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Integrating GeoGebra into geometry space learning: a lesson from traditional cultural festival *tumpeng sewu*

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Abstract. Some studies state that mathematical ideas sometimes could be derived through a cultural-based habit or activities. This research was investigated how students are struggle in making sense three-dimensional shapes concepts by observing how *Osing* people doing a simple mathematical explanation in their celebrating annual festival called *Tumpeng Sewu* (Thousands of *Tumpeng*). Besides, as one of the dynamic software, GeoGebra software seems to be a great idea to be integrated into university-level geometry learning. To that end, a study was conducted to know how the *Osing* ways in making *tumpeng* to be collected and presented during the *Tumpeng Sewu*. Moreover, it can help mathematics education students at University of Jember to do a better way in making sense of three-dimensional shapes concepts. After doing some research phases, the result of the statistical analysis shows the differences between pre-test and post-test score. In addition, a positive response related to the use of GeoGebra is achieved and the use of GeoGebra during geometry space learning can help in setting up effective geometry learning.

1. Introduction

Recently, science and technology become a major consideration in developing every aspect of human life, including how two things can make a huge acceleration in setting up better students' learning environment. Either science or technologies is believed can provide a great opportunity for students to do an exploration of their understanding of a certain concept. One of the uses of this technology is the use of applications as a medium to generate students' understanding. Integrating the use of a certain application in a learning process is in line with Leong which states using Geometer's Sketchpad application gave a positive effect on student achievement and attitudes towards mathematics [7]. In addition, the study of Zengin, Furkan, and Kutluca support that computer-assisted instruction is more effective rather than constructivist teaching method [14].

As one of the branches in mathematics, geometry is closely related to visualization. Students are required to be able to visualize an equation or shape. Using GeoGebra application is required in analytical geometry since students usually face some difficulties in visualizing an equation or some mathematical tasks relating to three-dimensional shapes. It can be seen when 60% of students who enrol in geometry course at the University of Jember mostly have scored less than 65.

In order to figure out the mentioned problem above, it needs a tool that can help students understanding geometry, especially concepts that related to three-dimensional shapes as well as having a good skill in visualizing the given geometry situation. Integrating GeoGebra into learning geometry is said to be one of the effective learning strategies in a mathematical learning process. Shadaan states that GeoGebra is one effective tool to improve mathematics teaching and learning, especially in



learning circles [11]. In addition, the use of GeoGebra also could increase performance student in learning system coordinates [10].

Mathematical learning activities are situated based on a local environment can significantly help the student learn more deeply in geometry learning activities [2]. It means that geometry learning activities could preserve culture. Besides students could extract the value contained in the proposed culture, students are also able to apply the values in their learning processes, such as their empathy, tolerance, or even solidarity among different ethnics of their classmates.

Osing is a local Banyuwangi tribal ethnic in Indonesia that mostly lived in the east of Java island. Most of *Osing* people migrated from one region to other regions. As one of the *Osing* destinations of their life expansion, Jember is well known as the second home for *Osing* people. In term of the number of undergraduate students that study at the University of Jember, almost half of its students are originated from Banyuwangi. By considering the huge amount of *Osing* people who study at the University of Jember, it is reasonable to integrate the *Osing* as one of the main consideration in developing the learning activities. Integrating *Osing* culture becomes one of seven excellent research that written on their 2016-2020 strategic plans for its productivity and welfare community [13]. This article emphasizes on how the integration of GeoGebra and *Tumpeng Sewu*, one of *Osing* cultural festival can be used as a way to accommodate the needs to overcome problems that usually come up during geometry learning process.

2. Literature Review

2.1. GeoGebra

GeoGebra as an open-access application that could be downloaded and used in order to solve problems [6]. Bhagat and Chan [3] and Dikovic [4] had concluded that GeoGebra becomes an innovative learning tool that integrates technology in teaching and learning mathematics because of GeoGebra also good in visualization and simulation. GeoGebra also supports the aim of learning mathematics such that modelling real problem and making a connection between real-world and mathematics [8].

