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Effectiveness of Integration of Learning Strategies and Higher-Order Thinking Skills for Generating Ideas among Technical Students

Yee Mei Heong[1]*, Kong Hie Ping[2], Jailani Md Yunos[3], Widad Othman[4], Tee Tze Kiong[5], Mimi Mohaffyza Mohamad[6] and Kok Boon Ching[7]

[1,2,3,5,6]Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA

[4]Faculty of Education and Language, Open University Malaysia, 50480 Kuala Lumpur, MALAYSIA

[7]Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA

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Abstract: Learning strategies and higher-order thinking skills (HOTS) play an important role in higher education learning. Every student as different preferences and strengths in learning strategies and HOTS, thus it can be a stimulus for developing new ways of learning. The purpose of this research is to evaluate the effectiveness of the integration of learning strategies and HOTS in generating ideas via a self-instructional manual among technical students. This quantitative approach research used the modified quasi-experimental design with a treatment group (TG) and a control group (CG) comprising 81 students. The pre- and post-individual assignments and assessment analytic rubric were used as the research instruments. The pre- and post-assignments were used to test the effectiveness of the integration of learning strategies and HOTS in generating ideas before and after treatment was given to TG students. The assessment analytic rubric was used to evaluate the pre- and post-assignments based on five evaluation criteria (ideas, designs, functions, materials and dimensions). Each TG student received a self-instructional manual for the integration of Kolb's learning strategies and Marzano's HOTS as a treatment for one month, while the CG students had no treatment but conventional teaching. The gathered data were analysed using SPSS software. The findings show that there are statistically significant differences between TG and CG on the five evaluation criteria for the individual post-assignment result. There are also statistically significant differences in the five evaluation criteria between the individual pre- and post-assignments results. Overall, the approach of integrating learning strategies and HOTS by using a self-instructional manual for generating ideas is significantly effective.

Keywords: Effectiveness, learning strategies, higher-order thinking skills, generate ideas

1. Introduction

In this era of globalisation, the economic growth of a country requires more knowledgeable and skilled technical workers that can adapt to the technological changes in order to produce the maximum output (Mustapha, 2013). The development of employability skills is majorly concerned by the Technical and Vocational Education (TVE) and these employability skills are the foundation upon which individuals within the sphere of Technical and Vocational Educational and Training (TVET) are trained (Chinedu, Olabiyi & Kamin, 2015). Technical workers should have the thinking skills of continuously thinking and reasoning, problem solving, decision making and interpersonal competence

*Corresponding author: mhyee@uthm.edu.my

(King, Goodson & Rohani, 2011). Therefore, thinking skills are the key to success in this rapid era of development (Wheelihan, 2011).

Based on Rajendran (2008), students who are taught to develop creative insights to solving problems are better in more complex problem-solving than those who are not. Therefore, the need for higher-order thinking skills (HOTS) in the teaching and learning of TVET cannot be over-emphasised (Chinedu, Olabiyi & Kamin, 2015). According to the Malaysian Ministry of Education (2013), HOTS is defined as the ability to adapt knowledge, skills and value in making decision and reflection in solution finding, problem solving, innovation and creativity in creating something new.

Besides that, idea generation is an important part of solving a problem (Sharp, 2008). Ideas can be generated through the cognitive, metacognitive, chemical and biological processes occurring in our brain (Abd. Hamid, 2001). Based on the knowledge of cognitive psychology, the two factors that are involved in generating ideas are the internal and external factors (Mohamad, Esa & Junoh, 2008). The internal factors for generating ideas are the individual factors such as interest, tendency, goals and self-motivation. Meanwhile, the external factors are the environment, employers, partners, problems encountered, rewards and others.

In certain situations, thinking skills enable a person to solve the problems by looking at different perspectives (Mohd & Hassan, 2005) especially in solving high-level complex problems. For this, HOTS are required when we work to understand information that will be used for generating ideas. The generation of new ideas is often emphasised at universities because work assignments are getting more complex and challenging (Kuh, 2001). Students are given different types of academic and non-academic projects that require them to solve problems creatively. Students need to learn and apply HOTS in their course work so that the work can be done more effectively. Based on Sulaiman et al. (2017), using HOTS in the teaching and learning processes can improve students' achievement and skills.

