An Exploratory Study of Teachers' Attitudes towards Integration of STEM in Malaysia

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Abstract – *Integrated science, technology, engineering and mathematics (STEM) education is a relatively new concept in Malaysia. It is also one of the core elements in the construction and implementation of the Secondary School Standard Curriculum (KSSM) in Malaysia, which is newly launched in 2017. Teachers are the key agent of any policy implementation which is related to teaching and learning process. Therefore, attention on teachers' attitudes towards STEM is an essential step in exploring the provision of the best practice in integrated STEM education. This small-scale survey is a preliminary study of the secondary school teachers' attitude towards integrated STEM in Malaysia. In this regard, an A-STEM Survey which contains 28 items of 5 points Likert scale with five constructs of attitudes was utilised. These include attitude towards science, attitudes towards technology, attitudes towards engineering, attitudes towards mathematics and attitudes towards integration of STEM. Fifty-five secondary school teachers* $(n = 55)$ *were purposively selected to be the sample. The collected data were analysed by using the SPSS software. Descriptive analysis included percentage and correlation analysis has been utilized to evaluate the collected data. The finding suggests that teachers' attitudes towards integration of STEM were overall positive. The positive attitudes towards STEM among the teachers can expedite the forming of integrated STEM education in Malaysia. It is expected that the results could provide useful information to the relevant stakeholders in formulating the implementation strategy for the integrated STEM education in Malaysia.*

Keywords*: Attitudes towards integration of STEM, integrated STEM education, secondary school teachers*

Article History
Received 2 January 2018
Received in revised form 18 January 2018
Accepted 24 January 2018

I. Introduction

The acronym STEM is coined up by the first letters of Science, Technology, Engineering and Mathematics. It was introduced in 2001 to replace the acronym SMET (Science, Mathematics, Engineering and Technology) which could cause issues of vulgarity [1], [2]. Later, Judith A. Ramaley, a former director of National Science Foundation (NSF)'s education and Human Resources Division, used STEM to refer to science, technology, engineering and mathematics curriculum.

From the educational point of view, the conceptions of STEM vary among researchers, educators and policy makers. There are two commonly accepted approaches to STEM education [1]–[3]. The first approach is often considered as the traditional disciplinary coursework that considered STEM as four separate fields taught [4], [5]. On the other hand, the integrated STEM education is a purposeful type of integration that combine various disciplines to solve real life problems [2], [6]. In this regard, integrated STEM education is a type of curriculum integration. The idea of curriculum integration is derived from educators' awareness that real world problems should not be separated into isolated disciplines that are taught in schools. Thus, the concept of curriculum integration is complex and challenging. As integration of subjects is more than a matter than simply putting different subject areas together [7].

Malaysia Education Blueprint 2013-2025 aimed to strengthen the fundamental reform of integrated STEM education in order to increase the students' enrolment in STEM field [8]. Integrated STEM education is a relatively new concept in Malaysia and also one of the new pillars embedded in the Secondary School Standard Curriculum which is newly launched in 2017. How far the written integrated curriculum concept can be fully delivered and implemented is still a question.

Currently in Malaysian primary and secondary schools' classrooms, STEM disciplines are still taught separately. Science and mathematics are taught as two isolated subjects as core and compulsory subjects while technology and engineering disciplines are taught as

elective subjects. Furthermore most teachers have received training in only one discipline, and most schools and classes still have separate departments and class periods for the STEM disciplines [9].

As revealed from past research, teacher is one of important factor and the key agent in determining quality as well as successfulness of integrated STEM education [10], [11]. Therefore, it is a need to investigate teachers' attitudes towards integrated STEM education to ensure the national level educational reform can achieve its objectives. However little research has so far been put together to examines the attitudes towards integrated STEM education among the teachers [11]–[14].

In this study, as in [2], definition of integrated STEM education was chosen as a reference. Integrated STEM approaches occurred when a teaching and learning process between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects. Hence, the targeted sample of this study included not only STEM subject teachers but other school subject teachers.

The purpose of this study was to identify the level of attitudes towards the integration of STEM among secondary school teachers in Malaysia. The information gained in this study provides recommendations for next steps in revise curriculum planning. The research questions are as follows:

1. What are the level of attitudes towards the integration of STEM among secondary school teachers?
2. What is the relationship between the attitudes towards every separated STEM subjects and the attitudes towards the integration of STEM?

II. Literature Review

Malaysia practice a centralized education system. In this system, all schools, regardless of states or region, must be used the officially recognised national school curriculum. The implementation of the integrated STEM education in Malaysia must begin with the highest authority, which is the Ministry of Education (MOE). The real shift in STEM education in Malaysia will only happen when the MOE launches a new school curriculum that uses the STEM approach. However, this was the first time for the Malaysian government formally used the STEM concept in its educational programs. In the Malaysia Education Blueprint 2013-2025 (Preschool to Postsecondary Education), is clearly stated that STEM will be the foundation of the new national curriculum [8].

