the success of the problem-solving process depends on representation skills which include construction and using mathematical representations in words, graphics, tables and equations solving and manipulating symbols. One part of the efforts that students can make is to create a model or representation of the problem. The models or representations made can vary depending on the ability of each individual in interpreting the problem at hand. Any mathematical concepts must be represented in a number of ways that are presented based on students' thinking.

The representations or interpretations presented based on students' thoughts produced are not imitations and are also a mental action. A situation or series of didactic situations to create a learning process that leads to one or several goals, namely the formation of mental objects, one of which is to create a solution to a problem (Bruner & Kenney, 2014). When faced with a situation or series of situations, a person (in this case students) will certainly respond by doing mental actions related to the situation, namely interpreting, guessing, inferring, concluding, explaining, compiling, generalizing, using, describing, clarifying, find and solve problems.

In the process of learning and learning in the classroom, students must be accustomed to solving problems independently to find something useful in themselves and deal with ideas because the essence of constructivist theory is an idea where students individually must find and transform information in a complex if they make it themselves. If students have been able to find information and are able to convey complex information to other situations, then learning and learning must be packaged into a process of "constructing," not "receiving" knowledge. Because the reality that exists in learning that is formed in a person/individual about something about learning or ideas and mathematical abilities are built based on the internal processes possessed by individuals through their perceptions about the experiences and situations faced. The series of mental actions continue until the solution is termed

Ways of Thinking (WoT). The uniqueness of WoT construction as each person represents the diversity in how to produce a mental object called Ways of Understanding (WoU).

Learning mathematics in the classroom should provide sufficient opportunities for students to be able to practice and develop mathematical representation abilities as an important part of solving problems. The problems presented are adjusted to the content and depth of the material at each level by taking into account the initial knowledge or prerequisites and thinking habits of students. In high school mathematics learning all the problems and material presented have linked the material and questions with real problems including the Trigonometry concept. Problems that still occur in students deal with not being able to present the problems given by the teacher in different contexts, meaning that students are only able to understand them but have not been able to apply the knowledge they have to the maximum in other contexts such as in daily life and cannot choose alternative answers or solutions that are considered most effective to be used in accordance with their abilities, besides that they lack mastery of prerequisite material. Because the process of conceptualizing and creating conditions of learning flow and the meaning of a mathematical object not only occurs in the context of learning but also through books or written material. Errors occur in aspects of prerequisites where students are not able to transform in mathematical models (Neria & Amit, 2004). Teachers often only emphasize aspects of the mathematical process compared to its application in everyday life.

The ability to interpret mathematical problems whose context is the real world of students and story problems is still not as good as when they interpret mathematical problems in the context of algebra or direct counts, in this case, students should interpret mathematical problems by students while thinking how to understand the problem, and then translating understanding it in the form of mathematical symbols, as well as telling/rewriting the contents of the problem in their own words. Ainsworth revealed that several research results showed that the majority of students failed to understand the importance of the relationship between different types of representations. Baer and Forbes revealed that most students only apply the formulas they have learned to solve problems, but do not always understand the real concepts or principles behind the formulas.

Students must build their own knowledge in order to be able to utilize thinking activities, especially in terms of mathematical representation. The teacher can help the process byways of learning, designing information to be more meaningful and more relevant to the needs of students. You do this by providing opportunities for students to find or implement their own ideas, and by inviting them to be aware and consciously using several methods or strategies in terms of representation in learning mathematics. Thinking or conceptual demands are too high can cause children to lose their learning orientation/ frustration, conversely, conceptual challenges that are too low can be the cause of underachiever in learning.

Conceptualizing and creating these conditions to facilitate the process of learning mathematical knowledge not only occurs in the context of learning but also through books or written material, the meaning of a mathematical object can occur from the process. Therefore, students naturally experience learning difficulties (learning obstacles). There are three types, namely ontogenically learning obstacle, (mental readiness of learning), didactical learning obstacle (due to teacher teaching) and epistemological learning obstacle (students' knowledge which has a limited application context).

