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# Exploring Marzano Higher-Order Thinking Skills: Demographic Disparities Among Technical Students

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**Abstract**

Higher-order thinking skills (HOTS) encompass the capacity to apply knowledge, skills, and values in comprehending, reflecting, solving problems, making decisions, innovating, and creating new ideas. These skills vary among individuals, especially in learning contexts, problem-solving, and product design. The goal of this study is to evaluate technical students' perceptions of their mastery of Marzano's Higher Order Thinking Skills. A total of 351 students, including those from Civil, Mechanical, and Electrical Engineering programs at Sultan Abdul Halim Muad'zam Shah Polytechnic, were randomly chosen as participants. This research employed a survey design with a quantitative approach, and data were analyzed using SPSS software, with results presented in terms of means, frequencies, and percentages. Findings suggest that overall, students' mastery of Marzano HOTS remains at a generally low level, except for four specific skills—analyzing error, constructing support, abstracting, and analyzing perspectives—which are rated at an intermediate level. On the contrary, nine HOTS areas were identified as being at a low level. An ETA analysis revealed a minimal positive correlation between Marzano HOTS mastery and variables such as gender, age, field of study, and year of study. Furthermore, no statistically significant differences were found in HOTS levels based on gender, age, and year of study. These outcomes suggest that students need further development in HOTS to better tackle learning challenges. The study also offers key insights that could assist TVET practitioners in developing more effective curricula and interventions for improving higher-order thinking skills among technical students.

## 1. Introduction

The Malaysian Ministry of Education (MOE) launched the Malaysia Education Development Plan 2015-2025 (Higher Education) or PPPM-PT on the 7th of April, 2015, which serves as a guideline for academia to respond to the challenges faced by Malaysia's higher education system. PPPM-PT outlined 10 shifts to achieve system aspirations and student aspirations. The goal of the 4th Shift in PPPM emphasizes quality TVET graduates, which aims to improve competencies among TVET graduates to meet the industry's demand and increase graduates'

ability for career advancement. In line with the essence of the 4th Shift, TVET plays an important role in producing a new generation of TVET graduates who possess the abilities required to compete in the labour market.

Janet, Kimberly and Ken (2010) assert that students need to be prepared for careers by incorporating 21st century skills and careers as well as technical education into the whole system. Students who master 21st century skills with the ability and skills to think critically, creatively and innovatively are able to compete at the global level (Ismail, Sidek & Mahbib, 2015). Polytechnic institutions play a vital role in preparing students for the workforce by providing them with academic knowledge, essential soft skills, and specialized technical expertise. Additionally, students must develop Higher Order Thinking Skills (HOTS) and acquire research competencies to effectively engage with modern technologies. By fostering HOTS, the nation cultivates a skilled workforce capable of driving innovation and producing creative solutions.

Students need to think more critically in this highly competitive era when it comes to accepting in new information, organizing it into long-term memory, connecting it to prior knowledge, and processing it to solve problems (Siti Marlina, 2013 & Yee et al., 2016). According to Kusuma et al. (2017), Sulaiman et al. (2017), Abdullah et al. (2017), HOTS foster the application of knowledge, skills, and values in reasoning, reflection, problem solving, decision making, innovation, and new product creation.

HOTS defines as the capacity to use knowledge, skills, and values in reflection to solve issues, make choices, strive to innovate, and create something (Lembaga Peperiksaan, 2014). According to the Ministry of Education (2013), HOTS also refers to the capacity to use knowledge, skills, and assessment in thinking, reflection, problem solving, decision making, innovation, and new product creation. According to Suleiman et al. (2017), the application of HOTS in teaching and learning can enhance student accomplishment in academics and skills by introducing HOTS in learning.

Marzano (1992) identified 13 HOTS in the framework of the Dimension to Improve and Increase Knowledge contained in Marzano's (1992) Learning Dimension Model. It consists of 13 types of thinking skills which are comparing, classifying, induction, deduction, error analysis, building support, abstracting, analyzing perspectives, decision making, investigation, problem solving, experimental inquiry and invention. Based on these 13 thinking skills, it shows that HOTS Marzano is able to provide a complex picture of how an individual learns and thinks. It is developed and published by the Supervision and Curriculum Development Association and aims to improve learning and thinking in all contexts. In other words, developing thinking skills is one of the most effective ways to improve performance, both in answering tests and completing assignments.

## 2. Problem Background

In higher education, including at polytechnic institutions, educators are encouraged to adopt student-centered learning methods, particularly those that foster problem-solving abilities. A study by Yee et al. (2016), which surveyed 60 polytechnic lecturers, revealed that 61.7% of the participants believed students encounter challenges when addressing problems during the teaching and learning process. Additionally, 60% of lecturers agreed that insufficient integration of thinking skills (TS) in their instruction contributes to students' struggles with problem-solving.

Despite the implementation of TS in the curriculum, students' cognitive abilities remain inadequate, and their critical thinking skills remain underdeveloped. This is a result of the learning session's absence of thinking skills instruction for every student and the insufficient emphasis on thinking skills. According to Toh (2003), Balakrishnan (2002), and Rajendran (2001), TS places less emphasis on teaching students with specialized thinking abilities. Yee et al. (2016) state that students enrolled in technical education also have a poor level of HOTS application and mastery. Because of this, graduates are unable to exhibit their knowledge and abilities in problem-solving, examining several approaches, synthesizing, formulating solutions, and putting those answers into practice (Department of Statistics Malaysia, 2011).

Students are also seen to use less HOTS components in the teaching and learning process. Therefore, students will face difficulties in solving a problem, especially in completing the coursework assignments given. A study analyzing the results of Yee et al. (2016) showed that the most problems faced by Polytechnic students when completing coursework assignments is that students experience difficulty in solving the problem. HOTS is the cause of weakness resulting in the application of a student being creative in solving all problems that arise (Yee et al., 2016). The mastery and use of HOTS in a student can help them solve a problem effectively (Rajendran, 2008).

However, gender, age, year of study and field of study of students also have an impact on thinking skills among students. This can be proven by Shubina & Kulakli (2019) who showed that gender has a significant effect on critical thinking skills and creativity. Similarly, Hunter et al. (2014) studies show older students exhibit better thinking skills in some subscales. Meanwhile, the research by Terenzini et al. (1995) found that the development of academic competence and critical thinking skills is particularly notable during the first year. In addition, Omar's study (2014) also shows that there is a difference in the field of study of students with creative and critical thinking. Marzano's HOTS is a vital framework for developing critical cognitive skills that enhance students' academic performance (Insani et al., 2019), promote lifelong learning (Ashari et al., 2021), support diverse learning styles (Yee et al., 2016), facilitate effective assessment (Patria & Istiyono, 2020), and foster creativity and

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innovation (Rowais, 2019). These skills are essential for students to succeed in both academic and real-world settings. Therefore, a study on the perception of mastery of Marzano HOTS among technical students would like to be conducted. In order to achieve one of the leaps in PPPM (PT) 2015-2025, students need to learn TS.

The aim of this study was to explore the influence of the skills taught during the teaching and learning process. Specifically, the objectives of this research are:

1) To identify the perception of the mastery of HOTS Marzano among technical students based on demography.
2) To analysis the relationship between Marzano HOTS and student's demography.
3) To analysis the differences in student's demography on the level of Marzano HOTS.