According to Yee et al. (2015), learning strategies refer to the behaviour of someone in performing their learning tasks. This behaviour consists of two basic aspects: cognitive learning strategies, which show the way of thinking, and learning strategies, which show the need for learning activities in the process to respond. As such, learning strategies are closely related to the tendency of students to think and communicate with others, the class condition and the activities that are carried out (Rogers, 2009). Thus, the learning strategies of students should be identified to help the students learn more about their thinking skills and improve their academic achievement.

Osman and Basar (2016) proposed that the learning skills for the 21st century are the learning that incorporates activities that require students to think, plan, discuss, analyse, evaluate, create and make decisions based on HOTS. Therefore, implementing HOTS is important in order to develop the skills and knowledge for technical students who can face the challenges of the 21st century (Rashid, 2016).

One of the methods to produce future employees is to educate students about how to think rather than find what to think (Ee, Chang & Tan, 2005). However, the findings of Tan and Samyudia (2009) showed that while university graduates have the ability to remember and calculate what has been learned, they lack problem-solving and higher-order thinking skills and are not able to apply the knowledge to think critically in new situations (MOE, 2012). This is because the students are often exposed to facts which are more concerned with the technical contents (Yusof, Othman & Karim, 2005). Therefore, they are less learned about how to apply knowledge more creatively and practically (Mohd & Hassan, 2005).

Furthermore, there are less of thinking skills development and teaching of specific thinking skills among students (Toh, 2003). Ng (2004) and Idris (2002) stated that most of the educational resources do not apply HOTS and, furthermore, learning activities do not involve metacognitive processes. The application of knowledge according to the highest cognitive taxonomic level is low, while the teaching and learning processes are more focused on low-level thinking (Mohd & Hassan, 2006).

In addition, some of the educators at universities face problems in developing thinking skills among students (Shuib, 2007). The research conducted by Ball and Garton (2005) found that most educators do not know how to apply HOTS to students and they are less confident when applying it. This shows clearly that HOTS should be taught in all subjects (Rajendran, 2008) and the HOTS should also be practised in technical and vocational education (Tee, 2013).

Besides that, students also face the problem of the lack of clear guidelines on the application thinking skills in the daily learning process. This is consistent with the findings on the need for thinking skills for 242 academic staff at UTHM (Yunos et al., 2011). The analysis showed that the effective learning of thinking skills is not achieved. As many as 69.7% of the academic staff think that the thinking skills learned by students in class are inadequate and incomplete. Thus, the lack of detailed information about thinking skills made students feel difficult to learn it.

On the other hand, the HOTS problem was detected by the findings in a primary research that conducted on 375 students in Years 1, 2, 3 and 4 from four technical universities known as Malaysia Technical University Network (MTUN). These are Universiti Tun Hussein Onn Malaysia (UTHM), Universiti Teknikal Malaysia Melaka (UTeM), Universiti Malaysia Pahang (UMP) and Universiti Malaysia Perlis (UNIMAP). The findings showed that among 13 of Marzano's HOTS, the student only mastered a moderate level in four of Marzano's HOTS and a low level in nine of Marzano's HOTS. The low level of Marzano's HOTS means less expertise in skills such as problem solving, support building, abstracts, error analysis, perspective analysis, experimental inquiries, inventions, classifications and decision making.

Consequently, students have face problems in applying appropriate and effective learning strategies in their studies (Rashid, 2008). As with many characteristics about student, however, there is wide variation in terms of the number of learning strategies we know and how we use them welly. But, only a few of students approached new types of tasks with enthusiasm and was typically able to figure out how to apply what he or she already knew to tackling a new problem (Protheroe & Clarke, 2008). Nowadays, when students read a textbook and asked to summarize the main points in the topic, they can present only a disjoined lists of thoughts with little sense of how they fit together. Student might use a strategy when approaching a problem even when that method repeatedly fails. As a result, students cannot have an unreliable achievement (Rashid, 2008). Bakar & Hanafi (2007) reported that Malaysia had the lowest domination in generic skills in field of thinking skills for technical and vocational students. Therefore, HOTS are very important in technical and vocational education (McCaslin & Parks, 2002) because:

a) Careers are increasingly dependent on cognitive ability.
b) Changes in the working environment require elasticity and adaptation on the ever-changing situation.
c) Technical and vocational education supplies real-world problems in the context of cognitive development.

