Modelling Teachers’ Perceptions Towards Science Technology Engineering Mathematics (STEM) among Secondary School in Kota Bharu

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Abstract. In an era of Education 5.0 where technology is advancing, Science Technology Engineering Mathematics education (STEM) is one of the important aspects. Teachers play an important role to support students in developing better awareness towards the importance of STEM education. Unfortunately, recent statistics show that there is a lack of students’ participation in choosing STEM education. Therefore, the aim of the study is to determine the teacher’s perception on factors which might influence students’ lack of interest towards Science Technology Engineering Mathematics (STEM) in secondary schools located in Kota Bharu. There are several factors that affect students’ interest in STEM education which are attitude, management policy, learning method and gender of students. A cross-sectional study was carried out among 290 secondary school teachers in Kota Bharu, Kelantan. A combination of stratified sampling and cluster sampling technique was applied to collect data. Pearson Correlation and Multiple Linear Regression revealed that management policy and learning method were significantly associated with teachers’ perception. Findings from this study indicated that it may be effective to increase the students’ interest towards STEM education by improving the management policies and learning method.

Keywords: perception, STEM, students, teachers

1. Introduction
Science, technology, engineering, and mathematics (STEM) education has become crucial in this growing economic advancement era. It is vital for students to remain globally competitive in the modern era that is full of complex problems. NAE & NRC[1] defines STEM literate as (1) awareness of the importance of science, technology, engineering, and mathematics in modern society; (2) familiarity with at least some of the basic concepts from each field; and (3) possessing a basic level of application fluency. The initial idea of STEM was implemented and introduced in the USA in the 1990 [2]. Since
then, many countries have begun to raise awareness about STEM education such as in Arab Saudi [3], South Korea [4], Thailand [5] and others. In Malaysia, STEM has been implemented since 2017[6]. Malaysia prioritizes STEM in the education transformation with the target to fulfill the demand of the national workforce. Malaysian Education Blueprint 2013 – 2025 (PPM) has been launched by the Ministry of Education (MOE) which aims to transform the Malaysian education system to compete with the growing international education system. One of the benchmarks to transform education is by enhancing the quality of STEM education [7]. The Malaysian government has already set an aim in 1996 to target the percentage of students’ participation in science stream with literature at 60:40. The percentage of students participating in science courses never reached 60 percent until 2020. The worst, it shows a worrying depreciating trend on the matter [8]. Besides, a shortfall of 236, 000 professionals in STEM-related fields are to be expected by the ministry of Science, Technology and Innovation [9]. Hence, there is a need for the government to develop effective preparation and strategies for successful implementation of STEM education. One of the strategies is to prepare the teachers. Teachers are a critical element and play important roles in implementing STEM education successfully [10].

A large body of literature exists on teacher’s perception towards STEM education [2-4,10-15]. A recent study by Rifandi et al. [2] paid particular attention to the perception on STEM education among pre-service teachers. The study recruited 48 pre-service teachers teaching mathematics and science subjects in Universitas Negeri Padang, Indonesia where it was found that the teachers had positive perceptions about STEM education. Likewise, Nguyen et al. [15] in their study revealed that most Vietnamese teachers indicated positive views about STEM education. Furthermore, they reported that novice teachers possessed positive views on STEM education. In a study among Thailand teachers, Srikoom et al. [11] also studied teachers’ perception regarding STEM education. However, unlike Rifandi et al. [2], their study was carried out among in-service teachers. They found that a majority of teachers indicated that they had never heard about STEM education. In addition, a small number of teachers were unable to provide the definition of STEM education. Another study in Malaysia also found some of the secondary school teachers could not explain further the definition of STEM [6].

Another recent study was conducted by Ng et al. [16] among Malaysian Physics teachers in which the objective was to determine the perspective of teachers regarding STEM education using Bybee’s nine perspectives. It was found that most teachers agree that engineering or technology is a bridge that connects science and mathematics.