## 3. Methodology

The design of this study was a survey study using a quantitative approach. This is because this study aims to identify the perception of mastery of HOTS Marzano among technical students. The population of this study consists of all diploma students in the fields of Civil Engineering, Electrical Engineering, and Mechanical Engineering at Sultan Abdul Halim Muad'zam Shah Polytechnic, Jitra, Kedah, in which was selected randomly according to their respective field of studies (stratified random sampling). The researcher chose a polytechnic located in North Malaysia as the research location because this polytechnic is one of the polytechnics with the most technical students. Based on the Sample Determination Table by Krejcie and Morgan (1970), the sample size for this study was identified as 351 students. Meanwhile, the sample size for each field was determined using stratified random sampling (Table 1).

**Table 1** *Population and study sample*

| Field | Population | Sample Size |
|---|---|---|
| Civil Engineering | 1505 | 158 |
| Electric and Electrical Engineering | 1196 | 82 |
| Mechanical Engineering | 781 | 111 |
| Total | 3482 | 351 |

### 3.1 Instrument of Research

In this study, the researcher used a test form as a research instrument. This test form contains two parts, Part A, Part B and Part C, as shown in Table 2. Part A consists of items that collect respondent information. Demographic information is intended to encourage respondents to provide honest and accurate feedback. Part B contains 25 items related to the Marzano HOTS 'Expanding and Perfecting Knowledge' dimension and Part C contains 19 items related to the Marzano HOTS 'Meaningful Use of Knowledge' dimension.

**Table 2** *Division and distribution of the number of instrument items*

| Part | Aspect | Item |
|---|---|---|
| Part A | Respondent Demographics | 9 |
| Part B | Dimension of 'Expanding and Perfecting Knowledge' | 25 |
| Part C | The 'Meaningful Use of Knowledge' Dimension | 19 |

Each HOTS in part B and part C has different items. There are eight HOTS in the dimension 'Expanding and Improving Knowledge' which is comparing, classifying, inductive, deductive, analyzing error, constructing support, analyzing perspective and abstract. While five HOTS in the dimension 'Using Meaningful Knowledge' are decision making, investigation, problem solving, experimental inquiry and invention.

### 3.2 Data Analysis

In this study, the researcher used several techniques in analyzing the research findings obtained. The researcher used SPSS software to conduct analysis for each raw data obtained. However, the raw data is first checked by the researcher manually. This research employs both descriptive and inferential statistical methods. Descriptive statistics are applied to summarize the collected data, while inferential statistics help make generalizations about the broader population based on sample data (Idris, 2013). Table 3 provides an overview of the research design and the data analysis techniques used to address each research question.

**Table 3** *Summary of data analysis methods for each research question*

| No. | Research Question (RQ) | Data Analysis Methods | Statistical Techniques |
|---|---|---|---|
| 1. | What are the perception of the mastery of HOTS Marzano among technical students based on demography? | Descriptive | Percentage and Frequencies |
| 2. | Is there any significant relationship between Marzano HOTS and gender, age, field of study and years of study? | Inferential | ETA |
| 3. | Are there any significant difference for gender, age, field of study and years of study on the level of Marzano HOTS | Inferential | ANOVA |

## 4. Result and Discussion

As analytical techniques, both inferential and descriptive statistics were used. In conjunction with the inferential statistics, parametric statistical approaches were applied. Table 4 and 5 showed the interpretation of the mean range for Marzano's HOTS level adapted from Wiersma & Jurs (2005) and the strength of correlation respectively.

**Table 4** *Interpretation of the mean range for Marzano's HOTS level (Adapted from Wiersma & Jurs, 2005)*

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

**Table 5** *The strength of the correlation coefficient (Adapted from Hinkle, D. E., Wiersma, W., & Jurs, S. G., 2003).*

| Correlation Coefficients | Correlation Strength |
|---|---|
| .91 - 1.0 | Very Strong |
| .71 - .90 | Strong |
| .51 - .70 | Medium |
| .31 - .50 | Low |
| .01 - .30 | Very Low |
| .00 | No Correlation |

### 4.1 Perception of The Mastery of Marzano HOTS Among Technical Students Based On Demographic Factors

This section will present the result of descriptive analysis of the mastery of Marzano HOTS among technical students based on gender, age, field of study, and year of study. The result and discussion are being laid in the following sub-sections accordingly.

#### 4.1.1 Perception of The Mastery of Marzano HOTS Among Technical Students Based On Gender

Table 6 shows the level of mastery of Marzano HOTS based on gender. For comparing skills, the results of the analysis show that most male and female respondents tend to apply comparative skills at a low level, namely 43.8% and 37.7% respectively. For classification skills, the majority of male respondents tend to apply this classification skill at a moderate level which is as much as 40.9% whereas female students apply this skill at a low level at 36.0%.

Similarly, for induction skills, it can be seen that most of the male students tend to apply this induction skill at a moderate level which is 45.5%, while female students apply this skill at a low level which is 46.3%. Next, on deduction skills, the results of the analysis show that both male and female respondents tend to apply deduction skills at a low level, namely 47.2% and 43.4% respectively.

For error analysis skills, the mastery level of this skill is at the moderate level for male students (47.7%) whereas female students apply this skill at a low level which is 41.1%. Next, on constructing support skills, the male students tend to apply these skills at a moderate level which is 47.2% while female students apply these skills at a low level which is 44%.

As for abstract skills, it can be seen that the level of mastery is at a moderate level for both male (44.3%) and female (44.6%) students. Similarly, for perceptive analysis skills, the level of mastery is also at a moderate level for both male (41.5%) and female (40.0%) students.

Moving on, for decision-making skills, the level of mastery of these skills is at 43.8% for male students (moderate level) while female students apply these skills at a low level which is 49.1%. Next, for investigative

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skills, the level of mastery is at a low level for both male and female students, which is 41.5% and 41.1% respectively.

For problem solving skills, the results of the analysis show that both male and female respondents tend to apply comparative skills at a low level, namely 50.0% and 46.3%. While for experimental investigation skills, both male and female respondents tend to apply experimental investigation skills at a low level, namely 49.4% and 45.1%. Finally, for invention skills, both male and female students tend to apply these skills at a low level which is 44.9% and 52.6%.

