

Systematic Literature Review: Analysis of Learning Obstacle in Didactical Design Research on Geometry Material

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Abstract

Learning geometry is an important lesson because it is studied at every level of education and geometry is a sub-matter in mathematics that is very closely related to the lives of students. However, field data shows that there are still many students who experience learning difficulties in geometry material, both obstacles that are classified as ontogenic obstacles, epistemological obstacles and didactical obstacles. This study aims to identify how the distribution of research that addresses learning barriers in Didactical Design Research research on geometry material and also aims to find out what learning barriers students often experience when studying geometry. The research method used is a Systematic Literature Review using 25 articles that have been published in indexed journals Sinta and Scopus in the 2019-2023 period. The article was obtained from search results on the Google Scholar and ERIC data base. The results of this study indicate that research discussing learning barriers in geometry material is mostly carried out at the elementary school level with the sub-material that is most often discussed is two-dimensional material. The results of this study also show that students still experience many types of learning barriers including ontogenic obstacles, epistemological obstacles, and didactical obstacles.

Keywords: Systematic Literature Review, Learning Obstacle, Didactical Design Research, Geometry

Abstrak

Pembelajaran geometri merupakan pembelajaran yang penting karena dipelajari di setiap jenjang pendidikan serta geometri merupakan sub-materi dalam matematika yang sangat erat dengan kehidupan siswa siswa. Namun data lapangan menunjukkan masih banyak siswa yang mengalami hambatan belajar pada materi geometri baik itu hambatan yang tergolong ontogenic obstacle, epistemologi obstacle maupun didactical obstacle. Penelitian ini bertujuan untuk mengidentifikasi bagaimana sebaran penelitian yang membahas hambatan belajar dalam penelitian Didactical Design Research pada materi geometri dan juga bertujuan untuk mengetahui hambatan belajar apa saja yang sering dialami siswa ketika mempelajari geometri. Metode penelitian yang digunakan adalah Systematic Literature Review dengan menggunakan 25 artikel yang sudah terbit di jurnal terindeks Sinta dan Scopus pada rentang tahun 2019-2023. Artikel diperoleh dari hasil pencarian pada data base Google Scholar dan ERIC Hasil penelitian ini menunjukkan bahwa penelitian yang membahas hambatan belajar pada materi geometri kebanyakan dilakukan pada jenjang pendidikan SD dengan sub-materi yang paling sering dibahas adalah materi dimensi dua. Hasil penelitian ini juga menunjukkan siswa masih mengalami banyak jenis hambatan belajar baik itu yang termasuk ontogenic obstacle, epistemology obstacle, maupun didactical obstacle.

Kata kunci: Systematic Literature Review, Hambatan Belajar, Didactical Design Research, Geometri

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INTRODUCTION

One of the sub-matters in mathematics is geometry. Geometry is an abstract presentation of visual and spatial experience, such as fields, patterns, measurements, and mapping, from a psychological standpoint. (Abdussakir, 2009). The importance of geometry is studied because the concept of geometry is extensively applied in students' everyday lives (Islami et al., 2018). According to van de Walle, the role of geometry in everyday life is to help people gain a

comprehensive comprehension of their environment, to aid in the development of problem-solving skills, to play a significant role in the field of mathematics, and to be utilized by a large number of people (Yuniarti, 2016). In addition to being examined at every educational level, geometry content is also always covered. At every level of education, geometry content is organized irrationally. Consequently, it is essential that the requirements of students' geometric comprehension be met at all educational levels.

