STEM Integration: Factors Affecting Effective Instructional Practices in Teaching Mathematics

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ABSTRACT

Malaysian Ministry of Education (MOE) has created initiatives in the Malaysian Education Blueprint (2013- 2025 that aim to increase teachers' and students' competencies in Science, Technology, Engineering and Mathematics (STEM) subjects and create learning experiences that will prepare students for the considerable array of STEM career fields. There are so many effective instructional practices suggested in integrating STEM education for teaching Mathematics. However, there are some factors that need to be concerned in producing effective instructional practices in teaching Mathematics. This study investigated the factors affecting instructional practices of mathematics since the implementation STEM education. Using a descriptive design method, a questionnaire was administered to 100 students and 50 mathematics teachers in Klang Valley. The overall mean score of all four factors (Lesson plan and implementation, Mathematical discuss and sensemaking, task implementation, and classroom culture) measured in this study is moderately high based on students' and teachers' perspectives. Teachers rated all factors higher than students' rate. Both teachers and students agreed that classroom culture is the important factor. There are no significant differences in the mean score of factors among gender of students and teachers. There is significant difference in the mean score of factors among the achieving abilities among the students.

Keywords: STEM Education, Mathematics, Lesson plan, Task, Classroom culture, Mathematical discuss

INTRODUCTION

"The future of the economy is in STEM," says James Brown, the executive director of the STEM Education Coalition in Washington, D.C. All countries in the world are busy in looking strategies to develop young generation's knowledge and skills for designing and developing innovation, technology, and scientific literacy in order to confirm their place in the global economy. Science, Technology, Engineering, and Mathematics (STEM) has become a government policy in countries such as United States (National Academy of Sciences [NAS], 2006; National Academy of Engineering [NAE], 2009; National Research Council [NRC], 2012). Malaysia also one of the countries that take seriously into STEM Education.

Among the efforts undertaken by the Ministry Malaysia Education (KPM) to increase skills and expertise in research and industry is through the strengthening of STEM education. Besides that, an understanding of scientific and mathematical principles, a working knowledge of technology and engineering, and the problem-solving skills are the features hunted in the future workforce and innovative world market. But what is this term they call STEM education? Most people are in the dark and moreover, most educators and students are as well.

In general, “STEM” itself stands for Science, Technology, Engineering and Mathematics. STEM fields are closely related and build on each other. Vilorio (2014) gave a brief description of STEM which Science workers study the physical and natural world through observation and experimentation. Besides that, technology workers use science and engineering to create and troubleshoot computer and information systems. Engineers and engineering technicians use math, science, and technology to solve real-world problems. Math workers use numerical, spatial, and logical relationships to study and solve problems. Hence, it is a strong proof that Mathematics is the technical foundation for science, engineering, and technology. (Vilorio, 2014)

Meanwhile, the definition of STEM education is “an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy” (Tsupros, Kohler, & Hallinen, 2009).

In order to ensure that the Malaysia has enough human resources in science and technology, 60% of students should choose science stream. Since 1970, the policy ratio 60:40 (Science: Arts) has been practiced in the national education system until today where in the National Education Policy, item 4.9, it is stated that secondary schools need to achieve that ratio (Ministry of Education Malaysia (KPM), 2004b). This policy is also mentioned in the Malaysia Education Blueprint 2001-2010 (KPM, 2001b) and Malaysia Education Blueprint (PPPM) 2013 – 2025. STEM Education is among the agendas highlighted in each Malaysia Education Blueprint.

The aims of STEM Initiative in Malaysia Education Blueprint (PPPM) 2013 – 2025 are: 1) prepare students with the skills to meet the science and technology challenges and 2) To ensure that Malaysia has a sufficient number of qualified STEM graduates (KPM, 2013). In Malaysia Education Blueprint 2013-2025, there are three waves in Strengthening Delivery of STEM Across the Education System which are Wave 1 (2013-2015) : Strengthening the foundations of existing programmes and encouraging school students to enrol in the science stream, Wave 2 (2016-2020): Engaging the support of broader group of stakeholder and Wave 3 (2021-2025) : Evaluation to develop roadmap for further innovation (KPM, 2013).

