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The Effects of Video Tutorial Screencast SketchUp Make (VTS-SUM) in Learning 3D Geometry for Low Achievers

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Abstract Problems in learning 3D geometry are related to students' spatial abilities that require them to create mental images representatives of the objects. Studies had shown that 3D software should be incorporated into teaching in order to assist students in visualizing. However, students often exhibit difficulties when using it as they are not familiar with tools and could not remember steps in completing a task. The purpose of the study is to examine the effect of a learning strategy which uses video tutorial screencast SketchUp Make (VTS-SUM) for topic plan and elevation, in mathematics for upper secondary school in Malaysia. The videos were designed using ADDIE Model which integrated screencast technique with a 3D software (SketchUp Make). A total of 30 low achiever students from one secondary school were involved in this study. They watched the video tutorials and performed hands-on activities using the software to complete the tasks. This paper includes a report of a usability test which used a seven point Likert scale. The questionnaire consists of four constructs: usefulness, ease of use, ease of learning and satisfaction. The findings showed that all means were at high level and the highest mean was satisfaction. Furthermore, pre- and post-test were also administered to students. The results of the paired sample t-test revealed that, there were significant differences in the mean scores of pre- and post-test, before and after learning via VTS-SUM ($t=-4.30$; $p<0.05$). Thus, we can conclude that VTS-SUM can be a potential learning strategy that enhances students' achievement in 3D geometry.

Keywords Video Tutorial, Screencast, SketchUp Make, 3D Geometry, VTS-SUM

1. Introduction

Students' performance in geometry is very alarming to educators. A report from Trend in Mathematics and Science Studies (TIMSS) showed that only 33% of Malaysian students answered correctly the geometry questions, 53% of the students mastered the cognitive domain of reasoning and 28% in the cognitive domain of reasoning [1]. The results indicate that students are having problems in learning geometry. Studies had shown that students who were struggling in learning geometry were also having low spatial abilities [2], [3], [4]. Spatial abilities include the capability to mentally represent and manipulate three-dimensional (3D) objects [5], [6]. Hence, mode of teaching that enhances spatial abilities should be implemented by teachers in class.

Teaching 3D topic is very challenging to teachers. According to [2], the teachers prefer to use 2D drawings and 3D models, but both teaching materials are considered ineffective while explaining 3D objects because they are inadequate to illustrate the 3D objects [7], [8]. Studies have proven that using manipulatives tools can enhance students' spatial abilities [9], [10], [11]. Thus, 3D software should be utilized among students. However, teachers are having problem when using the software in teaching students with different levels of cognitive [8]. Meanwhile, students also have problems in using tools as they cannot remember all the steps of using the tools to complete the task given to them [12].

Thus, we propose screencast technique to overcome the problems. Screencast is a tool that captures any activity on the computer screen using software [13]. In this study, SketchUp Make is chosen as 3D modelling software.

Moreover, plan and elevation is selected as a topic in 3D geometry for mathematics in upper secondary school. Problems that had been highlighted in this topic were students failed to correctly plot dashed lines (hidden sides) for Y-elevation and X-elevation and also their incapability to compare objects and orthogonal lines [14].

In Malaysia, most of the studies on Geometry, focused on students in elementary schools [15], lower secondary schools [16] and upper secondary schools [11]. Not much study in Malaysia related to geometry had been conducted for low achievers at upper secondary schools. Hence, the above discussion has prompted the researchers to study and identify the appropriate solutions which involve low achievers from upper secondary school. The objective of the study is to determine the effects of a learning strategy using VTS-SUM for topic plan and elevation in 3D geometry. The aim of this study is to examine students' perception of using VTS-SUM and to investigate the effects of VTS-SUM on students' achievement.

2. Background of the Study

2.1. Screencasting

VTS-SUM was developed using ADDIE model for two learning objectives: the concept of orthogonal projection and the concept of plan and elevation are as shown in Table 1.