Among the quantitative studies that are discussed above, most of them used descriptive statistics in an attempt to determine the teachers’ perception on STEM education. For example, Srikoom et al. [11] have used descriptive statistics such as frequency, mean, and standard deviation. Also, the study used one-way Analysis of Variance (ANOVA) to determine whether there is a percentage difference related to teachers’ concern on STEM education between age group, teaching level and teaching subject. Similarly, Rifandi et al. [2] presented the percentage to determine pre-service teachers’ perception about STEM education. In their study conducted among physics teachers, Ng et al. [16] also used descriptive statistics including mean, mode and median to describe perspectives of the teacher on STEM education. Early study by Smith et al. [17] used mean and standard deviation to describe the perception of agricultural teachers on STEM integration in agricultural education courses. In summary, there are several studies that have been done to determine the teachers’ perception on STEM education using descriptive statistics. To date, there is a lack of study in utilizing regression analysis for describing the teachers’ perception. Furthermore, it is also found that most of the studies focused solely on general perception of STEM. Hence, this study aims to fill the gap by studying the teachers’ perception on specific aspects including perception on students’ attitude, management policy, learning method and gender. In addition, this study will utilize regression analysis to examine the dependence of teachers’ perception upon each independent variable. It is anticipated that this study could contribute to the existing knowledge of teachers’ perception on STEM education as well as provide useful findings to policymakers for successful implementation of STEM in Malaysia.
2. Methodology

2.1 Study Design and population

A cross-sectional study was carried out among 290 randomly selected secondary school teachers in Kota Bharu, Kelantan. A combination of stratified and cluster sampling techniques was applied to collect the data. The sample was stratified according to types of school. The randomly selected 5 strata are as follows: Sekolah Menengah Kebangsaan (SMK), Sekolah Menengah Kebangsaan Agama (SMKA), Sekolah Menengah Berasrama Penuh (SBP), Sekolah Menengah Agama (SABK) and Kolej Vokasional. The sample size was determined by using Krejcie, Robert & Morgan’s table of sampling size that resulted in 290 teachers chosen to be the respondents. Later, the respondent’s name list was generated from the sampling frame that had been numbered previously. Two-hundred and fifty-three respondents were selected from Sekolah Menengah Kebangsaan, 11 respondents from SMK Agama, 6 respondents from SM Berasrama Penuh, 10 respondents from SM Agama and finally 10 respondents from Kolej Vokasional.

2.2 Instrument and data collection

Data was collected by using a six-part self-administered questionnaire. The questionnaire was provided in two languages: Malay and English. The first part was the socio-demographic, which sought information about gender, age, subject taught, years of experience in teaching, ethnicity, and type of school. The following sections of the questionnaire elicited information regarding teachers’ perception on STEM educations, teachers’ perception on attitude of students, teachers’ perception on management policy, teachers’ perception on learning methods and teachers’ perception on student’s gender. The perception was assessed using a nine-point scale ranging from (1 = strongly disagree) to (9 = strongly agree). The questionnaire was developed after an extensive literature review from previous studies [3,18-22]. Table 1 summarizes the questionnaire used in this study:

| Section | Section | Number of items | Measurement |
|---------|---------|-----------------|-------------|
| A       | Demographic profile | 6             | Nominal     |
| B       | Teachers’ perception on STEM education | 6             | Likert-Scale |
| C       | Teachers’ perception on attitude of students | 5             | Likert-Scale |
| D       | Teachers’ perception on management policy | 6             | Likert-Scale |
| E       | Teachers’ perception on learning method | 7             | Likert-Scale |
| F       | Teachers’ perception on student’s gender | 5             | Likert-Scale |

The questionnaire was pre-tested on 30 teachers to examine the validity and reliability of the questionnaires. Cronbach alpha was used to evaluate the reliability of all items in the questionnaire. The Cronbach alpha values for all the variables that are greater than 0.6 indicated that all variables are reliable and valid to use.