Expectations regarding the fulfillment of students' geometry needs are not in line with current reality. The fact is that students' geometry abilities have not been able to reach the expected needs. As seen in the results of the TIMSS survey (Trends in International Mathematics and Science Study) which assesses the mathematical abilities of students in several countries around the world, with several topics being assessed including geometry, with the results of a survey of the mathematical abilities of Indonesian middle school aged students below the international average (*TIMSS 2011 international results in mathematics. In TIMSS & PIRLS International Study Center*, 2012). In the case of junior high school students, students have difficulty understanding the concept of flat shapes, and cannot distinguish several plane shapes, nor can they apply them in problem solving (Ma'rifah et al., 2019). In other sub-materials, students have difficulty understanding the concepts of cubes and blocks, as well as difficulty finding and using the surface area concepts of cubes and blocks, this is the impact of students' habit of memorizing the concepts being taught (Mutia, 2017). The results of one study also found that most students were only able to pass the low-level geometric thinking level. Students are still only able to analyze the properties of quadrilaterals, their previous understanding of the material for quadrilaterals is still not strong, and they lack skills in using geometric ideas (Kriswandari et al., 2020).

Multiple factors, both internal and external to the student, contribute to the issue of low geometry ability. The existence of learning obstacle experienced by students can be a factor inhibiting the development of students' geometry abilities. Building an effective interaction in a learning process is not easy. Failure in this case results in learning obstacle experienced by students (Miftah et al., 2019). Learning obstacle are a type of learning difficulty due to external factors, namely didactic design (Suryadi, 2019a). Obstacle to learning are categorized into three, namely epistemological obstacle, ontogenic obstacle and didactic obstacle (Brousseau, 2002).

Knowing and investigating learning obstacle is important to know, because for each learning obstacle found in learning later it can be reduced by carrying out the right learning flow and can be adjusted to student learning obstacle (Novianda, 2022). One of the theories used in compiling the learning flow is the Didactical Design Research (DDR) theory. The theory of DDR includes three stages, namely analysis of the didactic situation prior to learning, metapedidactic analysis, and retrospective analysis (Suryadi, 2019b).

Research on Didactical Design Research in which it analyzes learning obstacle in geometry material has been carried out a lot. Therefore this study was structured to explore and identify what

kind of learning obstacle that often arise when studying geometry. This study aims and focuses on how the research on Didactical Design Research is distributed and also aims to find out the learning obstacle that are often encountered when learning geometry both at the elementary, junior high and high school levels.

METHOD

This research is qualitative and uses a systematic literature review as its methodology. This study's primary instrument is the researcher himself. In this Systematic Literature Review study, the analysis was conducted in four stages: (1) The first stage observed the structure based on the research context, determined the study protocol, and conducted a search; (2) The second stage deletes unnecessary data; (3) The third stage is data extraction by categorizing data items; and (4) The fourth stage is data extraction by grouping data items into categories. (4) In the fourth stage, the outcomes of research discussions are reported (Marbawi & Salim, 2019).

Google Scholar and ERIC serve as sources for the literature. The literature was then chosen based on the inclusion criteria specified. The purpose of the inclusion criteria is to obtain articles that align with the research objectives. Exclusion criteria can be used to eradicate irrelevant studies from selected studies (Stafic et al., 2006). In this study, five inclusion criteria were used: (1) The research was conducted in the field of geometry; (2) The research was conducted to analyze learning barriers; (3) The research was conducted on elementary, middle, and high school students; (4) Studies published within the last five years, namely from 2019 to 2022, with consideration of the relevance and updating of data with current conditions; (5) Studies published in Sinta and Scopus indexed journals. The results of a literature search revealed 35 articles published between 2019 and 2023 that discussed learning barriers in DDR research on geometry materials. 25 of the 35 articles met the requirements and were published in Sinta and Scopus-indexed journals.

HASIL DAN DISKUSI

Studies by Year of Publications

The data presented in Figure 1 is the data distribution of 25 Didactical Design Research research articles on geometry material in the last 5 years, namely 2019 to 2023.

