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KNOWLEDGE, ATTITUDE AND READINESS OF KUALA NERUS PRIMARY SCHOOL TEACHERS IN THE IMPLEMENTATION OF STEM IN TEACHING AND LEARNING PROCESS

PENGETAHUAN, SIKAP DAN KESEDIAAN GURU DALAM PELAKSANAAN PENGAJARAN DAN PEMBELAJARAN (PdP) PENDIDIKAN STEM DI SEKOLAH RENDAH DAERAH KUALA NERUS

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Abstract: Teachers are the most influential agents in implementing STEM as well as other changes to ensure the effectiveness of the new curriculum. For that reason, this study was conducted to identify the level of knowledge, attitude and readiness on STEM education and its implementation of primary school teachers who taught Science, Mathematics and RBT (Reka Bentuk dan Teknologi) in Kuala Nerus. It also sought to discover the relationship between teachers' readiness and knowledge, attitude and experience. This quantitative study collected data using online survey method involving 110 respondents consisting of Science, Mathematics and RBT teachers randomly selected from the population of primary school teachers in Kuala Nerus, Terengganu. The result showed that the level of knowledge, attitude and readiness of the respondents were at a moderate level. However, there was a significant relationship with moderate strength between teachers' readiness and knowledge; weak relationship between readiness and attitude; and strong negative relationship between readiness and teaching experiences. The findings enable schools to formulate appropriate strategies to strengthen the knowledge, skills, attitudes and confidence of the teachers in planning and delivering lessons of STEM education. The study concludes that knowledge and positive attitudes on STEM would help the teachers to deliver STEM education effectively. Moreover, by attending courses and practices continuously, they could gather experiences, enhance their teaching abilities and expose to the new innovation and changes in the education world.

Keywords: STEM; teachers' knowledge; teachers' attitude; teachers' readiness; teaching and learning

***Abstrak**: Guru merupakan agen perubahan yang sangat berpengaruh dalam pelaksanaan suatu kurikulum baharu atau inovasi kurikulum seperti pendidikan STEM. Bahkan, guru merupakan elemen terpenting dalam memastikan pendidikan STEM dapat dijalankan dengan lebih efektif. Sehubungan itu, kajian ini*

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dijalankan untuk mengenal pasti tahap pengetahuan, sikap dan kesediaan guru Sains, Matematik dan RBT (Reka Bentuk dan Teknologi) sekolah rendah di Daerah Kuala Nerus dalam melaksanakan PdP (pengajaran dan pembelajaran) pendidikan STEM dan hubungan antara kesediaan guru Sains, Matematik dan RBT dalam melaksanakan PdP pendidikan STEM dengan aspek pengetahuan, sikap dan pengalaman mengajar guru terhadap pelaksanaan pendidikan STEM. Kajian ini menggunakan reka bentuk kuantitatif dengan kaedah tinjauan secara atas talian. Responden seramai 110 guru Sains, Matematik dan RBT yang dipilih secara rawak daripada populasi guru sekolah rendah di Daerah Kuala Nerus. Analisis dapatan menunjukkan tahap pengetahuan, sikap dan kesediaan guru Sains, Matematik dan RBT berada pada tahap sederhana dalam melaksanakan PdP pendidikan STEM. Namun, terdapat hubungan yang signifikan dengan kekuatan sederhana wujud antara kesediaan guru dengan pengetahuan, lemah antara kesediaan guru dengan sikap, manakala hubungan yang kuat antara kesediaan guru dengan pengalaman mengajar mereka. Sehubungan itu, dapatan kajian ini membolehkan pihak sekolah merangka strategi yang sesuai untuk memantapkan pengetahuan, kemahiran, sikap dan keyakinan guru dalam PdP pendidikan STEM. Kesimpulannya, pengetahuan dan sikap guru pada tahap yang tinggi tentang pendidikan STEM akan menjadikan guru lebih bersedia dalam melaksanakan PdP pendidikan STEM. Bahkan, kursus atau latihan perlu diberikan secara berterusan kepada guru-guru untuk memastikan mereka sentiasa didedahkan dengan inovasi dalam semua aspek berkaitan perubahan pendidikan.