Hence, the purpose of this study was to test the effect of integrating the Kolb's learning strategies and Marzano's HOTS on generating ideas among the technical students. The research objectives are to analyse the differences in the mean score of individual post-assignment between the treatment group (TG) and the control group (CG), to analyse the differences in the mean score of five evaluation criteria for individual post-assignment between TG and CG, to analyse the mean score between individual pre- and post-assignments for TG and CG, and to analyse the differences in the mean score of five evaluation criteria between pre- and post-assignments for TG and CG.

2. Methodology

The methodology for this research is the quasi-experimental method of The Non-equivalent Control Group Design. According to McMillan (2011), this design of research is among the most widely used. The design of this research involves the treatment and control groups by using pre- and post-trials. In addition, both groups do not have the equivalence of pre-experiment sampling (Chua, 2006). The TG used the integration of Kolb's learning strategies and Marzano's HOTS self-instructional manual (X1) while the CG did not use any self-instructional manual but only followed the traditional teaching (X2). Table 1 shows the design of pre- and post-assignments for TG and CG. In this design, both groups needed to complete two individual assignments, namely pre- and post-assignments.

Table 1-Pre- and post-assignment designs for treatment and control groups

Group	Treatment		
Treatment Group (TG)	O1	X1	O2
Control Group (CG)	O1	X2	O2

The population of this research is the technical students in Malaysia. The researchers chose UTHM because UTHM is the technical university with the most number of technical students as compared to the three other technical universities in Malaysia. The sample for this research consists of two groups, namely TG and CG from one faculty. The sample selection was done by using a random sampling method. The students from the Faculty of Civil and Environmental Engineering were selected as the sample for this research. The sample per group needs at least 30 respondents (Fraenkel et al., 2012). However, the total sample for this research was 81 students who took the subject of Creativity and Innovation (CNI).

The research instruments consist of two types, which are the individual pre- and post-assignments and the assessment analytic rubric. The individual pre- and post-assignments are used to test the effect of integrating Kolb's learning strategies and Marzano's HOTS on individual assignments. The assessment analytic rubric is used to evaluate the individual pre- and post-assignments. The assessment analytic rubric comprises five main criteria, namely ideas, designs, functions, materials and dimensions.

The treatment for this research was a self-instructional manual for the integration of Kolb's learning strategies and Marzano's HOTS. The validity of the design content of all research instruments was done by seven field experts of instrument design, thinking skills, technical and language. The reliability value of Kolb's learning strategies inventory obtained through Cramer's V correlation test is .90 on all items. The reliability values of individual pre- and post-assignments obtained through alpha test are respectively .81 and .83. The inter-rater reliability value of assessment analytic rubric obtained by using Cohen's kappa test is k=.758.

The researchers used ANCOVA, MANCOVA and MANOVA methods to analyse the data of the research. The raw data obtained from the research instruments were reviewed and checked by the researchers manually by using SPSS 17.0 for Windows. Then, the data were analysed using descriptive and inferential statistical methods.

3. Result and Discussion

The findings on the research were analysed and discussed based on the research objective.

3.1 The Differences in the Mean Score of Individual Post-Assignment between TG and CG

ANCOVA (between subject factor: Groups (TG, CG); covariate: Gender, CGPA, SES, Learning strategy, Min-pre) reveals the main effects of Groups, F (1, 241) = 182.34, *p* = 0.000; for Gender, F (1, 241) = 0.44, *p* = 0.509; for CGPA, F(1, 241) = 0.00, *p* = 0.983; for SES, F(1, 241) = 0.07, *p* = 0.799; for Learning strategy, F(1, 241) = 3.07, *p* = 0.084; and for Min-pre, F(1, 241) = 0.74, *p* = 0.392.

