The Effect of Learning Plan and Elevation Using Orthogonal Projector Kit (OPK) as A New Teaching Aids with Innovation ICT in Teaching and Learning

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Abstract: The study aims to investigate the effects of using Orthogonal Projector Kit (OPK) on the topics of Plan and Elevation of mathematic topics among form 5 students in Malaysia Secondary school. OPK was created to enable students to touch and feel the objects that they need to draw and also give them a concrete experience through this concept. OPK consists of an Orthogonal Projector (OP), Colored Skeleton Blocks (CSB) and a module for teaching and learning. In this study, quasi experiment was use consisting of one experimental with non-equivalent control group pre-test and post-test research design. The quantitative data was analyzed by performing a t-test. Treatment group had a significance difference (M = 86.40 , SD = 5.667) compared to the control group (M = 73.40, SD = 8.240) conditions; t (60) = 7.120, p < 0.00. The use of OPK as a manipulatives in T&L in mathematics classroom has positive effect on the student's achievement and helps improved understanding in the topics of Plan and Elevation Mathematics Form 5.

Keywords and phrases: Orthogonal Projector Kit (OPK), achievement, effectiveness, Plan and Elevation

1. Introduction

Mathematical education in Malaysia is growing tremendously in line with the demands of society towards the enormous challenge in the environment. The community expect education will provide the opportunity for all students to be mathematical literacy. Teachers need to upgrade their strategies in order to improve the achievement of the students.

But teachers still tends to carry out traditional method. In fact, whiteboard and speech remains to be the main teaching method to deliver contents of mathematics while students learning without any other interactive teaching aids. Moore (2012) agreed that using traditional method likes textbooks and teacher-centered without assisted by teaching aids cutting off development of student proficiency visualization and understanding of the concepts of geometry. Teaching aids can be manipulative materials in the form of physical and also in the form of software. Therefore, the use of manipulative materials as teaching aids should be used to achieve learning objectives and thus, produce conducive and effective atmosphere in teaching and learning (T&L) (Allen, 2007). This matter is supported by Marshall and Swan (2008) who both prove the use of manipulative materials that can be touched, can

build students understanding in details as well as the involvement of students in T&L makes learning more fun. According to Allen (2007), the use of manipulative materials could help draw the focus and motivation of students since manipulative materials can be touch.

However, researches belief that the integration technology using software as virtual manipulative materials in T&L can increase student understanding and visualisation of geometric topics. It has been proven from study made by Hock, Tarmizi, Yunus, and Ayub (2015) that the use of teaching aids are parallel to the use of technology and can enhanced student visualization skills. In fact, the use of technology in the process of T&L will be able to help student achievement and mastery (Okumus and Hollebrands, 2010; Surif, Ibrahim Abdullah, and Ali, 2012; Yilmaz, 2015). Most studies conducted in other alternative agreed that student motivation and achievement will develop by integrating technology in T&L (Moore, 2012; Jia Leong and Eu, 2016).

However, research in the field of education identifies that the learning process will run successfully if students construct their own knowledge of mathematics based on the use of teaching aids (Boggan, Harper, & Whitmire, 2010). Therefore, educational policy in Malaysia has been enhanced by adding elements of Higher Order Thinking Skills (HOTs) in Malaysia Education Blueprint (MEB) 2013-2025 in order to compete at a global level. In this context, the used of manipulative materials along with technology in the lessons can potentially tap into higher order thinking skill from students in Malaysia.

2. Background

Basic geometric shapes have been introduced and taught formally since pre-school, primary and secondary school in mathematics. This disclosure covers 2 dimension (2D) shapes such as circles, triangles and squares in low level before switching to the more complex 3 dimension (3D) shapes such as cubes, cubic, cone and pyramid. Students in secondary schools also covered topics such as unit measurement for length, mass and volume while in form 1, transformations, geometry construction and surface area for 3D shapes. In accordance with the steps introduced in the Van Hiele Theory which asserts every individual should have the experience of learning geometry for each level before developed to higher levels in the Van-Hiele hierarchy of geometric thinking. Besides mathematics, there are also other subjects which have common syllabus to Plan and Elevation. Orthogonal projection has been taught in the subject of *Kemahiran Hidup* and *Lukisan Kejuruteraan* while students are in form 2 and form 4. However, research by Mohd Safarin N. dan Diyana, A.R. (2010) showed that students are still not able to imagine mutual link between objects in everyday life with Plan and Elevation questions asked. It means that the visualization skill among students were at a low level even though they have knowledge in the field of geometry.