There are two difficulties face by science education in Malaysia. Firstly, Malaysia is experiencing a decline in enrolment of STEM field students at secondary school and university levels [8], [10], [15], and secondly, Malaysian students' performance in science and mathematics at international level is far from encouraging [5], [8], [16]. Apart from this, MOE pointed several factors underlying the declining enrolment and quality of student outcomes in STEM. Unfortunately, teachers been highlighted as one of factors. As mentioned in the report, teachers often share a perception amongst students that STEM subjects are harder and do not always proactively encourage students to involve in STEM field. Thus, research needs to be done to look at teachers' attitudes towards STEM and hence looking for better solution to ensure teachers' understandings and implementation of STEM education.

A number of researches and studies have revealed that one of the fundamental problems in today's school is the traditional and separated [2], [17]–[19]. This has resulted many students fail to make connections between the prior knowledge and the new experience or skills within the real-world contexts. The traditional didactic teaching and learning methods may lead to memorization of factual information [20]. The students often fail to elicit comprehension of meaningful learning [7], [16]. Often students found difficulties in solving complex problem because they are unable to apply cohesively the knowledge learnt from separated classrooms.

Quality and effective STEM education are vital for the future success of students and prepare them for the 21st Century global challenges [21], [22]. STEM education is expected to prepare the students to have a solid foundation in science, technology, engineering and mathematics. In this regard, educators and researchers are trying to seek for the best solution to improve the quality of STEM education. This is to meet the goal of increasing students' interest and achievement in STEM fields. In fact, there was no common definition for STEM education. Neither educators nor researchers consistently agreed what STEM education should really be. According to [23], STEM education included the knowledge, skills and beliefs that are collaboratively constructed at the intersection of more than one STEM subject areas. STEM education covers a larger and more comprehensive understanding than theses individual.

However, when looking at the literature on integrated STEM education, there is not a single definition [1], [19], [23], and lack of agreement on what integrated STEM education is [24]. A number of definitions of integrated STEM education have been proposed, but there is still no clear consensus [9].

STEM as a merging of four disciplines [25][18]. The objectives are to deepen student understanding of each integration discipline by contextualizing concepts; broaden student understanding of STEM disciplines through exposure to socially and culturally relevant STEM contexts; and increase interest in STEM disciplines by increasing the pathways for students to enter the STEM fields [7], [19], [23], [26].

Apart from this, there is another point of view that, integrated STEM education do not need to involve all four STEM disciplines in a same class. [11] stated that integrated STEM education is an effort to combine the STEM disciplines into one class, but clarify that it can involve multiple classes and need not involve all four STEM disciplines [9]. Moreover, [2] defined integrated STEM education as "approaches that explore teaching and

learning between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects".

Although the larger and broader definition of STEM education allows more flexibility in the context of STEM education [27]. When thinking about the conceptualization of STEM education, there is still a need for a common view and vocabulary through which researchers, educators and policymakers can work towards a united goal [19], [23], [28]. Integration of subjects is much more than a matter of simply putting different subject areas together in a same class or teaching and learning lesson. As summary, integrated STEM education can provides great problem-solving opportunities for the students to experience learning STEM in a real-world situation.

III. Methodology

A. Participants

This is an exploratory study. Data were collected from 55 secondary teachers who attended a seminar on the STEM awareness. The demographics for the participants are presented in Table I.

TABLE I
DEMOGRAPHICS OF PARTICIPANTS

Measure		Frequency
Level of education	PhD	1
	Master's Degree	6
	Bachelor's degree	42
	Missing	6
Years of teaching experience	Mean	17.7
	Std. Deviation	6.2
Subject teaching in school	related STEM subjects	23
	Non-STEM subjects	23
	Missing	9
Total		55

Out of 55 respondents, there is almost equivalent numbers of male and female teachers. Teachers involved in this study are mostly experienced teachers. They had been teaching for an average of 17.7 years ($SD = 6.22\ years$). Interestingly, there is only a minor difference between the numbers of teachers teaching in STEM subject and other than STEM subjects who were willing to attend the seminar on the STEM awareness. Majority of the respondents are the Bachelor degree holder and about 42 out of total 55 and 7 teachers with the Master and PhD degree.