Kata kunci: *STEM, pengetahuan guru, sikap guru, kesediaan guru, pengajaran dan pembelajaran*

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INTRODUCTION

Experts in the early childhood education agree that the implementation of the curriculum innovation such as STEM (Science Technology Engineering Mathematics) should begin at an early age as suggested and proved in many studies. They revealed STEM would build the foundation for learning and development of children’s minds; develop critical thinking and reasoning; increase interest in learning Science and Mathematics; develop curiosity; love to ask and investigate; and provide extensive experience of the natural and artificial world around them (Katz, 2010; Hoachlander & Yanofsky, 2011; National Research Council (NRC), 2011; Bybee, 2013).

Consistent with the findings mentioned above, Malaysian Education Blueprints (2013-2025) focused on STEM as one of the important agendas of national transformation in education. The implementation of STEM education in the blueprint were framed into three phases (MOE, 2015). Wave 1 (2013-2015) was to provide equal access to quality education of an international standard by strengthening the STEM curriculum; providing teachers with courses and field training; and utilizing the multimode learning model. Wave 2 (2016-2020) was to hold many campaigns and collaboration with related agencies to create awareness and generate public interest towards STEM. Wave 3 (2021- 2025) emphasizes on moving STEM to the highest level through increased flexibility of the operation.

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Scholars hoped that before 2020, Malaysia was declared as a developed country, the MOE has made STEM Literacy as part of the national curriculum that must be studied by all students at all levels of education in Malaysia. But until now it has not been realized. In fact, the MOE found that the number of students taking STEM subjects is declining every year (Maszlee Malik, 2019). This situation causes the national education system to lose at least 6,000 potential students in STEM fields every year (Hazami, 2019). This is a significant decrease in students who opted STEM from 203,391 in 2012 to 167,962 in 2018.

One of the contributing factors to the success of STEM education is the teacher factor (El-Deghaidy & Mansour, 2015). They are the change agents trusted to run the new curriculum to bring STEM to another level in the world of education (Koehler, Binns & Bloom, 2016). However, a study found the implementation of STEM in Malaysia was still at the moderate stage (Mahmud et al., 2018). Another study revealed that the implementation of STEM among teachers in teaching and learning sessions was below satisfactory level (Nistor et al., 2018). Consequently, only 44% of Malaysian students took STEM in 2018 compared to 49% in 2012.

In this regard, MOE developed an instrument to assess teacher's teaching and learning practices in line with the second wave of the Malaysian Education Development Plan (PPPM) 2016-2020, which was standard 4 of the Malaysian of Standard Quality Learning Wave 2 (SKPMg2). This standard justifies the role of teachers as facilitators in effective teaching and learning to develop the potential of the student as a whole; and to ensure the achievement of the student at the optimum level on an ongoing basis. This instrument summarizes the critical aspects that need to be achieved by teachers in implementing teaching and learning in their respective classrooms.

However, the assessment of competencies in STEM conducted by the MOE found that the quality of teachers in delivering teaching and learning sessions was not consistent; they still needed to gain in-depth knowledge in the subjects of Science and Mathematics; they were too focused on student preparation to sit for exams; and they did not emphasize elements involving hands-on activities in the curriculum (MOE, 2013). In fact, there were still teachers who were not confident enough to integrate STEM elements in teaching and learning process even though they knew that STEM is important for their students' future achievement (Adam & Halim, 2019).

Accordingly, this study was conducted to identify the level of knowledge, attitude and readiness of teachers in implementing STEM education among Science, Mathematics and Design and Technology (RBT) primary school teachers. It also attempted to discover the relationship between teachers' readiness in implementing STEM education and teachers' knowledge, attitudes and experience. This is important to shed some light on the reality of STEM implementation in schools to inform policy and practice.