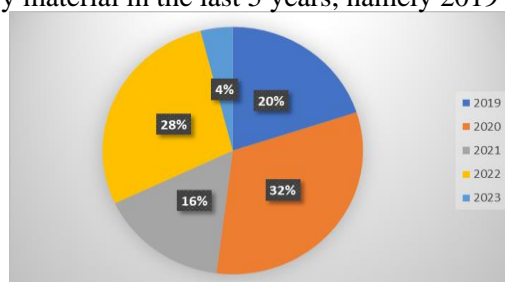


Figure 1 Literature on learning obstacle in DDR research in geometry materials by year of publication

Figure 1 shows that in 2019, a total of 5 articles (20%) regarding Didactical Design Research on geometry material were published out of a total of 25 articles. In 2020, there was a significant increase from the previous year, where 8 articles (32%) regarding Didactical Design Research on geometry material were published that year. In 2021, the number of articles published on Didactical Design Research on geometry material had decreased to 4 articles (16%), although in the end it had again increased to 7 articles (28%) out of a total of 25 published articles. In 2023, until May, only 1 article (4%) regarding Didactical Design Research in geometry material has been published.

Studies by Education Level

Research on Didactical Design Research on geometry material during the 2019-2023 period was carried out at various levels of education starting from elementary, junior high and high school. The following Figure 2 shows the distribution of Didactical Design Research research data on geometry material based on educational level in the 2019-2023 range. From Figure 2, it is found that during the last five years, from 2019-2023, research on Didactical Design Research on geometry material was carried out 10 times (40%) at the elementary level, 8 times (32%) at the junior high school level, and 7 times (28%) at the SMA level.

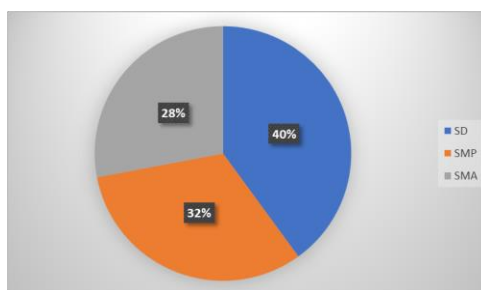


Figure 2 Literature on learning obstacle in DDR research in geometry material based on educational level

Studies Based on Journal Indexers

Figure 3 below illustrates the distribution of research on Didactical Design Research on material based on journal geometry indexes starting from Scopus indexed journals from Q1 to Q4 and indexed Sinta from Sinta 1 to Sinta 5. Based on these data, there is no research on Didactical Design Research on geometric materials. published in Q1, Q2, Q3, and Sinta 1 indexed journals. Meanwhile, 4 articles (16%) were published in Q4 indexed journals, 5 articles (20%) were published in Sinta 2 indexed journals, 5 articles (20%) published in Sinta 3 indexed journals, 7 articles (28%) published in Sinta 4 indexed journals, and 4 articles (16%) published in Sinta 5 indexed journals.

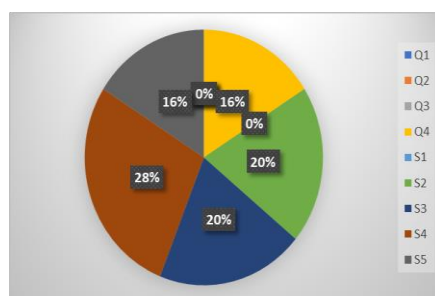


Figure 3 Literature on learning obstacle in DDR research in geometry materials based on journal indexes

Studies Based on Material

The topics used in research regarding Didactical Design Research on geometry material are divided into several topics. Figure 4 below shows the distribution of topics used in research on Didactical Design Research in geometry material. The topic of flat shapes is the most frequently discussed topic, namely 12 studies (48%), while the topic of geometric transformation is the least discussed topic, namely 3 studies (12%).

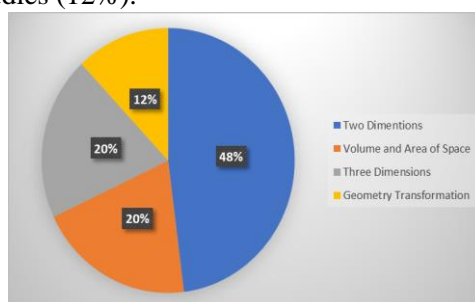


Figure 4 The literature on learning obstacle in DDR research in material-based geometry

The following will discuss the findings of various learning obstacles obtained from 25 literature on learning obstacle in DDR research in geometry material.

