

Effectiveness Analysis of Geometry Learning of 3-Dimensional Form with Augmented Reality Method

W. Santiyasa¹, G.A. Vida Mastrika Giri²

Faculty of Mathematics and Natural Sciences, Udayana University

Abstract: *Three-dimensional form in geometry learning material is a part of mathematics material which is considered difficult to be understood by students. The result of preliminary survey conducted in Badung Regency involving 200 students, 43.2% of students stated that it is very difficult and 33.7% of students stated that it is difficult when learning process is done conventionally. In this research, 200 students were given an augmented reality application treatment in learning process, then the result were analyzed using variant analysis and randomized block design (RBD). The research result shown that the student's ability to understand the geometry concept of 3-dimensional form with augmented reality application was 54.72% with a significance level at $\alpha = .05$ and corrected model at 2.79%. It shows that the use of augmented reality method in learning 3-dimensional geometry is capable to facilitate students in understanding the concept of 3-dimensional form.*

Keywords: Geometry Learning, Treatment, Augmented Reality, The Variant Analysis

1. Introduction

Student's comprehension in the learning process of 3-dimensional geometry is a part of mathematics learning that is considered difficult by students. Most students feel the fear when they have to learn geometry, especially in 3-dimensional form such as cubes, cones, spheres and prisms. Students find it difficult to imagine the 3-dimensional form as it requires a high level of imagination to build the image of the 3-dimensional form [3].

With a fairly high level of difficulty, from a survey of 200 students conducted in several junior high school in Badung, 43.2% of students stated that geometry lesson of 3-dimensional form is very difficult, 33.7% of students stated that it is difficult, and only 22.1% of students stated that 3-dimensional geometry lesson is not difficult. It can be seen from the data description that the students generally have difficulty in understanding 3-dimensional geometry lesson so that the students experience anxiety with mathematics lessons at school.

But with the development of information technology in recent years with the presence of augmented reality method which is capable of displaying 2-dimensional images to the form of 3-dimensional model, is expected to help in the geometry learning process. Learning shapes such as cubes, cones, spheres, and prisms may be easier and it could facilitate the comprehension of students in learning the geometry of 3-dimensional form. Augmented reality is a special 3D application which allows the user to show and live view animation or digital contextual information in a computer program directly or indirectly from the physical world environment which elements have been added or equipped with computer-generated sensing inputs such as sound, video and graphics [2].

The application of augmented reality technology is expected to help the student's learning process of 3-dimensional geometry [3],[5],[6]. Augmented reality application is also expected to help students in Badung Regency to understand the geometry concept of 3-dimensional form.

Level of effectiveness of the augmented reality technology application in learning 3-dimensional geometry was examined in this research, using 200 junior high school students in Badung Regency. The geometry learning process of 3-dimensional form including cubes, pyramids and prisms will be visualized using the augmented reality to provide the clarity of the 3-dimensional form components such as point components, edge components and side components that must be owned by every 3-dimensional form.

This research is not focused in augmented reality method, but rather focused in the effectiveness of augmented reality application in student's learning process of 3-dimensional geometry. The application of augmented reality method in 3-dimensional geometry learning process is expected to change the learning atmosphere to make it more interesting for the students so it is expected to improve the students' understanding in 3-dimensional geometry.

2. Methodology

2.1 The Concept of 3-Dimensional Form

The 3-dimensional form is a shape which have points, edges, and sides. Conventionally [3], 3-dimensional form is drawn with only points and edges so it is difficult for students to understand the concept of 3-dimensional form. Whereas with augmented reality technology [5], besides a visualization with the formation of points and edges, 3-dimensional form can be visualized with the sides that composed the 3-dimensional forms, such as cubes, pyramids, and prisms. The 3-dimensional cube is a form or shape that has the same length of edges so that the area of each side is the same for the eight sides. To ease the students' understanding, the cube is visualized with augmented reality method to display the eight sides of the cube as shown in Figure 1, while Figure 2 and Figure 3 shown the 3-dimensional form and parts of a pyramid and a prism.