STEM Education

MOE aims to increase student participation and interest in STEM through the STEM Strengthening Initiative as emphasized in Malaysian Education Blueprint 2013-2025 by striving to ensure that the number of potential and qualified students is sufficient to enter STEM at the tertiary level. This

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is to produce human capitals who have knowledge, skills, values and acculturate STEM practices (MOE, 2018).

STEM is an acronym which stands for Science, Technology, Engineering and Mathematics. STEM education is founded on the notion of teaching the four subject matters through interdisciplinary and practical methods. This means that the four disciplines will be taught as one interdisciplinary subject by introducing students to practical problems which require them to apply Science, Technology, Engineering and Mathematics to come up with solutions. STEM education views students as active knowledge constructors whereby students are engaged in their own learning and knowledge construction through critical and creative thinking to solve problems collaboratively for the betterment of the society. Thus, it is important to exert an effort on the implementation so that those students would be prepared to face the challenging competitive world in the near future globally (MOE, 2016b).

MOE is highly committed in promoting STEM education at all levels of education by building the Conceptual Framework of STEM Education to provide the country with a qualified and sufficient number of STEM graduates to meet the needs of employment; and to produce innovative human resources to drive the national economy (MOE, 2018). In fact, MOE took the initiative to promote STEM education by introducing Blended Learning Open Source for Science or Mathematics Studies (BLOSSOMS) which is a resource center for STEM; implement practical learning approaches and skills in STEM education; provide STEM educational infrastructure and facilities (MOE, 2018) which include video collections to increase interest in STEM. Meanwhile, the National Blue Ocean Strategy (NBOS) enables practical STEM learning with cheaper and faster laboratory preparation methods.

In addition, Pintar Foundation launched the Smart Mobile Learning Unit (PMLU) to further strengthen STEM education in Malaysia. This PMLU is specially designed for primary schools to provide a fun learning space; and to explore the smart schools in Peninsular Malaysia (Shanmugam & Balakrishnan, 2018). The implementation of PMLU is an inclusive approach to science and technology for primary school pupils. This initiative is an effort to help students in urban and rural areas to cultivate a culture of science, spark interest and educate students in STEM. In conclusion, MOE is so concerned and confident that continuous exposure in the field of STEM since primary school would result in a young generation who is sensitive to the needs of the world; and able to contribute creatively and innovatively for the betterment of the country.

To realize STEM education, the Curriculum Development Division of Ministry Education of Malaysia has prepared teaching and learning resources which was called '*Bahan Sumber Sains, Teknologi, Engineering dan Matematik*' (BSTEM) (Resource Materials for Science, Technology, Engineering, and Mathematics) to be the sequel of '*Buku Panduan Pelaksanaan Pengajaran dan Pembelajaran STEM*' (Guide Book for the Implementation of STEM in Teaching and Learning) which was produced to help teachers in the implementation of STEM in teaching and learning session (MOE, 2018). These resources would be the manual that guide teachers to plan and implement the activities before, during and after teaching and learning sessions using inquiry method, project-based learning and problem-based learning. This type of teaching and learning

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sessions gives the pupils an opportunity to upgrade their HOTS (Higher Order Thinking Skills) to experience deeper and wider learning (MOE,2018).

The Teachers' Knowledge

Teacher knowledge is emphasized as the most important factor to ensure effective teaching (Gitomer & Zisk, 2015). Therefore, from time to time, teachers need to add value and upgrade their knowledge to be consistent with the curriculum reforms designed and developed by the MOE. A teacher needs to master three main types of knowledge, namely content knowledge, basic pedagogical knowledge and content pedagogical knowledge (Shulman, 1987). Pedagogical knowledge is specialized knowledge on planning and delivering effective methods in teaching and learning sessions (Guerriero, 2017).

