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Analysis of Learning Obstacles in the Topic of Geometric Transformations

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ABSTRACT

This research aims to identify the learning obstacles experienced by students at Nurul Huda Jannatun Vocational High School. This study is a qualitative research that uses the Didactical Design Research (DDR) model. The study population consists of 32 students from the 11th grade of Nurul Huda Jannatun Vocational High School, while the sample is taken from 3 students using a purposive sampling method. The research findings reveal the following student obstacles: lack of readiness to receive learning due to a lack of motivation in learning, lack of knowledge of formulas to solve problems, miss interpretation of problems leading to errors in calculations, lack of understanding of the concepts presented in the given problems, inability to answer questions involving two transformation concepts, failure to respond story problems, perception of teachers explaining the material too quickly and lacking easily understandable illustrations, and inadequate teaching materials that do not explain the material in detail for each part.

Keywords: Didactical Design Research, Learning Obstacles, Transformation Geometry.

ABSTRAK

Tujuan dari penelitian ini adalah untuk mengidentifikasi hambatan belajar yang dialami siswa di SMK Nurul Huda Jannatun. Penelitian ini merupakan penelitian kualitatif yang menggunakan model Didactical Design Research (DDR). Populasi penelitian terdiri dari 32 siswa kelas 11 SMK Nurul Huda Jannatun, sedangkan sampel diambil dari 3 siswa dengan metode purposive sampling. Temuan penelitian mengungkapkan kendala siswa sebagai berikut: kurangnya kesiapan untuk menerima pembelajaran karena kurangnya motivasi dalam belajar, kurangnya pengetahuan tentang rumus untuk memecahkan masalah, salah tafsir masalah yang menyebabkan kesalahan dalam perhitungan, kurangnya pemahaman tentang konsep yang disajikan dalam masalah yang diberikan, ketidakmampuan untuk menjawab pertanyaan yang melibatkan dua konsep transformasi, Ketidakmampuan menjawab permasalahan cerita, persepsi guru menjelaskan materi terlalu cepat dan kurang ilustrasi yang mudah dipahami, serta bahan ajar yang kurang memadai sehingga tidak menjelaskan materi secara detail untuk setiap bagian.

Kata Kunci: Desain Didaktis, Hambatan Belajar, Transformasi Geometri.

INTRODUCTION

Geometry is one of the subjects or branches of mathematics taught to provide students with skills and knowledge to understand the elements of geometry and connect these elements to solve geometry-related problems effectively (Noto, 2019; Sudarja et al., 2018). Geometry is the study of shapes, sizes, and properties of space, and it underlies much of what we visualize in the world around us. Almost everything that we can imagine has some geometric aspects to it. From simple shapes like circles, squares, and triangles to more complex structures, natural forms, and patterns, geometry is fundamental in helping us understand and describe the visual world. Whether it's the architecture of buildings, the arrangement of molecules, the design of technology, or the patterns in nature, geometry provides a framework for understanding and visualizing these elements. (Cesaria et al., 2021; Muharram, 2021; Rosita et al., 2019). Geometry has the potential to become a more vibrant field of study because, in the branch of geometry, students can understand the world through shapes and elements as present in geometry. When students learn geometric concepts, they can recognize patterns, relationships, and structures in objects and phenomena around them (Primasatya & Jatmiko, 2018; Susanto & Mahmudi, 2021). In geometry, we are also trained in communication through exploration, discussion, and investigation. Exploration in geometry can enhance students' reasoning skills, especially in spatial and dimensional reasoning. The ability to reason and solve problems is one of the reasons why we study mathematics (Budiarto & Artiono, 2019).