BACKGROUND

In spite of the emphasis on STEM Education, STEM field is not the first choice for a majority of Malaysian students. According to the report of Malaysian High Institution Indicators 2013, the number of students’ enrolment in the stem field is 43.3% (242,867) which still not hit the target (KPM, 2013). According to Phang, Abu, Ali, & Salmiza (2014), although many students have positive attitudes and interests towards Science and Mathematics, there are many identified factors that have resulted in those who are qualified to choose the Science stream but not to choose it in Form 4, Form 5 and at the tertiary education level.

Some previous researches identified the factors that contributed to the interest in science-related subjects continues to decline. Among the dominant factors are: a) Factors related to students’ perceptions and anxiety towards the low attainment and difficulty in mastering the concepts of Science and Mathematics (Kinyota, 2013, Phang et al.,2014, Zhou, Anderson, Wang & li, 2017) b) Curriculum of Science and Mathematics is considered difficult to learn (Phang et al., 2014), c) the influence from peers and parents who are not courage to Science and Maths (Phang et al., 2014, Zhou et al., 2017), d) the belief that small opportunity to pursue in tertiary level for Science stream (Phang et al., 2014), and e) Limited knowledge and exposure towards available careers for Science and Mathematics (Kinyota,

2013, Phang et al., 2014, Zhou et al., 2017), f) gender and school resource contexts affect students' choice of science streams (Kinyota, 2013) g) the level of cognitive thinking of students (Phang et al., 2014), h) effective instructional practices (Phang et al., 2014), i) an increase in the number children in the household decrease the probability of pursuing college education in STEM (Zhou et al., 2017).
There are so the government has taken many initiatives to encourage the students to choose and have a deep interest in STEM. It starts from the ground whereby teachers need to use effective instructional practices and approaches. Teachers and educators have big challenge in this 21st century on how to teach students who have various capacities and different learning rates. Teachers are expected to teach an approach that allows students to master concepts of science and mathematics and at the same time acquire higher-order thinking skills. Various strategies have been encouraged in the teaching of science and mathematics classrooms, the teacher-centered approach to a student-centered approach.

Based on previous researches that focusing on specific strategies of integrated STEM, it is showed that one of the dominant factors is instructional practices. There are major challenges faced by teachers and educators in finding appropriate instructional strategies. There are many teachers are not only lack of knowledge but they are also unaware of effective instructional strategies (Mustafa, Ismail, Tasir, & Mohamad Said, 2016). Previous researches identified some of effective instructional practices of STEM education which are project-based learning – its included some criteria which included active learning, students' engagement, ability to enhance critical thinking through the exploration of real-world situations and developing the solutions upon project completion (Mustafa et al., 2016, Siew, Amir & Chong, 2015, Stohlmann, Moore, & Roehrig, 2012, Kennedy & Odell, 2014, Freeman, et al., 2014), inquiry based learning (Mustafa et al., 2016, Siew et al., 2015, Stohlmann et a;., 2012, Kennedy & Odell, 2014), that encourage students to invent and innovate – hands-on activities and project based learning (Mustafa et al., 2016, Kennedy & Odell, 2014), problem based learning (Mustafa et al., 2016), cooperative learning approach (Zakaria, Chin, & Daud, 2010, Kennedy & Odell, 2014, Smith, Rayfield, & McKim, 2015).

On top of that, educators should concern there are some factors need to be considered in producing effective instructional practices in STEM education. Stohlmann, Moore, & Roehrig (2012) found that some considerations for teaching STEM educations which are the good lesson planning, classroom practices, teachers' self-efficacy, teaching materials, support from school admins and collaboration with a university or nearby school. Schools need to provide adequate equipment and instructional resources to enhance teaching, activities, evaluation process and interactions of students during the science's and mathematics' lesson (Alshehry, 2014). Tasks implementation should relate with real-life problems that allowed students to struggle in solving the tasks hence develop mathematical discussion among them (Candela, 2016, NCTM, 2010, Yemi & Adeshina, 2013, Prince, 2014). Teachers also should leave the tasks with questions unanswered to inspire students to help students focus on relevant aspects of the their mathematics knowledge (NCTM, 2010, Mueller, Yankelewitz, & Maher, 2011)

There are limited studies focused on factors affecting effective instructional practices on STEM education in Mathematics particularly. Thus, this research will be focused on factors affecting effective instructional practices on Mathematics subject and will investigate the current situation of implementation STEM education in Malaysia since the blueprint has been announced. What are the main factors affecting effective instructional practices on Mathematics in STEM education? This research also considered the perceptions from students and Mathematics teachers.