In the same way, STEM education would be more efficient and effective if the teachers who are the agents of delivering the knowledge are equipped with and mastered both pedagogical and content knowledge they are going to teach (Eckman et al., 2016). In this context teachers should master content knowledge of Sciences, Technology, Engineering and Mathematics. In this research, the knowledge on STEM is referring to the concept of basic STEM education which comprises definition, characteristic, theories, importance, advantages, teaching approaches, teaching assessment techniques and the roles of the teacher in implementing STEM education.

The Teachers' Attitude

Attitude can be defined as a learned tendency to respond to attitude objects in a positive or negative way (Fishbein & Ajzen, 2010). Usually individuals tend to favor behaviors that they believe would produce a desired effect; and they will form a negative attitude toward the behavior that is associated with the undesirable effect. Therefore, attitude is considered to be a major determinant of a person's desire to perform a particular behavior.

Teachers' attitudes toward change are internal conditions that influence teachers' choices on teachers' personal preferences or the tendency to respond to change (Tai, 2013; Abu Hassan et al., 2018). It refers to overall evaluative judgments positively or negatively on the change initiatives need to be implemented. In general, teachers' attitudes toward change consist of teachers' cognitions about change, affective responses to change, and behavioral tendencies toward change. This conveys that attitude is explained by three dimensions which are cognitive-perception, affective-efficacy, and behavior-initiative. Teachers' attitude towards STEM influences their pedagogical behavior in STEM teaching and learning sessions. The attitude of the teachers towards STEM can be explained by their perception on STEM, feeling confidence in implementing STEM, and initiative taken towards realizing STEM education (Tai, 2013; Abu Hassan et al., 2018).

In Malaysia, a few studies were conducted to measure primary and secondary school teachers' attitude towards STEM. The studies found that majority of the participants had positive attitude towards STEM (Pau & Maat, 2018; Wong & Maat, 2020). These findings were not conclusive to make judgment on overall Malaysian teachers' attitude towards STEM.

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The Teachers' Readiness

Teacher readiness means a teacher's willingness to take on responsibilities that cover aspects such as interests, attitudes, knowledge and skills (Wearmouth, Edward & Richmond, 2000). The three main aspects that drive teachers' readiness to implement innovation in teaching and learning are perception; skills; and teachers' attitudes towards change (Siti Hajar Halili & Suguneswary, 2016).

While in the stage of adapting to new innovations, teachers begin to show positive or negative feelings towards change through their positive or negative opinions. These feelings are seen from both positive and negative angles. Confidence and innovation are positive feelings of teachers while discomfort and distrust are negative feelings (Parasuraman & Colby, 2015).

Thus, teachers need to have some specific skills to implement curriculum changes or innovations in teaching and learning sessions effectively. The level of teachers' readiness and ability to implement curriculum change is determined by teachers' knowledge and skills; and the ability to address challenges related to teaching and learning based on IR 4.0 (Othman & Awang, 2018). Teachers who are motivated and have high level of readiness will be more confident and tend to accept the tasks given to them (Boset & Asmawi, 2020). In the context of this study, teacher readiness is paramount in implementing the STEM curriculum. Teachers' acceptance of this curriculum innovation is the main thrust of this study.

The Teachers' Experience

Theoretically, experienced teachers are more knowledgeable and skillful in classroom teaching. Experienced teachers were found to be implementing STEM teaching and learning more often; more knowledgeable and skilled in relation to the teaching and learning process; more careful in decision making; and more skilled in finding information related to learning issues/problems compared to novice teachers. New teachers had to face major challenges in the first year and had to constantly look for opportunities to adapt to various aspects of the teaching and learning process (Yariv, 2013). Thus, the level of implementation and practice of teaching and learning of novice teachers was lower. However, a study found that novice teachers were more proficient in basic knowledge related to STEM content, STEM pedagogy, STEM context and 21st century skills (Yildirin & Turk, 2018). In addition, teachers with more than 16 years of teaching experience were more likely to practice STEM education than teachers with less experience (Madani & Forawi, 2019).