**Table 6** *Perception of the mastery of Marzano HOTS among technical students based on gender*

| Marzano HOTS | Gender | Low | | Moderate | | High | | Total |
|---|---|---|---|---|---|---|---|---|
| | | *f* | % | *f* | % | *f* | % | *f* |
| Comparison | Male | 77 | 43.8 | 60 | 34.1 | 39 | 22.2 | 176 |
| | Female | 66 | 37.7 | 51 | 29.1 | 58 | 33.1 | 175 |
| Classification | Male | 68 | 38.6 | 72 | 40.9 | 36 | 20.5 | 176 |
| | Female | 63 | 36.0 | 58 | 33.1 | 54 | 30.9 | 175 |
| Induction | Male | 70 | 39.8 | 80 | 45.5 | 26 | 14.8 | 176 |
| | Female | 81 | 46.3 | 64 | 36.6 | 30 | 17.1 | 175 |
| Deduction | Male | 83 | 47.2 | 61 | 34.7 | 32 | 18.2 | 176 |
| | Female | 76 | 43.4 | 52 | 29.7 | 47 | 26.9 | 175 |
| Analyzing Error | Male | 62 | 35.2 | 84 | 47.7 | 30 | 17.0 | 176 |
| | Female | 72 | 41.1 | 70 | 40.0 | 32 | 18.3 | 175 |
| Constructing Support | Male | 68 | 38.6 | 83 | 47.2 | 25 | 14.2 | 176 |
| | Female | 77 | 44.0 | 66 | 37.7 | 32 | 18.3 | 175 |
| Abstract | Male | 58 | 33.0 | 78 | 44.3 | 40 | 22.7 | 176 |
| | Female | 53 | 30.3 | 78 | 44.6 | 44 | 25.1 | 175 |
| Analyzing Perspectives | Male | 61 | 34.7 | 73 | 41.5 | 42 | 23.9 | 176 |
| | Female | 59 | 33.7 | 70 | 40.0 | 46 | 26.3 | 175 |
| Decision Making | Male | 76 | 43.2 | 77 | 43.8 | 23 | 13.1 | 176 |
| | Female | 86 | 49.1 | 62 | 35.4 | 27 | 15.4 | 175 |
| Investigation | Male | 73 | 41.5 | 70 | 39.8 | 33 | 18.8 | 176 |
| | Female | 72 | 41.1 | 64 | 36.6 | 39 | 22.3 | 175 |
| Problem Solving | Male | 88 | 50.0 | 67 | 38.1 | 21 | 11.9 | 176 |
| | Female | 81 | 46.3 | 75 | 42.9 | 19 | 10.9 | 175 |
| Experimental Inquiry | Male | 87 | 49.4 | 59 | 33.5 | 30 | 17.0 | 176 |
| | Female | 79 | 45.1 | 64 | 36.6 | 32 | 18.3 | 175 |
| Invention | Male | 79 | 44.9 | 74 | 42.0 | 23 | 13.1 | 176 |
| | Female | 92 | 52.6 | 62 | 35.4 | 21 | 12.0 | 175 |

The results of the data analysis show that the level of mastery of Marzano HOTS among technical students based on gender is generally at a low level for all HOTS. Previous study from Md Yunos et al. (2010) also show that the dominance of HOTS is still at a weak level. The results of this research are consistent with the findings from a study by Yee et al. (2016), which involved 375 technical university students in Malaysia. Their study revealed that students had only achieved moderate proficiency in 4 of Marzano's Higher Order Thinking Skills (HOTS), while the remaining 9 skills were still at a low level of mastery.

Findings from this study also show that there is a difference on the level of mastery between male and female students. Male students master seven HOTS at a moderate level and six HOTS at a low level. On the other hand, for female students, they mastered two HOTS at an intermediate level and 11 HOTS at a low level. The difference in the level of HOTS for some of these skills is supported by Mohd & Hassan (2005) and Abd Hamid (2001) who state that gender factors affect HOTS.

### 4.1.2 Perception of The Mastery of Marzano HOTS Among Technical Students Based on Age

Table 7 shows the mastery level of HOTS Marzano based on the age, which are grouped 17-18 years of old, 19-20 years of old, 21-22 years of old, and 23-24 years of old. For comparison skills, most of the students from the group of 17-18 years old master the skill at low level (44.9%). This is also similar for the group of 19-20 years old (40.4%) and 21-22 years old (37.8%). As for the student in the 23-24 years old group, most of them (50%) master the skill at moderate level.

For classification skills, the majority of the students master the skill at low level, specifically 37.2% for the 17-18 years old group, 37.8% for the 21-22 years old group, and 50% for the 23-24 years old group. Only the 19-20 years old group have the majority (38.3%) in moderate level of mastery of the skill. For the induction skills, the 17-18 years old group students mostly (42.3%) possess moderate level of mastery, 19-20 years old group and 21-22 years old group mostly at low level of mastery, namely 43.9% and 48.6%. Interestingly, 50% students from the 23-24 years old group shows the high level of mastery.

Next, the result of the analysis for deduction skills shows the level of mastery is at low level for the 17-18 years old group (51.3%), 19-20 years old group (43.0%), and 21-22 years old group (45.9%). For the 23-24 years old group, the mastery level is divided equally (50%) between low and moderate level. For analyzing error, the majority of the students master the skill at moderate level which is 39.7% for the 17-18 years old group, 47.0% for the 19-20 years old group, and 40.5% for the 21-22 years old group. While for the 23-24 years old group, majority student at low level 66.7%.

As for constructing support skills, it can be seen that most of students master the skills at low level, particularly 43.5% for the 19-20 years old group, 40.5% for the 21-22 years old group, and 50% for the 23-24 years old group. Only the 17-18 years old group majority student in moderate level which is 52.6%. While for abstract skills, mostly student master the skills at moderate level, specifically 44.9% for the 17-18 years old group, 43.9% for the 19-20 years old group, and 48.6% for the 21-22 years old group. For the 23-24 years old, the mastery level is at low and moderate level namely 33.3%.

Moving on, for the analyzing perspectives skills, the level of mastery shows that 17-18 years old group and 23-24 years old group tend to apply at low level, which is 41.0% and 83.3% respectively. Meanwhile, for the 19-20 years old group and 21-22 years old group, majority student at moderate level namely 40.9% and 45.9%. On decision making skills, the majority of the student master skills at low level, primarily 48.7% for the 17-18 years old group, 44.8% for the 19-20 years old group, and 51.4% for the 21-22 years old group. As for the student in the 23-24 years old group, the mastery level is at a low and moderate level that has the same value which is 33.3%.

While, for the investigation skill, majority of the student master the skill at low level, specifically 41.3% for the 19-20 years old group, 40.5% for the 21-22 years old group, and 50% for the 23-24 years old group. As for the 17-18 years old group, the mastery level is at low and moderate level which is 41.0%. Meanwhile, for the problem solving skills, the result of analysis shows the level of mastery is at low level for the 17-18 years old group (50.0%), 19-20 years old group (48.7%), and 21-22 years old group (45.9%). For the 23-24 years old group, the mastery level at moderate level which is 66.7%.

Next, for the experimental inquiry skills, it can be seen that majority students master skills at low level, chiefly 48.7% for the 17-18 years old group, 46.1% for the 19-20 years old group, and 56.8% for the 21-22 years old group. Only the 23-24 years old group majority student in moderate level which is 66.7%. Meanwhile, for the invention skills, all of the student master the skills at low level particularly 56.4% for the 17-18 years old group, 45.2% for the 19-20 years old group, 51.4% for the 21-22 years old group, and 66.7% for the 23-24 years old group.