OBJECTIVES OF THE STUDY

This study aims to assess the factors affecting effective instructional practices on Mathematics subject since the implementation of STEM education. All the teachers are teaching Mathematics or/and Additional Mathematics in secondary schools. Specifically, the questions addressed are:

1. What are the main factors effective instructional practices on Mathematics since the implementation STEM education from the perspective of students and teachers?
2. Are there any significant differences between students' gender and their achieving abilities towards the rating of the important factors in contributing to the effectiveness of instructional practices?
3. Are there any significant differences between teachers' gender and their teaching experience towards the rating of important factors in contributing to the effectiveness of instructional practices?

METHODOLOGY

This study employed a quantitative method using a descriptive research design via a set of questionnaires. The questionnaire was adapted from the questionnaire developed by Yasemin Copur-Gencturk (2012) to suit with STEM Education in Malaysia which consisted of (1) Lesson Plan and Implementation, (2) Mathematical Discuss and Sensemaking, (3) Task Implementation, and (4) Classroom Culture. This study will compare the expectations between students and teachers towards the factors affecting instructional practices in STEM education which have been implemented by the Malaysia Education System.

The questionnaire was administered to the 100 students from various form and 50 Mathematics' teachers in Klang Valley. They were required to respond to 20 items using 10-point Likert-scale (from 1- for 'extremely disagree" to 10- for 'extremely agree'). The students were briefed to answer the questionnaire as they were asked to provide their options based on their perceptions of what required of a Maths' teachers that would facilitate them to learn Maths. While the teachers were briefed to respond based on their experience of being Maths teachers since the implementation of STEM Education.

Table 1 describes the sample involved in this survey study. A total of 100 students and it comprised 47% of male students and 53% of females. The achieving ability of the students in Maths is categorized into three groups (low, moderate and high) achieving ability as shown in table 1. The achieving ability was determined by the Maths teachers who taught them Mathematics based on the students' examination result. There were 48% of male teachers and 52% of females involved in this study. The teachers are categorized into two groups (1 – 9 years of teaching and 10 years and above of teaching) of teaching experience.

Table 1
Distribution of respondents according to demographic background

Students		Frequency (%)	Teachers		Frequency (%)
Gender	Male	47(47)	Gender	Male	24(48)
	Female	53(53)		Female	26(52)
Achieving ability in Maths	High	27(27)	Teaching Experience	Less than 10 years	25(50)
	Moderate	39(39)		10 years and above	25(50)
	Low	34(34)			

FINDINGS

This study focused on four factors that affected effective instructional teaching in Mathematics which are:

1) Lesson plan and its implementation.
2) Mathematical discuss and sensemaking.
3) Task implementation.
4) Classroom culture.

This section investigates students' and teachers' perspective on the factors affected effective instructional practices in teaching Mathematics since the implementation STEM education. The overall results (Mean = 7.83; SD = 1.37) for students and (Mean = 8.02 ; SD = 1.17) in table 2 indicate a moderately high for students and high for level of agreement that these factors affected the instructional practices in class. Overall mean values were above 7.00, indicating students and teachers considered that all the factors of instructional practices are important in producing the effective instructional practice sin Mathematics classroom.

Table 2
Students' and teachers' perspective on the factors effecting effective instructional

Factors affecting effective instructional practices	No. of Items	Example of Items	Students		Teachers	
			Mean	SD	Mean	SD
Lesson Plan and Implementation (F1)	5	The instructional objectives of the lesson were clear and the teacher able to clearly articulate what mathematical knowledge and concept the students were expected to learn. The instructional strategies were consistent with problem solving mathematics.	7.74	1.40	8.09	1.29
Mathematical Discuss and Sensemaking (F2)	5	Students drew upon a variety of methods (verbal, visual, numerical, algebraic, graphical, etc.) to represent their mathematical knowledge and concept. The teacher and students engaged in making conclusion at the end of the activity/lesson. (There was a discussion about what was intended to be learned from doing the activity.)	7.42	1.30	8.21	1.11
Task Implementation (F3)	5	Tasks stimulated non-complex thinking and easy to be understood. Tasks encouraged students to employ multiple representation and tools to support their learning and knowledge.	7.74	1.34	8.10	1.15
Classroom Culture (F4)	5	Interactions reflected a productive working relationship among students. The classroom climate encourage students to engage in mathematical discuss.	8.42	1.43	8.39	1.12
Overall	20		7.83	1.37	8.20	1.17

