Jurnal Pendidikan Matematika
Volume 16, No. 1, January 2022, pp. 73-88
P-ISSN: 1978-0044, E-ISSN: 2549-1040, DOI: https://doi.org/10.22342/jpm.16.1.13789.73-88
Website: https://ejournal.unsri.ac.id/index.php/jpm
Accredited by SINTA 2: http://sinta2.ristekdikti.go.id/journals/detail?id=1811

Didactic Design of the Concept of Surface Area of Flat-Sided Prism Based on van Hiele's Theory in Online Learning

Yushilatu Felayati Aziiza[1], Rizky Rosjanuardi[2], Dadang Juandi[3]

[1, 2, 3]Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
Email: yushilatufa@upi.edu

Abstract

This research aimed to develop a didactic design of the concept of the surface area of a flat-sided prism by considering the stages of van Hiele's theory as a learning trajectory. The didactic design of the concept of the surface area of a flat-sided prism based on van Hiele's theory has been adapted to the pandemic situation and implemented to online learning. The research method employed was a qualitative method with data collected through observation, interviews, and documentation. The initial step in this research was to test the concept of the surface area of a flat-sided prism on 53 9th-grade students for the 2019/2020 school year to identify learning obstacles. Following the identification of the learning obstacles, an initial didactic design was then drawn up by applying the phases in van Hiele's model of geometric thinking. The didactic design prepared was subsequently implemented online to 8th-grade junior high school students. The results of the implementation of the didactic design were analyzed as the final product. The conclusion from this research is that by using a didactic design that considers the stages of van Hiele geometry in understanding the concept of surface area of a flat-sided prism, it can help students understand the concept of a flat-sided prism correctly. It was found that students' understanding of the concept of the surface area of a prism improved from visual level to informal deduction.

Keywords: Didactic Design, van Hiele's Theory, Flat-Sided Prism, Online Learning, Learning Obstacle

Abstrak

Penelitian ini bertujuan untuk menyusun desain didaktis konsep luas permukaan prisma sisi datar dengan mempertimbangkan tahapan teori van Hiele sebagai alur pembelajarannya *(learning trajectory)*. Desain didaktis konsep luas permukaan prisma sisi datar berdasarkan teori Van Hiele telah disesuaikan dengan situasi pandemi dan diimplementasikan melalui pembelajaran daring. Metode penelitian yang digunakan adalah metode kualitatif dengan teknik pengumpulan data yaitu observasi, wawancara, dan dokumentasi. Langkah awal dalam penelitian ini adalah uji kesalahan konsep luas permukaan prisma sisi datar kepada 53 peserta didik kelas IX tahun pelajaran 2019/2020 untuk mengidentifikasi *learning obstacle*. Setelah *learning obstacle* teridentifikasi, kemudian disusun desain didaktis awal dengan menerapkan fase-fase tahapan geometri van Hiele. Desain didaktis yang telah disusun selanjutnya diimplementasikan kepada peserta didik kelas VIII SMP melalui daring. Desain didaktis yang telah diimplementasikan dianalisis hasil implementasinya sebagai produk akhir. Kesimpulannya dari penelitian ini adalah dengan menggunakan desain didaktis yang mempertimbangkan tahapan-tahapan geometri van Hiele dalam memahami konsep luas permukaan prisma sisi datar, dapat membantu peserta didik memahami konsep prisma sisi datar dengan tepat. Pemahaman peserta didik dalam materi konsep luas permukaan prisma ditemui peningkatan dari level visual ke deduksi informal.

Kata kunci: Desain Didaktis, Teori van Hiele, Prisma Sisi Datar, Pembelajaran Daring, *Learning Obstacle*

How to Cite: Aziiza, Y. F., Rosjanuardi, R., & Juandi, D. (2022). Didactic design of the concept of the surface area of a flat-sided prism based on Van Hiele's Theory in online learning. *Jurnal Pendidikan Matematika, 16*(1), 73-88.

INTRODUCTION

Learning mathematics is essential in everyday life. Mathematics education provided with the development of mathematical understanding aims to train students in developing the ability to restate, classify, identify, apply, present, provide, and relate mathematical concepts in everyday life (Kemendikbud, 2014).

Received February 17, 2021; Revised December 20, 2021; Accepted December 30, 2021

One material that is directly related to everyday life and has a significant role at the junior high school level is geometry. The importance of geometry studied by students is because many geometric concepts are used in real life (Islami et.al., 2018). According to van de Walle, the role of geometry in everyday life is to assist humans to have a thorough sense of their surroundings, to help develop problem-solving skills, to play a key part in the field of mathematics, to be used by many people in everyday life, and to provide puzzles and enjoyment (Yuniarti, 2016; Suwito, 2018).

However, based on the results of the 2019 Junior High School National Examination report by the education unit (Agency of Research and Development of the Ministry of Education and Culture, 2019), only 23.14% of students correctly answered the indicators of applying formulas and calculating the area of a solid geometric figure. It indicates that student achievement of geometric abilities is still relatively low. Students' low ability in geometric material could be due to a misconception of the notion of solid geometric figure area and difficulty applying formulas to determine surface area. Furthermore, according to (Mayberry, 1983; Yadav, 2019; Dhungana, 2021), students do not understand the concept of geometry because they rely on a rote learning approach. Understanding based on formulas rather than concepts will lead to miscalculations, misunderstandings, and impediments to the development of individual knowledge (Rohendi, et.al, 2018; Madimabe, et.al, 2020; Kasabo & Chinamasa, 2020).

In relation to this, Aziiza and Juandi's (2021) study of the learning obstacle characteristics of junior high school students on the concept of prismatic surface area discovered several obstacles, including: (1) ontogenical obstacle, where students have difficulty specifying the name and elements of a prism, in which case the difficulty is due to forgetfulness, doubt, and misunderstanding about a prism's surface area; (2) epistemological obstacle, where students tend to memorize the definitions and formulas of the concept of prism surface area, causing them to misunderstand the concept as a whole; and (3) didactical obstacle, where the learning process remains procedural and fails to account for the challenges and misconceptions encountered by students while learning and where students have a lack of knowledge in the construction of geometric shape models like prisms.