In learning geometric transformations at Nurul Huda Jannatun Vocational High School in Cirebon City, it was found that students still it was found that students still had obstacles in studying geometry. The problems in learning geometry include students' weak reasoning skills, insufficient mathematical connections, and the need for more practice in verbal, visual, and applied skills (Cesaria & Herman, 2019). Students' reasoning abilities refer to their way of exploring their knowledge to solve problems they encounter, particularly in the context of geometry. Besides reasoning, there are also issues related to students' underdeveloped skills, such as their ability to connect geometric elements with spatial perception or misconceptions in understanding geometric concepts (Budiarto & Artiono, 2019; Listiani, 2020; Muharram, 2021).

Based on the facts mentioned, efforts are needed to provide effective and efficient learning. These efforts should be organized in a didactic design or Didactical Design Research (DDR) plan. The development of didactic design plays a crucial role in achieving the desired learning outcomes (Nindiasari et al., 2016; Oktarina et al., 2020; Pramuditya et al., 2021). In DDR (Didactical Design Research), various phenomenologists regarding learning will be discovered, ranging from learning obstacles, learning trajectories, and other characteristics of problems in learning that hinder optimal learning (Komala et al., 2021; Mulyana et al., 2014; Rohimah, 2015) DDR (Didactical Design Research) encompasses planning, development, and evaluation, all systematically arranged to solve problems encountered during learning by utilizing appropriate theories (Putra et al., 2017). A well-designed instructional plan is essential when teaching geometry transformations to achieve optimal learning. A carefully crafted learning design can significantly enhance students' understanding, engagement, and learning outcomes.

The research aims to identify the learning barriers experienced by students in the learning process. The analysis of these barriers will be categorized into three types of obstacles: ontogenical obstacles, epistemological obstacles, and didactical obstacles (Haqq & Toheri, 2019; Maharani et al., 2022; Purnama et al., 2023).

1. Ontogenical Obstacles: These occur due to the mismatch between the student's level of thinking and the instruction provided. This leads to difficulties in understanding the taught material.
2. Epistemological Obstacles: These obstacles arise from the limited context known to the student. This difficulty occurs when the student only partially understands a concept, making it challenging to grasp the material if the context changes.
3. Didactical Obstacles: These are learning difficulties resulting from the teaching provided by the teacher. It may indicate that the instructional approach used by the teacher is not effectively supporting the student's learning process.

This research aims to find students' learning barriers through student understanding tests and also interviews regarding students' learning experiences so far. This research aims to provide information to teachers in designing effective learning experiences to produce maximum student learning outcomes. By identifying the learning barriers and constraints students face, this research aims to provide valuable insights for educators to adapt their teaching approaches and create a more conducive learning environment.

METHOD

This research is a descriptive qualitative study to identify the learning barriers experienced by students on the topic of Geometry Transformations. The research design utilizes the Didactical Design Research (DDR) model. DDR is a research design that consists of three stages: Analysis of the Didactic Situation, Analysis of Metapedadidactic, and Retrospective Analysis (Lestarai, 2019; Sari et al., 2019; Septiati & Fuadiah, 2020). Using the DDR model, this research aims to understand the learning barriers students face in learning Geometry Transformations.

The subjects of this research are 32 students from 11th grade at SMK Nurul Huda Jannatun. From these subjects, 3 students are selected using purposive sampling based on their high, moderate, and low abilities. Additionally, the chosen 3 subjects should also be communicative when conducting interviews. The instruments used in this research are essay tests and interview guidelines. The procedure involves administering essay questions to all 32 students and selecting 3 students for interviews to obtain more comprehensive data regarding the learning obstacles experienced during the learning process.

The technique in this research uses test instruments regarding students' understanding of geometric transformation material. The test consists of questions in essay form. Furthermore, to strengthen the results, interview techniques were carried out. The interview guide is descriptive data that will be asked of the students who are the research objects. The interviews are open-ended questions that can increase or decrease depending on the student's answers.

Combining the essay test results with interview data, the research will obtain valuable information about the learning obstacles experienced by students with varying abilities and

communication skills. This will make it easier for researchers to analyze and understand the learning obstacles students face in learning Geometry Transformations and provide valuable insights for improving the teaching and learning process in the future.