Experience is gained when a person is successful in attempting to perform a specific task (Ngan et al., 2020). In the context of education, a teacher's teaching experience is associated with the teacher's level of competence, that is, the more experience a teacher has, the higher the teacher's level of competence will be; especially in management of students' behaviors and teaching and learning sessions (Darling-Hammond et al. 2013). Teachers can be grouped into three categories based on their teaching experiences namely novice teachers (young teachers), skilled teachers (teachers at the beginning of their careers) and expert/veteran teachers (highly experienced). Thus, in this study the respondents were grouped into three categories according to

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their experiences, namely novice teachers (one to three years), skilled teachers (four to 10 years) and expert teachers (more than 10 years).

Conceptual Framework

Teaching and learning of STEM education integrates teachers' STEM knowledge, teachers' attitudes about STEM and teachers' readiness in implementing STEM education in classrooms with real world backgrounds (daily life, environment, local and global communities). Accordingly, teachers' knowledge of education is a key factor to be the input linking work movements (skills) in STEM teaching and attitudes (Bryant's Educational Process Model, 1974). These inputs and attitudes in turn determine the effectiveness and success of STEM education in the classroom (Nur Fatahiyah & Siti Nur Diyana, 2020). In fact, teachers' attitudes toward change in teaching and learning are related to teachers' cognitive, affective and behavior (Model of Teachers' Attitudes toward Change, Tai & Omar, 2017). In the context of this study, cognitive is measured by teacher perception, affective by confidence and behavior by teacher initiative in implementing STEM education.

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Objectives of the Study

This study attempted to measure the level of teachers' knowledge, attitude and readiness on the implementation of STEM in teaching and learning among Science, Mathematics and RBT primary school teachers in Kuala Nerus district. The six research questions were as follows:

1) What is the level of knowledge of the Sciences, Mathematics and RBT teachers on the implementation of STEM?
2) What is the attitude of the Sciences, Mathematics and RBT teachers on the implementation of STEM?
3) What is their level of readiness to implement STEM in teaching and learning?
4) Is there any significant relationship between the teachers' readiness with their attitude towards STEM?
5) Is there any significant relationship between the teachers' readiness with their knowledge on STEM?
6) Is there any significant relationship between the teachers' readiness with their teaching experiences to implement STEM?

METHODOLOGY

This study was conducted using a quantitative approach through an online survey method. The link to the online survey was shared via email and WhatsApp with 110 randomly selected STEM teachers from the list provided by Pejabat Pendidikan Daerah Kuala Nerus, Terengganu. The sample size was determined based on the sample size determinant schedule by Krejcie and Morgan (1970). This study used a self-reporting instrument adapted from MOE's STEM education framework development study and other previous studies namely Ismail and Awang (2004), Stohlmann, Moore and Roehrig (2012), Sanitah and Norsiwati (2012), and Nor Shai'rah (2015). Respondents were asked to respond using 5-point Likert scale ("Strongly Disagree", "Disagree", "Neither", "Agree" and "Strongly Agree"). The data obtained were analyzed using Statistical Package for Social Sciences (SPSS) version 24.0.

Data Analysis Method

The collected data was analyzed using the Statistical Package for Social Sciences (SPSS) version 24.0. The instrument's internal reliability coefficient was measured using Cronbach's Alpha. The value for construct of teachers' knowledge about STEM was 0.987; teachers' attitude towards the implementation of STEM was 0.983; and teachers' readiness to implement the STEM was 0.915. The Alpha values generated from the constructs were more than 0.70. Hence, the instrument for this research has high internal consistency.

Pearson correlation was used to test the relationship between the level of the teachers' readiness in practicing STEM with knowledge, attitude and teachers' experience on STEM. In this context, correlation coefficient (r) estimated the strength of the relationship between the variables as shown below.