Table 2- The mean score and level of achievement of individual post-assignment between TG and CG

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	665.196(a)	6	110.866	34.001	.000
Intercept	154.781	1	154.781	47.469	.000
Gender	1.433	1	1.433	.440	.509
CGPA	.001	1	.001	.000	.983
SES	.213	1	.213	.065	.799
Learning strategy	10.008	1	10.008	3.069	.084
Min-pre	2.421	1	2.421	.743	.392
Groups	594.544	1	594.544	182.337	*.000
Error	241.291	74	3.261		
Total	7313.600	81			
Corrected Total	906.487	80			

*Significant differences in *p*<.05

The results of data analysis for ANCOVA show that there are significant differences in the mean score of individual post-work between TG and CG (*p* <.05). The results confirm that the treatment has a positive impact on the achievement of technical students in idea generation. There are also some variable control for controlling the treatment process, such as gender, academic achievement (CGPA), socioeconomic status (SES), learning strategy and min of individual pre-assignment (Min-pre).

Based on homogeneity subset analysis, TG > CG. The findings show that the individual post-assignment of TG (11.69%) is higher than CG (6.03%). This means that the achievement levels of individual post-assignment for TG and CG are respectively at good and medium level (Table 3). This shows that the use of MSL to integrate Kolb's learning strategies and Marzano's HOTS is effective in generating ideas. In the context of this study, TG students, who used the learning strategies of Kolb, are able to perform various activities in receiving and processing information to generate ideas in a complete learning cycle (Murphy et al., 2004). A complete learning cycle involves four levels of completing tasks based on critical thinking at a high level of performance (Kaye, 2010). Thus, by acquiring learning strategies and HOTS, technical students can combine new knowledge with existing ones to understand the knowledge more thoroughly (Sulaiman et al., 2017) and continue to apply the knowledge in practical work.

Table 3- Overall mean score and level of achievement of individual post-assignment between TG and CG

Groups	N	Individual post-assignment		Sig.
		Mean score	Level of achievement	
TG	41	11.69	Good	*.000
CG	40	6.03	Less satisfactory	

*Significant differences in *p*<.05

3.2 The Differences in the Mean Scores of Post-Assignment between TG and CG for Evaluation Criteria

MANCOVA (between subject factor: Groups (TG, CG); covariate: Gender, CGPA, SES, Learning strategy, Min-pre ideas, Min-pre designs, Min-pre functions, Min-pre materials, Min-pre dimensions) reveals the main effects of Groups in the score for criteria post ideas, F (1, 70) = 133.39, *p* = 0.000; for criteria post designs, F (1, 70) = 75.22, *p* = 0.000; for criteria post functions, F (1, 70) = 109.06, *p* = 0.000; for criteria post materials, F (1, 70) = 39.26, *p* = 0.000; and for criteria post dimensions, F (1, 70) = 17.45, *p* = 0.000.

Table 4- The mean score and level of achievement of individual post-assignment between TG and CG for five evaluation criteria