Based on the background that has been explained previously, the purpose of this study is to find out what obstacle learning is happening to students in solving representation problems in the mathematics learning process in high school.

oy starts here. Please continue text in single-spaced lines with 1 space at each paragraph. Please continue text in single-spaced lines with 1 space at each paragraph. Please continue text in single-spaced lines with 1 space at each paragraph. Text continues. Please continue text in single-spaced lines with 1 space at each paragraph. Please continue text in single-spaced lines with 1 space at each paragraph. Please continue text in single-spaced lines with 1 space at each paragraph. Please continue text in single-spaced lines with 1 space at each paragraph.

RESEARCH METHOD

This research reveals phenomena that occur under natural conditions in mathematics learning and then develops a solution based on the perspective of related theories. This research describes the experiences of students and identifies factors that are obstacles to the ability of representation in learning mathematics in high school, therefore this study uses qualitative methods in phenomenology.

The test questions were tested on 36th-grade high school students as many as 36 students who had learned the concept of trigonometry. Completion of the Open Questionnaire was conducted on 10 students purposively with consideration adjusted to the results of the representation ability test representing each student's ability, and 2 mathematics teachers as participants.

RESULTS AND DISCUSSION

Based on the results of the student's representational ability test, epistemological obstacles that arise or are detected based on students' responses to the tests given. Of the six questions given to the concept of trigonometry, it turns out that in each problem based on indicators of the ability of students to represent difficulties. Here are the details of each question:

3.1 Visual Representation Ability

Problem number 2 is a matter of concepts relating to solving trigonometric comparisons on right triangles involving images to clarify problems in cartesian coordinates. In this problem there are still students who are wrong because in representing questions in the form of images are still wrong inputting the values of x and y to illustrate the picture, resulting in errors in determining the location of angles θ, because students are usually given questions that directly use right triangles already in the previous image on. This indicates that the concept of the definition of a triangle is still not good. So that the epistemological obstacles that arise are related to the existing concept image of the definition of a triangle and the connection of the concept at the previous level.

Problem 2: Given *POQ* triangle, if point *P* $(-12,\ 5)$ and measure $\angle POQ = \theta°$ then determine the comparison value of$\sin\theta°$, $\cos\theta°$, dan $\tan\theta°$.

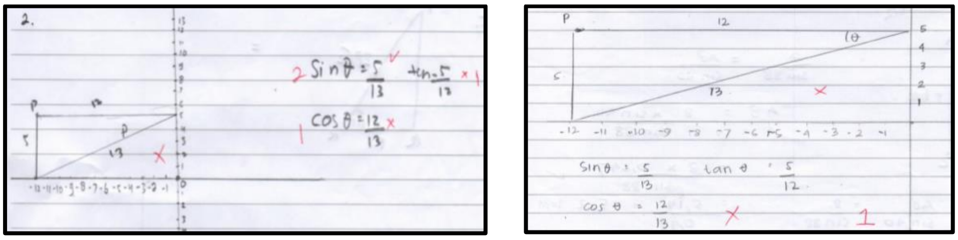


Figure 1. Example of student answers to question problem 2

Problem number 3 is a problem that includes visual representation with the aim of students being able to solve trigonometric comparisons on right triangles in the form of real contexts. In this problem, there are still students who are wrong because in representing questions in the form of images are still wrong in putting the angle on the picture.

Problem 3: Draw a triangle *ABC*, where ∠*C* is a right angle, *AB* = 4 cm and measure sin∠*A* = cos∠*A*. Determine the measure ∠*A* and the measure ∠*B*.

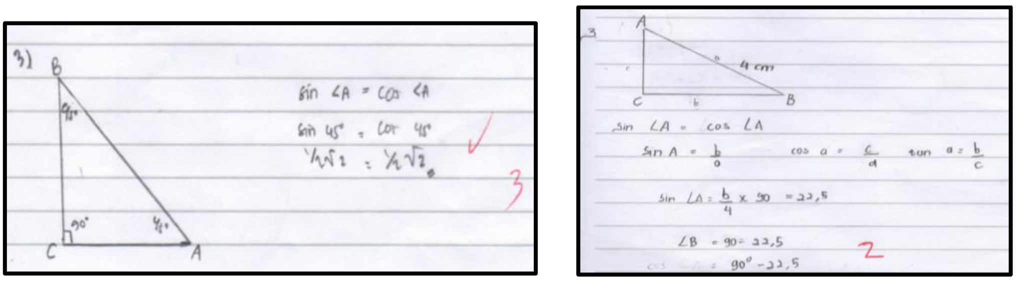


Figure 2. Examples of student answers to question problem 3

Problem number 5 aims to make students able to use the cosine rule. This question requires creative thinking because this problem can be done as simply as possible without using all the information available. This problem only requires accuracy in translating information about the angular comparisons in trigonometry so that when represented visually it becomes easy without complicated calculations. So the epistemological barriers that arise are related to understanding a given trigonometric comparison and how to choose information available. This is because, students do not get more variation problems so that students' representations of the concept of trigonometric comparisons are still lacking. Therefore, we need more variation problems as said in Brunner's theory of the contrast-variation theorem.

