

The Level of Marzano Higher Order Thinking Skills among Technical Education Students

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Abstract—Higher order thinking skills is an important aspect in teaching and learning especially at higher education institutions. Thinking skills practices are part of the generic skills that should be infused in all technical subjects. Students with higher order thinking skills are able to learn, improve their performance and reduce their weaknesses. Hence, the purpose of this research was to identify the level of Marzano Higher Order Thinking Skills among technical education students in the Faculty of Technical Education (FPTek), Universiti Tun Hussein Onn Malaysia. A total of 158 students of FPTek were randomly selected as sample. A set of questionnaires adapted from Marzano Rubrics for Specific Task or Situations (1993) was used as research instrument. This is a quantitative research and the gathered data was analyzed using Statistical Package for Social Science (SPSS) software. The findings indicated that students perceived they have moderate level for investigation, experimental inquiry, comparing, deducing, constructing support, inducing and invention. However, decision making, problem solving, error analyzing, abstracting, analyzing perspectives and classifying are at low level. The Eta analysis indicated that there is a very low positive relationship between the level of Marzano Higher Order Thinking Skills and gender, academic achievement as well as socio economic status. Besides that, the findings also showed that there is no statistically significant difference in gender, academic achievement and socio economic status on the level of Marzano Higher Order Thinking Skills. However, there is significant difference in socio economic status on the level of decision making.

Index Terms—Higher education institutions, Marzano higher order thinking skills, Quantitative research, Technical education.

I. INTRODUCTION

Higher order thinking skills (HOTS) is one component of the creative thinking skills and critical thinking. In Malaysia, the skills of critical and creative thinking has been emphasized since the drafting of the Integrated Curriculum for Secondary Schools (ICSS) in 1988 (Sulaiman, 2000). According to Poh (2000), creative thinking can develop individual to be more innovative, have good creativity, ideal and imaginative.

When students know how to use both of these skills, it means that students have applied high order thinking skills. All students are capable to think, but most of them need to be encouraged, taught and assisted to the higher order thinking processes. These higher order thinking skills are teachable

and learnable. All students have the right to learn and apply thinking skills, just like other disciplines of knowledge. Higher order thinking is defined as the expanded use of the mind to meet new challenges [1]. It requires someone to apply new information or prior knowledge and manipulate the information to reach possible answer in new situation [2]-[4].

A question to be answered or a problem to be solved cannot be done through routine application of previously acquired knowledge [5]. But it can be solved only when expanded use of mind occurred that a person must interpret, analyze or manipulate information. This is because higher order thinking is characterized as non algorithmic, complex, self regulative, meaningful, effortful and providing multiple solutions, nuanced judgments, multiple criteria and uncertainty [6].

Higher order thinking skills is an important aspect in teaching and learning. Thinking skills are fundamental in educational process. A person thought can affect the ability of learning, speed and effectiveness of learning. Therefore, thinking skills is associated with learning process. Students who are trained to think demonstrate a positive impact on the development of their education. The findings of Resnick's studies have reported an improvement in reading comprehension and the average grades, therefore an increase in the settlement of problems of Mathematics and Science which have undergone a training program to think [6]. This has shown that thinking skill is important for a student to solve problems in their learning process thus fostering a competitive student's thought, developing students' intellectual and helping to avoid errors in thinking.

II. MARZANO HIGHER ORDER THINKING SKILLS

Marzano's research on thinking skills is important to students and educators in higher education institution primarily. Marzano identifies 13 higher order thinking skills, namely comparing, classifying, inducing, deducing, error analysis, constructing supporting, analyzing perspectives, abstracting, decision making, investigation, problem solving, experimental inquiry, and invention which work within the Dimensions of Learning (1992) framework. The Dimensions of Learning model assumes that the process of learning involves the interaction of the following five types of thinking:

- 1) positive attitudes and perceptions about learning
- 2) thinking involved in acquiring and ntegrating knowledge
- 3) thinking involved in extending and refining knowledge

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- 4) thinking involved in using knowledge meaningfully
- 5) productive habits of mind

Marzano’s Dimensions of Learning is a comprehensive model that uses what researchers and theorists know about learning to define the learning process. Dimensions of Learning offer a way of thinking about the extremely complex process of learning so that study can be attended to each aspect and gain insights into how they interact. The five types of thinking are premised as five dimensions of learning that are essential to successful learning [7]. The Dimensions framework will help us to:

- maintain a focus on learning;
- study the learning process; and
- plan curriculum, instruction, and assessment that takes into account the five critical aspects of learning.