National Council of Teachers (NCTM, 2000) listed geometry as one of ten basic skills in mathematics to be learned. However, students at the secondary level is seen has a low level to understand topics of geometry more effectively (Noraini, 2007). Based on the *Trends in International Mathematics and Science Study* (TIMSS) report on 2015, Malaysian students only achieved medium level in the field of geometry with average score of 465. While the average score for the highest level of international benchmarking for TIMSS is 625. Based on the report from *Lembaga Peperiksaan Malaysia* (LPM), higher performance level candidates on SPM 2014 in mathematics is excellence in skills involving questions on plan and elevation. But not for medium (medium-performance candidates) and low (weak-performing candidates). This is because, according to the report, candidates from both groups was not able to draw accurately and neatly. They are weak and didn't

take seriously to answer questions given which causes the quality of the answers provided were very low.

Therefore, OPK was develop, to increase the understanding of students of the topic Plan and Elevation. OPK as teaching aids has been designed in this study not only use technology as its primary material but it acts as a manipulative materials that can be touch, hold and try by students either individually or in groups. OPK must be connected with computer and students can see front view and side views as well as views of the actual solid shape applied to a laptop screen. An overview of the Plan and the elevation will be reflected clearly and precisely. Hence the use of OPK as teaching aids in the T&L is reviewed to improve students' knowledge of geometry. Student achievement is measured for effectiveness.

3. Orthogonal Projector Kit (OPK)

OPK consists of an orthogonal projector (OP), colored skeleton blocks (CSB) and a module for T&L by using it. As a new teaching aid with innovative ICT, the main purpose of using OPK is to assist teachers and students in the process of T&L in topic Plan and Elevation, Engineering Drawing and Orthographic Projection. This OPK has been tested in schools and it can improve student's achievement in the subject that being taught.

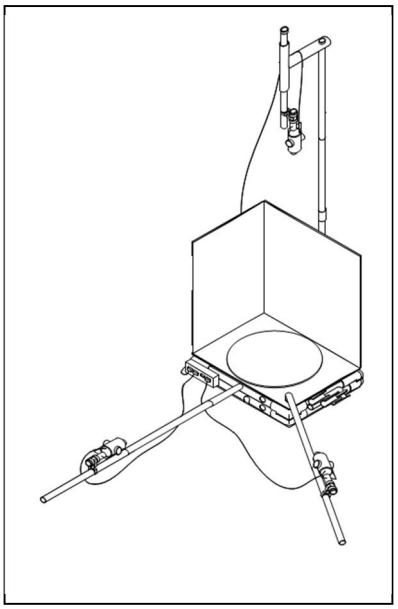

Figure1: Orthogonal Projector (OP)

3.1 Orthogonal Projector

OP is an innovative ICT teaching aids developed for use as a manipulative materials that will be used during the process of the T&L for topic of Plan and Elevation, Drawing and Painting Orthographic Projection. The structure of the OP is made by PVC pipes while all sites and barrier of OP are made from modeling board as in Figure 1. OP is equipped with three webcams that are put in a different position. Webcams function is to look at CSB from the top view, front and side view and can be adjustable to get the best view. PVC pipe that holds the camera are also can be adjusted to get

the best view of CSB where PVC pipe that holds the camera of top view can be lowered or raised, PVC pipe that holds the front camera can be lengthened or shortened and PVC pipe that holds the camera side can be moved to the left or to the right. Not only that, students and teachers are capable to take pictures and record videos of the CSB through the web cameras and stored on the laptop. At the same time, the display can also be viewed on the screen when connected to a LCD projector. Students can understand the concept easily because CSB are built with different colors of yellow, red and blue for each sides. The students can see the difference image of the top view, front and side view. OP has been tested in schools and increased student achievement in the subject being taught.