Problem 5: The *PQR* triangle with a measure $\angle PRQ = 45°$. If the distance $QR = p$ and $PR = 2p\sqrt{2}$, then the length of *PQ* is ...

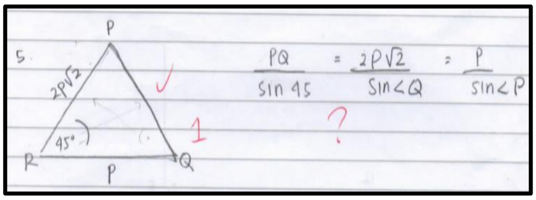


Figure 3. Examples of student answers to question problem 5

3.2 Ability to make mathematical models and mathematical expressions

Problem number 4 determines students to solve trigonometric comparisons on right triangles in a real-world context. In this problem students are required to be able to take the core of this story. In this problem there are still many students who are wrong because they use the direct method without illustrating the problem to form images. It also turned out to be the student's mistake because it was not usual to read long questions. Students are usually given a problem that is directly to the heart of the problem. This results in students being lazy to read a problem that must be sought first the purpose of this problem. According to Ausubel's theory, that learning means one of them through the stages of applying. So, students must be given questions that are application. So that the epistemological obstacles that arise are related to the ability of students to understand the purpose of a problem and represent it into a simpler notation or symbolic and mathematical model.

Problem 4: A tower stands perpendicular to the horizontal land. A child who stands 160 cm tall stands at a distance of 50 m from the foot of the tower. If the top of the tower elevation angle is 60°, whether the tower's height exceeds 100 m?

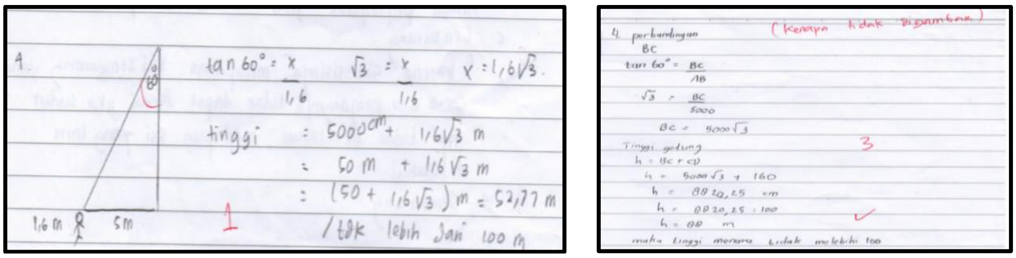


Figure 4. Examples of student answers to question problem 4

3.3 The ability to make words or text

Problem number 1 is a matter of basic concepts or prerequisites of trigonometry, namely the definition and types of triangles. In this problem there are only 10 students who answer correctly. 26 students (most of them) answered incorrectly and there were no students who did not answer, meaning students could not write down interpretations of a representation.

Problem 1: Determine the types of triangles if you know the length of the three sides, give a reason:

a. 5 cm, 5 cm, dan 8 cm
b. 6 cm, 8 cm, dan 10 cm
c. 2 cm, 5 cm, dan 9 cm

d. 5 cm, 7 cm, dan 11 cm

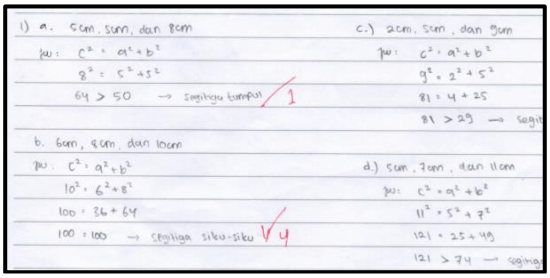
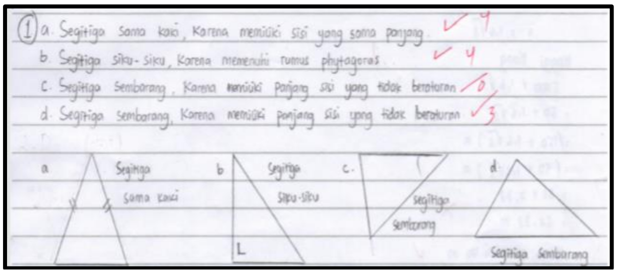



