Application of Virtual Learning Environment in the Teaching of Engineering Drawing to Enhance Students' Mental Rotation Skills.

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Abstract

Virtual learning environment seems to transform education process in a more flexible way as compared to other modes of learning and have great potential in ensuring successful learning. This study investigates the effectiveness of virtual learning environment in teaching engineering drawing in order to enhance mental rotation skills. A quasi- experimental design study was used involving engineering students in Universiti Teknologi Malaysia. The intervention group in this study was exposed to virtual learning environment courseware. Students in this study were given a pre-test before the intervention and a post-test prior to the intervention. The result of this research indicates that there are significant improvements in the mental rotation skills of the students who were being exposed to the virtual learning environment. This study also investigates the gender differences in visualization skills. Thus, this study shows that using courseware in the teaching of engineering drawing can act as a catalyst in enhancing productivity and quality of engineering drawing. As a result, students are capable of enhancing their visualization skills which is vital in engineering drawing.

Keywords. Virtual learning environment, mental rotation skills, gender differences

1 Introduction

1.1 Problems Faced by Students in Engineering Drawing

Engineering drawing is one of the essential subjects to be taken by engineering students. The goal of engineering drawing subject is generally on improving the skills of using standard geometry, geometry equipment as well as the abilities in developing visual images [9]. Many researchers had conducted research on the difficulties encountered by engineering drawing students. One of the problems involves difficulties in seeing images in three dimensions or known as visualization [8] and difficulties in transforming an object in 3D or isometric drawing into an image in orthographic drawing [10]. In addition, students are having difficulties in connecting various views mentally when visualizing the cutting of object mentally using 2D drawing [12]. Engineering students need to improve their visualization skills as it plays an important role in explaining the process, ideas and concept in engineering drawing [2].

Problems faced by students in learning engineering drawing can be overcome by using suitable teaching methods and teaching aids. However, many lecturers face difficulties in developing students' understanding when they solely depended on static media such as sketches on the blackboard or printed modules [1]. This failure caused students to visualize only the abstract on a dynamic content of a subject [1]. The trend of using computer technologies in education especially the use of teaching courseware has generated a positive contribution in improving transmission of technical information and understanding of spatial configuration. Thus due to its advantages, virtual learning environment approach can be applied in order to increase knowledge proficiency and also enhance visualization skills among students. Recent studies found that virtual learning environment is effective as a learning medium in engineering drawing topic [4].

1.2 Gender Differences in Visualization Skills

The issues on gender differences and their relation to visualization skills have been studied by many researchers. Most researchers discovered that male students achieved better than their counterparts in terms of mastering visualization skills [6]. In addition, Vanderberg and Kuse [13] found that male students performed better than female students in terms of mental rotation. However, there are findings which show that there are no differences between genders after going through spatial training [11]. Furthermore, differences between gender in mental rotation ability are also getting smaller after appropriate training [5] showed that sex difference in cognitive and psychosocial are getting smaller in which they promote designing re-learning environment in promoting gender equality. Therefore, the objective of this study is to determine the level and gender differences in mental rotation skills among students who are pursuing their undergraduate studies in UTM Skudai.

2 Methods

This study was conducted at Universiti Teknologi Malaysia, Skudai Campus involving undergraduate engineering students as respondents for this study. Purdue Spatial Visualization Test: Rotation (PSVT: R) which is the standard visualization test are used in order to determine students' level of mental rotation skills. The methodology in this study are quantitative method with the studies are being analyze using descriptive and inferential statistics. The data collected for this study are analyzed using the Statistical Packages for Social Science (SPSS) version 13.0.

3 Results and Discussion

4.1 Pre-Test before learning using virtual learning environment

Descriptive analysis were used in analyzing this pre-test results to find out the level of mental rotation skills of students before being exposed to the virtual learning environment. Table 1 shows the mean and standard deviation of the pre-test Purdue Spatial Visualization Test: Rotation (PSVT:R).

Table 1. Mean and standard deviation of the pre-test visualization test

Visualization Test	Group	N	Mean Scores	Standard Deviation
PSVT:R	Experimental	30	61.333	7.608

The experimental group has an average mean scores for the PSVT:R (M= 61.333, SD= 7.608). This finding shows that respondents from this group had a moderate level of 3D mental rotation skills before they were exposed to the virtual environment courseware.