Table 1. VTS-SUM using ADDIE Model

Stages	Attribute

Analyse	• Learning Environment
	  • Tools, time, expert
	• Learning Content
	  • Content, Learning Objective
	• Behavioral Determination
	  • Spatial abilities, level of geometrical thinking
	• Identifying Learning Object Learning Outcome

Design	• Design Objective • Develop item • Select Learning Strategy
Develop	• Develop Flow Cart • Develop VTS-SUM • Produce VTS-SUM
Implement	• Pilot Test
Evaluate	• Formative • Summative

VTS-SUM integrates screencast technique using a software (Camtasia Studio) with a 3D manipulative software (SketchUp Make). Screencast videos are known as 'how-to' video that support users to learn new tools for a new software [17], [18], [19]. Camtasia studio was chosen as it was the best-known screencasting software [20]. It contains audio narration and 'visual effects' such as callout (wide arrow with text). The special effects as shown in Figure 1 are also known as interactive elements [20].

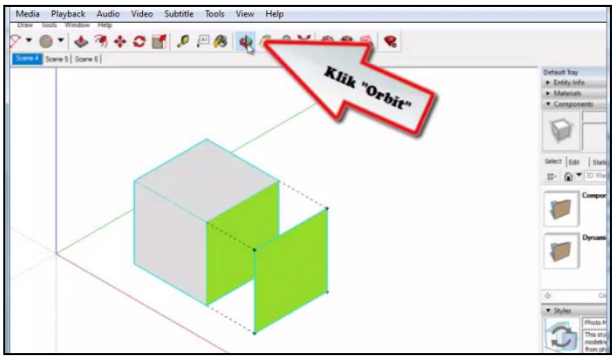

Figure 1. Callout using Wide Arrow in VTS-SUM

These effects aim to assist students to view all steps involved in completing the tasks [21]. Studies have shown that screencast videos could reduce learners' cognitive load [25] and promote self-paced learning [13].

2.2. SketchUp Make

SketchUp Make is free 3D software which is widely used in teaching 3D Geometry [9], [10], [11]. Four main tools are highlighted in the videos to assist students in visualizing the objects as shown in Figure 2.

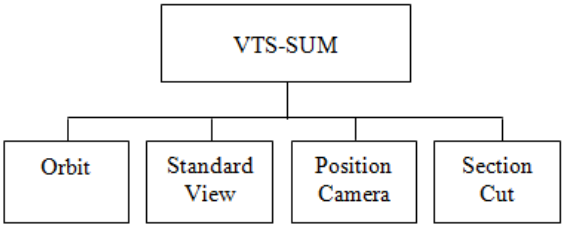

Figure 2. Four main tools embedded in VTS-SUM

The orbit tool is used to rotate the 3D object while the standard view tool is used to transform the 3D object to 2D orthogonal plane. Figure 3 and 4 show steps in using standard view tool to view the 3D object from top using VTS-SUM.

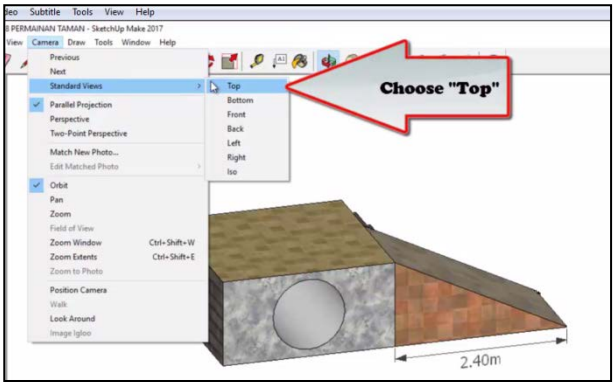

Figure 3. Steps in using standard view tool

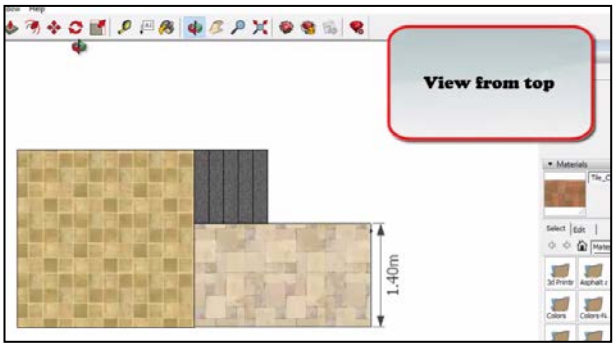

Figure 4. Top view of 3D object

The position camera tool is used to view the 3D object from certain angle as shown in Figure 5.