Based on the issues raised above, a learning strategy that takes into account the variability of student responses is required to assist them in overcoming learning difficulties in learning the concept of prism surface area. The aim is for the learning sequence to be in line with the didactic situation, i.e., learning that integrates the connection between student, teacher, and material (Suryadi & Suratno, 2013). Furthermore, the researchers consider the van Hiele geometric thinking stages as a learning trajectory to develop the maturity of students' geometric thinking in the didactical design of the concept of prism surface area. van Hiele's geometric thinking stages are divided into five levels, including: level 0 (visualization), level 1 (analysis), level 2 (abstract/informal deduction), level 3 (formal deduction), and level 4 (rigor). From one level to the next, van Hiele proposed five phases of learning, including information, direct orientation, explication, free orientation, and integration (Crowley, 1987).

Given the current state of the COVID-19 pandemic, the didactic design of the concept of prism surface area was implemented online. Based on this description, the authors conducted didactic design research on the concept of the surface area of a flat-sided prism, which takes into account the stages in van Hiele’s theory and is applied to online learning.

METHODS

The didactical design research was carried out through three stages of analysis, including: in the first stage is Didactic situation analysis (DSA) before learning. The stage didactic situation analysis are; 1) determine the research material, which is the surface area of a flat-sided prism, 2)search for learning literature on the surface area of a flat-sided prism, 3) study and analyze the surface area of a flat-sided prism, 4) develop and conduct an initial error test to obtain error characteristics, 5) conduct interviews to determine whether the errors encountered are barriers to students, 6) triangulate data, 7) develop a hypothetical didactic situation regarding the surface area of a flat-sided prism by considering learning obstacles and linking van Hiele’s theory in learning trajectory and by paying attention to mathematical competencies that can be developed utilizing the didactic design, and 8) predict student responses that might appear in didactic situations.

In the second stage metapedadidactic analysis. The stages are; 1) implement the learning design of the concept of the surface area of a flat-sided prism to online learning, and 2) analyze didactic situations based on various student responses that arise during learning.

In the third stage is retrospective analysis. The stages are; 1) connect the predictions of responses and anticipations that have been established previously, 2) conclude the results of the implementation of the hypothetical didactic design, and 3) develop a revised didactic design according to the results of the implementation of the hypothetical didactic design for improvement.

Data collection in this study was conducted using a triangulation (combined) process. The triangulation employed in this study included observation, interviews, and documentation. Meanwhile, data analysis in this study was carried out by first collecting all the data obtained for further selection and then grouping of existing data. Next, the data were analyzed according to research requirements and the preparation of a didactic design. The data of error test were collected from 53 9^{th}-grade students for the 2019/2020 academic year, while the research subjects in the implementation of the didactic design to online learning were 12 8^{th}-grade students for the 2019/2020 academic year in West Bandung Regency.

This study employed two instruments, the first of which was in the form of error test questions intended to identify obstacles. Second, there was the didactic situation design, which includes hypothetical designs for student responses and anticipations in the classroom as outlined in the form of learning designs and student worksheets.

Table 1. Error test indicators to determine student learning obstacles

Indicators	Question number
1. Students were presented with a problem. They were asked to determine the solid geometry of flat-sided and non-flat-sided prisms.	1
2. Students determine prism nets and explained the reasons.	2
3. Students identified the elements of a flat-sided prism.	3 and 4
4. Students solved problems concerning the surface area of a prism with a trapezoidal base.	5

RESULT AND DISCUSSION

Stage 1: Didactic Situation Analysis (DSA) Before Learning

In this study, a preliminary analysis was performed, including identifying the obstacles to learning the surface area of a flat-sided prism. The identification was carried out in various ways, including posing the initial test questions (error test), analyzing the results of interviews conducted with students and teachers, and analyzing the textbooks utilized.

Learning Obstacles

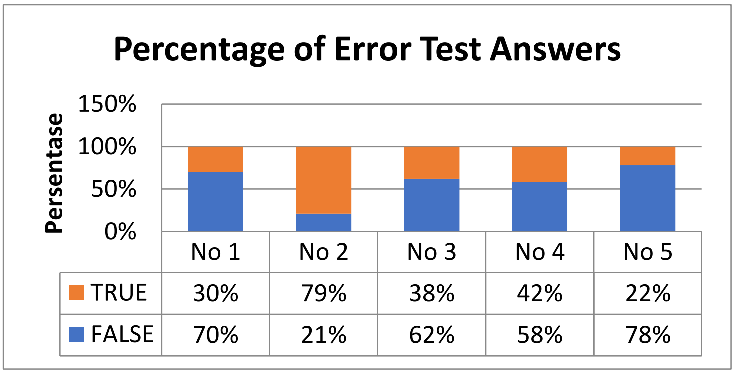


Figure 1. Percentage of error test answers

Based on the results of the initial test on the students, some learning obstacles were identified. Two problems were classified as ontogenic obstacles, where a discrepancy was found between the learning and the thinking ability. These ontogenic obstacles included 1) the students' errors in identifying the shape of a flat-sided prism, i.e., students identified it as a shape with only triangular elements (Figure 2a.); 2) the students' understanding of prism nets in question No. 2. This problem occured because the students were not involved in the recognition of the shapes of prism nets. They tended to choose prism nets in the form of parallel bases and roofs (Figure 2b).