Figure 5. Examples of student answers to question problem 1

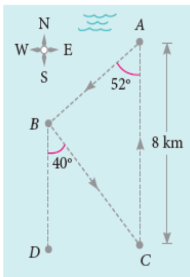
In the group of students who answer incorrectly there are several types of answers. The first group, students immediately answered that questions no 1 a, b, c and d considered all to be triangles with the immediate reason to assume the four were triangles by calculating the sides of a triangle, in addition there were students who deduced the type of committee by giving a picture based on the length of each side of the triangle. From this it can be seen that students do not understand the definition of a triangle in understanding. In the student concept image, that if three sides are known, then the three sides will form a triangle. David Tall states that individual development is built on three basic set-before namely recognition, repetition and language. In this case, the students did not repeat many basic questions on the triangle material.

This indicates that the concept of the definition of a triangle is still not good. So that the epistemological obstacles that arise are related to the existing concept image of the definition of a triangle and the connection of the concept at the previous level. This shows that the representation to make words or text of students about previous material which is still not good causes students to experience errors. According to Dubinsky's theory of the term action, someone who experiences problems will try to relate them to prior knowledge and someone who has a deeper understanding will take better action.

In problem number 6 using the sine rules in solving problems in the form of real context, measuring how students can read the intent of the picture and whether students can represent the context to form words. In this problem students already understand the purpose of this picture but cannot write it in the form of completion so that students find it difficult to determine what trigonomerial formula is used to solve the problem, this problem is difficult because many students answer incorrectly and do not answer.

So that the epistemological obstacles that arise are related to the representation in the form of words and how to choose the information available. This is because, students do not get more variation problems so the concept of sine rules in the real context is still lacking. Therefore, we need more variation problems as said in Brunner's theory [13] regarding the contrast-variation theorem.

Problem 6: In training to drive a fast boat in the waters, the training track is designed as given in Fig. The driver must start from point A, and move southwest to form an angle of 52° to point *B*, then move southeast to form an angle of 40° to point *C*, proceed back to point *A*. Distance from point *A* to *C* is 8 km. Calculate the length of the fast boat driver's trajectory?



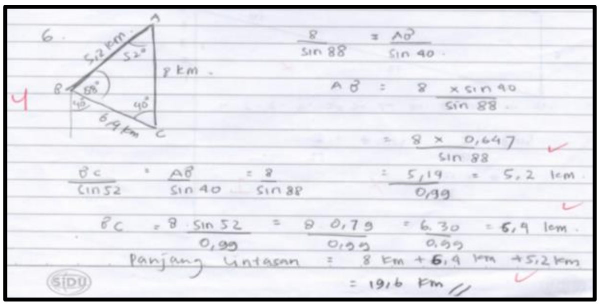


Figure 6. Examples of student answers to question problem 6

Based on the results of student questionnaires, they always answer with the statement "forgetfulness". There is a mistake in teaching that is the lack of reinforcement of prerequisite material such as definitions and types of triangles, how to make triangles in cartesian coordinates.

Experiencing meaning based on the results of the teacher questionnaire, students are not ready at the time of learning. Researchers suspect these difficulties are caused by the ontogenic obstacle, which is learning difficulties caused by lack of readiness to study or lack of psychological aspects. This was reinforced when the researchers conducted interviews with some students who could not explain the definition of a triangle and they looked confused when asked how to solve the problem when the context was in real form. The Meaning Experience in terms of the source book, in the textbook itself, there are still many similar and monotonous questions in quite a large amount. It should be made questions that are not routine and more applicable and varied so that it can improve students 'ability to represent mathematically so that they can solve questions that can later explore students' abilities more deeply. In the context of trigonometry as in high school textbooks used that related questions represent images, usually the pictures and length of the sides are known immediately while students just need to find the results. Books tend to provide information directly and not in excess.