Among the factors of effective instructional practices, the classroom culture (F4) demonstrated the highest mean value (M = 8.42; SD = 1.43) by the students and (M = 8.39; SD = 1.12) by the teachers. Both teachers and students feel that it is important to create an encourage environment during the lesson to produce the a good engagement from the students in discussing the task. Next is the lesson plan and implementation (F1) factor had the second highest rated by the students and teachers. Both of them understand that each lesson must follow the planning in order to achieve the objectives posted by the teachers before starting the class. In Malaysia, each teacher need to put the objectives of the lesson in the front of the class so that students will acknowledge the objectives too. Based on the table 2, students rated the least important the mathematical discuss and sense making with the mean score (M = 7.42;

SD = 1.30), however, teachers rated F2 among the higher rate with (M = 8.21; SD = 1.11). This is showed that teachers realised the important of discuss and sense making in Mathematics class since the implementation of STEM education. Students also rated task implementation (F3) among the higher factors (M = 7.74; SD = 1.34) and teachers rated (M = 8.10; SD = 1.15). We can say that students think that it is a need for teachers to provide variety of tasks. The tasks could encourage students to search for multiple solution strategies and to recognize task constraints that may limit solution possibilities.

Table 3
Descriptive statistics of factors according to the demographic background

	Variable	Subvariable	Mean	SD	Mean	SD	Subvariable	Variable
Factors		Teachers					Students	
Lesson Plan and Implementation (F1)	Gender	Male	7.68	1.25	7.88	1.08	Male	Gender
		Female	8.48	1.23	7.62	1.64	Female	
	Teaching Experience	less than 10 years	8.31	1.41	8.25	1.12	80-100	Achieving ability in Maths
		10 years and above	7.87	1.15	7.68	1.55	60-79	
			-	-	7.40	1.35	40-59	
Mathematical Discuss and Sensemaking (F2)	Gender	Male	8.23	1.04	7.54	1.19	Male	Gender
		Female	8.18	1.19	7.31	1.40	Female	
	Teaching Experience	less than 10 years	8.17	1.25	7.91	1.25	80-100	Achieving ability in Maths
		10 years and above	8.25	.97	7.44	1.37	60-79	
			-	-	7.01	1.15	40-59	
Task Implementation (F3)	Gender	Male	7.81	1.07	7.80	1.35	Male	Gender
		Female	8.36	1.18	7.68	1.34	Female	
	Teaching Experience	less than 10 years	8.31	1.21	8.42	.84	80-100	Achieving ability in Maths
		10 years and above	7.88	1.07	7.77	1.48	60-79	
			-	-	7.15	1.25	40-59	
Classroom Culture (F4)	Gender	Male	8.08	1.00	8.46	1.39	Male	Gender
		Female	8.68	1.17	8.40	1.48	Female	
	Teaching Experience	less than 10 years	8.73	1.12	8.99	1.00	80-100	Achieving ability in Maths
		10 years and above	8.06	1.04	8.19	1.81	60-79	
			-	-	8.25	1.11	40-59	

As shown in Table 3, overall, the high-achieving ability students had high expectations of all factors. The high achieving groups had high expectations on two of four of the factors affecting instructional practices in Mathematics classroom. The two factors were Task Implementation (F3) (M = 8.42; SD = 0.84) and Classroom Culture (F4) (M = 8.99 ; SD = 1.00).The other two groups of students also had high rates of the teaching factors but overall their demand seems to be less than the high achieving group. The moderate achieving group also indicated a high mean value for Classroom culture (F4) and Task Implementation (F3). It was found that students from the low achieving group rated all the factors lower than the other two groups except for classroom culture with the mean score (M = 8.25; SD = 1.11) higher than moderate achieving group. It is showed that low achieving group need a comfortable environment during the lesson.

Besides that, table 3 also revealed that male students rated all the four factors higher than female students. It follows that male students rated high for two factors which are lesson plan and implementation and classroom culture. Generally, all the male students' expectations were slightly higher than female's expectations. It is contrast with the teachers' analysis. From table 3, it is showed that male teachers rated three factors lower than female teachers. The three factors are F1, F3 and F4. It can be said that, male teachers stressed on discuss and sense making in Mathematics classroom with the mean score (M = 8.23; SD = 1.04). Female teachers rated two factors among four factors which are

F1 (M = 8.48; SD = 1.23) and F4 (M = 8.68; SD = 1.17). To test whether the mean scores were statistically significant or not between gender of students and teachers, t-test were conducted as presented in table 4.