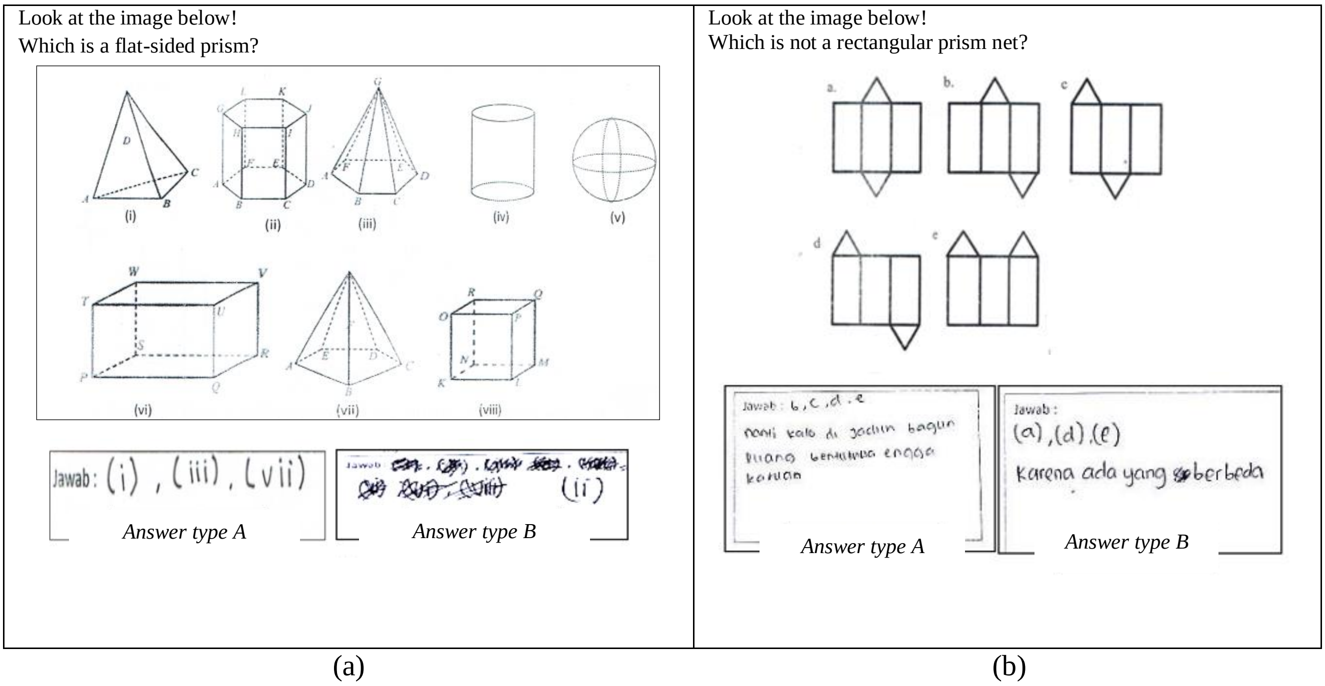
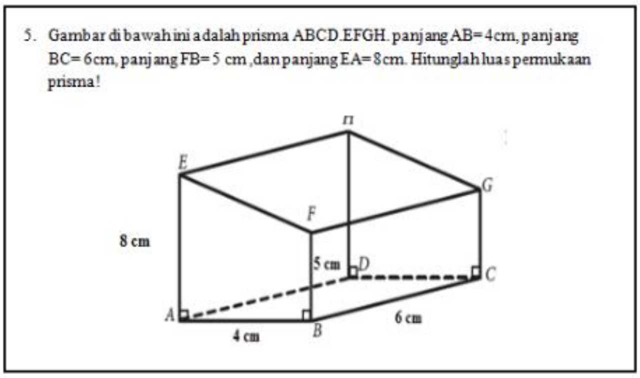


Figure 2. Question number 1 and question number 2

Then, in another issue (Figure 3), the students' errors in answering a question were identified. The errors were identified as a type of difficulty caused by the students' limits in developing an understanding of the material (epistemological obstacle).

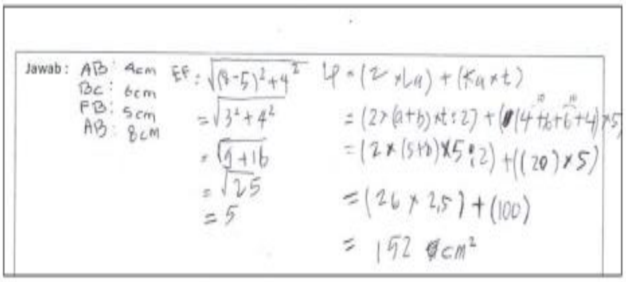


Translation:

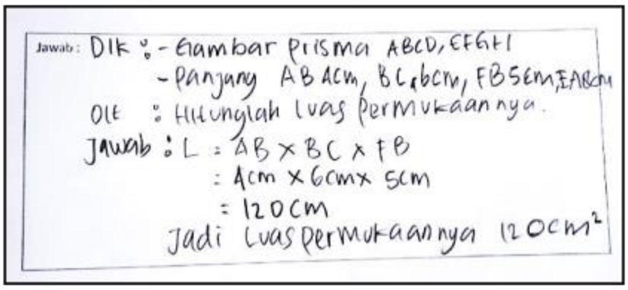
The figure below is a prism ABCD.EFGH, length AB = 4cm, length BC = 6cm, length FB = 5cm, and length EA = 8cm. Calculate the surface area of the prism!

Figure 3. Problem number 5 regarding the surface area of a prism

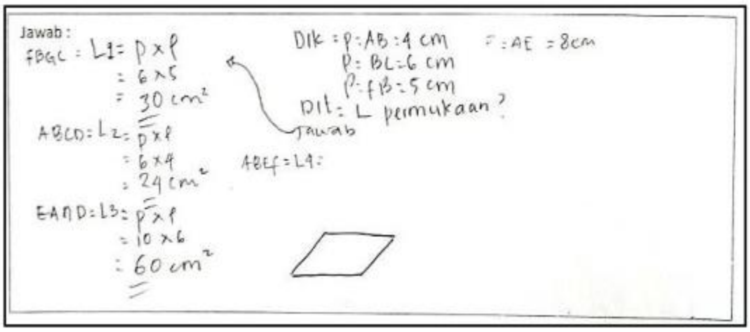
Two problems included in the epistemological obstacle were as follows: 1) students only knew of the elements of a hexagonal prism, but they did not have an understanding of them; 2) the students had some limitations in solving the surface area of a flat-sided prism. In this case, there were errors in the students' conception of the surface area of a flat-sided prism (Figure 4a), and in their understanding of the concept of the surface area of a flat-sided prism (Figure 4b), and there was an additional error in their identifying the shape of the base of a flat-sided prism (Figure 4c).