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	Score for criteria post ideas	66.341(a)	10	6.634	15.427	.000
	Score for criteria post designs	33.789(b)	10	3.379	9.049	.000
	Score for criteria post functions	37.494(c)	10	3.749	12.137	.000
	Score for criteria post materials	16.550(d)	10	1.655	6.555	.000
	Score for criteria post dimensions	8.149(e)	10	.815	2.568	.010
Intercept	Score for criteria post ideas	5.941	1	5.941	13.816	.000
	Score for criteria post designs	5.782	1	5.782	15.484	.000
	Score for criteria post functions	5.213	1	5.213	16.873	.000
	Score for criteria post materials	8.572	1	8.572	33.955	.000
	Score for criteria post dimensions	1.351	1	1.351	4.258	.043
Gender	Score for criteria post ideas	.407	1	.407	.947	.334
	Score for criteria post designs	.010	1	.010	.027	.871
	Score for criteria post functions	.053	1	.053	.172	.680
	Score for criteria post materials	.884	1	.884	3.502	.065
	Score for criteria post ideas	.121	1	.121	.381	.539
CGPA	Score for criteria post designs	.346	1	.346	.805	.373
	Score for criteria post functions	.006	1	.006	.015	.903
	Score for criteria post materials	.028	1	.028	.092	.763
	Score for criteria post dimensions	.295	1	.295	1.170	.283
	Score for criteria post ideas	.004	1	.004	.014	.906
SES	Score for criteria post ideas	.123	1	.123	.287	.594
	Score for criteria post designs	.000	1	.000	.001	.981
	Score for criteria post functions	.008	1	.008	.025	.875
	Score for criteria post materials	.029	1	.029	.114	.737
	Score for criteria post dimensions	.011	1	.011	.033	.856
Learning strategy	Score for criteria post ideas	.658	1	.658	1.530	.220
	Score for criteria post designs	.438	1	.438	1.173	.282
	Score for criteria post functions	.015	1	.015	.049	.826
	Score for criteria post materials	1.336	1	1.336	5.294	.024
	Score for criteria post dimensions	.164	1	.164	.518	.474
Min-pre ideas	Score for criteria post ideas	.000	1	.000	.001	.978
	Score for criteria post designs	.325	1	.325	.870	.354
	Score for criteria post functions	.096	1	.096	.310	.580
	Score for criteria post materials	.021	1	.021	.083	.774
	Score for criteria post dimensions	.223	1	.223	.702	.405
Min-pre designs	Score for criteria post ideas	.351	1	.351	.817	.369
	Score for criteria post designs	.000	1	.000	.001	.976
	Score for criteria post functions	.021	1	.021	.069	.794
	Score for criteria post materials	.576	1	.576	2.282	.135
	Score for criteria post dimensions	.408	1	.408	1.287	.260
Min-pre functions	Score for criteria post ideas	.474	1	.474	1.103	.297
	Score for criteria post designs	.436	1	.436	1.167	.284
	Score for criteria post functions	.021	1	.021	.055	.815
	Score for criteria post materials	.092	1	.092	.363	.549
	Score for criteria post dimensions	.077	1	.077	.242	.624
Min-pre materials	Score for criteria post ideas	.382	1	.382	.887	.349
	Score for criteria post designs	.769	1	.769	2.060	.156
	Score for criteria post functions	.422	1	.422	1.367	.246
	Score for criteria post materials	.306	1	.306	1.213	.274
	Score for criteria post dimensions	.067	1	.067	.210	.648
Min-pre dimensions	Score for criteria post ideas	.302	1	.302	.702	.405
	Score for criteria post designs	.000	1	.000	.000	.982
	Score for criteria post functions	1.269	1	1.269	4.107	.047
	Score for criteria post materials	.443	1	.443	1.754	.190
	Score for criteria post dimensions	.120	1	.120	.377	.541

Table 4 (continued)-The mean score and level of achievement of individual post-assignment between TG and CG for five evaluation criteria

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Groups	Score for criteria post ideas	57.361	1	57.361	133.391	*.000
	Score for criteria post designs	28.088	1	28.088	75.217	*.000
	Score for criteria post functions	33.693	1	33.693	109.063	*.000
	Score for criteria post materials	9.912	1	9.912	39.263	*.000
	Score for criteria post dimensions	5.536	1	5.536	17.450	*.000
Error	Score for criteria post ideas	30.102	70	.430		
	Score for criteria post designs	26.140	70	.373		
	Score for criteria post functions	21.626	70	.309		
	Score for criteria post materials	17.672	70	.252		
	Score for criteria post dimensions	22.208	70	.317		
Total	Score for criteria post ideas	544.000	81			
	Score for criteria post designs	374.400	81			
	Score for criteria post functions	348.120	81			
	Score for criteria post materials	255.240	81			
	Score for criteria post dimensions	116.640	81			
Corrected total	Score for criteria post ideas	96.442	80			
	Score for criteria post designs	59.929	80			
	Score for criteria post functions	59.120	80			
	Score for criteria post materials	34.222	80			
	Score for criteria post dimensions	30.357	80			

*Significant difference in $p<.05$

The results of data analysis for MANCOVA show that there are significant differences in the mean scores of individual post-assignment between TG and CG for five evaluation criteria, namely ideas, designs, functions, materials and dimensions ($p<.05$). The results of this analysis show that the treatment has a positive impact on the achievement of the five criteria in generating ideas after controlling some variables such as gender, academic achievement, SES, learning strategy and the mean score of pre-assignment for five evaluation criteria.