The result from table 3 also shows that teachers with teaching experience less than 10 years rated with the high mean score (M = 8.73; SD = 1.12) for F4. However, teachers with teaching experience 10 years and above rated Mathematical discuss and sense making (F2) as the top rate with mean score (M = 8.25; SD = 0.97).

Table 4
Comparison of perspectives of factors affecting effective instructional practices between gender of students and teachers.

Factors of instructional practices		Students						Teachers					
	Gender	N	Mean	SD	t	df	Sig.	N	Mean	SD	t	df	Sig.
Lesson Plan and Implementation (F1)	Male	47	7.88	1.08	.928	98	.356	24	7.68	1.25	-2.288	48	.027
	Female	53	7.62	1.64				26	8.48	1.23			
Mathematical Discuss and	Male	47	7.54	1.19	.869	98	.387	24	8.23	1.04	.153	48	.879
Sensemaking (F2)	Female	53	7.31	1.40				26	8.18	1.19			
Task Implementation (F3)	Male	47	7.80	1.35	.418	98	.677	24	7.81	1.07	-1.735	48	.089
	Female	53	7.68	1.34				26	8.36	1.18			
Classroom Culture (F4)	Male	47	8.46	1.39	.205	98	.838	24	8.08	1.00	-1.918	48	.061
	Female	53	8.40	1.48				26	8.68	1.17			

As can be seen in table 4, there were no significant differences between students' gender towards four factors ($p > 0.05$). This means that gender as not affect the mean scores level of factors. This result also indicated that the score of the different gender regarding their perception towards all rated factors not differ from each other.

Besides, the result revealed that there was a significant difference between teachers' gender towards lesson plan and implementation (F1) ($p = 0.027$). From the table, mean score of male (M = 7.68; SD = 1.25) for F1 lower than females (M = 8.48; SD = 1.23). It is showed that F12 is the least important factor for male teachers compared to female teachers. There were no significant difference between teachers' gender towards the other three factors (F2, F3 and F4).

Table 5.
Comparison of perspectives of factors affecting effective instructional practices among students achieving abilities using One-way ANOVA

Factors	Mean and SD			F	Sig	Difference between group	Sig
	High	Moderate	Low				
Lesson Plan and Implementation (F1)	8.25 (1.12)	7.68 (1.55)	7.40 (1.35)	2.937	.058	High - Low	.018
Mathematical Discuss and Sensemaking (F2)	7.91 (1.25)	7.44 (1.37)	7.01 (1.15)	3.849	.025	High - Low	.007
Task Implementation (F3)	8.42 (0.84)	7.77 (1.48)	7.15 (1.25)	7.686	.001	High – Moderate	.041
						High - Low	.000
						Moderate - Low	.039

Classroom Culture (F4)	8.99 (1.00)	8.19 (1.81)	8.25 (1.11)	2.966	.056	High – Moderate	.026
						High - Low	.044

Table 5 shows there was a statistically significant difference at p < 0.05 level four factors of effective instructional practices from students perspective [F (2, 97) = 4.843, p = 0.010]. Despite reaching statistical significance, the actual difference in mean scores between groups is quite small (8.39, 7.77, and 7.45). One-way ANOVA on each factor suggests that there is significant difference in two of for factors, which were Mathematical discuss and sense making [F(2, 97) = 3.849, p = 0.025] and task implementation [F(2, 97) = 7.686, p = 0.001].

Thus, LSD comparison revealed significant difference between groups of students for each factor. Based on table 4, F1 and F2 have significant differences seem to appear between high-low achieving groups only (p = 0.018, p = 0.007). As for task implementation (F3), significant differences appear between all three groups of students (p = 0.041, p = 0.000, p = 0.039). For the classroom culture (F4), there was a significant difference between high – moderate achieving groups (p = 0.026) and high – low achieving groups (p = 0.044). It appears, overall, the low-achieving students constantly have low expectation on factors affecting effective instructional practices in Mathematics classroom except for classroom culture compared to high and moderate students.

Table 6.
Comparison perspectives of factors affecting effective instructional practices among teachers' teaching experience using t-test.