There are seven menus in GeoGebra such that file, edit, view, options, tools, window, and help. GeoGebra also has some tools to visualize two-dimensional objects, such that points, lines, perpendicular lines, polygon, circle, ellipse, angle, reflect about the line, slider, and move graphics view. GeoGebra could visualize two or three-dimensional shapes. The menus and tools help us to visualize a geometry object according to our purpose. We also could make colourful graphics with GeoGebra.

2.2. *Osing* culture in Indonesia

One of the ethnics in East Java, Indonesia is *Osing* ethnic. It is originated from Banyuwangi community that feast to some village in the middle and north part which has fertile agriculture. Those villages are in the district Banyuwangi, Banyuwangi, Rogojampi, Glagah, Singojuruh, Giri, Songgon, Cluring, and Tile district [12]. *Osing* ethnic has a unique characteristic about language, custom, society system, art, physical and the most important thing is the *Osing* Traditional House. The shape of *Osing* traditional house is an example of geometry visualization in the community. One of *Osing* tradition is *Tumpeng Sewu*. *Osing* community also has a traditional house that is still used by *Osing* community, especially in the Kemiren village.

3. Method

This research was conducted to thirty-four students of the third semester of mathematics Education Study Program at the University of Jember in Bondowoso. This research was conducted in geometry course, especially geometry space that is related to *Osing* culture, Festival *Tumpeng Sewu*. The research was conducted into three phases as presented as follows.

Phase 1: Literature review related research studies in order to develop a teaching and learning method. The objective of this phase is creating a prototype of lesson plan related to geometry space using GeoGebra as a tool and *Osing* culture as its context.

Phase 2: Developing a lesson plan related to geometry space using GeoGebra as a tool and Festival *Tumpeng Sewu* as one of *Osing* cultures as its context

Phase 3: Evaluating a lesson plan related to geometry space using GeoGebra as a tool and Festival *Tumpeng Sewu* as one of *Osing* cultures as its context in term of how students develop their knowledge in solving the given problems.

The research instruments that used to gather the data were (1) lesson plan, (2) observation sheets to observe the lecture's activities, (3) students' questionnaire, and (4) test. Observation sheet and students' questionnaire is used to evaluate practicality prototype learning geometry space using GeoGebra from Festival *Tumpeng Sewu*.

This research was analysed and described qualitatively by describing the geometry space learning using GeoGebra from Cultural Festival *Tumpeng Sewu*. There were four procedures employed to analyse the data in this study. First, analyse the result of validation based on Table 1 below.

Table 1. Validity level.

Score V_a	Validity Level
$V_a = 4$	More Valid
$3 \leq V_a < 4$	Valid
$2 \leq V_a < 3$	Less Valid
$1 \leq V_a < 2$	Not Valid

The second is analysing the result of observation sheet. The third is analysing the students' questionnaire. The result of observation sheets and students' questionnaire was used to determine the practicality criteria in the classroom. The practicality criteria of geometry space learning is analysed based on Table 2.

Table 2. The practical criterion of geometry space learning.

Percentage (P)	Practical Criterion
$85 \leq P \leq 100$	Very practical
$70 \leq P < 85$	Practical
$55 \leq P < 70$	Practical enough
$40 \leq P < 55$	Less practical
$0 \leq P < 40$	Not practical

The last step is analysing the final test score using inferential statistics. Specifically, the *t*-test was implemented using the Statistical Package for Social Sciences (SPSS). The *t*-test was used to test for statistical significance difference between the score of pre-test at the beginning and the score of post-test at the end.

4. Result

4.1. Geometry space learning

The geometry space learning begins by giving a problem with Festival *Tumpeng Sewu*. The students are asked to determine the minimum cost to make a thousand of *tumpeng*. To find the minimum cost, they have to minimize the number of rice and the banana's leaves that are used to make a cone. Formerly, the researcher reminds the students about GeoGebra that has already learned by students. Afterwards, the researcher facilitates the students to discuss and prove the theorem about the volume surface area of the cone. The students also create a visualization of the theorem proving using GeoGebra. Next, students are asked to solve the problem of *Tumpeng Sewu* with their group as the

project. The students are as well observed by the observers during the activities. The design instructional and students' projects are shown in Figure 1 below.