(a) Example answer of type A



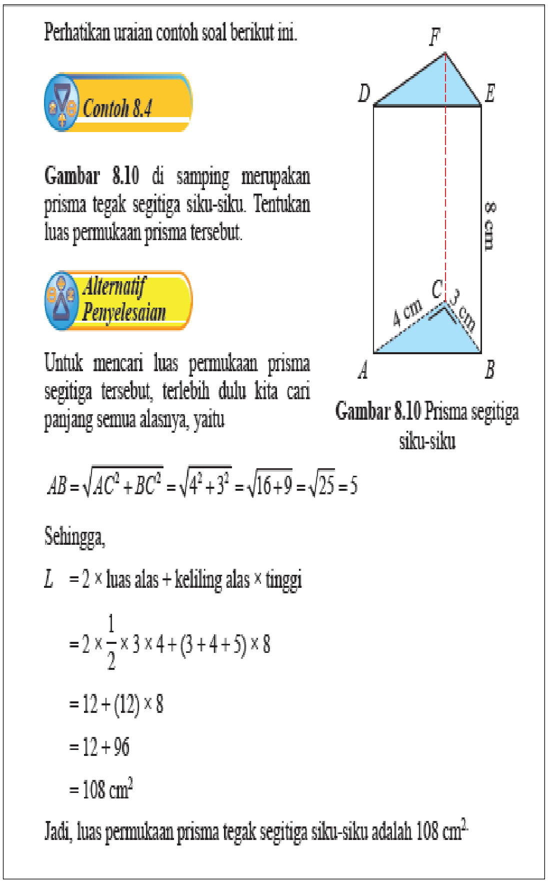
(b) Example answer of type B



(c) Example answer of type C

Figure 4. Type of answers for problem number 5

The limited comprehension of the concept of prism surface area caused the students to be inclined to solving problems using the formulas that they memorized. Another obstacle encountered by the teacher in the learning process on the concept of the surface area of a flat-sided prism was that the teacher did not predict the students' responses and thus did not anticipate them. Setting, another obstacle was the inaccuracy of the textbooks used by the teacher and students. It was discovered that there was a lack of explanation regarding the relationship between definitions, elements, and properties of prisms. This deficiency reduced the benefits of understanding the concept of the surface area of a flat-sided prism.



Perhatikan uraian contoh soal berikut ini.

Contoh 8.4

Gambar 8.10 di samping merupakan prisma tegak segitiga siku-siku. Tentukan luas permukaan prisma tersebut.

Alternatif Penyelesaian

Untuk mencari luas permukaan prisma segitiga tersebut, terlebih dulu kita cari panjang semua alasnya, yaitu

$AB = \sqrt{AC^2 + BC^2} = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5$

Sehingga,

$L = 2 \times \text{luas alas} + \text{keliling alas} \times \text{tinggi}$

$= 2 \times \frac{1}{2} \times 3 \times 4 + (3 + 4 + 5) \times 8$

$= 12 + (12) \times 8$

$= 12 + 96$

$= 108 \text{ cm}^2$

Jadi, luas permukaan prisma tegak segitiga siku-siku adalah 108 cm².

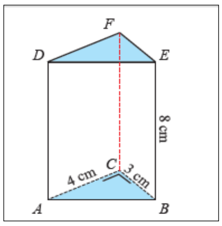
Gambar 8.10 Prisma segitiga siku-siku

Translation:

Look at the following example

Example 8.10

The picture on the right is a right-angled triangular prism. Determine the surface area of the prism.



Alternative Solution

To find the surface area of the triangular prism, we first need to find the lengths of all the bases.

$$AB = \sqrt{AC^2 + BC^2} = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5$$

Then,

$$L = 2 \times base\ area \times around\ the\ base \times height$$

$$= 2 \times \frac{1}{2} \times 3 \times 4 + (3 + 4 + 5) \times 8$$

$$= 12 + (12) \times 8 = 12 + 96 = 108\ cm^2$$

So, the surface area of a right triangular prism is $108\ cm^2$

Figure 4. Picture of one of the textbooks used by the students

Figure 5 demonstrates that the textbook does not address all levels of geometric thinking, and neither does it explain the surface area of a flat-sided prism, resulting in material transitions that are less helpful. This will result in the emergence of didactical obstacles.

Based on these findings, the authors created instructional resources that are intended to help students develop their thinking processes when it comes to grasping the concept of the surface area of a flat-sided prism. The stages of learning have been considered and implemented online utilizing van Hiele’s theory.

Before compiling a didactic design on the topic of the surface area of a flat-sided prism, the author first generated a new trajectory of prerequisite material and the concept of the surface area of a flat-sided prism that was designed using stages in van Hiele’s theory in developing a hypothetical didactic design. The stages are as follows:

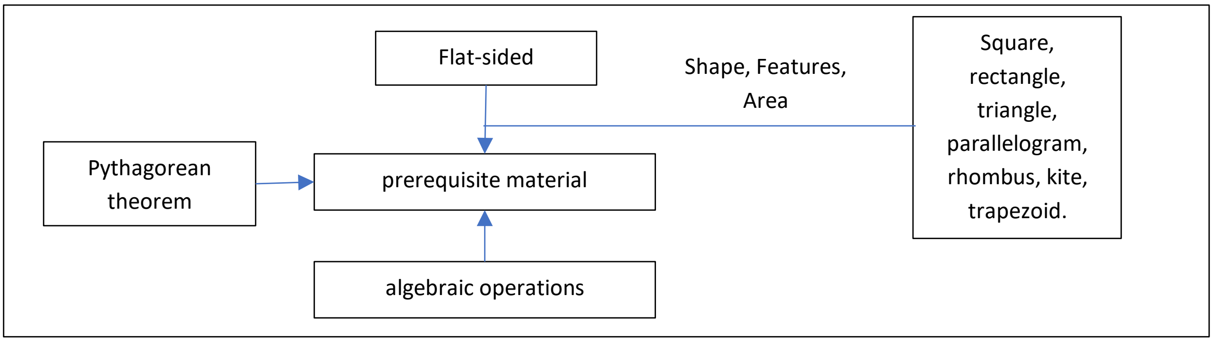


Figure 5. Learning trajectory of prerequisite material

The design consists of four didactic designs developed using van Hiele geometry stages. The first didactic design is intended to offer students a grasp of the prerequisite material prior to learning about the surface area of a flat-sided prism, which is recognizing plane figures.

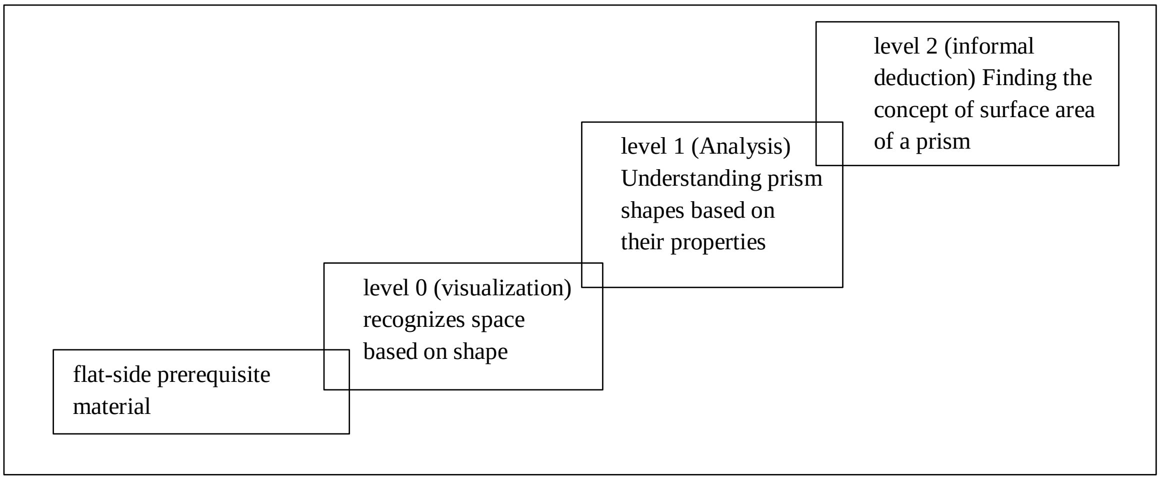


Figure 6. Learning trajectory of the concept surface area of a flat-sided prism based on the stages by van Hiele

The purposes are as follows: 1) students can recall plane figures, 2) students are aware of the properties of plane figures, and 3) students can find the broad concept of plane figures.

Initial Didactic Design of the Concept of the Surface Area of a Flat-Sided Prism

The second didactic design is concerned with the shapes of the flat side areas of a solid geometric figure. In this learning process, students enter the level of visual thinking, which is the level of geometric thinking, to recognize a flat side geometric figure based on its shape. This instructional design comprises two worksheets (LK). This lesson's aims are to 1) connect objects in everyday life; 2) recognize the names of solid geometric figures; 3) classify prisms; and 4) distinguish prism elements.

The third didactic design is the didactic design of the elements of a flat-side geometric figure, which consists of two worksheets (LK). The objectives are as follows: 1) students can recognize prism properties; 2) students can identify prism properties; 3) students can draw prisms; and 4) students can identify prism nets.

The fourth didactic design is the didactic design of the surface area of a flat-sided prism, which consists of two worksheets (LK). This design aims for students to identify prism nets and comprehend the concept of the surface area of a prism.

The concept design of the surface area of a flat-sided prism comprises 9 worksheets (LK). The preparation of these prerequisite material worksheets was adjusted to the van Hiele stages which were adapted from the introduction (visualization) stage to the stage of finding concept (informal deduction) (Crowley, 1987). The first worksheet (LK 1) encourages students to complete the names of the pictures of the types of plane figures that have been provided. The purpose is for students to recall the prerequisite material that has been learned at the elementary school level. Then, the second worksheet (LK 2) comprises the identification of the properties of the plane figures. LK 2 consists of LK 2 number 1 and LK 2 number 2 because this stage was tailored to the analysis stage proposed by van Hiele. The next is the third worksheet (LK 3) which comprises six worksheet parts. Each of the worksheets parts in LK 3 aims for students to determine the concept of the areas of a square, a rectangle, a triangle, a trapezoid, a parallelogram, a rhombus, and a kite.

The fourth (LK 4) and fifth (LK 5) worksheets go through the first of the van Hiele stages, which is visualization. LK 4 includes directions for observing various solid geometric figures and filling in the blanks with their names. Meanwhile, LK 5 instructs students to examine the shapes, symbols, and terminology related to rectangular prisms (beams), square prisms (cubes), and triangular prisms. This worksheet has been tailored to van Hiele's proposed stage of introduction (visualization) (Crowley, 1987).

The sixth (LK 6) and seventh (LK 7) worksheets proceed to the next stage, which is analysis. These worksheets provide observations and properties of flat-sided prisms. In LK 6, students are given eight pictures of solid geometric figures (prisms and pyramids) and instructed to examine and select the solid geometric figures that are categorized as prisms, aided by a table of prism properties with three rows and eight columns. The table includes the following properties: 1) having congruent polygonal base and roof; 2) having upright ribs; and 3) each upright side being rectangular.