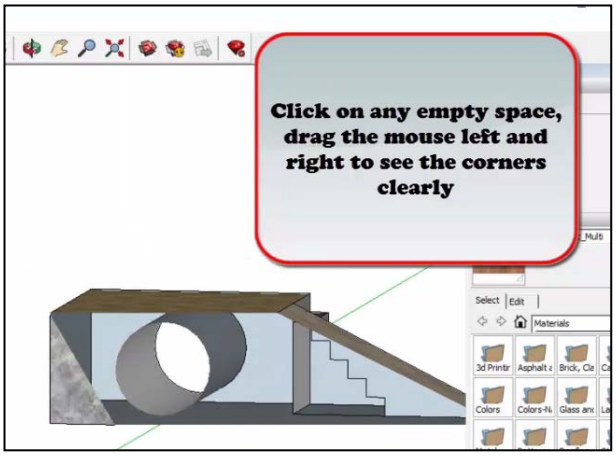

Figure 5. View of the angles in 3D object

The section cut is used for cutting the 3D object to see the hidden lines in the object. Figure 6, 7 and 8 show the steps in using section cut tool.

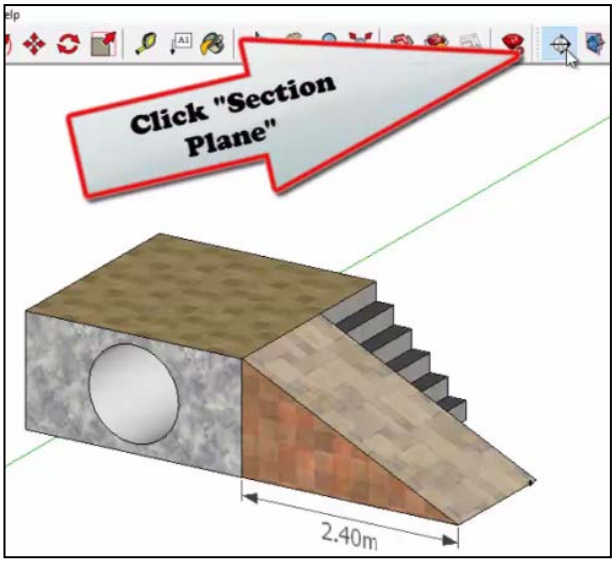

Figure 6. Section Plane icon in VTS-SUM

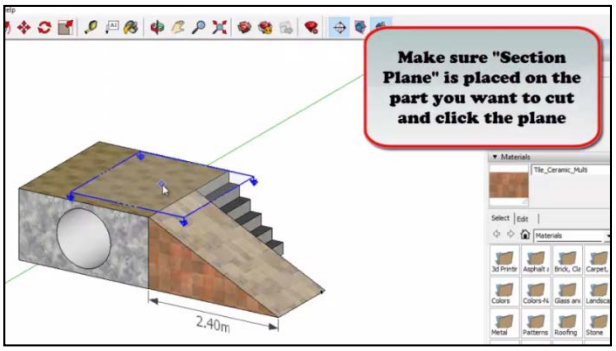

Figure 7. Position of selection plane on 3D object

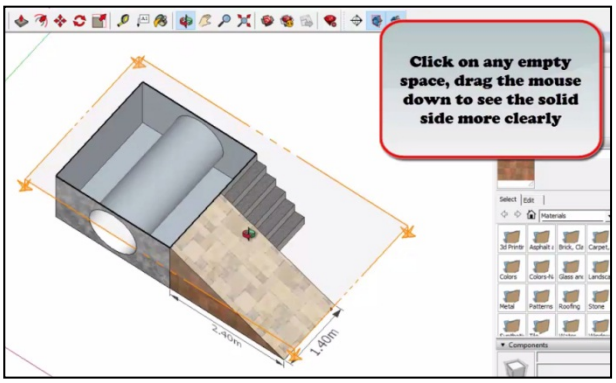

Figure 8. Hidden lines in 3D object

The selection of tools in SketchUp Make could enhance students' performance in mathematics [8], [23], [11], visual spatial skills [11], [24], [25], level of geometrical thinking [11],[24] and geometric skills [25].

3. Methodology

This study was conducted using the method of quantitative research which includes collection of quantitative. Onwards, this study was carried out for four weeks through a quasi-experimental design approach that involves single group with pre and post data collection.