2.3 Multiple Linear Regression

Multiple linear regression was used in this study. The parameter estimation of multiple linear regression is more complicated than the one-dimensional linear regression model. Montgomery [23] stated that regression analysis can explain how the value of the dependent variable changes when one of the independent variables varies, while the other independent variable is held constant. In this study, factors associated with the teachers’ perception on STEM education \( Y \) were determined by using Multiple linear regression. The following independent variables were included to testing teachers’ perception on
attitude of students \((x_1)\), teachers’ perception on management policy \((x_2)\), teachers’ perception on learning method \((x_3)\) and teachers’ perception on student’s gender \((x_4)\). Goodness-of-fit model was checked using coefficient of determination \((R^2)\) and adjusted coefficient of determination \((R_{adj}^2)\). In multiple linear regression analysis, variables for inclusion in the model were selected by using backward elimination. Variables with a significant value (p-value) less than level of significant value \((\alpha = 0.05)\) reported to be influenced by a dependent variable which is teachers’ perception on STEM education. The multiple linear regression model is as specific as Equation 1:

\[
y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + e_i
\]

where \(y_i\) is teacher’s perception and \(\beta_0, \beta_1, \beta_2, \beta_3\) are the regression coefficients which are estimated from the sample data. The error random is represented by \(e_i\).

2.4 Pearson’s Correlation

Pearson’s correlation is used to evaluate the relationship between teachers’ perception on STEM education, teachers’ perception on attitude of students, teachers’ perception on management policy, teachers’ perception on learning method and teachers’ perception on student’s gender. Kutner [26] stated that Pearson’s correlation measures the strength of the linear relationship between the dependent and independent variables and evaluates the degree of relationship. The strength of a relationship can be indicated by a value between -1 and +1. The stronger the correlation, the closer the correlation coefficient comes to ±1. If the coefficient is a positive number, the variables are directly related or vice versa.

2.5 Model Adequacy Checking

Model adequacy checking was done to check the assumption of a regression model in which the dependent and independent variables must be linearly related, no significant outlier, the error terms are normally distributed and have constant variance, and the independent variables are not correlated.

2.5.1. Normality Assumption

Normality P-P plot of residuals was used to check normality assumptions. Residuals \((e_i)\) was plotted against the cumulative probability \((P_i)\). If the resulting points lie approximately along a straight line, the normality assumption was achieved [24].

2.5.2 Homoscedasticity of error

A plot of residual \((e_i)\) against the fitted values \((\hat{y}_i)\) was used to detect homoscedasticity (constant variance) assumption. If the residuals show there is no obvious pattern that exists, therefore we can conclude the assumption of homoscedasticity is not violated [24].

2.5.3 Multicollinearity

Multicollinearity is a serious problem that may give an impact to the usefulness of a regression model. Multicollinearity exists if the independent (regressors) are related to each other. Variance Inflation Factor (VIF) and tolerance value were used to check multicollinearity. Serious multicollinearity problem exists if VIF is larger than 10 and tolerance value is below 0.1 [24].
3. Results

3.1 Reliability Analysis
Table 2 shows the results of reliability test for each section by using the actual data for all items in the questionnaire. Garson [29] stated that an exploratory study is reliable if the Cronbach’s Alpha for all items is as low as 0.6. The results show that all items in Section B until Section F are acceptable and said to be reliable and consistent since the value of Cronbach’s Alpha is greater than 0.6.

Table 2. Reliability Test for Actual Study

| Section | Variable                                | Number of Item | Cronbach’s Alpha |
|---------|-----------------------------------------|----------------|------------------|
| B.      | Teachers’ perception on STEM education  | 6              | 0.916            |
| C.      | Teachers’ perception on attitude of students | 5              | 0.825            |
| D.      | Teachers’ perception on learning method | 7              | 0.906            |
| E.      | Teachers’ perception on management policy | 6              | 0.886            |
| F.      | Teachers’ perception on student’s gender | 5              | 0.877            |

3.2 Socio-demographic characteristics
Based on table 3, of the 290 teachers, more female teachers (75.2%) participated in this study. Half of the teachers (50.7%) were in the age group 40-49 years old while 25.5% were in the age group 50 - 59 years, 20.7% age ranged from 30 to 39 years old and 3.1% of the teachers aged below 30 years old. With regards to subjects taught, 19% of them taught Mathematics/ Additional Mathematics followed by Bahasa Melayu (13.8%), English (10.3%) and the remaining taught other subjects. Regarding years of experience, more than half (59.7%) of the teachers participated in the study were with at least 10 but less than 21 years of experience; 29.3 with at least 21 but less than 31 years of experience; 9.7% with less than 11 years of experience and only 1.4% with at least 31 but less than 41 years of experience. Ethnicity for the entire sample is reported as follows: a majority of respondents (92.4%) were Malay, 4.1% Indian and 3.4% Chinese.