RESULT AND DISCUSSION

Result

This research obtained student data through written test results and interviews. The questions given were in the form of 6 essay questions about geometric transformations. These questions consisted of Category C2 questions related to understanding, Category C3 questions related to application, and Category C4 questions related to analysis (Fatmawati, 2013; Giani et al., 2015). The results of students' answers are then categorized based on the following criteria for students' abilities (Rambe & Afri, 2020), as seen in Table 1.

Table 1. criteria for students' abilities

No	Ability Groups	Criteria
1	High	Students who have a score ≥ $\bar{x}$ + s
2	Moderate	Students who have scores between $\bar{x}$ – s and $\bar{x}$ + s
3	Low	Students who have a score ≤ $\bar{x}$ – s

Description:
$\bar{x}$: Mean
s : standard deviation

Next, the average score of the students is calculated to be 45.31, and the standard deviation obtained is 13.25. Based on this data, the student's ability data is in Figure 1.

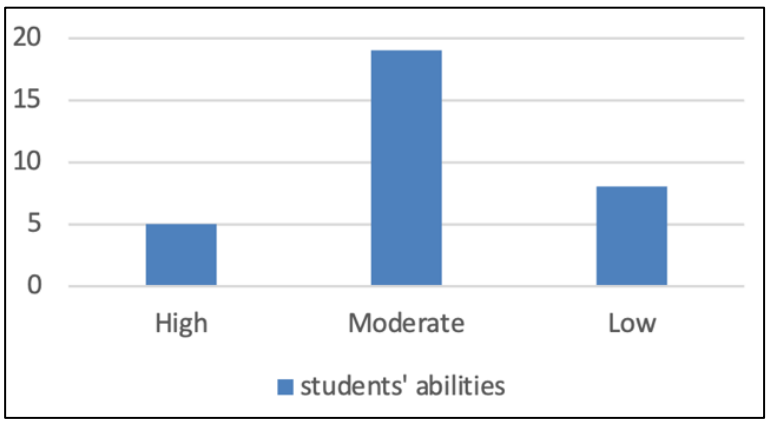

Figure 1. Student Ability Diagram

The diagram shows that 5 students have high ability, 19 have moderate ability, and 8 have low ability. After that, representatives from each group are selected to sharpen the analysis of learning obstacles experienced by the students. The results from the 3 students, representing the high, moderate, and low ability categories, are as follows.

Result of Student 1

Student 1 represents the high-ability group, as he scored 65. He already has some understanding of geometric transformations, as evidenced by the correct answers to questions 1, 3, and 4. In the interview, the student explained the concepts of reflection, translation, rotation, and dilation. However, he encountered difficulties in answering the essay questions due to the uncommon variations of the questions that he rarely studied, as shown in Figure 2.

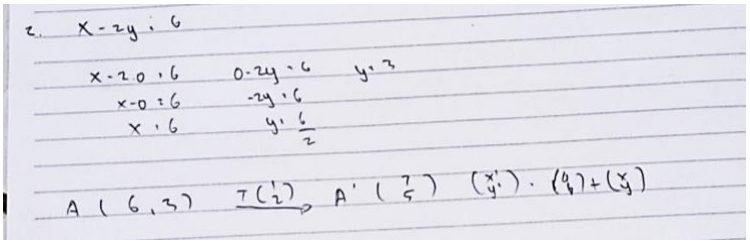

Figure 2. Result from Student 1 in Number 2

The image shows that the student understands the concept of translation by shifting points or objects according to the given questions. However, unfortunately, the student answered less accurately. Instead of directly applying the concept of translation, the student used the idea of systems of equations and inequalities to find points that lie on the line. As a result, the answers obtained were translations of individual points rather than the entire line as required by the question. A similar situation also occurred in question number 5, the answer to which can be seen in Figure 3.