These 13 higher order thinking skills are identified in Dimension 3 and 4 which will help students use knowledge meaningfully. The most effective learning occurs when we use knowledge to perform meaningful task.

TABLE I. THE DEFINITION OF FIVE MARZANO HIGHER ORDER THINKING SKILLS (HOTS)

Marzano HOTS	Definition
<i>comparing</i>	Identifying and articulating similarities and differences among items.
<i>classifying</i>	Grouping things into definable categories on the basis of their attributes.
<i>inductive reasoning</i>	Inferring unknown generalization or principles from information or observation.
<i>deductive reasoning</i>	Using generalization and principles to infer unstated conclusion about specific information or situations.
<i>analyzing errors</i>	Identifying and articulating error in thinking.
<i>constructing support</i>	Building system of support for assertions.
<i>analyzing perspectives</i>	Identifying multiple perspectives on an issue and examining the reasons or logic behind each.
<i>abstracting</i>	Identifying and articulating the underlying theme or general pattern of information.
<i>decision making</i>	Generating and applying criteria to select from among seemingly equal alternative.
<i>investigation</i>	Identifying and resolving issues about which there are confusions or contradictions.
<i>problem solving</i>	Overcoming constraints or limiting conditions that are in the way of pursuing goals.
<i>experimental inquiry</i>	Generating and testing explanations of observed phenomena.
<i>invention</i>	Developing unique products or processes that fulfill perceived need.

III. PROBLEM BACKGROUND

Exam-oriented learning is still in practice at higher educational level. The conventional teaching and learning process emphasize more on low level cognitive activities like memorizing, remembering and understanding [8]. Students learn to rote memorization as preparation to pass in the examination. Thus, students’ ability is measured by performance in examination.

Moreover, teachers in secondary schools are still using

traditional methods in teaching and learning which limit the critical and creative thinking skills among students [9]-[10]. Most of the implementation of teaching and learning at the school is teacher-centered teaching practices [11]-[12]. This situation causes students to become passive and does not use the mind to think otherwise just hear when the teacher is teaching. As consequence, the graduates’ ability to apply knowledge at the workplace becomes an issue to be debated [13].

As a result of this, graduates are increasingly expected not only to employ the knowledge and skills they have acquired during the process of growing up and schooling, but more important is to be able to find new ways and means to solve their daily problems and make appropriate decisions [1].

According to research [14], technical education students perceived their mastery and application of higher order thinking skills at the low level. Also, these students perceived themselves as facing difficulty in completing higher order thinking skills-based tasks as well as generating of ideas. Consequently, the need to investigate the level of Marzano HOTS for the Dimensions; Extend and Refine Knowledge; and Meaningful Use of Knowledge among the technical education students arises. In addition, the relationships and differences between the Marzano HOTS with gender, academic achievement, and socio-economic status will also be identified.

Specifically, the objectives of this study are:

- 1) To identify the level of Marzano HOTS among technical education students.
- 2) To identify the relationship between Marzano HOTS and gender, academic and socio-economic status.
- 3) To identify the difference for gender, academic achievement and socio-economic status on the levels of Marzano HOTS.

IV. METHODOLOGY

This is a survey research where data can be collected directly from respondents [15]. Common in most survey research, the characteristics of the population can be described through the distribution of frequencies and percentages.

A. Population and Sample

Population is a group of people who have similar characteristics. Population should be identified appropriately based on the research to be conducted [16]. In this study, the target population was the technical education students taking the Technical and Vocational Education course (BBV) at Faculty of Technical Education, Universiti Tun Hussein Onn Malaysia. A total of 158 students were selected as samples. The sampling procedure used for this study was stratified random sampling. The stratification was based on year of study and intake qualification. The samples were randomly selected in a specified layer to reduce sampling error such as the size of a large variance of sample estimates [17]. Table II shows the sample of students by year of study and intake qualification.