CONCLUSIONS

Based on the results of the analysis conducted, identification learning obstacles are obtained: Ontogenic psychological obstacles identified are related to students' interests and motivations for learning on trigonometric concepts, conceptual ontogenic obstacles are related to conceptual designs that are too difficult and too fast for students; Didactical obstacle deals with designs that do not represent the interconnectedness of concepts so that they are not aligned with the students' continuous thinking needs (mathematical representation ability); The epistomological obstacle relates to students' knowledge in solving the problem of representational ability related to the trigonomic concept, as follows: (1) epistemological barriers related to the existing concept image regarding the definition and type of triangles as preconditions for trigobmetry material, (2) epistemological barriers related to the context of variations in information available in the problem, (3) epistemological barriers related to students' ability to represent visually, represent in the form of mathematical modeling and represent in the form of words.

Based on the results of this study, the authors argue that there needs to be an improvement in the preparation of teaching materials (didactic design) related to the concept of trigonometry used as a guide in the process of learning mathematics in high school following the learning barriers that occur. Therefore, the suggestions proposed by the authors are as follows: (1) in the preparation of the material, more presenting various examples of trigonometry to provide a complete understanding of the students, (2) provide questions that vary in terms of providing information on question. This is done so students are able to choose the information provided to determine the extent to which students are able to represent the given problem, (3) provide questions that practice the child's ability to represent concepts in visual form, mathematical symbols and notations, and words (4) reduce the provision of similar questions, add more questions that are more applicable and relate the concept of trigonometry. Suggestions for further research related to the improvement of the learning flow and learning design to provide more space for students to be able to interpret the ability of representation in the concept of trigonometry.

REFERENCES

Brooks, J. G. & Brooks, M. G. (1993). The case for constructivist classrooms. Alexandria, VA: ASCD.
Brousseau, G. *Theory of Didactical Situation in Mathematics*. Dordrecht: Kluwer Academic Publishers.
Brown, J.S, Collins A, & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher* 18.1: 32-42.
Bruner, J.S, & Kenney, J.H. (2014). “Representation and Mathematics Learning.” *Monographs of the Society for Research in Child Development* 30(1): 50–59.
Duval, R. (1999). *Representation, Vision, and Visualization: Cognitive Functions in Mathematical Thinking. Basic Issue for Learning. Proceeding of The Annual Meeting of The North American Chapter of The International Group for The Psychology of Mathematics Education*, P. 3-26, Cuernavaca Mexico, 23-26 Oktober 1999.
Harel, G. (2008). What is Mathematics? A Pedagogical Answer to a Philosophical Question. Dalam B. Gold & R. A Simons (Eds): *Proof and other Dilemmas: Mathematics and Philosophy* (pp.265-290). The Mathematical Assosiation of America.

Hwang, et al. 2007. Multiple Representation Skills and Creativity Effects on Mathematical Problem Solving Using a Multimedia Whiteboard Sistem.*Educational Technology & Society Journal.*

Khasanah, Ummi. (2015). Kesulitan Menyelesaikan Soal Cerita Matematika Siswa SMP. Surakarta. Online. Tersedia: http://eprints.ums.ac.id/32806/20/10.%20ARTIKEL%20PUBLIKASI.pdf. Diakses pada 23 September 2015.

Leindhardt, G. (1993). On teaching. (R. Glaser, Ed.) Advances in Instructional Technolog)), 1-54.

Neria, D. & Amit, M. 2004. Students Preference of Non-Algebraic Representations in Mathematical Communication. *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematical Education, 2004. Vol. 3* pp 409 – 416.

Steffe, Leslie and Jerry *Gale*. *(*1995)*.* Constructivsm in Education. New Jersey: Lawrence Erlbaum Associates.

Suryadi, Didi. (2018). *Ontologi dan Epistimologi dalam Penelitian Desain Didaktis (DDR)*. Makalah bahan diskusi di lingkungan Departemen Pendidikan Matematika. Bandung: FMIPA UPI.

Tatjana, H.C. (2018). Exploring Processes in Contructing Mathematical Concept an Reasoning through Linking Representation. *CEPS Journal, Vol. 8, No. 2.* [Online]. Tersedia: https://doi:10.26529/ceps.545.