B. Instrument

Participants were assessed using a set of *A-STEM Survey*. The *A-STEM Survey* contains a demographic survey, a survey of attitudes towards science, technology, engineering and mathematics respectively of attitudes towards the integration of STEM. The demographic survey gathers a range of personal characteristics which includes gender, level of education, years of teaching experience and subject teaching in school. A-STEM Survey was adapted from [3]. The 28-items A-STEM Survey uses responses on a 5-point Likert ranging from "1" as "strongly disagreed" to "5" as "strongly agreed". There were five constructs which measure separately the teachers' attitudes towards science (4 items), technology (4 items), engineering (4 items), mathematics (4 items) and attitudes towards integration of STEM (12 items). The reliability of each of the five constructs of A-STEM Survey were determined using Cronbach's Alpha coefficients, which results in 0.761, 0.867, 0.824, 0.789, and 0.902, respectively. All the five Cronbach's Alpha coefficients are above 0.7 which is an accepted value as suggested by [31].

IV. Data Analysis

Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) software, version 23 (IBM Corporation). Both the descriptive statistical analysis and inferential statistical analysis were used in this study. For the first research question, descriptive statistical analysis through frequency was used to identify the level of attitudes towards STEM among the participants. The Pearson r correlation coefficient was used to measure the degree of the linear relationship between two variables. In this study, Pearson r correlation used to determine the relationship between attitudes towards science, technology, engineering and mathematics respectively and attitudes towards integration of STEM.

V. Result and Discussion

It is strongly encouraged that the authors may use SI (International System of Units) units only.

A. The Level of Attitudes towards STEM and the Integration of STEM among the Secondary Teachers

A construct score was calculated for each participant for every single STEM subjects and integration of STEM constructs by summing up the Likert-scale responses for all the items in any given construct. The possible range of the total scores was divided into three levels which are low, medium and high level. Table II and Fig. 1 shows the total scores for each construct.

The results indicate that, both STEM and non-STEM group teachers show a high level of attitudes towards technology, mathematics and integration of STEM. However, both group teachers' attitudes towards engineering only show a medium level. The group of non-STEM teachers also show a medium level of attitudes towards science. Results also revealed that, teachers' attitudes towards integration of STEM are more positive than the others construct. In addition, across all STEM subject areas, the attitudes of non-STEM teachers show

the most positively level towards technology than other construct.

TABLE II
TOTAL SCORES AND LEVEL OF ATTITUDES TOWARDS STEM

Constructs	Groups	Total scores	Level of Attitudes
Attitudes towards Science	STEM	96.16	High
	Non-STEM	83.16	Medium
Attitudes towards Technology	STEM	91.16	High
	Non-STEM	90.33	High
Attitudes towards Engineering	STEM	72.64	Medium
	Non-STEM	66.32	Medium
Attitudes towards Mathematics	STEM	93.52	High
	Non-STEM	87.34	High
Attitudes towards Integration of STEM	STEM	96.25	High
	Non-STEM	87.75	High

Note. STEM = science, technology, engineering, and mathematics

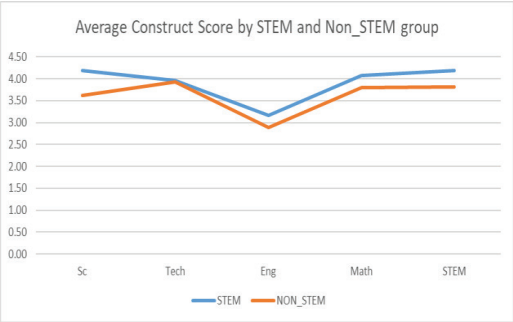

Fig. 1 Average constructs score by STEM and Non-STEM teachers' group

TABLE III
CORRELATIONS BETWEEN MEASURES

Measures		1	2	3	4	5
1	Attitudes towards Science	-	-	-	-	-
2	Attitudes towards Technology	.486**	-	-	-	-
3	Attitudes towards Engineering	.509**	.771**	-	-	-
4	Attitudes towards Mathematics	.665**	.366*	.365*	-	-
5	Attitudes towards Integration of STEM	.693**	.797**	.727**	.618**	

Note. STEM =science, technology, engineering, and mathematics
*p =< .05, **p < .01.

A correlation analysis as shown in Table III revealed teachers attitudes towards science ($p < .01$), technology ($p < .01$), engineering ($p < .01$) and mathematics ($p < .01$) to be significantly related to attitudes towards integration of STEM. Attitudes toward science ($r = .693$), technology ($r = .797$), engineering ($r = .727$), and mathematics ($r = .618$) were found to have significant positive correlation with attitudes towards integration of STEM. Furthermore, teachers' attitudes towards technology and engineering have strong correlation with attitudes towards integration of STEM.

Thus, the attention paid to teachers' attitudes towards STEM education is an essential step in exploring the provision of the best practice in STEM education. The objectives of this study are to investigate teachers' attitudes towards separated single subject and the integration of STEM. The first four constructs in *A-STEM Survey* was used to determine the teachers' attitudes towards STEM separately. On the other hand, the fifth construct focuses on attitudes towards integration of STEM. Hence, the discussion focused on teachers' backgrounds, the relationship between teachers' attitudes towards engineering and technology, science and mathematics and integration of STEM.