The eighth (LK 8) and ninth (LK 9) worksheets provide instructions for constructing the concept of the surface area of a prism. LK 8 comprises ten nets of prisms and non-prisms. Students are asked to identify the nets that can construct prisms. Then, LK 9 comprises three forms of prism geometry and an analysis of their respective surfaces. LK 9 number 1 contains rectangular prisms (beams), LK 9 number 2 contains square prisms (cubes), while LK 9 number 3 contains pentagonal prisms. Students examine the surface area of each of these prisms to create the notion of a flat-sided prism surface area based on the prism image provided.

Stage 2: Metapedadidactic Analysis

Results of the Implementation of the Didacting Design of Plane Figure Area

The learning design was implemented to online learning, which was accomplished through the use of an e-learning system. WhatsApp, Zoom, Google Drive, and YouTube were some of the programs utilized in e-learning. Each learning phase included information, direct orientation, explication, free orientation, and integration.

It was discovered in the first lesson that students remembered the names of plane figures based on their sides. Some students had identified plane figures based on the elements (angles, sides, and planes) they perceived. The students were then actively involved in a discussion led by the teacher to investigate nine different types of plane figures. Some students did the exercise in LK 1, precisely one which instructed them to identify the name of plane figure point e, incorrectly plane figure point ***e*** was simply given the name trapezoid, instead of, more specially, right-angled trapezoid.

According to the outcomes of the first lesson, most students were still unsure of how to name the type of the trapezoid. The type of the trapezoid was not written in full. For example, instead of naming it isosceles trapezoid or right-angled trapezoid, the students named it just trapezoid. The students' failure to write the complete name of the trapezoid was due to a lack of comprehension of LK 1 number e. This was also discovered in the research conducted by (Mulyani, 2017; Adkhadiah, Khusniah, & Nurmalitasari, 2018; Ristianti, 2019), that students' inability to recognize the qualities of a trapezoid is because the concept has not been thoroughly comprehended, resulting in inaccuracies in answering (Ristianti, 2019).

In LK 2, the students were then able to recognize the properties of squares and rhombuses. However, it was discovered that some students were unfamiliar with the phrase diagonal and rotational symmetry. Based on the responses, the teacher anticipated using paper props. According to Murdiyanto and Mahatama (2014), using mathematics teaching aids to transmit knowledge, concepts, and principles to students will provide a more authentic experience. Students were able to accurately identify the properties of plane figures after being provided with the paper props.

Other findings show that some students did not comprehend the term 'at least' used in statements 1 and 5 in LK 2 No.2. The teacher anticipated that by providing an example of the number of sides in a polygon. A polygon with at least 3 sides is called a triangle. Then, polygons with more than 3 sides are quadrilaterals, pentagons, and so on.

Results of the Implementation of the Didactic Design of the Elements of Flat-Sided Solid Geometry

Learning activities began with the information phase that directed students to prepare objects that resemble solid geometric figures. The teacher themselves prepared 12 pictures of objects that resembled solid geometry to be presented as references for the students to distinguish shapes. The teacher encouraged the students to gather information on solid geometry. It aimed for the students to get into activities to describe geometric shapes. According to van Hiele (Crowley, 1987), the stage where students receive/complete exercises to describe geometric structures and construct them verbally using everyday language is included in the visualization.

Overall, the implementation of the didactic design elements of flat-sided solid geometry demonstrated that the students could classify flat-sided solid geometry of non-flat-sided solid geometry, and solid geometry with congruent bases. According to Vojkuvkova (2012), the ability of these students is classified to be at the basic level at the van Hiele stages, which is level 0: visualization.

Furthermore, students were given LK 5 to stimulate the next level of the thinking process. Some students felt doubtful in answering question on the shape of the example of the diagonal of the geometry and the diagonal field. The students' uncertainties in the 2nd lesson were foreseen in the initial didactic design, and it is undeniable that the predicted responses of students who did not write down the complete names of the elements were frequently encountered. Errors and difficulties were faced by students in solving problems regarding surface area because they did not fully understand the concept and merely memorized formulas (Sidik, 2018).

If it was not anticipated, there would be errors or difficulties in the following material learning. Therefore, in this 2nd lesson, the teacher anticipated this error by asking the students to repeat working on the questions, specifically about the comprehension of the elements of flat-side solid geometry. This 2nd learning reached the free orientation phase of Van Hiele's theory. The teacher provided experience for the students to explore ways to complete the given task by directing them to investigate objects into explicit items (Crowley, 1987).

Results of the Implementation of the Didactic Design of Solid Geometry and Flat-Side Prism Nets

Upon the completion of LK 6, it was discovered that the students perceived the picture of a trapezoidal prism to be a picture of a parallelogram or a beam. The teacher had expected the students' incorrect answer, and in anticipation of it the teacher redefined the geometry of the trapezoidal prism and evaluated the plane figures that comprise the trapezoidal prism.

In the previous lesson, the teacher introduced the plane figure of the prism but did not introduce the solid geometry with a congruent base in the form of a trapezoid (trapezoidal prism). This was one of the reasons why students felt hesitant to determine the name of the shape in point ***c*** (trapezoidal prism). Furthermore, the geometry of the image of a trapezoidal prism does not illustrate the shape of a trapezoidal prism. According to Suwangsih and Tiurlina (2006), the nature of the mathematics learning process is learning by doing and experiencing. Learning entails doing; by doing, students will gain a better understanding of mathematical concepts and will be able to recall them for a longer period of time.

The next activity was to identify and analyze prism and non-prism nets. The first media option was block nets, aiming to make it easier for students to grasp the properties of blocks. Based on the previous research conducted by Hikmiah (2013), using proper media as tools for students to grasp the nature of cubes and blocks allows the students to determine concrete edges, angles, and sides.

The result this activity shows that the students were not careful in following the instructions given to them. This can be seen from the answers of students who did not describe symbol A or those who did not make shading to indicate the base. Then, another finding shows that the majority of the students did not complete LK 7 No. 2. The reason was that the students were immediately focused on working on LK 7 No. 3. As a result, they were unaware that LK 7 No. 2 had yet to be completed. The teacher made an anticipation to respond to mistakes and errors made by students.