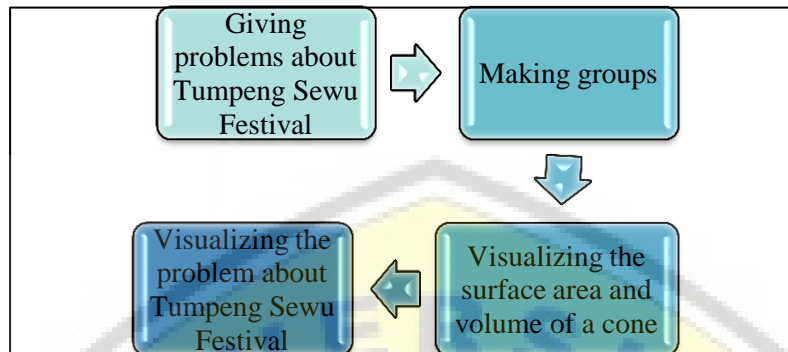


Figure 1. Diagram of geometry space learning.

One of the students' projects in visualizing the theorem of cone's volume is shown in Figure 2 below.

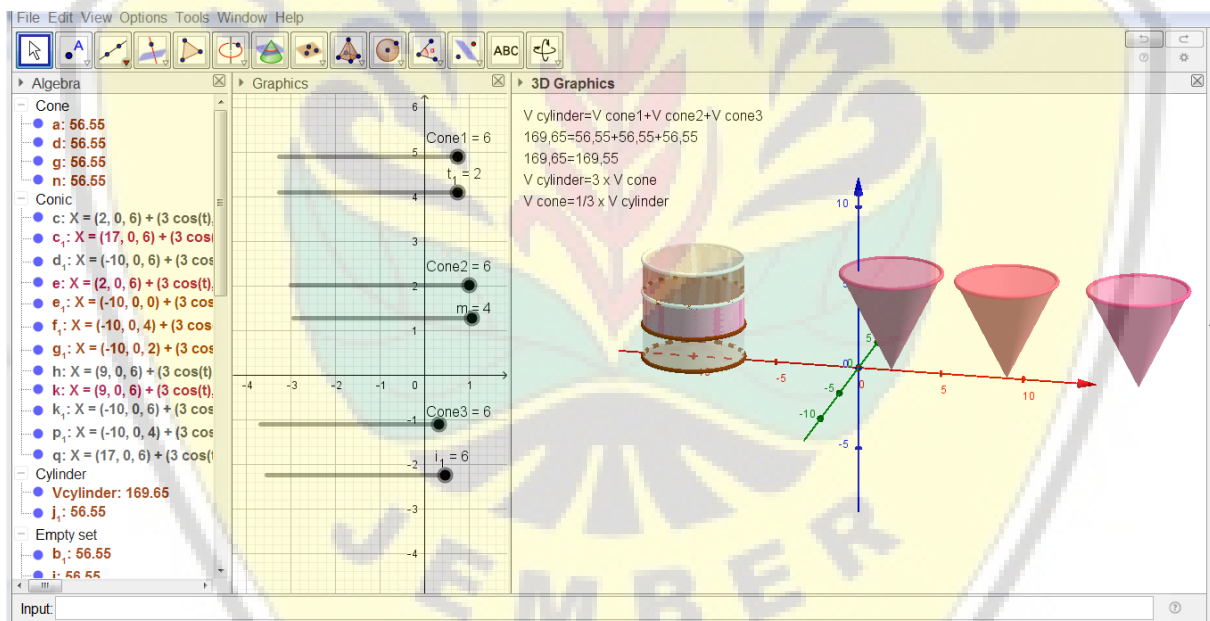


Figure 2. Proving the theorem of cone's volume by using GeoGebra.

Figure 2 shows that the students proofing the theorem of cone's volume by the volume of the cylinder. The students prove that the volume of cylinder is equal to three times the volume of cone. It also can be written as the volume of cone is equal to 1/3 times volume of a cylinder by animation in GeoGebra. It is proven that the students challenge themselves to prove the theorem by visualization. It also could explore the students' creativity because every group made different ways to prove the theorem of cone's volume.