Factors	Teaching experience	N	Mean	SD	t	df	sig
Lesson Plan and Implementation (F1)	less than 10 years	25	8.31	1.41	1.211	48	.232
	10 years and above	25	7.87	1.15			
Mathematical Discuss and Sensemaking (F2)	less than 10 years	25	8.17	1.25	-.252	48	.802
	10 years and above	25	8.25	0.97			
Task Implementation (F3)	less than 10 years	25	8.31	1.21	1.340	48	.187
	10 years and above	25	7.88	1.07			
Classroom Culture (F4)	less than 10 years	25	8.73	1.12	2.197	48	.033
	10 years and above	25	8.06	1.04			

Based on table 6, there was a significant difference (p = 0.033) between teachers' teaching experience on one factor only which is classroom culture. The result revealed that the teachers who have teaching experience less than 10 years rated F4 most important factor for producing effective instructional practices in Mathematics classroom. The result also shows that teachers who experience less than 10 years rated all the factors at high level of important with mean score above 8 (M = 8.31, M = 8.17, M = 8.31, M = 8.73). Both teachers with two levels of experience have almost similar perspective on factor mathematical discuss and sensemaking with the mean score slightly different (p = 0.802).

CONCLUSION AND DISCUSSION

This study investigated students' and teachers' perspective on the four factors that affected in producing effective instructional practices since the implementation STEM education in Mathematics classroom particularly. In conclusion, both students and teachers felt that all four factors in this study are important to produce effective teaching practices in Mathematics. Teachers rated all the four factors with the mean score above 8 which at high level of agreement. Besides, the students rated the other three factors (F1, F2 and F3) with the mean score lower than 8 but above 7.

The results revealed that both students and teachers agreed that F4 as the most important factors in creating an effective instructional practices is classroom culture at the mean score of 8.42; (SD = 1.43) for students and 8.39; (SD = 1.12) for teachers. Then, t-test has been conducted to test the significant difference between Mathematics teachers' gender and their teaching experiences towards the mean scores of factors that contributing to effective instructional practices. From the results, it is revealed that there was a significant difference (p = 0.027) between teachers' gender towards one factor only which

is lesson plan and implementation (F1). There were no significant differences between teachers' gender towards the other three factors (F2, F3, and F4). This study also found that there was a significant difference in the mean scores of F4 between teachers' teaching experience. T-test revealed that there were no significant differences in the mean score of another 3 factors (F1, F2, and F3) between teachers' teaching experience.
From the descriptive analysis, male students rated all four factors higher than female students. All low-achieving groups have rated lowest among the other two groups for three factors (F1, F2, and F3). However, all groups of students rated with the mean score above 8 for one factor which is classroom culture. Further analysis across students' gender and their achieving abilities was conducted if there was a significant difference in their perspectives towards factors affecting effective instructional practices. Results show that there was no significant difference ($p > 0.05$) between students' gender towards all four factors. Then, ANOVA test has been conducted to test whether there is significant difference between students' achieving abilities towards their perspective on the four factors. It revealed that, there were significant difference in two factors which are F2 and F3.

Classroom culture is shown as the most important factor in teaching Mathematics in STEM education. This result is parallel to a research conducted by El-Deghaidy & Mansour (2015), teachers in their study reported that the schools need to provide/create an environment that linking to real life situations that are necessary to inspire students to take future careers in STEM. The culture of STEM education can induce students' interest in studying science and understanding STEM and take careers in STEM (El-Deghaidy & Mansour, 2015). In developing a motivational classroom culture, teacher need to understand what motivates their students. In other words, teachers must be familiar with their students' interests and abilities so that teacher can facilitate the students to learn Mathematics effectively (NCTM, 2010).

Overall results revealed that students and teachers agreed that lesson plan and implementation (F1) and task implementation (F3) are at the same level of importance as they rated at the same mean scores. Lesson planning is important before implementing any teaching strategies in a class (NTCM, 2010. Alshehry, 2014, Stohlmann, et al., 2012). Hence, NCTM (2010) suggested teacher should have a careful planning in order to elicit, explore, and critique students' mathematical thinking. Teachers need to know that the tasks that they will carry out would match their teaching performance and expectations from the students. Students believed that their teacher knew them well, then teacher should know how to explain Mathematics to them and make them feel that they could learn Mathematics (Ismail, Shahrill, & Mundia, 2015).

Results have shown that lower achieving students put the least important factors of task implementation, and mathematical discuss and sense making in STEM education. These two factors are strong related with each other. The tasks encouraged students to search for multiple solution strategies, and they need to employ multiple representation. Then, students need to determine the sensibility of an idea based on the mathematical method presented. Besides that, the teacher and students engaged in making conclusion at the end of the activity/lesson. The lower achieving students might face difficulty in dealing with the tasks if they are weak in understanding the mathematical concepts, processes, and relationships.