3.2 Colored Skeleton Blocks (CSB)

CSB are provided along with OP where students can see all sides of the CSB clearly because it is colored with three different colors, which are yellow, red and blue as in Figure 2. The used of CSB are recommended because it is easier to understand the concept compare to solid blocks. If solid blocks being used, students cannot clearly see the back side of those blocks from the point of view of the webcam. But using CSB, all sides of the CSB can be seen clearly which because it is colored with different colored. Students can draw Plan and Elevation by identify which side of the CSB that is in front and behind for the angle of webcam that they want. However, the OP also can be used with other object to draw Plan and Elevation of the object. The use of manipulative can make the curiosity of students increased and enhanced HOTs.

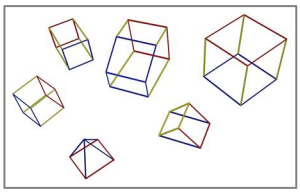

Figure 2: Colored Skeleton Blocks (CSB)

3.3 Module

This module consists of the manual using OP and a teaching module by using OP for topic Plan and Elevation. Based on the manual, users will able to learn step by step from the beginning, on how to install the OP, connect it with a laptop, change the webcam's viewer until the way to fold and store it. Teaching module was built according to the specifications of the mathematics curriculum for form 5, which comprises three main objectives; to understand the characteristics of geometric cube, cuboid, prism, cylinder, cone and sphere; understand and use the concept of orthogonal projection; understand and use the concept Plan and elevation.

4 Methodology

4.1 Research Sample

A total of 60 Form Five students were involved in this quasi-experiment study. They consisted of 30 students in the treatment group, who are those learning the form five's Plan and Elevation topic by implementing T&L with the assistance of the OPK and 30 students in the control group who learned the same topic conventionally. A school is selected in Kuala Selangor district, Selangor based on infrastructure and computer lab facilities.

4.2 Research Instrument

Achievement test were used for data collection containing the pre-test and post-test. The purpose of conducting the achievement tests is to investigate the effect by implementing T&L with the assistance of the OPK achievement Plan and Elevation topic on students' achievement. Pre-test and post-test consists of five questions that assess the level of mastery of the subject students to Plan and Elevation. Three simple questions were form from simple geometry topics on Mathematic form 1 until form 4 and two questions on problem solving similar with real SPM questions given to students to test their understanding of concept of Plan and Elevation in mathematic. Pre-tests carried out on both the control group and treatment group before treatment. At the end of the treatment, post test are given to both group to test their achievement on this topic. The Cronbach Alpha value is shown on Table 1 indicating that the reliability of the achievement test is appropriate.

Table 1 Reliability between Pre-test and Test Post

Test	Cronbach Alpha
Pre	0.685
Post	0.757

4.3 Instructional Materials

The goal of instructional activities in this study was to improve achievement in Plan and Elevation. For treatment group, module for T&L have been prepared for the teachers to use during the treatment. Teaching module will serve as a guide to give emphasis on topics that need to be taught and learned. Its contains three main objectives; to understand the characteristics of geometric cube, cuboid, prism, cylinder, cone and sphere; understand and use the concept of orthogonal projection; understand and use the concept Plan and Elevation. The treatment group using OPK as T&L strategies along with colored skeleton blocks (CSB) and the teaching module. OPK can be used with CSB or any other materials as a manipulative materials. Images will be transmitted after OPK connected to a laptop or computer. Students can improved visual skills by imagine images for each object at the same time increasing their achievement.

4.4 Data Analysis

Data from students' achievement in pre-test and post-test were analyse using quantitative analysis. The data obtained were analyzed using Statistical Package for the *Social Sciences* (SPSS) version 24.

5 Results

5.1 Effects of OPK on Plan and Elevation achievement

The result as shown in Table 2 show the difference on the topics of the Plan and Elevation between treatment group and the control group. Mean score (mean = 18.27; Standard deviation = 7.534) and from treatment group is approximately equal to the mean score for the control group (mean = 19.80; Standard deviation = 6.895). Then both groups treatment and control features of the distribution of the respondents are almost the same in terms of the level of understanding on topic Plan and Elevation before the treatment are given.