The second task, the students are asked to solve the problem about cone's area. They are asked to find the area of cone to make the mold of tumpeng from banana's leaf. From the result of the problem, *Osing* society could predict the cost in making one thousand tumpeng. One of the students' projects in solving problem about area of cone is shown in Figure 3 below.

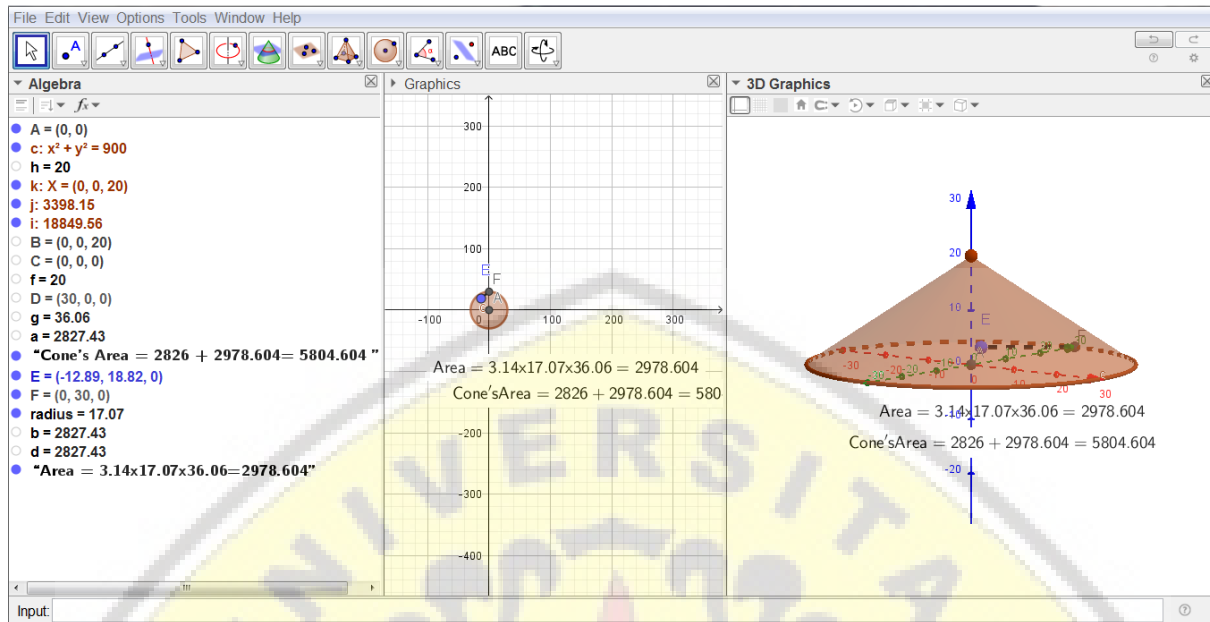


Figure 3. Solving problems about cone's area by using GeoGebra.

Figure 3 shows that the students had made the syntax to find the area of cone. So we only input the diameter and the height of cone to find the area. Then we could find how many banana's leaf that we need to make one thousands of tumpeng. So, the *Osing* society could predict the cost and make it more efficient with different size of cone. It also could explore the students' creativity to find the size to make the minimum cost of tumpeng sewu.

4.2. Practical criteria of geometry space learning

Based on the analysis of each instrument, it is obtained the results that:

1. observation lecturer sheets reach criteria practicality with the percentage of 86.32% or practical,
2. observation student sheets reach criteria practicality with percentage 84.17% or practical, and
3. students' questionnaire reach criteria practicality with percentage 91.33% or practical.

The third instrument reaches minimum practical criteria, so it can be concluded that geometry based learning using GeoGebra from festival *Tumpeng Sewu* has developed through lesson plan reach criteria practical.

4.3. Effectiveness of integrating GeoGebra in geometry space lesson from cultural festival Tumpeng Sewu

A paired samples *t*-test was executed to compare the pre-test score and post-test score. The result of the paired sample *t*-test is shown in Table 3 below.

Table 3. Result of paired sample *t*-test.