The implementation of learning in meeting 3 aimed to train students' in the-ability to conduct observations and determine the characteristics of a figure. The students were at level 1: analysis. They were able to recognize prism shapes based on their characteristics through observation and experimentation in distinguishing the characteristics of figures and their properties. These emergent features were then utilized to demonstrate that an image shape can be identified from its constituent elements. For instance, a beam may be identified from its sides, number of edges, and base (Crowley, 1987). The teacher then stimulated students to proceed to level 2 in the next meeting: informal deduction.

Results of the Implementation of the Didactic Design of the Concept of the Surface Area of a Flat-Sided Prism

The fourth meeting's implementation was done online, using Zoom and Whatsapp as communication channels. The students were instructed to actively participate in determining which nets were flat-sided prisms and which were not. The students were actively involved in activities led by the teacher during this phase. In LK 9, three errors in the concept of the surface area of a pentagonal prism were discovered: 1) the students made a mistake in determining the areas of the prism's base and roof, 2) the students ignored the concept of the surface area of the prism and worked on/solved the problem mathematically, and 3) the students correctly solved the concept of the surface area of a prism.

Stage 3: Retrospective Analysis

Revised Didactic Design

The didactic design of the concept of the surface area of a flat-sided prism based on van Hiele's theory in online learning is divided into four, including 1) the concept of the area of a plane figure; 2) recognizing a flat-sided solid geometric figure based on its shape; 3) recognizing the solid geometry of a flat-sided prism based on its properties; 4) finding the concept of the surface area of a flat-sided prism.

The findings in the first lesson (didactic design of the concept of the area of a flat-sided solid geometry) was the inaccuracy made by the students in the naming of the type of a trapezoid. This was because the students ignored the symbols given. Therefore, the authors made a revision (Figure 8) on the situation of didactic design 1 in phase 2.

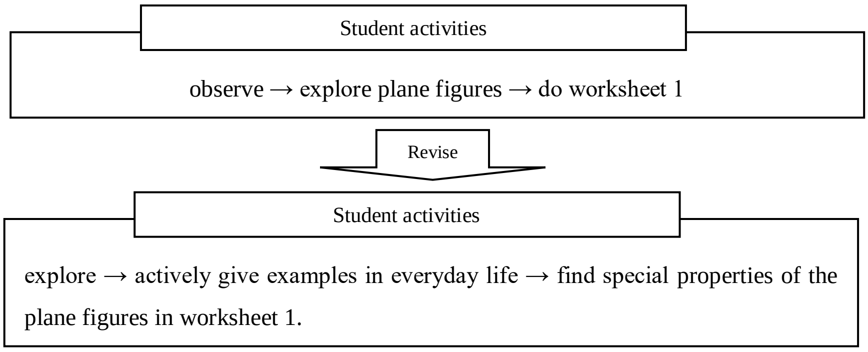


Figure 7. Revision of student activities in LK 1

The next finding was the difficulty of the students in comprehending the term 'at least' in worksheet 2. The authors revised the phrase 'has at least a pair of parallel sides' to 'has a minimum of two parallel sides.

The finding in the third lesson (didactic design of flat-sided geometrical elements) was that the students did not correctly answer LK 6 point c (Figure 9). Many of the students misunderstood the picture as a parallelogram prism. This is because students are familiar with trapezoids with shorter side shapes and had not had the experience of observing trapezoidal prisms before. Therefore, the authors revise LK 6 point c by modifying the shape of the previous image into an image that resembled a trapezoidal prism.

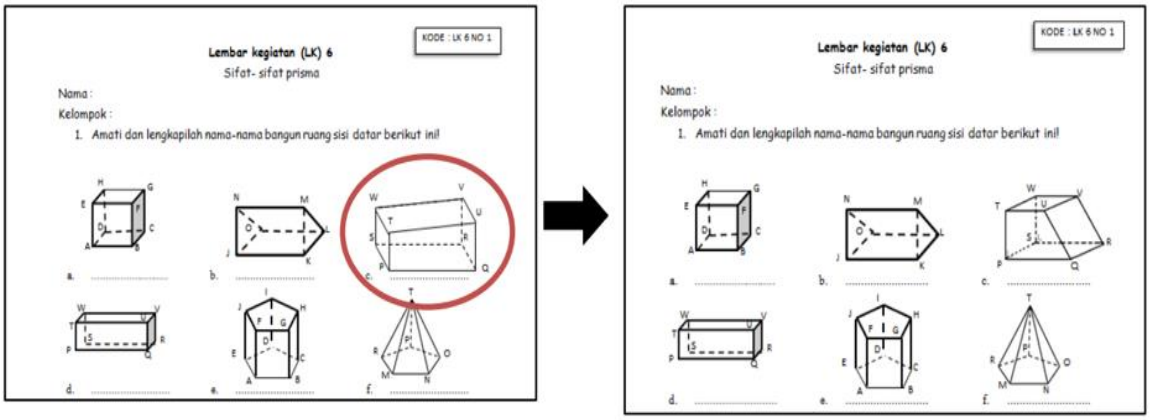


Figure 8. Revision of the shape of the trapezoidal prism in LK 6

The finding in LK 7 shows that the students ignored the instructions in completing LK 7, resulting in unfilled question points. In the revised didactic design, it is important to re-emphasize the accuracy in answering each stage of the questions on the worksheet.

The finding in the fourth lesson (didactic design of the concept of the surface area of a flat-sided prism) shows that the majority of the students ignored the unit area in answering the worksheet on the concept of the surface area of a flat-sided prism. Therefore, to respond to this, the authors revised the validation activities to require students to write down the unit area for each calculation.