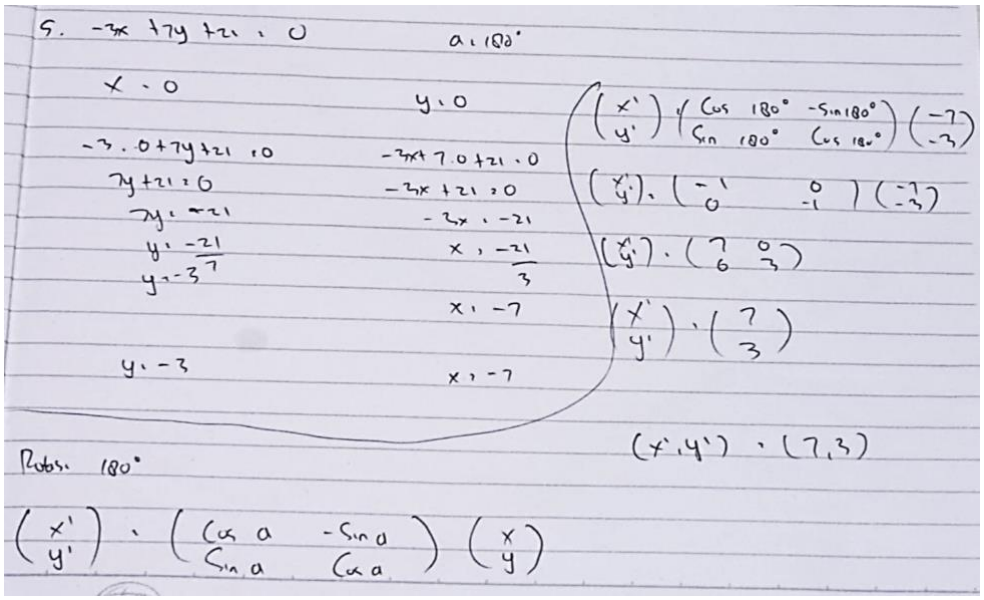

Figure 3. Result from Student 1 in Number 5

Question number 5 is a question that requires students to understand the concept of rotation. The student generally understands the idea of rotation; however, they answered using the same method as finding points through the line indicated in the question.

Overall, through the interview, the researcher found that the student understands geometric transformations well. Based on the interview results, the student encountered difficulties in answering the question due to forgetting the method taught by the teacher and the lack of practice with such contextual questions. Initially, the students thought they could answer the question by finding points

x and y first, but when asked in the context of a line, they became confused about how to respond according to the question's requirements.

Result from Student 2

Student 2 represents the moderate ability category, as he scored 50. The student has a basic understanding of geometric transformations, as evidenced by the correct answers to questions 1, 2, and 3. This was also confirmed during the interview, where the student could explain the concepts of reflection, translation, and rotation. However, these students experienced difficulties as can be seen in Figure 4.

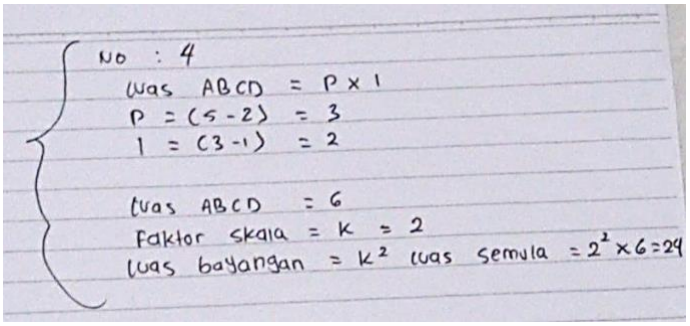

Figure 4. Result from Student 2 in Number 4

In the image, it is evident that the student's answer does not use the concept of translation as required by the question. The answer would be correct if only the area of the rectangle is asked, as the result is 24. However, the student responded with an unclear concept. During the interview, the student could not explain the origin of the answer. Although the student understands translation and what is meant by scale in the question, it was evident during the interview regarding the student's understanding of the question. After that, it was also found that the student answered question number 6 with a response as in Figure 5.