B. Instrument of Research

A set of the questionnaire adapted from the Rubrics for Specific Task or Situation (1992) was developed. It comprises 44 items based on the 13 Marzano HOTS with 4 points scale responses. Prior to the actual research, a pilot test was conducted to determine the reliability of the instrument and to achieve the desired objective of this study. The reliability of this set of instrument is .7030.

TABLE II. SAMPLE OF STUDENTS BY YEAR AND INTAKE

Year of Study	Intake Qualification	
	Matriculation	Diploma
Year 2	24	42
Year 3	21	55
Year 4	16	-
Total	61	97

C. Data Analysis

The collected data were analyzed using Statistical Package for Social Sciences (SPSS) software. The statistics selected for data analysis was based on the research questions as illustrated in Table III. The findings are presented in the table format.

TABLE III. SUMMARY OF RESEARCH QUESTIONS AND STATISTICAL TECHNIQUES USED IN THE STUDY

No	Research Questions (RQ)	Statistical Techniques
RQ1	What are the level of Marzano HOTS among technical education students?	Percentages and frequencies
RG2	Is there any significant relationship between the level of Marzano HOTS and gender, academic achievement and socio economic status?	ETA
RQ3	Are there any significant differences in gender, academic achievement and socio economic status on the level of Marzano HOTS?	ANOVA

V. RESULTS AND DISCUSSION

Both descriptive and inferential statistics were used as analytical tools. Parametric statistical techniques were used with the inferential statistics. Table IV and Table V showed the categorization levels of HOTS according to mean score and the strength of correlation respectively.

TABLE IV. CATEGORIZATION LEVEL OF HOTS

Mean Score	Level
1.00 – 2.00	Low
2.01 – 3.00	Moderate
3.01 – 4.00	High

TABLE V. THE STRENGTH OF THE CORRELATION COEFFICIENT

Correlation Coefficient	Correlation Strength
.91 sehingga 1.0	Very Strong
.71 sehingga .90	Strong
.51 sehingga .70	Medium
.31 sehingga .50	Low
.01 sehingga .30	Very Low
.00	No Correlation

A. The level of Marzano HOTS Among Technical Education Students

The findings from the study showed none of the students perceived their thinking skills' levels to be high. Only seven thinking skills are rated at the moderate level namely investigation, experimental inquiry, comparing, deducing, constructing support, inducing, and invention. On contrary, decision making, problem solving, error analyzing, abstracting, analyzing perspectives and classifying are rated as low (Table VI).

TABLE VI. THE LEVEL OF MARZANO HOTS

Marzano HOTS	Mean	SD	Skill Level
<i>comparing</i>	2.15	0.76	Medium
<i>classifying</i>	1.76	0.59	Low
<i>inductive reasoning</i>	2.04	0.73	Medium
<i>deductive reasoning</i>	2.13	0.64	Medium
<i>analyzing errors</i>	1.96	0.67	Low
<i>constructing support</i>	2.08	0.55	Medium
<i>analyzing perspectives</i>	1.84	0.73	Low
<i>abstracting</i>	1.96	0.71	Low
<i>decision making</i>	1.55	0.38	Low
<i>investigation</i>	2.01	0.62	Moderate
<i>problem solving</i>	1.59	0.27	Low
<i>experimental inquiry</i>	2.16	0.53	Moderate
<i>invention</i>	2.17	0.48	Moderate

B. Relationship Between The Level of Marzano HOTS and Gender, Academic achievement and Socio Economic Status

Using Eta Test, it was found that there was a very low positive relationship between the level of Marzano HOTS and gender, academic achievement and socio economic status (Table VII). The findings indicated that gender, academic achievement, and socioeconomic status do not affect students' thinking skills. These findings are in coherence with the results of researches conducted by experts of psychology. Their findings showed that humans only use general guidelines based on personal experiences when they make decisions [19].