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Table1: The strength relationships between the variables

Size of Correlation Coefficient (r)	Correlation Strength (Relationship)
± 0.91 hingga ± 1.00	Very strong
± 0.71 hingga ± 0.90	Strong
± 0.51 hingga ± 0.70	Intermediate
± 0.31 hingga ± 0.50	Weak
± 0.01 hingga ± 0.30	Very weak

Source: Piaw, C. Y (2006)

RESULTS AND DISCUSSION

Teachers' Level of Knowledge on the Implementation of STEM in Teaching and Learning Session

Table 2 shows the results of teachers' level of knowledge on the implementation of STEM in teaching and Learning. The findings showed that majority of the teachers claimed that they knew the characteristics of STEM education; but their knowledge on the theories of STEM was at the intermediate level. This result was consistent with the results from studies conducted by Breiner et al. (2012), and Nuangchalerm (2018). The STEM education would be effective if the teachers knew and understood well the characteristics and all of the elements related to STEM.

Similarly, the result revealed that 57% of the teachers reported that they knew the methods of implementing STEM in teaching and learning. This means that 43% of teachers had no knowledge on how to deliver STEM education in the classrooms. Similarly, 45% of the teachers reported that they had no idea of how to assess students' achievement in STEM education. This was considered as a huge number since almost half of the teachers needed to be trained and 37% of the teachers did not know the roles teachers in the implementation of STEM education. These findings were different from the findings of research done by Yildirin & Turk (2018) and Muhammad Daud (2019) which found that majority of the respondents had no knowledge on how to implement STEM in teaching and learning.

In conclusion, Sciences, Mathematics and RBT teachers from Kuala Nerus need to improve their knowledge on STEM education and its characteristics. They also need to be trained in the methods of implementing STEM education. Lack of knowledge will be an obstacle in implementing an innovation in education when they do not make the obstacle as an opportunity to enhance professionalism.

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Table 2: Descriptive analysis on the level of the teachers' knowledge in the implementation of STEM in teaching and learning session

Knowledge Constructs			**Scale Frequency (Percent, %)**				
			1	2	3	4	5
1		I know the definition of STEM education	4 (3.6)	8 (7.3)	6 (5.5)	75 (68.3)	17 (15.5)
2		I know the characteristics of STEM education	4 (3.6)	9 (8.2)	19 (17.3)	68 (61.8)	10 (9.1)
	2.1	I know the characteristics of an integrated STEM education.	3 (2.7)	10 (9.1)	17 15.5	68 61.8	12 10.9
	2.2	I know the characteristics of STEM education that relate the disciplines learned to the real world.	4 (3.6)	9 (8.2)	10 (9.1)	73 (66.4)	14 (12.7)
	2.3	I know the characteristics of STEM education is inquiry-based learning.	4 (3.6)	9 (8.2)	10 (9.1)	76 (69.1)	11 (10.0)
	2.4	I know the characteristics of STEM education is problem-based learning.	3 (2.7)	10 (9.1)	16 (14.5)	71 (64.5)	10 (9.1)
	2.5	I know the characteristics of STEM education, students collaborate in small groups.	3 (2.7)	10 (9.1)	10 (9.1)	77 (70.0)	10 (9.1)
	2.6	I know the characteristics of STEM education, teachers as facilitators.	5 (4.5)	8 (7.3)	5 (4.5)	77 (70.0)	15 (13.6)
	2.7	I know the characteristics of STEM education is the application of alternative assessment or evaluation.	3 (2.7)	10 (9.1)	18 (16.4)	74 (67.3)	5 (4.5)
3		I know theories related to STEM education.	3 (2.7)	12 (10.9)	31 (28.2)	63 (57.3)	1 (9.0)
	3.1	I know constructivism theory.	3 (2.7)	9 (8.2)	18 (16.4)	76 (69.1)	4 (3.6)
	3.2	I know Piaget's cognitive theory.	4 (3.6)	8 (7.3)	27 (24.5)	69 (62.7)	2 (1.8)
	3.3	I know Vygotsky's theory.	1 (9.0)	15 (13.6)	41 (37.3)	52 (47.3)	1 (9.0)
4		I know the importance of implementing teaching and learning of STEM education.	2 (1.8)	10 (9.1)	15 (13.6)	73 (66.4)	10 (9.1)
5		I know the advantages of implementing teaching and learning of STEM education.	2 (1.8)	11 (10.0)	19 (17.3)	66 (60.0)	12 (10.9)
6		I know the methods of implementing teaching and learning of STEM.	2 (1.8)	15 (13.6)	30 (27.3)	59 (53.6)	4 (3.6)
7		I know the assessment process in the teaching and learning of STEM education.	2 (1.8)	14 (12.7)	33 (30.0)	58 (52.7)	2 (2.7)
8		I know the role of teachers in implementing the teaching and learning of STEM education.	2 (1.8)	15 (13.6)	23 (20.9)	65 (59.1)	5 (4.5)