Carless (2003) highlighted that when the tasks were carried out by the teachers, teachers should prepare three level of tasks (easy, medium, and hard), teaching aids required by the tasks, language used, activities involved and the level of students in the class. This is supported by NTCM (2010) that teacher should choose worthwhile mathematical tasks in order to establish a supportive and challenging environment in the class to promote the mathematical discourse among students in a class. In addition, teachers need to employ all teaching methods with the facilities provided in school to increase the learning abilities such as presenting interactive lectures and allow students express their opinion during group discussions (Alshehry, 2014), Yemi & Adeshina, 2013).

Ismail, et al., (2015) and Stohlmann, et al., 2012 found that some teachers had difficulties in determining the students' difficulties in learning mathematics. This is the cause of some students refused to participate in classroom discussion. Low achieving students always perceive their teachers to use various of teaching practices and helped them to think for themselves in Mathematics and tried to help every student to do well in Mathematics (Ismail, Shahrill, & Mundia, 2015). Thus, teacher will play important role in this situation. In STEM education, teacher should encourage students to pursue the question until it can engage the students in the multiple mathematics' concepts as well as provide a fruitful context or making mathematical arguments (NTCM, 2010, Stohlmann, et al., 2012, Candela, 2016). Previous researches proposed problem-based learning as an effective teaching strategy for integrating STEM education. Thus, Prince (2004) suggested that real problem raised in problem-based learning require teams to solve effectively as such cooperative learning provided a natural environment to promote interpersonal skills while problem-based learning will develop students' problem-solving and life-long skills parallel with the aim of STEM education. Mueller, Yankelewitz, & Maher (2011) suggested a good learning environment us encourage students to communicate their understanding of the task, and their ideas are valued and respected. This respect develops students' positive self-concepts in Mathematics.

In conclusion, the four factors are important in promoting effective instructional practices in teaching Mathematics since the implementation STEM educations. All the four factors closely related each other. Classroom culture factor plays important role in STEM education. Both students and teachers need to feel comfortable during the lesson. Then, teachers need to plan their lesson appropriately that suits with students' achieving level and strategies to tackle students. Tasks chosen also must be related to real-life situation to develop the students' problem-solving skills and require a team to discuss the solution of the tasks. Teachers also plays important role in developing the learning environment and keep asking questions that can excite students' ideas, mathematical concepts and arguments.

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TABLES

Table 1.
Distribution of respondents according to demographic background

Students		Frequency (%)	Teachers		Frequency (%)
Gender	Male	47(47)	Gender	Male	24(48)
	Female	53(53)		Female	26(52)
Achieving ability in Maths	High	27(27)	Teaching Experience	Less than 10 years	25(50)
	Moderate	39(39)		10 years and above	25(50)
	Low	34(34)			

Table 2.
Students' and teachers' perspective on the factors effecting effective instructional

Factors affecting effective instructional practices	No. of Items	Example of Items	Students Mean	Students SD	Teachers Mean	Teachers SD
Lesson Plan and Implementation (F1)	5	The instructional objectives of the lesson were clear and the teacher able to clearly articulate what mathematical knowledge and concept the students were expected to learn. The instructional strategies were consistent with problem solving mathematics.	7.74	1.40	8.09	1.29
Mathematical Discuss and Sensemaking (F2)	5	Students drew upon a variety of methods (verbal, visual, numerical, algebraic, graphical, etc.) to represent their mathematical knowledge and concept. The teacher and students engaged in making conclusion at the end of the activity/lesson. (There was a discussion about what was intended to be learned from doing the activity.)	7.42	1.30	8.21	1.11
Task Implementation (F3)	5	Tasks stimulated non-complex thinking and easy to be understood. Tasks encouraged students to employ multiple representation and tools to support their learning and knowledge.	7.74	1.34	8.10	1.15
Classroom Culture (F4)	5	Interactions reflected a productive working relationship among students. The classroom climate encourage students to engage in mathematical discuss.	8.42	1.43	8.39	1.12
Overall	20		7.83	1.37	8.20	1.17

Table 3.
Descriptive statistics of factors according to the demographic background