This study involved 30 low achiever students, 18 female and 12 male. Low achievers' students were referred to students who obtained the lowest marks for the end year of form four Mathematics Modern examinations. Students had been learning Plan and Elevation in the traditional methods earlier than after that they were exposed by learning through VTS-SUM. They received instruction in a computer laboratory and they were introduced to SketchUp Make for six hours where they carried out exercises using the tools as shown in Figure 9. After that, they took the course using VTS-SUM with worksheets. During the course, the students completed the activities on the worksheets. Pre-test was conducted after attend classes in traditional way and post data collection was carried out shortly after the students attended the activities.

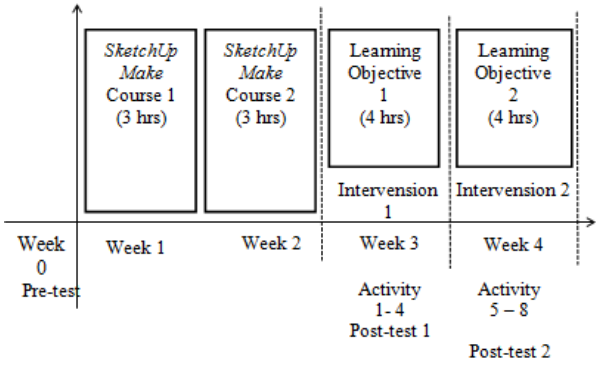

Figure 9. Design procedure for one group time series

This study naturally implemented quantitative method. The quantitative data were collected by using three tools; two tools were taken from the pre- and post-test and another tool was taken from the usability test. Questions for pre- and post-test were developed based on two learning objectives: drawing orthogonal projections and drawing plan and elevations for solid objects.

Meanwhile, usability is defined by the International Standards Organization's "Ergonomics of Human System Interaction Part 11: Guidance on Usability" [27] as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". In this study, the usability is defined as students' acceptance of VTS-SUM. The test consists of four constructs: usefulness, ease of use, ease of learning and satisfaction. Usefulness is to determine if the students will find the video tutorial is useful to them and ease of learning is to examine whether the video tutorial is easy for the students to use in learning. Meanwhile ease of use is find out whether the video is easy to be used for students with different cognitive levels, whereas satisfaction is to test the students' acceptance of the video. The questionnaire is referred to as USE (Usefulness, Satisfaction, Ease of Use and Ease of Learning), developed by [28].

4. Results and Discussion

Table 2 presents the descriptive statistics of the usability test. The findings revealed that the means of all of the constructs were high and the highest mean is 'Satisfaction'. This implies that students had positive perception on VTS-SUM. This proves that screencast technique is capable to assist learners in learning new software [17].

Table 2. Usability test

Construct	Mean	Standard Deviation
Useful	6.03	0.53
Ease of Use	6.04	0.58
Ease of Learning	6.01	0.59
Satisfaction	6.09	0.51

Furthermore, pre- and post-test were also deployed to students to measure students' achievement prior and after treatment. The results of the paired sample t-test revealed that, there were significant differences in the mean scores of pre- and post-test, before and after learning via VTS-SUM ($t=-4.30$; $p<0.05$). As shown in Table 3, the mean scores increased in the post-test. Therefore, the learning strategy using VTS-SUM had increased students' achievement in topic plan and elevations. The findings are also supported by [23] that SketchUp Make could enhance learners' performance in learning mathematics.

Table 3. Paired sample t-test results of pre- and post-test

Test	N	Mean	SD	df	t	p
Pre	30	5.88	1.72	29	-4.30	0.00
Post		7.48	1.61			

5. Conclusions

This study investigated the effects of a learning strategy using VTS-SUM for topic plan and elevation in 3D geometry. The aims of this study are to examine students' perception of using VTS-SUM and to investigate the effects of VTS-SUM on students' achievement. The findings indicated that students had positive attitude towards this mode of teaching. Moreover, the findings also showed that the teaching strategy had increased students' performance in topic plan and elevation. Thus, VTS-SUM can be recommended to teachers. Therefore, the Ministry of Education (MOE) should take initiative to conduct training to teachers on how to use VTS-SUM as learning objects for blended learning. Meanwhile, VTS-SUM can also be recommended to students as their supporting materials. Further studies may investigate the effectiveness of this learning strategy using control group and treatment group. We believe that the learning strategy using VTS-SUM can support students to develop the knowledge and skills required for Malaysian society.

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