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The Teacher's Attitude towards the Implementation of STEM Education

Table 3 shows the results of teachers' attitude towards the implementation of STEM education. The teachers' attitude towards changes and innovation in teaching and learning is explained from the cognitive, affective and behavior aspects (Tai & Omar, 2017). In this study, the cognitive dimension of attitude was measured by perception on STEM education; the affective dimension was characterized by confidence on the effectiveness of STEM education in developing students' higher order thinking, attracting students to opt for STEM-related careers, and improving students' learning; and behavior dimension was indicated by teachers' initiatives in STEM teaching and learning process.

The findings showed that majority of the teachers reported that they had positive attitude towards STEM education with more than 80% of the teachers had positive perception on STEM education; about 83% of the teachers were confidence of the positive impacts of STEM education on students' thinking, career and learning; and about 30% of the teachers had not initiated ways to improve STEM teaching and learning. These findings confirmed previous studies done by Nor Azlina (2015) and Nur Fatahiyah and Siti Nur Diyana (2020).

The positivity showed by majority of these teachers had been one of the factors that influenced their readiness in accepting and implementing an innovation in teaching. The Fullan Theory (2001) explained that the implementation of the changes in education needs this type of positivity as early as the beginning phase. Thus, the teachers in Kuala Nerus were ready to enhance their capability in applying the STEM education in and outside of the classrooms since they had formed a positive attitude towards STEM education.

Table 3: Descriptive analysis of the level of the teachers' attitude on STEM education.

Attitude Construct		Scale Frequency (Percent, %)				
		1	2	3	4	5
Cognitive: Perception						
1	STEM education meets the educational needs of the 21st Century.	4 (3.8)	8 (7.3)	7 (6.4)	72 (65.5)	18 (17.3)
2	STEM education increases the level of mastery of students in the subjects of Science, Technology, Engineering and Mathematics.	4 (3.6)	9 (8.2)	7 (6.4)	72 (65.5)	18 (16.4)
3	STEM education actively involves students in the learning process.	4 (3.6)	7 (6.4)	7 (6.4)	75 (68.2)	17 (15.5)
4	STEM education makes student learning more relevant and connected.	6 (5.5)	5 (4.5)	11 (10.0)	75 (68.2)	13 (11.8)
Affective: Confidence						
5	STEM education is very effective in training students to think outside the box or at a higher level.	4 (3.6)	7 (6.4)	8 (7.3)	72 (65.5)	19 (17.3)

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6	STEM education is believed to be able to attract students to STEM-related career fields.	4 (3.6)	7 (6.4)	7 (6.4)	76 (69.1)	16 (14.5)
7	STEM education can improve the quality of students' learning experiences.	4 (3.6)	7 (6.4)	6 (5.5)	77 (70.0)	16 (14.5)
Behavior: Teachers' Initiative						
8	I always innovate in the process of teaching and learning Science/Mathematics/RBT according to the suitability of the Topic/Content Standard taught.	7 (6.4)	8 (7.3)	18 (16.4)	71 (64.5)	6 (5.5)
9	I always talk to other teachers to find solutions to overcome weaknesses in the STEM teaching process.	7 (6.4)	7 (6.4)	20 (18.2)	67 (60.9)	9 (8.2)
10	I always ready to work with other teachers to ensure the successful implementation of teaching and learning of STEM education.	5 (4.5)	10 (9.1)	6 (5.5)	73 (66.4)	16 (14.5)