TABLE VII. THE RELATIONSHIP BETWEEN THE LEVEL OF MARZANO HOTS AND GENDER, ACADEMIC ACHIEVEMENT AND SOCIO ECONOMIC STATUS

Marzano HOTS	Gender	Academic achievement	Socio Economic Status
<i>comparing</i>	.000	.079	.188
<i>classifying</i>	.110	.169	.180
<i>inductive reasoning</i>	.030	.138	.166
<i>deductive reasoning</i>	.129	.192	.224
<i>analyzing errors</i>	.033	.100	.109
<i>constructing support</i>	.114	.161	.213
<i>analyzing perspectives</i>	.021	.126	.091
<i>abstracting</i>	.069	.127	.245
<i>decision making</i>	.104	.082	.144
<i>investigation</i>	.051	.129	.026
<i>problem solving</i>	.075	.126	.051
<i>experimental inquiry</i>	.131	.067	.052
<i>invention</i>	.036	.101	.077

C. Differences in gender, academic achievement and socio economic status on The Level of Marzano HOTS

Table VIII shows that there was no significant difference between gender on the level of Marzano HOTS. It can be

safely concluded that all technical education students whether females or males have the same level of thinking skills.

Table IX shows that there was no significant difference among students' academic achievement on the level of Marzano HOTS. Evidently, students' academic achievement has no influence on the level of thinking skills. Students who have good academic achievement do not necessarily have a high level in HOTS as compared to students with low academic achievement [19].

Table X shows that there was no significant difference in socio economic status on the level of Marzano HOTS except for decision making. Surprisingly, students from low socio economic status are better in decision making as compared to students from higher socio economic status.

TABLE VIII. THE DIFFERENCE BETWEEN GENDER ON THE LEVEL OF MARZANO HOTS

Marzano HOTS	Female		Male		P
	Mean	SD	Mean	SD	
<i>comparing</i>	2.15	0.73	2.15	0.74	.602
<i>classifying</i>	1.78	0.50	1.65	0.60	.890
<i>inductive reasoning</i>	2.13	0.67	1.97	0.56	.095
<i>deductive reasoning</i>	1.94	0.67	1.99	0.60	.696
<i>analyzing errors</i>	1.87	0.62	1.78	0.53	.977
<i>constructing support</i>	2.08	0.60	2.25	0.63	.557
<i>analyzing perspectives</i>	2.03	0.62	2.07	0.61	.575
<i>abstracting</i>	1.97	0.66	1.94	0.65	.187
<i>decision making</i>	1.52	0.34	1.60	0.45	.189
<i>investigation</i>	1.99	0.66	2.06	0.54	.909
<i>problem solving</i>	1.58	0.27	1.62	0.27	.717
<i>experimental inquiry</i>	2.20	0.51	2.06	0.54	.851
<i>invention</i>	2.16	0.47	2.20	0.49	.849

*Difference is significant at the .05 level.

TABLE IX. THE DIFFERENCE AMONG ACADEMIC ACHIEVEMENT ON THE LEVEL OF MARZANO HOTS

Marzano HOTS	CGPA ≥ 3.70		3.00 ≤ CGPA < 3.69		2.70 ≤ CGPA < 2.99		2.00 CGPA < 2.69		P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
<i>comparing</i>	2.10	0.70	2.15	0.74	1.67	-	2.67	-	.325
<i>classifying</i>	1.52	0.41	1.76	0.54	1.75	-	1.00	-	.342
<i>inductive reasoning</i>	1.90	0.57	2.11	0.65	1.33	-	1.33	-	.392
<i>deductive reasoning</i>	2.36	0.87	2.69	0.69	2.33	-	1.33	-	.391
<i>analyzing errors</i>	1.74	0.60	1.86	0.60	1.67	-	1.00	-	.892
<i>constructing support</i>	2.23	0.74	2.12	0.59	1.00	-	3.00	-	.615
<i>analyzing perspectives</i>	1.95	0.64	2.04	0.61	3.00	-	2.33	-	.177
<i>abstracting</i>	2.18	0.81	1.94	0.64	2.00	-	1.33	-	.785
<i>decision making</i>	1.48	0.39	1.55	0.38	1.50	0.35	1.25	-	.464
<i>investigation</i>	2.06	0.68	2.00	0.62	2.00	0.00	3.00	-	.139
<i>problem solving</i>	1.48	0.26	1.60	0.27	1.62	0.18	1.75	-	.301
<i>experimental inquiry</i>	2.11	0.42	2.16	0.54	1.88	0.18	2.25	-	.650
<i>invention</i>	2.05	0.66	2.18	0.47	2.38	0.18	2.50	-	.904