**Table 7** *Perception of the mastery of HOTS Marzano among technical students based on age*

| Marzano HOTS | Age | Low | | Moderate | | High | | Total |
|---|---|---|---|---|---|---|---|---|
| | | *f* | % | *f* | % | *f* | % | *f* |
| Comparison | 17–18 | 35 | 44.9 | 22 | 28.2 | 21 | 26.9 | 78 |
| | 19–20 | 93 | 40.4 | 74 | 32.2 | 63 | 27.4 | 230 |
| | 21–22 | 14 | 37.8 | 12 | 32.4 | 11 | 29.7 | 37 |
| | 23–24 | 1 | 16.7 | 3 | 50.0 | 2 | 33.3 | 6 |
| Classification | 17–18 | 29 | 37.2 | 27 | 34.6 | 22 | 28.2 | 78 |
| | 19–20 | 85 | 37.0 | 88 | 38.3 | 57 | 24.8 | 230 |
| | 21–22 | 14 | 37.8 | 13 | 35.1 | 10 | 27.0 | 37 |
| | 23–24 | 3 | 50.0 | 2 | 33.3 | 1 | 16.7 | 6 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Induction | 17–18 | 31 | 39.7 | 33 | 42.3 | 14 | 17.9 | 78 |
| | 19–20 | 101 | 43.9 | 99 | 43.0 | 30 | 13.0 | 230 |
| | 21–22 | 18 | 48.6 | 10 | 27.0 | 9 | 24.3 | 37 |
| | 23–24 | 1 | 16.7 | 2 | 33.3 | 3 | 50.0 | 6 |
| Deduction | 17–18 | 40 | 51.3 | 19 | 24.4 | 19 | 24.4 | 78 |
| | 19–20 | 99 | 43.0 | 80 | 34.8 | 51 | 22.2 | 230 |
| | 21–22 | 17 | 45.9 | 11 | 29.7 | 9 | 24.3 | 37 |
| | 23–24 | 3 | 50.0 | 3 | 50.0 | 0 | 0.0 | 6 |
| Analyzing Error | 17–18 | 30 | 38.5 | 31 | 39.7 | 17 | 21.8 | 78 |
| | 19–20 | 87 | 37.8 | 108 | 47.0 | 35 | 15.2 | 230 |
| | 21–22 | 13 | 35.1 | 15 | 40.5 | 9 | 24.3 | 37 |
| | 23–24 | 4 | 66.7 | 0 | 0.0 | 2 | 33.3 | 6 |
| Constructing Support | 17–18 | 27 | 34.6 | 41 | 52.6 | 10 | 12.8 | 78 |
| | 19–20 | 100 | 43.5 | 93 | 40.4 | 37 | 16.1 | 230 |
| | 21–22 | 15 | 40.5 | 13 | 35.1 | 9 | 24.3 | 37 |
| | 23–24 | 3 | 50.0 | 2 | 33.3 | 1 | 16.7 | 6 |
| Abstract | 17–18 | 27 | 34.6 | 35 | 44.9 | 16 | 20.5 | 78 |
| | 19–20 | 73 | 31.7 | 101 | 43.9 | 56 | 24.3 | 230 |
| | 21–22 | 9 | 24.3 | 18 | 48.6 | 10 | 27.0 | 37 |
| | 23–24 | 2 | 33.3 | 2 | 33.3 | 2 | 33.3 | 6 |
| Analyzing Perspectives | 17–18 | 32 | 41.0 | 31 | 39.7 | 15 | 19.2 | 78 |
| | 19–20 | 71 | 30.9 | 94 | 40.9 | 65 | 28.3 | 230 |
| | 21–22 | 12 | 32.4 | 17 | 45.9 | 8 | 21.6 | 37 |
| | 23–24 | 5 | 83.3 | 1 | 16.7 | 0 | 0.0 | 6 |
| Decision Making | 17–18 | 38 | 48.7 | 30 | 38.5 | 10 | 12.8 | 78 |
| | 19–20 | 103 | 44.8 | 95 | 41.3 | 32 | 13.9 | 230 |
| | 21–22 | 19 | 51.4 | 12 | 32.4 | 6 | 16.2 | 37 |
| | 23–24 | 2 | 33.3 | 2 | 33.3 | 2 | 33.3 | 6 |
| Investigation | 17–18 | 32 | 41.0 | 32 | 41.0 | 14 | 17.9 | 78 |
| | 19–20 | 95 | 41.3 | 89 | 38.7 | 46 | 20.0 | 230 |
| | 21–22 | 15 | 40.5 | 11 | 29.7 | 11 | 29.7 | 37 |
| | 23–24 | 3 | 50.0 | 2 | 33.3 | 1 | 16.7 | 6 |
| Problem Solving | 17–18 | 39 | 50.0 | 33 | 42.3 | 6 | 7.7 | 78 |
| | 19–20 | 112 | 48.7 | 93 | 40.4 | 25 | 10.9 | 230 |
| | 21–22 | 17 | 45.9 | 12 | 32.4 | 8 | 21.6 | 37 |
| | 23–24 | 1 | 16.7 | 4 | 66.7 | 1 | 16.7 | 6 |
| Experimental Inquiry | 17–18 | 38 | 48.7 | 28 | 35.9 | 12 | 15.4 | 78 |
| | 19–20 | 106 | 46.1 | 83 | 36.1 | 41 | 17.8 | 230 |
| | 21–22 | 21 | 56.8 | 8 | 21.6 | 8 | 21.6 | 37 |
| | 23–24 | 1 | 16.7 | 4 | 66.7 | 1 | 16.7 | 6 |
| Invention | 17–18 | 44 | 56.4 | 27 | 34.6 | 7 | 9.0 | 78 |
| | 19–20 | 104 | 45.2 | 96 | 41.7 | 30 | 13.0 | 230 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 21–22 | 19 | 51.4 | 11 | 29.7 | 7 | 18.9 | 37 |
| | 23–24 | 4 | 66.7 | 2 | 33.3 | 0 | 0.0 | 6 |

Based on the age factor, the level of mastery of Marzano HOTS among technical students is at a low level for all HOTS. Salleh Huddin et al. (2016) found that students' ability to master the level of knowledge and understanding shows that the level of mastery of HOTS among students does not reach the required level. This shows that the mastery of students regardless of age is still at a low level. Lack of mastery and knowledge about HOTS will impact students in terms of their readiness for learning (Mohd Anuar & Abdul Razak, 2019).

### 4.1.3 Perception of The Mastery of HOTS Marzano Among Technical Students Based on Field of Study

Table 8 shows the level of mastery of HOTS Marzano by their field of study, which are civil engineering, electrical engineering and mechanical engineering. For comparison skills, the result of the analysis show that most of the students from the field of civil engineering and electrical engineering tend to apply comparative skills at low level, namely 53.2% and 39.0% respectively. While, for the field of mechanical engineering, students apply these skills at a high level which is as much as (43.2%).

For classification skills, it can be seen that most of the civil engineering student tend to apply this classification skill at a low level which is 55.1%, while electrical engineering students apply this skill at a moderate level which is 41.5%. Interestingly, 40.5% students from the mechanical student shows the high level of mastery. Next, for the induction skill, the mastery level of this skill is at the moderate level for civil engineering students (43.7%) whereas electrical engineering and mechanical engineering apply this skill at a low level, namely 50.0% and 46.8% respectively.

As for the deduction skills, most of students master this skill at high level, chiefly 37.8% for electrical engineering and 39.6% for the mechanical engineering. Only civil engineering students tend to apply deduction skills at low level which is 60.1%. Next, for analyzing error skills, most of student master the skills at low level particularly 46.3% for the electrical engineering student and 44.1% for the mechanical engineering student. Meanwhile, for the civil engineering students, majority of student form civil engineering student master these skills at low level which is 47.5%.

Moving on, for constructing support skills, majority of the student master skills at low level specifically 44.9% for the civil engineering students and 43.9% for the electrical engineering students. As for the mechanical engineering students, the mastery level is at moderate level which is 44.1%. Meanwhile, for the abstract skills, the result of analysis shows the level of mastery is at moderate level for the civil engineering students (46.8%), electrical engineering students (41.5%), and mechanical engineering student (43.2%).

Next, for the analyzing perspective skills, all the field of study shows the different mastery skills. Most of civil engineering student tend to apply this mastery skill at low level which is 41.8%, electrical engineering students at moderate level particularly 63.4% and mechanical engineering students at high level namely 36.0%. For the decision making skills, majority of student show the mastery level at low level, particularly 48.1% for the civil engineering students and 45% for the mechanical engineering students. While, for the electrical engineering student, majority of student apply decision making skills at low level and moderate level namely 43.9%.