Based on homogeneity subset analysis, TG scores more than CG in five evaluation criteria. The levels of achievement of individual post-assignment for five evaluation criteria for TG are higher than CG (Table 5). The mean score and level of achievement of individual post-assignment for five evaluation criteria are shown in Table 5 in descending order, starting from ideas and followed by designs, functions, materials and dimensions.

It clearly shows that the learning strategies in each type of learning style and HOTS play a significant role (Sternberg, Grigorenko & Zhang, 2008) in idea generation (Ernst & Clark, 2008). The process of generating ideas using the integration of learning strategies and HOTS allows the individual's thinking to be apparent by translating the thoughts onto paper sheets. Students who are able to generate ideas effectively demonstrate that they are capable of implementing a good integration of learning strategies and HOTS.

Table 5- Mean score and level of achievement of individual post assignment between TG and CG for five evaluation criteria

Criteria	Groups	Mean score	Level of achievement	Sig.
Ideas	TG	3.22	Good	*.000
	CG	1.46	Less satisfactory	
Designs	TG	2.59	Excellent	*.000
	CG	1.34	Satisfactory	
Functions	TG	2.55	Excellent	*.000
	CG	1.22	Satisfactory	
Materials	TG	2.02	Good	*.000
	CG	1.32	Satisfactory	
Dimensions	TG	1.32	Good	*.000
	CG	0.78	Less satisfactory	

*Significant difference in $p<.05$

3.3 The Differences in the Mean Score between Individual Pre- and Post-Assignments for TG and CG

Data were analysed using MANOVA with within-subject factors of pre and post and between subject factor of Groups (TG, CG). The main effect of pre and post in TG, F (1, 39) = 210.21, *p* = 0.000; and the main effect of pre and post in CG, F (1, 39) = 0.20, *p* = 0.660.

Table 6- The mean score between individual pre- and post-assignments for TG and CG

Source	Measure	Pre-Post	Type III Sum of Squares	df	Mean Square	F	Sig.
Pre and post	TG	Level 1 vs. Level 2	1028.196	1	1028.196	210.206	*.000
	CG	Level 1 vs. Level 2	1.225	1	1.225	.197	.660
Error (pre and post)	TG	Level 1 vs. Level 2	190.764	39	4.891		
	CG	Level 1 vs. Level 2	242.495	39	6.218		

*Significant difference in *p*<.05

The results of data analysis for MANOVA show that there is a significant difference in the mean score of individual pre- and post-assignments for TG (*p*<.05). It is found that there is a high increase in the overall mean score between the individual pre- and post-assignments, which was 5.07%, from 6.58% to 11.65% for TG (Table 7). Based on the university's grade system, the score is an increase of 5% from the total score of 100%, which affects the grade level of the subject (Academic Management Office, 2010). Since there is an increase of 5.07% in the overall mean score of individual post-assignment for TG, then this means an increase in the students' grade in the course work after the treatment was given. The findings of this research also show that TG, who uses MSL, managed to increase the overall mean score of 33.8% from 15%, which is the full score of the post-assignment during the treatment process for a month.

On the other hand, there is a low increase in the pre- and post-assignments for CG, which is 0.18%, that can be considered as no improvement. In addition, there is an increase in the level of completion of individual pre- and post-assignments for TG from the satisfactory level to the good level, while there is no increase in the level of completion of individual pre- and post-assignments for CG, which remains at the moderate level.

The integration of learning strategies and Marzano's HOTS is to teach the students to shift from cognitive to metacognitive process by knowing the "what" method for receiving and processing information to the "how" of receiving and processing information in an effective way in order to generate ideas. In general, the knowledge of learning strategies allows students to clearly understand effective learning methods and skills (Harb et al., 1995) and self-learning potential (Duff, 2000) can be developed using various learning strategies to improve their academic achievement (Crossley, 2007).