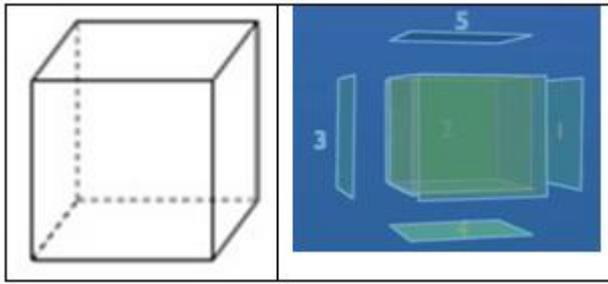


Figure 1: Three-dimensional and Parts of Cube

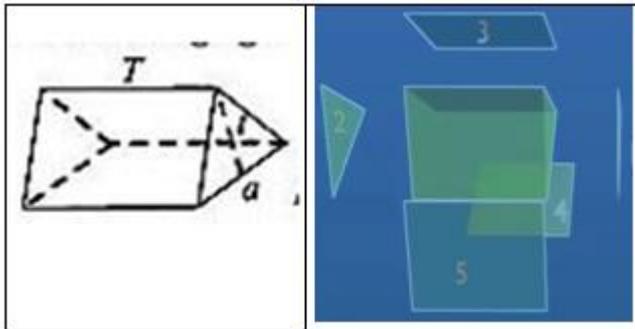


Figure 2: Three-dimensional and Parts of Pyramid

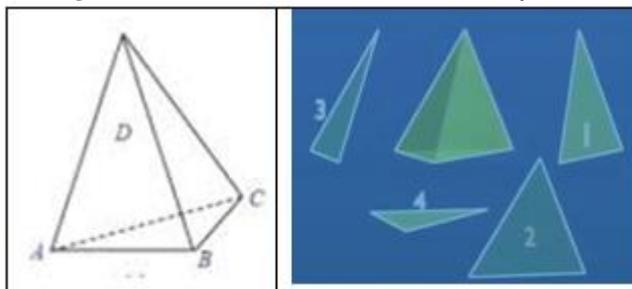


Figure 3: Three-dimensional Form and Parts of Prism

2.2. Research Design

This research studied 200 students who were taking geometry lessons of 3-dimensional form. The 200 students divided into two groups and given different treatments, 100 students learn conventionally and 100 students learn with 3-dimensional visualization using augmented reality method to learn cubes, prisms, and pyramids. By using randomized block design method, effectiveness level of learning process with 3-dimensional visualization will be calculated statistically [1],[7],[8].

Table 1: The Design of Learning Processes

Treatment	Conventional	Visualization
Without Repetition	50	50
With Repetition	50	50

Statistically, the design of learning process can be approached by group analysis that is Randomized Block Design with each parameter in a group have an F distribution as follows [1],[4],[7],[8]:

Table 2: Randomized Block Design

Treatment	K-1	K-2	K-3
P-1	X_1Y_1	X_1Y_2	X_1Y_3
P-2	X_2Y_1	X_2Y_2	X_2Y_3
P-3	X_3Y_1	X_3Y_2	X_3Y_3

$Y_{ij}(t) = \mu + K_j + P(t) + \epsilon_i(t)$ (1)
 where:

$i = 1, 2, \dots, n$; and $t = 1, 2, \dots, n$
 $Y_{ij}(t)$ = observation value at the i -th row, the j -th column which get the t -th treatment.
 μ = general average value
 K_i = influence of the i -th group
 $P(t)$ = influence of the t -th treatment
 $\epsilon_i(t)$ = error effect on the i -th group, which gets the t -th treatment.

3. Results and Discussion

Two hundred students were chosen as a research sample. Two-treatment of randomized block design was used to find out the effectiveness level of learning geometry of 3-dimensional form. The learning process was repeated three times with different treatment in each repetition. 1st-treatment is a conventional learning method (without 3-dimensional visualization), 2nd-treatment is a conventional learning with an animated 3-dimensional collaboration, and 3rd-treatment is a learning process with an animated 3-dimensional visualization. Table 3 shown the result obtained from the research.

Table 3: Students' Comprehension Data in Learning Geometry of 3-Dimensional Form

Treatment	K-1	K-2	K-3	Sum
Conventional	12	14	13	39
Conventional + Visualization	28	31	36	95
3-Dimension Visualization	21	23	22	66
Total	61	68	71	200

Using a randomized block design method, statistically by calculating the sum of squares for each group and treatment to produce the F-Test value of the treatment used, the results obtained as shown by Table 4 below:

Table 4: The Variant Analysis of Randomize Block Design

Source	Sum of Squares	df	Mean Square	F-value	Sig.
Corrected Model	53.351	4	13.3375	2.7916	.001
Intercept	173.667	1	173.667	36.3491	.001
Group	17.556	2	8.778	1.8372	.275
Treatment	522.889	2	261.445	54.7212	.003
Error	19.111	4	4.7775		
Total	559.556	9			
Corrected Total	61.756	8			

From the data analysis, it is found that at the level of significance $\alpha=.05$ the addition of animated 3-dimensional visualization treatment in students' geometry learning process can increase students' comprehension by 54.72% with the corrected model of 2.79%, compared by students' comprehension in the learning process which was done conventionally, only 36.35% of students understand the lesson.

4. Conclusion

- 1) The geometry lesson of 3-dimensional form is quite difficult to be understood by the students. Only 36.35% of students could understand the lesson if the learning process is done conventionally. Students' comprehension

- can be improved by adding 3-dimensional visualization in the geometry learning process.
- 2) The addition of 3-dimensional visualization was able to increase students' comprehension of geometry of 3-dimensional form by 54.72%.

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