Table 2. Pre-test and post-test between the treatment and control group

	Control Group (n=30)		Treatment Group (n=30)				
	M	SD	M	SD	*Df*	*t*	*P*
Pre- test	18.27	7.534	19.80	6.895	58	0.822	0.414
Post-test	86.40	5.667	73.40	8.240	58	7.120	0.000

The mean difference is not significant at 0.05

Table 2 shows the Independent Sample t-test analysis. There is a statistically significant difference between the mean of group treatment and control group ($t(58) = 7.120$, $p > 0.05$) of the dependent variable which is learning behavior of the post-test according to groups. The result of post-test increased by 68.13% compared with pre-test. This result shows that there is significant difference in post-test scores on both treatment and control groups after using each approach in T&L. Findings indicating there are differences impact on teaching strategies using OPK compare with the group using traditional teaching. The mean score for the treatment group showed better improvement than the control group. These results clearly show the effect of learning Plan and Elevation using OPK in T&L improving the achievement of students.

6 Discussions

6.1 The effectiveness of the OPK to students

From the results obtains, both treatment and control group showed an improvement in performance, but increase from the treatment group is larger than the control group. In other words, the use of mathematical models of the OPK in the T&L increasing students' achievement in Mathematics for 13%, based on the mean score of 86.40 compared to 73.40. Effectiveness depends on how T&L process between teachers and students. In Malaysia, the T&L are still using traditional methods as the main method even though 21st learning century has been highlighted in the T&L. One-way Communications only restrict students to mastery of mathematics at once led to the decline in math achievement.

6.2 Implementation in T&L Plan and Elevation

Teaching strategies using OPK will be able to help improve student proficiency in making visuals for students on Plan and Elevation. Although this study did not carry out a visual examination to assess the visual learner proficiency stage, but several studies have shown off the use of manipulatives increased students visual skills indirectly on the basis of the achievements of students (Shaw, 2002; Noraini, 2005; Marshall & Swan, 2008; Howse & Howse, 2014).

Based on findings obtained, this study can be used as a reference on educational policy makers so that the new measures more proactive in the use of manipulative physical nature or software in mathematics (Noraini, 2009; Azlina & Lok, 2010). However, this study contradicts the study conducted by (Azlina & Lok, 2010; Noraini, 2009; Abd Halim & Effandi, 2011; Abd Halim & Effandi, 2013; Abd Halim et al., 2014, Žilinskiene & Demirbilek, 2015) on running Geometers' Sketcpad software (GSP) and Geogebra. GSP software and Geogebra has widely used around the world and in Malaysia in T&L geometry. According to studies performed by, (Žilinskiene & Demirbilek, 2015), in spite of using technology in T&L, it is not necessarily dominated the whole

process of T&L as it does not meet the needs of students to master and understand Mathematic. In addition, the results of this study, support research made by Boggan et al. (2010) and Toptas, ÇelIk, who found the use of manipulative in T&L will be able to improve student math achievement compared to the use of traditional methods of T&L.

Thus, using OPK in T&L can be used as an alternative strategy successfully increasing achievement of Mathematic students. Collaboration between school administration system, in order to implement changes in T&L teachers and student preparedness will be able to maximize the effectiveness of the OPK for the future of the students and the success of our education system.

Conclusion

Based on the results and discussion, it can be said that T&L using PO is an effective strategies to increase students' achievement in Plan and Elevation topic. This proves that the use of manipulative are able to improve students mathematical concepts (Boggan et al., 2010). Compared with traditional teaching strategies that more to teacher-centered, the use of teaching aids either in the form of manipulative physical or in the form of software makes the process of T&L goes smoothly. To strengthen the use of technology in T&L, teachers are advised to be more open-minded and creative in finding appropriate teaching strategies. Teachers should be out of the scope of traditional teaching and be more creative with the use of teaching aids and manipulative materials. The learning process will be more meaningful and fun when every students in the class are involved in the process of learning.

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