Geometry Transformation

Of the 25 articles studied, there were 3 articles which discussed geometric transformation material, namely research (Haqq et al., 2019), (Miftah et al., 2019), and (Nurhikmayati et al., 2022). From the three articles, several findings were obtained learning obstacle, namely as follows:

1. Ontogenic Obstacle

Students still experience many mistakes such as understanding and using symbols, understanding the center point, the size of the angle, and so on. The basic concept of Geometry Transformation is not fully known by students. This is due, among other things, because the concepts that are understood only come from the teacher, not from the knowledge and understanding of students independently. Prerequisite material that students have not mastered is also an obstacle in learning geometric transformation material. In addition, students also show low motivation and interest in learning the concept of Geometry Transformation.

2. Epistemological Obstacle

Obstacle experienced by students like this are due to understanding the context and

knowledge of students who are still limited. Students often experience difficulties when faced with non-routine problems. Students are limited in the ability to solve routine questions or questions that are used to being given during learning. If students are faced with a different or unfamiliar context, they will experience obstacles as if they cannot take advantage of what students have previously understood. Moreover, when students are given context in the form of problems regarding geometric transformations, of course students experience obstacles. These obstacles also arise due to students' incomplete comprehension of the information they receive in order to acquire knowledge. Exemplary mathematical problems are only understood by students in specific contexts. When students are given mathematical problems in other contexts they cannot solve them (Sulistiawati et al., 2015).

3. Didactical Obstacle

Didactic obstacles were caused by the lack of introduction and integration of the benefits of the Geometry Transformation concept in everyday life. The sequence structure of the material is also often found not to be systematically arranged. For example, several practice questions on material prior to the concept of Geometry Transformation explicitly or implicitly gave rise to the idea of Geometry Transformation in student books. The order of the materials does not match the function. There is no formal definition of the concept of Geometric Transformation.

Three Dimensions

Learning Obstacle The following is based on learning obstacle found in five studies namely ((Haqq, 2020), (Fitriani et al., 2020), (Putri et al., 2020), (Dharma et al., 2021), and (Miftah et al., 2022)). The following are some of the learning obstacle found:

1. Ontogenic Obstacle

This phenomenon is seen when students do not understand the concept of the position of points and lines in space and points and planes in space. Students still have difficulty determining examples and non-examples. Several students experienced a leap of thought in understanding three dimensions which in this case was exemplified, namely the jump from direct spatial analytic thinking to using a formula without paying attention to other elements. This three dimension is closely related to previous materials, including material on the Pythagorean theorem, area of triangles and congruence. While in the three prerequisite materials students also still have obstacles which of course have an impact on the emergence of learning obstacle when studying three-dimensional material.

2. Epistemological Obstacle

Several epistemological obstacle that were successfully uncovered were students having difficulty understanding the location and relationships between points, lines, and planes in three dimensions. Students also encounter difficulty visualising images, projecting points on lines and planes, determining the type of triangle and the position of perpendicular lines, and performing calculation procedures utilising the triangle approach and the Pythagorean theorem. Due to the fact that students only comprehend a particular context in the illustrative math problems, they encounter

difficulties when they are presented with various question formats. This includes epistemological obstacle because students only partially comprehend the information that becomes their knowledge.

3. Didactical Obstacle

The teacher is still too procedural in giving examples of problem solving. The teacher's teaching style tends to be limited to explaining the material then giving examples of questions and giving exercises. This resulted in limited students' ability to deal with new problems. Another obstacle is that the delivery between the two concepts is conveyed partially. In addition, the use of media is also limited to two-dimensional media, such as blackboards and paper, not in three-dimensional form so that students' needs are not met.