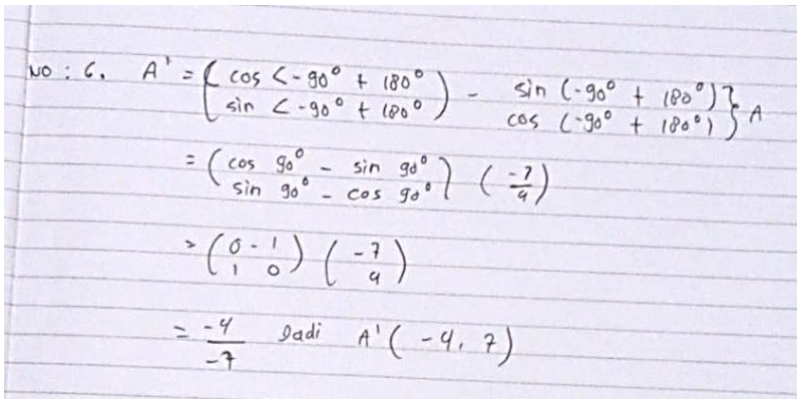

Figure 5. Result from Student 2 in Number 6

In the student's response, it is evident that the student understands the concept of rotation; however, they did not perform the dilation as required by the question. During the interview, the student mentioned that they forgot to perform the dilation, resulting in an incorrect answer. The

student only applied the concept of rotation to answer the question, and that's why their response was wrong.

Result from Student 3

Next, let's analyze Student 3, who falls under the low ability category due to their score 10. The student could only answer question 1 correctly, while the other questions were incomplete or unanswered. For instance, their responses to questions can be seen in Figure 6.

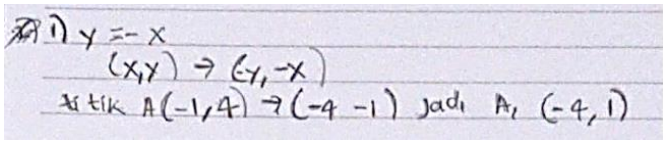

Figure 6. Result from Student 3 in Number 1

In this response, the students answered correctly but could not explain how they arrived at the correct answer for question number 1. The student also lacks understanding of the concept of reflection and the symbols "x" and "y" used in the question. When further questioned, the student also showed a lack of understanding regarding the Cartesian coordinate system used to represent points in the question. Next, for question number 2, students' answers are shown in Figure 7.

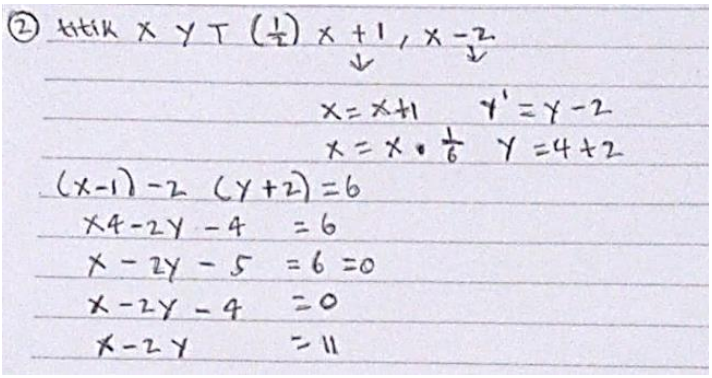

Figure 7. Result from Student in Number 2

In that question, the student's initial steps were quite reasonable. The student seemed to understand the purpose of the question. However, when the researcher interviewed to validate the answer, the student could not explain it again. The image also has two adjacent equal signs that the student couldn't explain. The researcher then attempted to delve deeper into the issue by asking about the student's understanding of arithmetic concepts. The result showed that the student did not grasp the arithmetic concepts, which should have been understood to answer the geometric transformation questions.

Discussion

Based on the presentation of results from students representing each category, students are still experiencing various learning difficulties, especially in geometric transformation topics. Table 2 is a summary of the learning obstacles faced by students in geometry subjects.