For the investigation skills, the majority of the students master the skill at low level, specifically 44.3% for the civil engineering students and 40.5% for the mechanical engineering students. While for the electrical engineering students tend to apply these skills at moderate level namely 41.5%. As for the problem solving skills, most of student master this skill at low level, specifically 50.6% for the civil engineering students and 46.8% for the mechanical engineering students. Meanwhile, students from electrical engineering apply problem solving skills at moderate level which is 46.3%.

As for the experimental inquiry, the result of analysis showed that students from all three fields of study mastery this level at low level namely 48.7%, 47.6% and 45.0% respectively. Meanwhile, for the invention skills, majority of student tend to apply invention skills at low level particularly 45.1% for the electrical engineering students and 64.9% for the mechanical engineering students. As for the civil engineering student, most of student's mastery this skill at moderate level which is 49.4%.

**Table 8** *Perception of the mastery of HOTS Marzano among technical students based on field of study*

| Marzano HOTS | Field of Study | Low | | Moderate | | High | | Total |
|---|---|---|---|---|---|---|---|---|
| | | *f* | % | *f* | % | *f* | % | *f* |
| Comparison | Civil Engineering | 84 | 53.2 | 50 | 31.6 | 24 | 15.2 | 158 |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Electrical Engineering | 32 | 39.0 | 25 | 30.5 | 25 | 30.5 | 82 |
| | Mechanical Engineering | 27 | 24.3 | 36 | 32.4 | 48 | 43.2 | 111 |
| Classification | Civil Engineering | 87 | 55.1 | 57 | 36.1 | 14 | 8.9 | 158 |
| | Electrical Engineering | 17 | 20.7 | 34 | 41.5 | 31 | 37.8 | 82 |
| | Mechanical Engineering | 27 | 24.3 | 39 | 35.1 | 45 | 40.5 | 111 |
| Induction | Civil Engineering | 58 | 36.7 | 69 | 43.7 | 31 | 19.6 | 158 |
| | Electrical Engineering | 41 | 50.0 | 33 | 40.2 | 8 | 9.8 | 82 |
| | Mechanical Engineering | 52 | 46.8 | 42 | 37.8 | 17 | 15.3 | 111 |
| Deduction | Civil Engineering | 95 | 60.1 | 59 | 37.3 | 4 | 2.5 | 158 |
| | Electrical Engineering | 29 | 35.4 | 22 | 26.8 | 31 | 37.8 | 82 |
| | Mechanical Engineering | 35 | 31.5 | 32 | 28.8 | 44 | 39.6 | 111 |
| Analyzing Error | Civil Engineering | 47 | 29.7 | 75 | 47.5 | 36 | 22.8 | 158 |
| | Electrical Engineering | 38 | 46.3 | 35 | 42.7 | 9 | 11.0 | 82 |
| | Mechanical Engineering | 49 | 44.1 | 44 | 39.6 | 18 | 16.2 | 111 |
| Constructing Support | Civil Engineering | 71 | 44.9 | 67 | 42.4 | 20 | 12.7 | 158 |
| | Electrical Engineering | 36 | 43.9 | 33 | 40.2 | 13 | 15.9 | 82 |
| | Mechanical Engineering | 38 | 34.2 | 49 | 44.1 | 24 | 21.6 | 111 |
| Abstract | Civil Engineering | 63 | 39.9 | 74 | 46.8 | 21 | 13.3 | 158 |
| | Electrical Engineering | 23 | 28.0 | 34 | 41.5 | 25 | 30.5 | 82 |
| | Mechanical Engineering | 25 | 22.5 | 48 | 43.2 | 38 | 34.2 | 111 |
| Analyzing Perspectives | Civil Engineering | 66 | 41.8 | 57 | 36.1 | 35 | 22.2 | 158 |
| | Electrical Engineering | 17 | 20.7 | 52 | 63.4 | 13 | 15.9 | 82 |
| | Mechanical Engineering | 37 | 33.3 | 34 | 30.6 | 40 | 36.0 | 111 |
| Decision Making | Civil Engineering | 76 | 48.1 | 58 | 36.7 | 24 | 15.2 | 158 |
| | Electrical Engineering | 36 | 43.9 | 36 | 43.9 | 10 | 12.2 | 82 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mechanical Engineering | 50 | 45.0 | 45 | 40.5 | 16 | 14.4 | 111 |
| Investigation | Civil Engineering | 70 | 44.3 | 56 | 35.4 | 32 | 20.3 | 158 |
| | Electrical Engineering | 30 | 36.6 | 34 | 41.5 | 18 | 22.0 | 82 |
| | Mechanical Engineering | 45 | 40.5 | 44 | 39.6 | 22 | 19.8 | 111 |
| Problem Solving | Civil Engineering | 80 | 50.6 | 63 | 39.9 | 15 | 9.5 | 158 |
| | Electrical Engineering | 37 | 45.1 | 38 | 46.3 | 7 | 8.5 | 82 |
| | Mechanical Engineering | 52 | 46.8 | 41 | 36.9 | 18 | 16.2 | 111 |
| Experimental Inquiry | Civil Engineering | 77 | 48.7 | 53 | 33.5 | 28 | 17.7 | 158 |
| | Electrical Engineering | 39 | 47.6 | 30 | 36.6 | 13 | 15.9 | 82 |
| | Mechanical Engineering | 50 | 45.0 | 40 | 36.0 | 21 | 18.9 | 111 |
| Invention | Civil Engineering | 62 | 39.2 | 78 | 49.4 | 18 | 11.4 | 158 |
| | Electrical Engineering | 37 | 45.1 | 33 | 40.2 | 12 | 14.6 | 82 |
| | Mechanical Engineering | 72 | 64.9 | 25 | 22.5 | 14 | 12.6 | 111 |

The level of mastery of HOTS Marzano based on the fields of civil, mechanical, and electrical engineering is generally at a low level. Students who are weak in high-level thinking skills can be seen at every level of Education (Chew, 2017). Indirectly, the results of this study show that students of different fields of study do not have differences in mastery of HOTS. Therefore, students should take advantage of the opportunities available to learn HOTS and apply HOTS in the learning process.

### 4.1.4 Perception of The Mastery of Marzano HOTS Among Technical Students Based on Year of Study

Table 9 shows the mastery level of HOTS Marzano based on the year of study which are students from year 1, year 2, year 3 and year 4. For comparison skills, all the students master the skills at low level, specifically 40.6% for the year 1 students, 38.8% for the year 2 students, 41.2% for the year 3 students, and 45.5% for the years 4 students. For classification skills, the majority of the students master the skill at moderate level, specifically 42.0% for the year 1 students and 43.3% for the year 2 students. As for the years 3 students, the mastery level is at low level which is 40.7%. Only the year 4 students tend to apply classification level at low and moderate level, namely 36.4%.

For the induction skills, the year 1 and year 2 students mostly at moderate level of mastery, namely 42.0% and 46.3%. While for the year 3 and year 4 student, most of student's mastery these skills at low level namely 43.6 % and 54.5%. Next, the result of the analysis for deduction skills shows the level of mastery is at low level for the year 1 students (46.4%), year 2 students (46.3%), year 3 student (44.1%), and year 4 students (54.5%).