Table 3. Summary of demographic profile

| Variable         | Class Variable     | Frequency (n) | Percentage (%) |
|------------------|--------------------|---------------|----------------|
| Gender           | Female             | 218           | 75.2           |
|                  | Male               | 72            | 24.8           |
| Age              | 20-29 years old    | 9             | 3.1            |
|                  | 30-39 years old    | 60            | 20.7           |
|                  | 40-49 years old    | 147           | 50.7           |
|                  | 50-59 years old    | 74            | 25.5           |
| Subject Taught   | Bahasa Melayu      | 40            | 13.8           |
|                  | English            | 30            | 10.3           |
|                  | Pendidikan Islam   | 24            | 8.3            |
|                  | Pendidikan Moral   | 7             | 2.4            |
|                  | History            | 25            | 8.6            |
|                  | Mathematics/ Additional Mathematics | 55       | 19             |
|                  | Science            | 22            | 7.6            |
|                  | Biology            | 20            | 6.9            |
### Years of Experience

| Years of Experience | Perception |
|---------------------|------------|
| 0-10 Years          | 28         |
| 11-20 Years         | 173        |
| 21-30 Years         | 85         |
| 31-40 Years         | 4          |

### Ethnicity

| Ethnicity     | Perception |
|---------------|------------|
| Malay         | 268        |
| Chinese       | 10         |
| Indian        | 12         |

### Type of School

| Type of School                          | Perception |
|-----------------------------------------|------------|
| Sekolah Menengah Kebangsaan (SMK)       | 253        |
| Sekolah Menengah Kebangsaan Agama (SMKA)| 11         |
| Sekolah Menengah Agama (SABK)           | 10         |
| Sekolah Berasrama Penuh (SBP)           | 6          |
| Kolej Vokasional                        | 10         |

### 3.3 Results of Correlation Analysis

Table 4 shows the results of Pearson correlation analysis between perception of teachers towards STEM education, attitude of students, management policy, learning method and students’ gender. There is a moderate positive relationship with the teacher’s perception on management policy since the value of coefficient correlation is \( r = 0.540 \). The findings also suggest that there is weak positive relationship between perception of teacher towards STEM education and teacher’s perception on attitude of students, teacher’s perception on learning methods and teacher’s perception on students’ gender given the correlation coefficient values \( r = 0.461 \), \( r = 0.496 \) and \( r = 0.301 \) respectively. All the independent variables which are teacher’s perception on management policy, teacher’s perception on attitude of students, teacher’s perception on learning methods and teacher’s perception on students’ gender have significant positive relationship with perception of teacher towards STEM education since p-value (p = 0.0000) less than alpha at 0.05 level significance. This means that an increase in teachers’ perception on management policy, teachers’ perception on attitude of students, teachers’ perception on learning methods and teachers’ perception on student’s gender will proportionately increase the perception of teachers towards STEM education.

**Table 4. Result of Pearson Correlation between perception of teacher towards STEM education and independent variable**

| Relationship                                      | Correlation Coefficient | p-value |
|---------------------------------------------------|-------------------------|---------|
| Perception of teacher towards STEM education * Attitude of Students | 0.461                   | 0.000   |
| Perception of teacher towards STEM education * Management Policy       | 0.540                   | 0.000   |
| Perception of teacher towards STEM education * Learning Method          | 0.496                   | 0.000   |
| Perception of teacher towards STEM education * Perception on Students’ Gender | 0.301                   | 0.000   |
3.4 Analysis on Multiple Linear Regression

3.4.1 Model Adequacy Checking

Model adequacy checking was done to examine the appropriateness of the regression model. Figure 1 shows a normal probability plot to examine the distribution of residuals. Next, figure 2 depicts the residual versus predicted plot to study whether the errors have equal variance.

As depicted in figure 1, it can be concluded that the residuals have a normal distribution since most of the points are scattered roughly along the line. Scatterplot of residual versus predicted in figure 2 shows no obvious pattern of increasing or decreasing in any circumstances. Thus, the results indicated that the assumptions are satisfied. Therefore, it is suggested that the regression model is appropriate in predicting teachers’ perception on STEM education.