Table 7- Overall mean score and level of completion of individual post-work between TG and CG

Groups	N	Mean score of individual work: Pre Mean	Pre Level	Post Mean	Post Level	Sig.
TG	40	6.58	Satisfactory	11.65	Good	*.000
CG	40	5.85	Moderate	6.03	Moderate	

*Significant difference in *p*<.05

3.4 The Differences in the Mean Score of Five Evaluation Criteria between Individual Pre- and Post-Assignments for TG and CG

Data were analysed using MANOVA with a within-subject factor of the mean score of five evaluation criteria (ideas, designs, functions, materials and dimension) in pre- and post-assignments and between subject factor of Groups (TG, CG). The main effects of the mean score for criteria ideas in pre- and post-assignments for TG, F (1, 39) = 129.11, *p* = 0.000; the main effects of mean score for criteria designs in pre- and post-assignments for TG, F (1, 39) = 96.55, *p* = 0.000); the main effects of mean score for criteria functions in pre- and post-assignments for TG, F (1, 39) = 123.73, *p* = 0.000; the main effects of mean score for criteria materials in pre- and post-assignments for TG, F(1, 39) = 18.16, *p* = 0.000; and the main effects of mean score for criteria dimensions in pre- and post-assignments for TG, F(1, 39) = 19.42, *p* = 0.000. The main effects of mean score for criteria ideas in pre- and post-assignments for CG, F (1, 39) = 0.15, *p* = 0.701; the main effects of mean score for criteria designs in pre- and post-assignments for CG, F (1, 39) =

1.40, $p = 0.243$); the main effects of mean score for criteria functions in pre- and post-assignments for CG, F (1, 39) = 0.62, $p = 0.438$; the main effects of mean score for criteria materials in pre- and post-assignments for CG, F(1, 39) = 0.11, $p = 0.743$; and the main effects of mean score for criteria dimensions in pre- and post-assignments for CG, F(1, 39) = 0.12, $p = 0.732$.

Table 8- The mean score of five evaluation criteria between individual pre- and post-assignments for TG and CG

Source	Measure	Pre-Post	Type III Sum of Squares	df	Mean Square	F	Sig.
Pre and post	TG ideas	Level 1 vs. Level 2	94.864	1	94.864	129.107	*.000
	TG designs	Level 1 vs. Level 2	60.516	1	60.516	96.552	*.000
	TG functions	Level 1 vs. Level 2	63.504	1	63.504	123.734	*.000
	TG materials	Level 1 vs. Level 2	11.664	1	11.664	18.155	*.000
	TG dimensions	Level 1 vs. Level 2	10.000	1	10.000	19.422	*.000
	CG ideas	Level 1 vs. Level 2	.144	1	.144	.149	.701
	CG designs	Level 1 vs. Level 2	.900	1	.900	1.403	.243
	CG functions	Level 1 vs. Level 2	.324	1	.324	.615	.438
	CG materials	Level 1 vs. Level 2	.081	1	.081	.109	.743
	CG dimensions	Level 1 vs. Level 2	.064	1	.064	.119	.732
Error (pre and post)	TG ideas	Level 1 vs. Level 2	28.656	39	.735		
	TG designs	Level 1 vs. Level 2	24.444	39	.627		
	TG functions	Level 1 vs. Level 2	20.016	39	.513		
	TG materials	Level 1 vs. Level 2	25.056	39	.642		
	TG dimensions	Level 1 vs. Level 2	20.080	39	.515		
	CG ideas	Level 1 vs. Level 2	37.616	39	.965		
	CG designs	Level 1 vs. Level 2	25.020	39	.642		
	CG functions	Level 1 vs. Level 2	20.556	39	.527		
	CG materials	Level 1 vs. Level 2	29.079	39	.746		
	CG dimensions	Level 1 vs. Level 2	21.056	39	.540		