As for analyzing error, the majority of the students master the skill at moderate level which is 50.7% for the year 2 students, 43.6% for the year 3 students, and 45.5% for the year 4 students. While for the year 1 students, majority student mastery at low level 39.1%. For constructing support skills, it can be seen that most of students master the skills at moderate level, particularly 56.5% for the year 1 students and 50.7% for the year 2 students. Meanwhile, the year 3 and year 4 students mostly tend to apply this mastery level at low level namely 44.6% and 36.4%.

Next, for abstract skills, mostly all student master the skills at moderate level, namely 59.4% for the year 1 students, 46.3% for the year 2 students,38.7% for the year 3 students, and 45.5% for the year 4 students. On

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analyzing perspectives skills, the level of mastery shows that year 1 students and year 2 students tend to apply at moderate level, which is 50.7% and 47.8% respectively. For the year 3 students majority mastery at moderate level which is 37.3%. Only for the year 4 students inclined to apply at low level and moderate level namely 36.4%.

Moving on decision making skills, the majority of the student master skills at low level, primarily 47.8% for the year 1 students, 46.6% for the year 3 students, and 45.4% for the year 4 students. As for the student in the year 2, the mastery level is at a moderate level which is 44.8%. While, for the investigation skill, majority of the student master the skill at low level, specifically 44.8 % for the year 2 students, 42.2% for the year 3 students, and 63.6% for the year 4 students. As for the year1 students, the mastery level is at moderate level which is 53.6%.

Meanwhile, for the problem solving skills, the result of analysis shows the level of mastery is at low level for the year students (50.7%), year 2 students (50.7%), and year 3 students (47.1%). For the year 4 students, the mastery level at moderate level which is 54.5%. As for the experimental inquiry, all of the student master the skills at low level particularly 49.3% for the year 1 students, 52.2% for the year 2 students, 45.1 % for the year 3 students, and 45.4% for the year 4 students. Similarly, for the invention skills, it can be seen that all students from year 1, year 2, year 3 and year 4 mastery skills at low level, namely 58.0%, 50.7%, 44.1% and 63.6% respectively.

**Table 9** *Perception of the mastery of HOTS Marzano among technical students based on year of study*

| Marzano HOTS | Year of Study | Low | | Moderate | | High | | Total |
|---|---|---|---|---|---|---|---|---|
| | | *f* | % | *f* | % | *f* | % | ***f*** |
| Comparing | Year 1 | 28 | 40.6 | 25 | 36.2 | 25 | 36.2 | 69 |
| | Year 2 | 26 | 38.8 | 23 | 34.3 | 18 | 26.9 | 67 |
| | Year 3 | 84 | 41.2 | 61 | 29.9 | 59 | 28.9 | 204 |
| | Year 4 | 5 | 45.5 | 2 | 18.2 | 4 | 36.4 | 11 |
| Classification | Year 1 | 18 | 26.1 | 29 | 42.0 | 20 | 29.0 | 69 |
| | Year 2 | 26 | 38.8 | 29 | 43.3 | 12 | 17.9 | 67 |
| | Year 3 | 83 | 40.7 | 66 | 32.4 | 55 | 27.0 | 204 |
| | Year 4 | 4 | 36.4 | 4 | 36.4 | 3 | 27.3 | 11 |
| Induction | Year 1 | 28 | 40.6 | 29 | 42.0 | 12 | 17.4 | 69 |
| | Year 2 | 28 | 41.8 | 31 | 46.3 | 8 | 11.9 | 67 |
| | Year 3 | 89 | 43.6 | 81 | 39.7 | 34 | 16.7 | 204 |
| | Year 4 | 6 | 54.5 | 3 | 27.3 | 2 | 18.2 | 11 |
| Deduction | Year 1 | 32 | 46.4 | 21 | 30.4 | 16 | 23.2 | 69 |
| | Year 2 | 31 | 46.3 | 23 | 34.3 | 13 | 19.4 | 67 |
| | Year 3 | 90 | 44.1 | 66 | 32.4 | 48 | 23.5 | 204 |
| | Year 4 | 6 | 54.5 | 3 | 27.3 | 2 | 18.2 | 11 |
| Analyzing Error | Year 1 | 27 | 39.1 | 26 | 37.7 | 16 | 23.2 | 69 |
| | Year 2 | 24 | 35.8 | 34 | 50.7 | 9 | 13.4 | 67 |
| | Year 3 | 81 | 39.7 | 89 | 43.6 | 34 | 16.7 | 204 |
| | Year 4 | 2 | 18.2 | 5 | 45.5 | 4 | 36.4 | 11 |
| Constructing Support | Year 1 | 21 | 30.4 | 39 | 56.5 | 9 | 13.0 | 69 |
| | Year 2 | 29 | 43.3 | 34 | 50.7 | 4 | 6.0 | 67 |
| | Year 3 | 91 | 44.6 | 73 | 35.8 | 40 | 19.6 | 204 |
| | Year 4 | 4 | 36.4 | 3 | 27.3 | 4 | 36.4 | 11 |
| Abstract | Year 1 | 12 | 17.4 | 41 | 59.4 | 16 | 23.2 | 69 |
| | Year 2 | 23 | 34.3 | 31 | 46.3 | 13 | 19.4 | 67 |
| | Year 3 | 73 | 35.8 | 79 | 38.7 | 52 | 25.5 | 204 |
| | Year 4 | 3 | 27.3 | 5 | 45.5 | 3 | 27.3 | 11 |
| | Year 1 | 21 | 30.4 | 35 | 50.7 | 13 | 18.8 | 69 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Analyzing Perspectives | Year 2 | 19 | 28.4 | 32 | 47.8 | 16 | 23.9 | 67 |
| | Year 3 | 76 | 37.3 | 72 | 35.3 | 56 | 27.5 | 204 |
| | Year 4 | 4 | 36.4 | 4 | 36.4 | 3 | 27.3 | 11 |
| Decision Making | Year 1 | 33 | 47.8 | 27 | 39.1 | 9 | 13.0 | 69 |
| | Year 2 | 29 | 43.3 | 30 | 44.8 | 8 | 11.9 | 67 |
| | Year 3 | 95 | 46.6 | 79 | 38.7 | 30 | 14.7 | 204 |
| | Year 4 | 5 | 45.5 | 3 | 27.3 | 3 | 27.3 | 11 |
| Investigation | Year 1 | 22 | 31.9 | 37 | 53.6 | 10 | 14.5 | 69 |
| | Year 2 | 30 | 44.8 | 25 | 37.3 | 12 | 17.9 | 67 |
| | Year 3 | 86 | 42.2 | 68 | 33.3 | 50 | 24.5 | 204 |
| | Year 4 | 7 | 63.6 | 4 | 36.4 | 0 | 0.0 | 11 |
| Problem Solving | Year 1 | 35 | 50.7 | 27 | 39.1 | 7 | 10.1 | 69 |
| | Year 2 | 34 | 50.7 | 26 | 38.8 | 7 | 10.4 | 67 |
| | Year 3 | 96 | 47.1 | 83 | 40.7 | 25 | 12.3 | 204 |
| | Year 4 | 4 | 36.4 | 6 | 54.5 | 1 | 9.1 | 11 |
| Experimental Inquiry | Year 1 | 34 | 49.3 | 26 | 37.7 | 9 | 13.0 | 69 |
| | Year 2 | 35 | 52.2 | 19 | 28.4 | 13 | 19.4 | 67 |
| | Year 3 | 92 | 45.1 | 74 | 36.3 | 38 | 18.6 | 204 |
| | Year 4 | 5 | 45.5 | 4 | 36.4 | 2 | 18.2 | 11 |
| Invention | Year 1 | 40 | 58.0 | 21 | 30.4 | 8 | 11.6 | 69 |
| | Year 2 | 34 | 50.7 | 27 | 40.3 | 6 | 9.0 | 67 |
| | Year 3 | 90 | 44.1 | 85 | 41.7 | 29 | 14.2 | 204 |
| | Year 4 | 7 | 63.6 | 3 | 27.3 | 1 | 9.1 | 11 |

The level of mastery of HOTS Marzano based on the year of study is generally at a low level. A study by Yee et al. (2016) found that there was a very weak positive relationship between students' inquiry skills and their creative skills with their year of study. Therefore, educators should further expand teaching and learning activities based on HOTS to their students regardless of the student's year of study or university entrance qualification. With this, students can further improve their HOTS level during teaching and learning sessions.