4.2 Post-Test after learning using virtual learning environment

This post-test is done to determine the skills of mentally rotate 3D object skills among the respondents in the group based on the differences of the average scores of PSVT:R pre-test and post-test by analyzing the data using t-test. Table 2 shows the differences in mean scores PSVT:R pre-test/ post-test. Hypotheses of the study are as follow:

Ho There is no statistically significant difference in mentally rotate 3D object skills.

Table 2. Differences in mean scores PSVT: R pre-test/ post-test

Paired sample statistic

	Mean	N	Std. Deviation	Std. Error Mean
PSVT:R PRE	61.333	30	7.6083	1.3891
PSVT:R POST	70.333	30	12.9301	2.3607

Paired sample test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			

PSVT:R PRE PSVT:R POST	-9.0000	14.5210	2.6512	-14.4222	-3.5778	-3.395	29	.002

Based on the results, the average score in the PSVT:R test shows that the post-test results (M= 70.333, SD= 12.9301) are higher than the pre-test results (M= 61.333, SD= 7.6083). Paired sample test results indicates that there was in increase in the PSVT:R scores (M= -9.000, SD= 14.5210) among the respondents after going through teaching and learning process of engineering drawing using the virtual environment courseware. The increase was significant at the $t(29) = -3.395$, $p < 0.05$. This results shows that virtual environment courseware helps improving the students' mental rotation which significantly higher than before they are being exposed. This is because Mayer [7] had shown that students' visualization ability is related to student's achievement in the use of multimedia learning. Virtual environment approach in learning engineering drawing is useful as cognitive tools which also provide unavailable symbol in real world which makes the abstract more concrete.

4.3 Gender Differences after learning using virtual learning environment

This section analyzes the differences between male and female respondents in the score improvements of the PSVT: R test after the intervention being implemented on the group. Table 3 and 4 shows the gain scores in mentally rotates 3D object tests according to gender and independent samples test. Hypotheses of this study are as follows:

Ho there is no statistically significant difference in mentally rotate 3D object skills between male and female students after being exposed using the virtual environment courseware in orthographic projection.

Table 3. PSVT: R post-test gain scores according to gender

Group	N	Gain Scores (GS)	Std. Deviation
Male	19	11.580	10.579
Female	11	4.537	16.124

The results shown in the table indicates that gain scores for male is higher (GS= 11.580) than the gain scores for female (GS= 4.537). Male's skills in mentally rotate 3D object skills are higher than females after being exposed to the courseware.

Table 4. Independent sample test for test scores in PSVT: R post-test between male and female respondents

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
PSVT:R POST	Equal variances assumed	1.151	.293	-1.191	28	.244	-5.7943
	Equal variances not assumed			-1.066	15.085	.303	-5.7943

Results shown in the table of independent sample test shows that the value of 1.151 at significant value .293 which is small. Hence, the null hypotheses stated that the two population variances were equal was rejected and the value of t-test not assuming equal variances were used to determine the significant differences. Independent sample test shows that value of t-test with no equal variances was 1.191 at degree of freedom equal to 28 and $p>0.05$ which makes the null hypotheses accepted. The study showed no significant differences in mentally rotate 3D object skills between male and female respondents after being exposed to the virtual learning environment courseware and was supported by Gorska et al. [3] which found that there is no significant difference between male and female in visualization ability especially in mental rotation skills. This finding also indicates that teaching using virtual learning environment courseware helped to reduce the

gap of visualization skills between male and female students and proves that this courseware is able to act as spatial appliances which can help enhance students' mental rotation ability.

4 Conclusion

Usage of courseware in teaching and learning process can improve the performance of engineering students in the visualization skills especially in engineering drawing subjects. This is because engineering drawing requires a high level of visualization skills to solve engineering drawing problems. Hence, the findings from this study support the conclusion that the virtual learning environments become one of the key factors in the delivery of education in higher education which this method can be a catalyst for productivity and quality of engineering drawing education. Other than that, this study had demonstrated the effectiveness in bridging the gap of visualization skills between male and female with the use of virtual learning environment. The use of new technology like virtual environment can increase the quality of education especially technical and engineering education to a more prestigious world-class standard.

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