Table 3. Summary of Students' Learning Obstacles

Learning Obstacles	Student Obstacles
Ontogenical Obstacles	1. Students are not adequately prepared to receive the learning process due to a lack of motivation to learn, both from within themselves and from their surrounding environment, such as the family. 2. Students do not know the formulas to solve the problems. 3. Students misrepresent the problems, leading to errors in the calculation process. 4. Students do not understand the concepts presented in the given problems.
Epistemology Obstacles	1. Students cannot determine translation on a line; they can only do it when it involves a single point. 2. Students cannot answer questions involving two transformation concepts, as seen in questions 5 and 6. 3. Students are unable to answer story problems like in question number 4.
Didactical Obstacles	1. Students feel the teacher explains the material too quickly and does not provide understandable illustrations. 2. The available teaching materials do not explain the material in detail for each part.

Ontogenic barriers refer to the obstacles experienced by students due to their lack of readiness to receive certain materials or subjects. This can occur due to the students' insufficient mastery of prerequisite knowledge, low motivation, and lack of interest in learning. However, based on the context you provided earlier, "ontogenic barriers" seem to refer to obstacles or challenges in education related to students' individual development or readiness. These barriers may include Lack of Prerequisite Knowledge, Motivation and Interest, Cognitive Development, Learning Styles, Emotional Factors, and Cultural and Socioeconomic Factors (Marlina & Sugiatno, 2020; Ulfa et al., 2021).

Epistemological barriers refer to the obstacles experienced by students who only understand a concept or subject matter in a limited context. This little understanding can lead to confusion when the same material is presented differently. These barriers are related to students' epistemological beliefs and perspectives about knowledge and learning. Students with a rigid or narrow view of knowledge may struggle to apply their understanding to new situations or contexts. Some common characteristics of epistemological barriers include Difficulty in Transfer of Learning, Inflexible Thinking, Surface Learning, and Limited Problem-Solving Skills (Dewi et al., 2021; Elfiah et al., 2020).

Overcoming epistemological barriers involves promoting a more flexible and adaptive approach to learning. Encouraging critical thinking, metacognition, and a deeper understanding of concepts can help students develop more robust epistemological beliefs and improve their learning outcomes. Teachers can also design learning experiences that encouraging students to explore and apply knowledge in diverse contexts to enhance transferability and comprehension. This is a didactic obstacle.

Didactic obstacles refer to the hindrances in the learning process caused by issues or constraints with the teaching methods or approaches used to deliver the instructional content to students. In the mentioned case, students have limited understanding because the way the material

is taught leans towards rote memorization of rules or formulas without presenting the concepts comprehensively or in various contexts.

CONCLUSION

Based on the conducted research, the learning obstacles experienced by students in geometric transformations are as follows: Lack of readiness to learn due to low motivation in learning, both from within themselves and from the surrounding environment, such as the family, Lack of knowledge of formulas to solve problems, Misinterpretation of the problem presentation, leading to errors in the calculation process, Lack of understanding of the concepts presented in the given problems, Inability to determine translation on a line, only capable if it involves a single point., Inability to answer questions that involve two transformation concepts, as seen in questions number 5 and 6, Inability to answer story problems like in question number 4, Perception that the teacher explains the material too quickly and lacks easily understandable illustrations, The available teaching materials do not provide detailed explanations for each part of the material.

This research indicates that students' abilities are low to moderate in geometric transformations. Students still need more practice and more profound learning to master the material of geometric transformations. Based on these findings, the researcher recommends teachers design learning activities that can explain the concepts of geometric transformations with more apparent illustrations or visual representations. This can be related to real-life situations to make the learning more understandable. Furthermore, teachers should provide more contextual and diverse exercises to help students become more familiar with the concepts and develop their thinking processes. Students can enhance their understanding and problem-solving skills in geometric transformations. By implementing these recommendations, students' learning experiences and achievements in geometric transformations are expected to improve, helping them better grasp the subject matter.

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