## 4.2 Relationship Between the Level Marzano HOTS and Gender, Age, Field of Study and Years of Study

The level of Marzano HOTS was shown to have a very weak positive relationship with age, gender, year of study, and field of study using the Eta Test (Table 10). The results showed that students' cognitive abilities are unaffected by their gender, age, year of study, or field of study. These results are consistent with the outcomes of studies carried out by psychologists with expertise in the field. Their research indicated individuals only make decisions using general guidelines derived from their own experiences (Mohd & Hassan, 2005).

**Table 10** *The relationship between the level Marzano HOTS and gender, age, field of study and years of study.*

| Marzano HOTS | Gender | Age | Field of study | Years of Study |
|---|---|---|---|---|
| Comparing | .123 | .069 | .303 | .077 |
| Classifying | .123 | .027 | .362 | .117 |
| Inductive | .090 | .083 | .098 | .045 |
| Deductive | .105 | .073 | .405 | .008 |
| Analyzing Error | .078 | .030 | .140 | .029 |
| Construction Support | .098 | .113 | .118 | .193 |
| Analyzing Perspective | .028 | .003 | .134 | .132 |
| Abstracting | .034 | .061 | .235 | .156 |
| Decision Making | .085 | .054 | .038 | .047 |

| | | | | |
|---|---|---|---|---|
| Investigation | .047 | .067 | .043 | .147 |
| Problem Solving | .049 | .107 | .087 | .045 |
| Experimental Inquiry | .043 | .038 | .032 | .053 |
| Invention | .078 | .051 | .241 | .085 |

*Significant difference at p <.05.

## 4.3 Difference for Gender, Age, Field of Study and Years of Study on The Level of Marzano HOTS

Table 11 shows that there was no significant difference between gender on the level of Marzano HOTS. It is reasonable to state that all students enrolled in technical education, male or female, possess the same cognitive abilities. The findings of this study are in line with the study conducted by Yee et.al (2016) who stated that no significant difference between gender on the level of Marzano HOTS. According to Coşkun's (2018) study, there are not significant differences in cognitive thinking between genders. This is a result of both male and female students being in the same class and field of study, where they are simultaneously getting knowledge, making adjustments, and receiving input. The teaching and learning (T&L) affects will thus be the same for men and women. According to Maaroff (2013), the effectiveness of this process (T&L) will influence lesson thinking.

**Table 11** *The difference between gender on the level of Marzano HOTS*

| Marzano HOTS | Female | | Male | | df | F | *p* |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| Comparing | 1.95 | 0.84 | 1.78 | 0.78 | 1 | 3.833 | .051 |
| Classifying | 1.95 | 0.82 | 1.82 | 0.75 | 1 | 2.425 | .120 |
| Inductive | 1.71 | 0.74 | 1.75 | 0.70 | 1 | .290 | .590 |
| Deductive | 1.83 | 0.82 | 1.71 | 0.76 | 1 | 2.158 | .143 |
| Analyzing Error | 1.78 | 0.74 | 1.82 | 0.70 | 1 | .283 | .595 |
| Construction Support | 1.74 | 0.75 | 1.76 | 0.69 | 1 | .028 | .867 |
| Analyzing Perspective | 1.93 | 0.77 | 1.89 | 0.76 | 1 | .411 | .681 |
| Abstracting | 1.95 | 0.74 | 1.90 | 0.74 | 1 | .169 | .522 |
| Decision Making | 1.66 | 0.73 | 1.70 | 0.69 | 1 | .225 | .635 |
| Investigation | 1.81 | 0.78 | 1.77 | 0.74 | 1 | .227 | .634 |
| Problem Solving | 1.65 | 0.67 | 1.62 | 0.69 | 1 | .132 | .716 |
| Experimental Inquiry | 1.73 | 0.75 | 1.70 | 0.75 | 1 | .475 | .491 |
| Invention | 1.59 | 0.70 | 1.68 | 0.69 | 1 | 1.394 | .239 |

*Significant difference at p <.05.

Table 12 shows that there was no significant difference between age on the level of Marzano HOTS. The polytechnic study program's curriculum is built on a student-centered learning method, which emphasizes students' active participation in the learning process (Department of Polytechnic Studies, 2013). As a result, all students, whatever of age, bear full responsibility for their own education and do not rely solely on the lecturer to impart knowledge.

**Table 12** *The difference between age on the level of Marzano HOTS*

| Marzano HOTS | 17- 18 Year | | 19 -20 Year | | 21 -22 Year | | 23 – 24 Year | | df | F | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | | |
| Comparing | 1.82 | 0.83 | 1.87 | 0.81 | 1.92 | 0.83 | 2.17 | 0.75 | 3 | .400 | .753 |
| Classifying | 1.91 | 0.81 | 1.88 | 0.78 | 1.89 | 0.81 | 1.67 | 0.82 | 3 | .186 | .906 |
| Inductive | 1.78 | 0.73 | 1.69 | 0.69 | 1.76 | 0.83 | 2.33 | 0.82 | 3 | 1.792 | .148 |
| Deductive | 1.73 | 0.83 | 1.79 | 0.78 | 1.78 | 0.82 | 1.50 | 0.55 | 3 | .352 | .788 |
| Analyzing Error | 1.83 | 0.76 | 1.77 | 0.69 | 1.89 | 0.77 | 1.67 | 1.03 | 3 | .420 | .739 |
| Construction Support | 1.78 | 0.66 | 1.73 | 0.72 | 1.84 | 0.80 | 1.67 | 0.82 | 3 | .347 | .791 |
| Analyzing Perspective | 1.78 | 0.75 | 1.97 | 0.77 | 1.89 | 0.74 | 1.17 | 0.41 | 3 | .456 | .023 |
| Abstracting | 1.86 | 0.73 | 1.93 | 0.75 | 2.03 | 0.73 | 2.00 | 0.89 | 3 | 3.213 | .713 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Decision Making | 1.64 | 0.70 | 1.69 | 0.70 | 1.65 | 0.75 | 2.00 | 0.89 | 3 | .526 | .664 |
| Investigation | 1.77 | 0.74 | 1.79 | 0.76 | 1.89 | 0.84 | 1.67 | 0.82 | 3 | .293 | .831 |
| Problem Solving | 1.58 | 0.63 | 1.62 | 0.67 | 1.76 | 0.80 | 2.00 | 0.63 | 3 | 1.193 | .312 |
| Experimental Inquiry | 1.67 | 0.73 | 1.72 | 0.75 | 1.65 | 0.82 | 2.00 | 0.63 | 3 | .465 | .707 |
| Invention | 1.53 | 0.66 | 1.68 | 0.69 | 1.68 | 0.78 | 1.33 | 0.52 | 3 | 1.362 | .254 |

*Significant difference at p <.05.