*Difference is significant at the .05 level.

TABLE X. THE DIFFERENCE AMONG SOCIO ECONOMIC STATUS ON THE LEVEL OF MARZANO HOTS

Marzano HOTS	RM1501-RM2500		RM2501-RM3500		RM3501-RM4500		≥RM4501		P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
<i>comparing</i>	1.99	0.72	2.15	0.82	2.40	0.54	2.00	0.60	.070
<i>classifying</i>	1.65	0.50	1.70	0.47	1.93	0.83	1.98	0.54	.987
<i>inductive reasoning</i>	2.01	0.60	1.81	0.72	2.17	0.61	2.39	0.47	.485
<i>deductive reasoning</i>	1.90	0.65	1.93	0.63	2.13	0.67	1.82	0.85	.203
<i>analyzing errors</i>	1.68	0.51	1.80	0.57	2.20	0.45	2.06	0.83	.850
<i>constructing support</i>	2.23	0.61	2.17	0.60	2.37	0.62	2.30	0.55	.423
<i>analyzing perspectives</i>	2.13	0.66	2.13	0.69	2.03	0.76	1.76	0.45	.334
<i>abstracting</i>	1.99	0.68	1.93	0.70	1.77	0.47	1.88	0.75	.209
<i>decision making</i>	1.42	0.35	1.60	0.29	1.63	0.46	1.61	0.44	.034
<i>investigation</i>	2.00	0.58	1.82	0.62	2.21	0.55	2.07	0.78	.538
<i>problem solving</i>	1.60	0.25	1.60	0.25	1.60	0.30	1.56	0.30	.702
<i>experimental inquiry</i>	2.10	0.55	2.17	0.48	1.81	0.41	2.28	0.44	.533
<i>invention</i>	2.14	0.54	2.07	0.40	2.23	0.61	2.14	0.28	.056

* Difference is significant at the .05 level.

VI. RECOMMENDATIONS

The Outline Perspective Plan, which was tabled and approved in Parliament in April 2001, required the Education System to be reviewed in order to ensure that Malaysian students are taught explicitly to acquire and use several thinking skills [1]. The research findings support the teaching and learning of thinking skills because it will enable students to be aware of their own thinking skills while performing tasks. Through this awareness, students can improve their performance on those tasks [22].

Models, strategies, techniques, and activities are model lesson plans showing how thinking skills could be taught together with subject matter using the integrated approach have been implemented in the school system in Malaysia since 1993 [1]. Nevertheless, a self-instructional manual can be an alternative approach. The manual is self-paced and can cater to the more extendable individual differences of learner's abilities, interest and degrees of application. Besides, the manual is self-instructional requiring a specific basic study programme which can be conducted either as a pre-requisite or as part of a total programme structure of the technical and vocational education [23]. Based on these arguments, we proposed the use of self instructional manual to develop HOTS among students. These manuals for individualized learning will be able to support the current learning system since students can study at their own pace [21].

VII. CONCLUSION

This study illustrated the technical education students' perceptions of Marzano HOTS levels in their academic and daily lives. Also, the findings indicated there was a very low positive relationship between the level of Marzano HOTS with gender, academic achievement and socio economic status. There exist no significant differences in thinking levels between male and female students; neither among their academic achievement or socio economic status. Consequently, students should be assisted to acquire HOTS; either through the conventional teaching and learning environment or a self- instructional, individualized manual.

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