3.4.2 Goodness of Fit of the Model

| Table 5. R-Square and R-Square Adjusted |
|----------------------------------------|
| Model | R Square | R square Adjusted |
|-------|----------|-------------------|
| 1     | 0.349    | 0.340             |

As shown in table 5, the values of $R^2$ and $R^2_{adj}$ were 0.349 and 0.340 respectively. Referring to the value of $R^2$, it can be said that 34.9% of total variation in the perception of teachers towards STEM education are explained by the independent variables which are perception of teachers towards attitude, management policy, learning method and gender of students. The balance of 65.1% are explained by other factors. Based on both values, it can be concluded that the regression line is fairly fit in this model.

3.4.3 Multicollinearity

The presence of multicollinearity is examined by referring to the value of tolerance and VIF. Referring to table 6, the VIF value is less than 10 and tolerance value is greater than 0.1. Therefore, there is no multicollinearity problem, indicating that all the independent variables are not correlated to each other.
Table 6. Multicollinearity Result

| Model                                           | Collinearity |
|-------------------------------------------------|--------------|
|                                                 | Tolerance    | VIF    |
| Perception of Teachers towards Attitudes of Students | 0.486        | 2.057  |
| Perception of Teachers about Management Policy   | 0.49         | 2.04   |
| Perception of Teachers towards Learning Method   | 0.52         | 1.922  |
| Perception of Teachers towards Gender of Student | 0.77         | 1.298  |

3.4.4 Significance of the model (ANOVA)
Table 7 shows the F-value and significant p-value. The F-value and p-value are (F = 38.277 and p = 0.000) respectively. Since p-value 0.000 is less than alpha at 0.05 level of significance, therefore the model is significant. This means at least one of the independent variables give significant effect on perception of teachers towards STEM education.

Table 7. ANOVA Table

| F-Value | Sig  |
|---------|------|
| 38.277  | .000 |

3.4.5 Full and reduced model
Table 8 presents the result of t-test to examine the significance of each independent variable. Two variables (perception of teachers on management policy and perception of teachers towards learning method) are found to be significant since the p-value is less than alpha=0.05. Thus, the management policy and learning method were significantly associated with teachers' perception. The multiple regression analysis was performed again by using the two significant variables. The summary of the final model can also be seen in the table 8 below.

Table 8. Result of Regression Coefficients

| Variable                                           | Full Model | Reduced Model (Final Model) |
|----------------------------------------------------|------------|-----------------------------|
|                                                   | t-test     | Coefficient β | P-value | t-test | Coefficient β | P-value |
| Constant                                           | 6.008      | 2.409          | 0.000   | 6.807  | 2.610          | 0.000   |
| Perception of teacher towards Attitudes of Students| 1.120      | 0.081          | 0.224   |         |                 |         |
| Perception of teachers about Management Policy     | 4.915      | 0.329          | 0.000   | 6.494  | 0.374          | 0.000   |
| Perception of teachers towards Learning Method      | 3.350      | 0.243          | 0.001   | 4.692  | 0.302          | 0.000   |
Perception of teachers towards Gender of Student

| Perception of teachers towards Gender of Student | 1.202 | 0.058 | 0.230 |

Hence, the final model is

\[
\hat{y} = 2.610 + 0.374x_2 + 0.302x_3,
\]

where

\(x_2\) - perception of teachers about management policy

\(x_3\) - perception of teachers towards learning methods

4. Conclusion

This study used Pearson correlation coefficient to study the relationship between independent variables (attitude, management policies, learning method and students’ gender) and dependent variable (teacher’s perception on STEM education). More specifically, this study set out to identify which factors contribute to teachers’ perception on STEM education. The correlation between all independent variables and teachers’ perception about STEM education was statistically significant. Multiple linear regression analysis revealed that management policies and learning methods significantly contributed to teachers’ perception about STEM education. Based on the findings, there is a need for the Ministry of Education to develop a better strategy in increasing the awareness of STEM education. The ministry should strengthen the implementation of the STEM for All (STEM4ALL) initiative, which had first been established 3 years ago. To ensure that it fits into the requirements of an industry, a long-term plan relating to the basic syllabus that has been established by the government must be updated and continuously evolving according to the trend of time.

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