The ability of junior high school students in drawing 3D pyramids

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Abstract. Drawing ability is part of the spatial ability, which is a crucial ability needed in science and daily life. Students often make a mistake in identifying objects in geometry learning. Students’ difficulties in identifying objects also occur in drawing a pyramid. This study aims to design student’s activities to determine the ability of junior high school students in drawing pyramids. The approach used in this study was a qualitative approach toward 28 students. Then, the researchers also did short interviews with four students. Results from the ability of junior high school students in drawing pyramids showed that 7% of 28 students were on level 1, 21% of the students were on level 2, 21% of the students were on level 3, and 19% of the students were on level 4. Meanwhile, 32% of the students were not able to draw all types of pyramids. Thus, most of the students still faced difficulties in drawing three-dimensional pyramids.

1. Introduction
Geometry has an essential position in life and education because geometry is a knowledge which represents the process of reaching a solution by thinking process [1]. According to Ozdemir, understanding geometry by involving real-life contexts and mathematical concepts promotes the understanding of other topics in mathematics [2]. Therefore, geometry has a more abstract concept compared to other mathematics topics, especially for students that need a more complex thinking skill in learning geometry [3].

Several studies note that most students still experience difficulties in understanding geometrical concepts [4]. According to Purnomo, the evidence shows that students' achievement in geometry is still unsatisfied [5]. According to Burger and Shaughnessy, students often incorrectly identify the images in learning geometry [6]. Besides, students’ difficulties in learning geometry also occur in learning pyramids. The students have difficulties in understanding pyramids because not all of them have sufficient knowledge about geometry, especially pyramids [7]. This was also stated by Ubuz and Gökbulut that pyramid is still challenging to learn even though it is often found in everyday life [8].

Spatial ability is the ability to make changes by seeing or imagining, describing the idea of visual-spatial and explaining accurately spatial arrangements such as colours, liners, shapes, spaces, and relationships [9]. Also, the spatial ability is an essential ability in learning geometry [10]. This matter aligns with Nugroho’s research revealing that spatial ability is a highly crucial aspect in studying
geometry because the level of spatial ability possessed by students influences the quality of their spatial ability [11].

The education system should pay attention to the development of students’ spatial ability. In Indonesia, mathematics in the curriculum 2013 has not provided sufficient support to develop students’ spatial ability, especially in drawing pyramids. This is in accordance with the statement of Usiskin as cited in Olkun [12], which states that the mathematics curriculum in learning geometry does not provide sufficient opportunities for students to develop their spatial ability. Thus, activities need to be carried out to provide opportunities for students to develop their spatial ability.

Activities to develop students’ spatial ability are varied. For example, students determine the arrangement of objects on a student’s desk, then ask students to draw them [13] and arranging several tissue packs, and then students arrange to draw 3D shapes [14].

This study aims to analyze students’ spatial ability in drawing 3D objects, such as triangular, rectangular, pentagonal and hexagon pyramids with different levels. Henceforth, the research question of this study is “how is students’ ability in drawing 3D pyramids?”

2. Method

The purpose of this study is to see the students’ ability in drawing 3D pyramids. A qualitative approach was used in this study to gain data. This research was conducted for two meetings in a seventh-grade classroom in MTsS Darul Ihsan Aceh Besar, Aceh Besar. Twenty-eight students got involved in this learning process.

The data were analyzed using a set of the category listed in Table 1 to describe student's drawing ability. Triangulation involved various sources: activity video, students’ work, and brief interviews with several students. These sources were used to answer the research question.

| Level 1 | Level 2 | Level 3 | Level 4 |
|---------|---------|---------|---------|
| The student draws the objects like a two-dimensional object; all the lines are a straight line and only 1 out of 4 drawings correct. | The student draws the objects with few isometrics; the drawing does not show any right or left side, or student draws many lines on the same edge and not parallel, and there are 2 out of 4 drawings correct. | The student draws the objects with several isometrics, there are few non-parallel lines, and 3 out of 4 drawings correct. | The student draws the objects isometrically, and all the objects drawn are correct. |