Retrospection

Based on the experience of doing DDR cycles, several significant insights have been acquired. First, the students still need guidance in identifying the properties of a plane figure, which is determining the area of a kite with a rectangular area approach. They experienced difficulty constructing a kite into a rectangle. Second, the students still require guidance in comprehending diagonal solid geometry and diagonal plane figures. Third, some students were not familiar with variations of trapezoidal prism. Fourth, the implementation of online learning found several obstacles, including; 1) the students were divided into several learning sessions in the implementation of the learning process, 2) some students did not collect worksheets on time, and 3) there was an internet connection problem afflicting one of the students, thus affecting the run of the learning stage of the surface area of a flat-sided prism.

ACKNOWLEDGMENTS

The authors would like to thank the principal and mathematics teacher of State Junior High School 3 of Lembang for providing the opportunity to conduct this research.

REFERENCES

Adkhadiah, A., Khusniah, R., & Nurmalitasari, D. (2018). Analysis of errors in word problems on the topic of 2D space class VII in secondary school number 2 Bangil Pasuruan Regency [in Bahasa]. *Konvergensi Sains & Humaniora*, *1*(1), 345-362.

Aziiza, Y. F., & Juandi, D. (2021). Student's learning obstacle on understanding the concept of prism surface area. *Journal of Physics Conference Series*, *1806*(1), 012115. https://doi.org/10.1088/1742-6596/1806/1/012115.

Crowley, M. L. (1987). The van Hiele model of the development of geometric thought. In Lindquist, M. M. (Eds), Learning and Teaching Geometry (pp. 1 – 16). Reston, VA.

Dhungana, S. (2021). Problems in Learning Geometric Theorems In Secondary Schools: A Mixed Method Study. *Doctoral Dissertation*. Kathmandu University. https://doi.org/10.13140/RG.2.2.17101.36322

Hikmiah, A. N. U. (2013). Improving the learning outcomes in determining the properties of 3D space using skewer media in primary school [in Bahasa]. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *1*(2), 1-10.

Islami, M. D., Sunardi, S., & Slamin, S. (2018). The mathematical connections process of junior high school students with high and low logical mathematical intelligence in solving geometry problems. *International Journal of Advanced Engineering Research and Science, 5*(4), 237427. https://dx.doi.org/10.22161/ijaers.5.4.3

Kabaso, M., & Chinamasa, E. (2020). *Ordinary Level Students'perceived Errors In Earth Geometry: Implications For Instructions*. ISSN: 2582-0745.

Kemendikbud. (2014). *Permendikbud No 58 Tahun 2014 tentang Kurikulum 2013 Sekolah Menengah Pertama/Madrasah Tsanawiyah*. Jakarta: Menteri Pendidikan dan Kebudayaan Republik Indonesia.

Litbang Kemendikbud. (2019). *National Exam Results Report 2018/2019* [in Bahasa]. Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. http://litbang.kemdikbud.go.id.

Mayberry, J. & College, G. (1983). The van hiele levels of geometric thought in undergraduate preservice teachers. *Journal for Research in Mathematics Education, 14*(1), 58-69. https://doi.org/10.2307/748797.

Madimabe, M. P., Omodan, B. I., & Tsotetsi, C. T. (2020). Indigenous Knowledge as An Alternative Pedagogy to Improve Student Performance in The Teaching and Learning of Mathematical Geometry In Tvet College. *Proceedings of ADVED, 2020(6th)*.

Mulyani, E. (2017). Design didactic on surface concept of trapezoidal area at secondary school mathematics learning [in Bahasa]. *Supremum Journal of Mathematics Educatio, 1*(2), 79-87. https://doi.org/10.35706/sjme.v1i2.752.

Murdiyanto, T. & Mahatama, Y. (2014). Development of math props to increase interest and motivation in learning math of elementary school learners [in Bahasa]. *Sarwahita, 11*(1), 38-43. https://doi.org/10.21009/sarwahita.111.07.

Ristianti, T. (2019). Analysis of Learning Obstacles and Didactic Surface Area Concepts of Trapezoids on Mathematics Learning [in Bahasa]. *Unpublished Bachelor Thesis*. Siliwangi: Universitas Siliwangi.

Özerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *Procedia - Social and Behavioral Sciences, 55*, 720–729. https://doi.org/10.1016/j.sbspro.2012.09.557.

Rohendi, D., Septian, S., & Sutarno, H. (2018). The use of geometry learning media based on augmented reality for junior high school students. *IOP Conference Series: Materials Science And Engineering, 306*(1), 012029). IOP Publishing.

Sidik, M. J., Hendriana, H., & Sariningsih, R. (2018). Analysis of students' mistakes of grade ix secondary school on 3D space materials in solving critical thinking problems. *Jurnal Pembelajaran Matematika Inovatif, 1*(5), 837-846. http://dx.doi.org/10.22460/jpmi.v1i5.p837-846.

Sumalwan., Anggo. M., & Ikhman. (2014). Analysis of error in solving 3D space problems for 8th class student at secondary school number 14 Kendari. *Jurnal Penelitian Pendidikan Matematika, 2*(2).

Suryadi, D., & Suratno, T. (2013). Metapedadidaktik dan Didactical Design Research dalam Implementasi Kurikulum dan Praktik lesson study. *Proceedings of the Seminar Nasional Matematika dan Pendidikan Matematika*. Surabaya: Universitas Negeri Surabaya.

Suwangsih, E. & Tiurlina. (2006). *Mathematical Learning Model*. Bandung: UPI Press.

Suwito, A. (2018). Analysis of thinking geometrically in solving algebraic problems in class VIII [In Bahasa]. *Proceedings of the National Seminar of Etnomatnesia*, 64–69.

Vojkuvkova, I. (2012). The van Hiele model of geometric thinking. *Proceedings of the Contributed Papers WDS'12*.

Yadav, D. K. (2019). Experiential learning and geometry teaching: A call to action. *Think India Journal*, *22*(28), 32-36.

Yuniarti, Y. (2016). Indonesian realistic mathematics education (PMRI) to improve understanding of geometry concepts in elementary schools [in Bahasa]. *EduHumaniora: Jurnal Pendidikan Dasar Kampus Cibiru*, *3*(2).