Factors	Variable	Subvariable	Mean	SD	Mean	SD	Subvariable	Variable
	Teachers						Students	
Lesson Plan and Implementation (F1)	Gender	Male	7.68	1.25	7.88	1.08	Male	Gender
		Female	8.48	1.23	7.62	1.64	Female	
	Teaching Experience	less than 10 years	8.31	1.41	8.25	1.12	80-100	Achieving ability in Maths
		10 years and above	7.87	1.15	7.68	1.55	60-79	
			-	-	7.40	1.35	40-59	
Mathematical Discuss and Sensemaking (F2)	Gender	Male	8.23	1.04	7.54	1.19	Male	Gender
		Female	8.18	1.19	7.31	1.40	Female	
	Teaching Experience	less than 10 years	8.17	1.25	7.91	1.25	80-100	Achieving ability in Maths
		10 years and above	8.25	.97	7.44	1.37	60-79	
			-	-	7.01	1.15	40-59	
Task Implementation (F3)	Gender	Male	7.81	1.07	7.80	1.35	Male	Gender
		Female	8.36	1.18	7.68	1.34	Female	
	Teaching Experience	less than 10 years	8.31	1.21	8.42	.84	80-100	Achieving ability in Maths
		10 years and above	7.88	1.07	7.77	1.48	60-79	
			-	-	7.15	1.25	40-59	
Classroom Culture (F4)	Gender	Male	8.08	1.00	8.46	1.39	Male	Gender
		Female	8.68	1.17	8.40	1.48	Female	
	Teaching Experience	less than 10 years	8.73	1.12	8.99	1.00	80-100	Achieving ability in Maths
		10 years and above	8.06	1.04	8.19	1.81	60-79	
			-	-	8.25	1.11	40-59	

Table 4.
Comparison of perspectives of factors affecting effective instructional practices between gender of students and teachers.

Factors of instructional practices	Students							Teachers					
	Gender	N	Mean	SD	t	df	Sig.	N	Mean	SD	t	df	Sig.
Lesson Plan and Implementation (F1)	Male	47	7.88	1.08	.928	98	.356	24	7.68	1.25	-2.288	48	.027
	Female	53	7.62	1.64				26	8.48	1.23			
Mathematical Discuss and Sensemaking (F2)	Male	47	7.54	1.19	.869	98	.387	24	8.23	1.04	.153	48	.879
	Female	53	7.31	1.40				26	8.18	1.19			
Task Implementation (F3)	Male	47	7.80	1.35	.418	98	.677	24	7.81	1.07	-1.735	48	.089
	Female	53	7.68	1.34				26	8.36	1.18			
Classroom Culture (F4)	Male	47	8.46	1.39	.205	98	.838	24	8.08	1.00	-1.918	48	.061

Female	53	8.40	1.48		26	8.68	1.17

Table 5.
Comparison of perspectives of factors affecting effective instructional practices among students achieving abilities using One-way ANOVA

Factors	Mean and SD High	Mean and SD Moderate	Mean and SD Low	F	Sig	Difference between group	Sig
Lesson Plan and Implementation (F1)	8.25 (1.12)	7.68 (1.55)	7.40 (1.35)	2.937	.058	High - Low	.018
Mathematical Discuss and Sensemaking (F2)	7.91 (1.25)	7.44 (1.37)	7.01 (1.15)	3.849	.025	High - Low	.007
Task Implementation (F3)	8.42 (0.84)	7.77 (1.48)	7.15 (1.25)	7.686	.001	High – Moderate	.041
						High - Low	.000
						Moderate - Low	.039
Classroom Culture (F4)	8.99 (1.00)	8.19 (1.81)	8.25 (1.11)	2.966	.056	High – Moderate	.026
						High - Low	.044

Table 6.
Comparison perspectives of factors affecting effective instructional practices among teachers' teaching experience using t-test.

Factors	Teaching experience	N	Mean	SD	t	df	sig
Lesson Plan and Implementation (F1)	less than 10 years	25	8.31	1.41	1.211	48	.232
	10 years and above	25	7.87	1.15			
Mathematical Discuss and Sensemaking (F2)	less than 10 years	25	8.17	1.25	-.252	48	.802
	10 years and above	25	8.25	0.97			
Task Implementation (F3)	less than 10 years	25	8.31	1.21	1.340	48	.187
	10 years and above	25	7.88	1.07			
Classroom Culture (F4)	less than 10 years	25	8.73	1.12	2.197	48	.033
	10 years and above	25	8.06	1.04			