Table 13 shows that there was no significant difference in field of study on the level of Marzano HOTS except for comparing, classifying, deductive, analyzing error, abstract and invention. This is due to the fact that all three fields employ the same teaching and learning strategies, specifically Problem-Based Learning (PBL) (Instructional and Digital Learning Division, 2014). PBL is a trend in education that is utilized in community colleges and polytechnics (Instructional and Digital Learning Division, 2018). Students' thought processes can also be impacted by PBL (Kamal, 2008).

**Table 13** *The difference between field of study on the level of Marzano HOTS*

| Marzano HOTS | Civil Engineering | | Electrical Engineering | | Mechanical Engineering | | df | F | *p* |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | | | |
| Comparing | 1.62 | 0.74 | 1.91 | 0.83 | 2.19 | 0.80 | 2 | 17.451 | .000 |
| Classifying | 1.54 | 0.65 | 2.17 | 0.75 | 2.16 | 0.79 | 2 | 32.749 | .000 |
| Inductive | 1.83 | 0.73 | 1.60 | 0.66 | 1.68 | 0.73 | 2 | 3.145 | .044 |
| Deductive | 1.42 | 0.54 | 2.02 | 0.86 | 2.08 | 0.84 | 2 | 32.912 | .000 |
| Analyzing Error | 1.93 | 0.72 | 1.65 | 0.67 | 1.72 | 0.73 | 2 | 5.218 | .006 |
| Construction Support | 1.68 | 0.69 | 1.72 | 0.72 | 1.87 | 0.74 | 2 | 2.567 | .078 |
| Analyzing Perspective | 1.80 | 0.78 | 1.95 | 0.61 | 2.03 | 0.84 | 2 | 10.176 | .053 |
| Abstracting | 1.73 | 0.68 | 2.02 | 0.77 | 2.12 | 0.75 | 2 | 2.969 | .000 |
| Decision Making | 1.67 | 0.73 | 1.68 | 0.68 | 1.69 | 0.71 | 2 | .034 | .967 |
| Investigation | 1.76 | 0.77 | 1.85 | 0.76 | 1.79 | 0.75 | 2 | .414 | .661 |
| Problem Solving | 1.59 | 0.66 | 1.63 | 0.64 | 1.69 | 0.74 | 2 | .779 | .460 |
| Experimental Inquiry | 1.69 | 0.76 | 1.68 | 0.73 | 1.74 | 0.76 | 2 | .178 | .837 |
| Invention | 1.72 | 0.66 | 1.70 | 0.71 | 1.48 | 0.71 | 2 | 4.465 | .012 |

*Significant difference at p <.05.

Table 14 shows that there was no significant difference in year of study on the level of Marzano HOTS. This is due to the fact that all courses, regardless of program, will employ the cognitive, psychomotor, and affective learning taxonomies throughout every year of study. All three taxonomies should be included in the learning objectives of the courses that are established (Department of Polytechnic Studies, 2013). This is also because, inside the educational system, children may learn these skills through a variety of approaches and strategies that are organized in line with their abilities and intelligence levels throughout all educational levels (Musa, 2020).

**Table 14** *The difference between year of study on the level of Marzano HOTS*

| Marzano HOTS | Year 1 | | Year 2 | | Year 3 | | Year 4 | | df | F | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | Mean | Mean | SD | Mean | SD | | | |
| Comparing | 1.83 | 0.79 | 1.88 | 0.81 | 1.88 | 0.83 | 1.91 | 0.94 | 3 | .083 | .969 |
| Classifying | 2.03 | 0.75 | 1.79 | 0.73 | 1.86 | 0.81 | 1.91 | 0.83 | 3 | 1.150 | .329 |
| Inductive | 1.77 | 0.73 | 1.70 | 0.67 | 1.73 | 0.73 | 1.64 | 0.81 | 3 | .160 | .923 |
| Deductive | 1.77 | 0.81 | 1.73 | 0.77 | 1.79 | 0.80 | 1.64 | 0.81 | 3 | .218 | .884 |
| Analyzing Error | 1.84 | 0.78 | 1.78 | 0.67 | 1.77 | 0.72 | 2.18 | 0.75 | 3 | 1.243 | .294 |
| Construction Support | 1.83 | 0.64 | 1.63 | 0.60 | 1.75 | 0.76 | 2.00 | 0.89 | 3 | 1.368 | .252 |
| Analyzing Perspective | 1.88 | 0.70 | 1.96 | 0.73 | 1.90 | 0.80 | 1.91 | 0.83 | 3 | 1.095 | .954 |
| Abstracting | 2.06 | 0.64 | 1.85 | 0.72 | 1.90 | 0.78 | 2.00 | 0.77 | 3 | .111 | .351 |
| Decision Making | 1.65 | 0.70 | 1.69 | 0.68 | 1.68 | 0.72 | 1.82 | 0.87 | 3 | .175 | .913 |
| Investigation | 1.83 | 0.66 | 1.73 | 0.75 | 1.82 | 0.80 | 1.36 | 0.50 | 3 | 1.479 | .220 |
| Problem Solving | 1.59 | 0.67 | 1.60 | 0.68 | 1.65 | 0.69 | 1.73 | 0.65 | 3 | .259 | .855 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Experimental Inquiry | 1.64 | 0.71 | 1.67 | 0.79 | 1.74 | 0.75 | 1.73 | 0.79 | 3 | .341 | .796 |
| Invention | 1.54 | 0.70 | 1.58 | 0.65 | 1.70 | 0.70 | 1.45 | 0.69 | 3 | 1.457 | .226 |

*Significant difference at p <.05.

## 5. Conclusion

In conclusion, the level of mastery of Marzano HOTS among technical students based on gender is generally at a low level for all HOTS. Findings show that male students master seven HOTS at a moderate level and six HOTS at a low level. On the other hand, for female students, they mastered two HOTS at a moderate level and 11 HOTS at a low level. Also, the findings indicated there was a very low positive relationship between the level of Marzano HOTS with gender, age, field of study and year of study. There exist no significant differences in thinking levels between male and female students, neither among their age and year of study.

Each student's journey in mastering thinking skills is not uniform and each student develops at a different rate and maybe at a different level. Several factors such as original ability, learning approach, and the ability to interpret and apply thinking skills can also affect a person's level of mastery in Marzano's thinking skills. Therefore, by knowing the level of mastery, students can learn how to use various learning strategies or techniques that enable the achievement of tasks based on high-level thinking skills. Lecturers can provide high-level problem-solving questions that can challenge students' minds and develop high-level questions to encourage students to give insights and conduct structured research and exploration. Teachers also should help students learn HOTS; this can be done through traditional classroom or by providing them with a personalized, self-instructional manual.

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

*The authors confirm contribution to the paper as follows:* ***study conception and design****: Yee Mei Heong, Nuraffefa Hamdan, Tee Tze Kiong, Eddy Sutadji, & Syifaul Fuada;* ***data collection:*** *Nuraffefa Hamdan & Saiful Hadi Masran;* ***analysis and interpretation of results:*** *Nuraffefa Hamdan & Yee Mei Heong;* ***draft manuscript preparation:*** *Nuraffefa Hamdan, Yee Mei Heong & Saiful Hadi Masran. All authors reviewed the results and approved the final version of the manuscript.*

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