Source: adapted from Johar [14]

3. Results and discussion

Firstly, before students took the drawing test, few examples of pyramids in real life were shown to the students, such as Giza Pyramids, mosque roof, pyraminx, and so on. Next, students were asked to draw different types of pyramids, such as triangular, rectangular, pentagonal, and hexagonal pyramids in the sheets of paper distributed to students.
Table 2. Level 1; there were 2 out of 28 students that drew pyramids like two-dimensional objects; the lines on the drawings were all straight lines, and there were only 1 out of 4 drawings correct.

| No | Triangular pyramid | Rectangular pyramid | Pentagonal pyramid | Hexagonal pyramid | Notes |
|----|--------------------|---------------------|--------------------|-------------------|-------|
| 1  |                    |                     |                    |                   | The student was only able to draw 1 out of 4 drawings correctly, which was the hexagonal pyramid. The student drew the pentagonal pyramid like a two-dimensional object. After that, the student was not able to draw the triangular and rectangular pyramids. |
| 2  |                    |                     |                    |                   | The student was only able to draw 1 out of 4 drawings correctly, which was the rectangular pyramid. However, isometrics on the rectangular pyramid base was better shaped as parallelogram so that the side size and angles of the pyramid could be seen clearly. |

Table 3. Level 2; there were 6 out of 28 students that drew pyramids with few isometrics; the drawing did not show right or left side clearly, or the students drew many lines on the same edge and not parallel lines, and there were only 2 out of 4 drawings correct.

| No | Triangular pyramid | Rectangular pyramid | Pentagonal pyramid | Hexagonal pyramid | Notes |
|----|--------------------|---------------------|--------------------|-------------------|-------|
| 1  |                    |                     |                    |                   | The student was only able to draw the triangular and rectangular pyramids. The student drew three triangular pyramids, and all of them are correct. Isometrics on the rectangular pyramid base was better shaped as parallelogram so that the side size and angles of the pyramid could be seen clearly. Meanwhile, the pentagonal and hexagonal pyramids were drawn like two-dimensional objects. |
The student was only able to draw the pentagonal and hexagonal pyramids correctly while the triangular and rectangular ones looked like two-dimensional objects.

The student was only able to draw the rectangular and pentagonal pyramids correctly. The triangular pyramid drawn looked like a two-dimensional object, and the student was not able to draw the hexagonal pyramid.

The student was only able to draw the rectangular and hexagonal pyramids correctly. The triangular pyramid drawn looked like a kite, and the student was not able to draw the pentagonal pyramid.

The student was only able to draw the triangular and pentagonal pyramids correctly. The student coloured every side of the triangular pyramid so that the difference between sides could be identified. On the pentagonal pyramid, the student coloured the base of the pyramid. Meanwhile, the student was not able to draw rectangular and hexagonal pyramids.

The student was only able to draw the pentagonal and hexagonal pyramids correctly. On the triangular pyramid, the student did not draw the base and sidelines for the pyramid, and the student was not able to draw the rectangular pyramid.
Table 4. Level 3; there were 6 out of 28 students that drew pyramids with several isometrics, few non-parallel lines, and 3 out of 4 drawings drawn were correct.