Two-Dimensional Figure

Of the 25 articles studied, there were 12 articles which discussed flat shapes, namely research (Maryati et al., 2019), (Hendri Prayogi, 2019), (E Nur'Aeni et al., 2019), (Suryati & L, 2020), (Komalasari et al., 2021), (Rerev, 2021), (Desrina Hardianti, 2021), (Nurhalimah et al., 2022), (Nopriana et al., 2022), (Widuri, R., Fuadiah, N. F., & Pratama, 2022), (Erika et al., 2022), and (Lestari et al., 2023). From the results of the analysis of each article obtained the following learning obstacles:

1. Ontogenic Obstacle

Most students still cannot master the concept of flat shapes and have not mastered the meaning of the circumference and area of flat shapes. Students still cannot identify the shape of each flat shape.

2. Epistemological Obstacle

Some of the obstacles that are categorized as epistemological obstacles are students not being able to associate the characteristics of a flat shape with the properties of another flat shape. The student's orientation towards a flat shape is still in the visual or image display, not in the properties attached to the shape. This has an impact on when an image is shifted or rotated slightly in other words the context is changed, students feel they find a different flat shape even though the context has only been changed. Completion of flat shape problems that have been made into the context of everyday life is also an obstacle for students.

3. Didactical Obstacle

The teaching materials prepared by the teacher are not in accordance with the learning activities carried out, such as questions or instructions contained in the teaching materials, they do not provide information that can be understood by students, resulting in students being confused in learning. The information conveyed is also sometimes lacking in detail, such as not mentioning what type of quadrilateral is meant and images that are unable to convey the intended information. Presentation of flat shape images also raises obstacles where students become fixated on certain shapes. Analysis of textbooks used by teachers is also the cause of learning obstacles because there are aspects that are still lacking, namely textbooks that do not provide examples of questions

regarding basic competencies in solving problems related to square perimeters in everyday life.

Concepts, Surface Area and Building Volume of Space

Based on the five articles that have been analyzed, namely (Indasari & Ratna, 2019), (Nurjanah & Juliana, 2020), (Pamungkas et al., 2020), (Sawitri et al., 2020), and also (Aziiza et al., 2022) obtained learning obstacle as follows:

1. Ontogenic Obstacle

Students' understanding of the concept of geometric shapes that are still not quite right becomes an obstacle that has a domino effect on other obstacles. Students who have not been able to understand the correct definition between geometric shapes result in students having difficulties in grouping geometric shapes. The concept of surface area and volume of a geometric shape has always been a challenge.

2. Epistemological Obstacle

The impact of students not being able to classify geometric shapes includes raising new obstacles, namely students not being able to make relationships between geometric shapes. The introduction of shapes and spatial networks from only one perspective creates obstacle in the form of students' limited perspectives. Students are incapable of recognising geometric objects exhibited in various forms.

3. Didactical Obstacle

In the delivery of material by teachers, they are often more inclined to provide questions related to calculations in learning geometry compared to understanding the basic concepts of geometry. The use of visual aids in learning geometry, especially the material of flat shapes and plane side shapes that are inadequate causes students to tend to find it difficult to imagine geometric objects and will affect understanding of geometry.

CONCLUSION

Based on the results of an analysis of 25 literature that discusses learning obstacle in Didactical Design Research in geometry material, it was found that some of the learning obstacle that are often found are: (1) ontogenic obstacle, namely the lack of ability to understand students' basic geometric concepts and also prerequisite material which are not mastered by students, (2) epistemological obstacle, namely students only understand geometry from one context in the form of images presented during learning so that students experience obstacles when connecting one geometric object with an object. (3) didactic obstacles include (a) the material in the teaching materials prepared has not been able to convey the expected information and there are still conceptual errors in it, the teacher also presents learning geometry only in the form of calculating numbers not in understanding geometry itself.

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