	Mean	S.D.	<i>t</i>	df	Sig. (2 tailed)
Pair 1 post-test score-pre-test score	10.441	7.715	7.891	33	0.000

The result in Table 3 shows that the mean differences between post-test and pre-test was 10.441. The *t*-value was 7.891 and $\rho < 0.5$ value was low ($\rho < 0.5$) indicating the significant differences between pre-test and post-test. From these result, it can be concluded that students have increased the final test score.

4.4. Students' perception of integrating GeoGebra into geometry space learning based on festival *Tumpeng Sewu*

As a result, the students understand more about geometry space concept and its application. Moreover, the researcher also analyses the students' questionnaire. The questionnaire items were modified from the item questionnaire by Shadaan & Leong [11]. The result of questionnaire is shown on the table below.

Table 4. Result of questionnaire.

No.	Statement	Y	N
1.	I was excited about using GeoGebra software	82%	18%
2.	I learnt a lot using GeoGebra	88%	12%
3.	I understood the concept of geometry space more using GeoGebra	82%	18%
4.	I was able to visualize the theorems proving and problems	79%	21%
5.	I was able to visualize the problems	74%	26%
6.	I could explore my knowledge about geometry concept	79%	21%
7.	I enjoyed learning mathematics much more using GeoGebra	88%	12%

Table 4 shows that students generally give a positive feedback toward integrating GeoGebra into geometry space learning. The students have learned new knowledge about learning geometry space from *Tumpeng Sewu* tradition. They also could integrate GeoGebra to visualize the problem in learning geometry so that they could understand the concept of geometry space. Then they would try to visualize other problems using GeoGebra in order to explore their knowledge and experiences.

5. Discussion

Learning by using technology is beneficial since students could be motivated to improve the learning process. Students were interested in learning geometry space using GeoGebra because they had new experience and knowledge in understanding concept geometry space. They had more experiences in understanding geometry space concept since they are requested to show the theorem of cone's volume by visualizing it using GeoGebra collaboratively. They used GeoGebra to explore their knowledge about geometry space. GeoGebra gave experience that the students could understand and solve problem about geometry easier. They could input data by themselves after they input the syntax. GeoGebra gave the result based on your data and your need because it could visualize graph in two or three dimensional. From that result, it is supported that computer prosecuted higher-order thinking skills and had a positive effect on motivating students toward learning. They could explore creative skill because the researcher allowed the students to do their own way in showing the theorem of cone's volume. They also could give full colours on the graph and make it more interest. In the end of learning process, there are some different projects of every group. They could be pleased on their work.

GeoGebra could be utilized in learning geometry, specifically in geometry space where a significant increase in understanding student. That result is supported by Shadaan [11] that states GeoGebra as an effective tool in enhancing mathematics teaching and learning, specifically in learning circles. Besides, Akkaya, et al [1] concluded that using GeoGebra is useful in enabling students to learn about symmetry better. The teachers also response that GeoGebra could help students grasp concepts in geometry [9].

Besides, learning geometry by using *Tumpeng Sewu* festival also contributes in generating students' motivation. They had new experience and knowledge about learning geometry space by using *Osing* culture its context. Finally, students feel challenged for complete problems related to that tradition. It is shown that the use of technology, specifically GeoGebra leads to the solutions of a real-world problem [5]. The students could be motivated to integrate another culture besides them in order to understand the geometry concept. They could understand more about geometry because they practice to solve the problems by doing.

6. Conclusion

In this study, integrating GeoGebra in learning geometry space had to be an effective way in improving mathematics teaching and learning, especially in learning cone. It could help students to understand the concepts. GeoGebra as mathematics dynamic opened-source software provides an opportunity for lecturer and students to learn and visualize mathematical concepts. This is supported the interactive interactional environment where everyone works collaboratively, help and assist another one to reach the learning outcomes. Besides, geometry space using GeoGebra learning has created an *Osing* culture gave a new experience. It could make the students challenge themselves, satisfy their potential and explore their learning process. Teaching geometry using GeoGebra could make the students excite to visualize geometry space relate to the theorems and problems. While applied GeoGebra was an effective tool in learning geometry space from Festival *Tumpeng Sewu*, it is highly recommended as an alternative media to facilitate students in teaching and learning geometry to increase effective teaching methods and learning process.

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