| No | Triangular pyramid | Rectangular pyramid | Pentagonal pyramid | Hexagonal pyramid | Notes |
|----|--------------------|---------------------|-------------------|------------------|-------|
| 1  | ![Triangular pyramid](image1) | ![Rectangular pyramid](image2) | ![Pentagonal pyramid](image3) | ![Hexagonal pyramid](image4) | On the triangular pyramid, there was no line for isometrics in the bottom rear of the object; so, the base shape was not precise. For the rectangular, pentagonal and hexagonal pyramids, the student was able to draw isometrically. |
| 2  | ![Triangular pyramid](image5) | ![Rectangular pyramid](image6) | ![Pentagonal pyramid](image7) | ![Hexagonal pyramid](image8) | The student was able to draw the triangular, pentagonal, and hexagonal pyramids isometrically and correctly. On the triangular pyramid, the student gave shading to each pyramid side with different intensities so that each side could be distinguished. On the pentagonal and hexagonal pyramids, the student gave shading to the pyramid bases. However, the student was not able to draw the rectangular pyramid. |
| 3  | ![Triangular pyramid](image9) | ![Rectangular pyramid](image10) | ![Pentagonal pyramid](image11) | ![Hexagonal pyramid](image12) | On the triangular pyramid, there was no line for isometric in the bottom rear of the object so that the base shape was not precise. The student was able to draw the other three pyramids isometrically and correctly. |
| 4  | ![Triangular pyramid](image13) | ![Rectangular pyramid](image14) | ![Pentagonal pyramid](image15) | ![Hexagonal pyramid](image16) | The student was only able to draw the rectangular, pentagonal, and hexagonal pyramids correctly. On the triangular pyramid, the student incorrectly drew the base; the student drew the rectangular base instead of the triangular one. |
The student was able to draw the triangular, rectangular, and hexagonal pyramids correctly with isometrics. Meanwhile, on the pentagonal pyramid, the right and the left sides were not clear since the students drew many lines on the same edge.

The student was able to draw the triangular, rectangular, and pentagonal pyramids correctly with isometrics while the hexagonal pyramid was drawn like a two-dimensional object, not three-dimensional one.

Table 5. Level 4; there were 5 out of 28 students that drew all the pyramids correctly and isometrically.

| No | Triangular pyramid | Rectangular pyramid | Pentagonal pyramid | Hexagonal pyramid | Notes |
|----|--------------------|---------------------|--------------------|------------------|-------|
| 1  |                    |                     |                    |                  | The student was able to draw the triangular, rectangular, pentagonal, and hexagonal pyramids correctly and isometrically. On the triangular pyramid, the student shaded the pyramid base so that the base could be distinguished from other sides. |
| 2  |                    |                     |                    |                  | The student was able to draw the triangular, rectangular, pentagonal, and hexagonal pyramids correctly and isometrically. On the triangular and rectangular pyramids, the student shaded the pyramid base so that the base could be distinguished from other sides. |
| 3  |                    |                     |                    |                  | The student was able to draw the triangular, rectangular, pentagonal, and hexagonal pyramids correctly and isometrically. On the triangular and rectangular pyramids, the student shaded the pyramid base so that the base could be distinguished from other sides. However, isometrics on the rectangular pyramid base was better shaped as parallelogram so that the side size and angles of the pyramid could be seen clearly. |
The student was able to draw the triangular, rectangular, pentagonal, and hexagonal pyramids correctly and isometrically. On the triangular pyramid, the student shaded the pyramid base so that the base could be distinguished from other sides.

The student was able to draw the triangular, rectangular, pentagonal, and hexagonal pyramids correctly and isometrically.

Table 6. The overall research results.

| Level of Students' Drawing Ability in 3D Pyramid | Students (%) |
|-----------------------------------------------|--------------|
| Level 1                                       | 2 Students (7%) |
| Level 2                                       | 6 Students (21%) |
| Level 3                                       | 6 Students (21%) |
| Level 4                                       | 5 Students (19%) |
| Unable to draw a pyramid                      | 9 Students (32%) |
| Total                                         | 28 Students |

Based on the tables and explanation above, a total of students that reached level 1, level 2, level 3, and level 4 are 19 students (68%). There were nine students (32%) out of 28 students who were not able to draw any types of pyramids. Based on the interview with the students unable to draw any kinds of pyramids, it was known that they could not recall the geometry subjects about the pyramid, although the students had learned it in elementary schools. Besides, the students had some difficulties and doubted while drawing 3D objects. This finding is in accordance with research reporting that there are many students who struggle drawing 3D objects, and most of the students are unable to draw 3D or even 2D objects [14].

4. Conclusion
Junior high school student ability test in drawing pyramids showed that there were two out of 28 students on level 1 (7%), six students on level 2 (21%), six students on level 3 (21%), and five students on level 4 (19%). Meanwhile, the other nine students (32%) were not able to draw all types of pyramids. The students still struggled in drawing 3D objects in geometry.
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