*Significant difference in $p<.05$

The results of data analysis for MANOVA show that there is a significant difference in the mean score of five evaluation criteria between individual pre- and post-assignments for TG ($p<.05$). The results of the findings show that there is an increase in the mean score between individual pre- and post-assignments in TG by as much as 1.56%, 1.24% and 1.26% based on the ideas, designs and functions criteria, respectively (Table 9). This means there is an increase in the achievement level from satisfactory to excellent. Besides that, the highest increase in the mean scores between individual pre- and post-assignments in TG are by as much as 0.55% and 0.51% based on the materials and dimensions criteria, respectively. This means there is an increase in the achievement level from satisfactory to good. On the other hand, there is a lesser increase in the mean score of 0.04% to 0.15% between individual pre- and post-assignments for CG based on all five assessment criteria. Only the designs criterion has an increase in the level of completion of individual pre- and post-assignments, while there is no increase in the achievement level for the other four criteria.

There is an increase in the achievement level for the five criteria for generating ideas (Table 9). The findings of this study have shown that if a longer period of treatment is used in this study, it is able to produce a higher achievement of idea generation. This is in line with Masek and Yamin (2012) and Behar-Horenstein and Niu (2011) who emphasised that longer treatment periods will result in a significantly higher increase in the achievement of idea generation. Hence, HOTS's long-term learning practices are more effective in improving student empowerment (Miri, David & Uri, 2007). Moreover, learning strategies are effective strategies in learning HOTS (Othman & Rahman, 2011). This is because the cycle of learning process is related to the strategy for receiving and processing different types of knowledge or information. Besides that, according to Yee (2014), the compatibility between the usage of HOTS and learning strategies occurs.

Next, the manual gives the students examples in the real world to learn from. When students relate their learning to their own life experiences, their understanding and memory capabilities will increase (Sherman, 2013). Besides that, the theme of graphic organisers is also used in the manual because graphic organisers are effective learning strategies for encouraging HOTS (Singh et al., 2018). Graphic organisers are linked with HOTS because they promote reasoning, comparing and contrasting ideas, listing, and making connections. For example, graphic organisers' role as I-THINK map can enhance HOTS among students to understand the study content more effectively (Tee, 2013).

Table 9- The decreasing order of the mean score and level of achievement by the individual post-assignment between TG and CG based on five evaluation criteria

Criteria	Groups	Pre		Post		Sig.
		Mean	Level	Mean	Level	
Idea	TG1	1.66	Satisfactory	3.22	Excellent	*.000
	CG	1.44	Moderate	1.46	Moderate	
Design	TG1	1.35	Satisfactory	2.59	Excellent	*.000
	CG	1.19	Moderate	1.34	Satisfactory	
Function	TG1	1.29	Satisfactory	2.55	Excellent	*.000
	CG	1.13	Satisfactory	1.22	Satisfactory	
Material	TG1	1.47	Satisfactory	2.02	Good	*.000
	CG	1.28	Satisfactory	1.32	Satisfactory	
Dimension	TG1	0.81	Satisfactory	1.32	Good	*.000
	CG	0.74	Moderate	0.78	Moderate	

*Significant difference in $p<.05$

4. Conclusion

It can be concluded that integrating the teaching of learning strategies and HOTS is very helpful to students in developing their ability to generate ideas. The integration of learning strategies and HOTS enables students to generate ideas more effectively as well as improving student achievement. In addition, students learning the integration of learning strategies and HOTS are likely to use HOTS to generate ideas. This is because students learning the integration of learning strategies and HOTS know about the activities that can be done at every learning cycle to receive and process information for idea generation. Later, the students focused on the selection and use of Marzano's HOTS, which is suitable for receiving and processing information effectively. With this, the students understand more clearly the HOTS usage that is appropriate to the activities carried out at each stage of the learning cycle. The integration of Kolb's learning strategies and Marzano's HOTS brings two simultaneous benefits to the students in terms of the achievement of ideas generation. If TVET strictly aims for the application of HOTS to be materialised, continuous and serious monitoring and improvement of HOTS need to be implemented. Subsequently, TVET can produce graduates who can develop new slights creativity and workable solutions in future.

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