B. STEM related and non-STEM related background

Taking out the missing data, there are 50% of STEM teachers and non-related STEM teachers involved in this study respectively. However, results still indicate a medium to high level of teachers' attitudes towards separated and integration STEM. It seems that people enjoying the convenience that was brought by the technology in their everyday life. Therefore, it can be suggested that majority of the teachers involved in both STEM and non-STEM related are aware of the importance of STEM subjects for the country future development. Hence, the transformation of integration of STEM education is imperative as it was always being referred as a connection of daily life. As a result, remove the annoying exams and replaced it with a more innovative assessment method will certainly lead to the happier students. Thus, learning STEM in a fun and more interactive way would increase the students' performance in these subjects. Consequently, this will attract more students to enrol in STEM study.

C. Attitudes towards engineering and technology

The teachers' attitudes towards engineering were located at the medium level and less positive if compared to others constructs. The majority of secondary school teachers may never be learnt about engineering course during their secondary school or university curriculum. Attitudes towards STEM may be a proxy for the large issues of teacher knowledge for the related STEM areas. This finding reinforces the notion that it is crucial and necessary to integrate the separated STEM knowledge in the primary and secondary schools' syllabus. The early engagement of students with STEM into their daily life would greatly help them to appreciate STEM rather than seeing STEM as the difficult subjects. It is interesting to note that, attitudes towards technology was located at a high level. Technology was more related to daily life usage, teachers are more familiar and hence have a positive attitude towards technology. Again, making connection between the prior knowledge and the new experience or skill within the real-world contexts is crucially and best solution to improve the quality of STEM education.

D. Attitudes towards science and mathematics

As the results consistently revealed, attitudes towards science and mathematics are both located at the high level. All teachers experienced the traditional and separated STEM education system for the past years. Since science and mathematics are still remain the compulsory subjects taught in primary and secondary classroom, teachers are more familiar with them and hence a high level of attitudes towards science and mathematics is observed. The attitudes of teacher are frequently transferred to their students in classroom practice [29], [30]. Hence, students' attitudes towards science and mathematics should also located at a high level. How if the progress of studying science and mathematics only focus on drilling and remembering facts and repetition of problem solving exercises? The unachieved target of 60:40 maybe one of the result.

E. Attitudes towards integration of STEM

The items in the fifth construct measure teachers' opinion and perception regards how STEM subjects are related and connected to each other, such as "Learning science helps me learn mathematics, engineering, or technology" and "To learn engineering, I have to be good at science and mathematics." The results indicated a high level of teachers' attitudes towards integration of STEM. Teachers agreed that STEM subjects are related and connected to each other. The analysis suggests that, integration of STEM education is a prerequisite in primary and secondary schools in Malaysia. Furthermore, attitudes towards integration of STEM are positively and high correlated to attitudes towards technology, engineering, science and mathematics. This is also important to note that, attitudes towards integration of STEM has stronger correlation with attitudes towards technology ($r = .797$), followed by engineering ($r = .727$), then science ($r = .693$) and lastly mathematics ($r = .618$). As the results consistently revealed, cultivation and development of the good attitudes towards technology and engineering among the teachers and students are feasible in integrating STEM education from younger education.

VI. Conclusion and Recommendation

The teachers' attitudes towards STEM and integration of STEM have been highlighted in this study. Interestingly, among the STEM subjects, mathematics has the highest score in teachers' attitude while engineering subject scored the least. Furthermore, teachers' attitudes towards integration of STEM has the strongest positive correlation with teachers' attitudes towards technology. The positive attitudes towards STEM among the teachers can expedite the forming of integrated STEM education in Malaysia. The findings provide information that may be useful to relevant stakeholders to be taken into consideration in implementing and revised the written national curriculum of integrated STEM education.

Teachers cannot be expected to develop an integration of STEM subjects' knowledge and practice without the support from the government. This study only involved teachers from the same school district, which might be a limitation. However, the participants were fairly diverse in their experience and background. Although the findings of this analysis are not generalised to all Malaysia's teacher, the concern and issue need to be taken seriously. Further research and studies needed to be conducted in how STEM teachers implementing new STEM curriculum in schools. We also need to emphasize that integrated STEM education is a new to Malaysia's teachers. The authorities play a significant role to disseminate understanding and provide training to teachers.

Acknowledgements

The author would like to thank the Bahagian Tajaan Pendidikan, Kementerian Pendidikan Malaysia for their *Cuti Belajar Bergaji Penuh* scholarship program.

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