The Level of Teachers' Readiness towards the Implementation of STEM Education

The results showed that overall, teachers who taught Sciences, Mathematics and RBT from Kuala Nerus, were not well prepared to implement STEM education. About 80% of the teachers were ready to learn and improve their skills in implementing STEM education. However, 41 % of them thought that STEM education was a burden to them and 46% felt uncomfortable with the implementation of STEM education. No wonder 55% of the teachers were anxious about integrating all four subjects in STEM education. Moreover, 31% of the teachers thought that STEM education was not for primary school students. These findings supported the previous researches conducted by Nor Shai'rah (2015) and Nur Fatahiyah and Siti Nur Diyana (2020). Even so, the teachers are still making opportunities for their pupils to learn and contribute to the objectives of STEM education (72.2%) and encourage them to be proactive (70%).

Table 4: Descriptive analysis on the teachers' readiness in implementing STEM

Readiness Construct		**Scale Frequency (Percent, %)**				
		1	2	3	4	5
1	I am ready to practice STEM teaching in my classroom.	2 (1.8)	6 (5.5)	14 (12.7)	75 (68.2)	13 (11.8)
2	I always provide opportunities for students to jointly contribute to the outcome of STEM learning objectives.	1 (9.0)	5 (4.5)	13 (11.8)	80 (72.7)	11 (10.0)
3	In my opinion, STEM teaching is suitable to be implemented in primary schools.	2 (1.8)	7 (6.4)	26 (23.6)	66 (60.0)	9 (8.2)
4	I am ready to try new approaches in the teaching and learning activities of STEM education.	4 (3.6)	5 (4.5)	19 (17.3)	74 (67.3)	8 (7.3)

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5	I am anxious to practice STEM teaching in my students' learning activities.	2 (1.8)	11 (10.0)	37 (33.6)	56 (50.9)	4 (3.6)
6	I am always looking for opportunities to innovate in my STEM teaching.	2 (1.8)	5 (4.5)	32 (29.1)	65 (59.1)	6 (5.5)
7	I think, STEM activities only add to the burden on teachers.	1 (2.7)	10 (9.1)	52 (47.3)	39 (35.5)	6 (5.5)
8	I always encourage students to interact proactively when conducting STEM activities.	-	7 (6.4)	18 (16.4)	77 (70.0)	8 (7.3)
9	I am more comfortable with teaching and learning that is not associated with STEM.	2 (1.8)	11 (10.0)	46 (41.8)	46 (41.8)	5 (4.5)
10	In my opinion, STEM activities are not practical to implement in teaching and learning.	3 (2.7)	16 (14.5)	50 (45.5)	36 (32.7)	5 (4.5)
11	I am always looking for opportunities to solidify the implementation methods of teaching and learning of STEM in my classes.	2 (1.8)	7 (6.4)	30 (27.3)	65 (59.1)	6 (5.5)
12	I am always ready to take any course that can improve my STEM related skills.	2 (1.8)	11 (10.0)	14 (12.7)	73 (66.4)	10 (9.1)
13	I am always willing to spend more time celebrating student presentation activities in the teaching and learning of STEM education.	2 (1.8)	10 (9.1)	21 (19.1)	69 (62.7)	8 (7.3)
14	I am always prepared for any approach applied in teaching and learning of STEM as long as my students can understand what is being presented.	1 (9.0)	10 (9.1)	14 (12.7)	75 (68.2)	10 (9.1)

The Relationships between Teachers' Readiness in Implementing STEM with Their Knowledge

Ho_1: There is no significant relationship between the teachers' readiness in implementing STEM with the knowledge they possessed on STEM education.

The Pearson correlation was used to determine the relationship between the teachers' readiness to implement and their knowledge on the implementation of STEM education. The finding showed that there was a positive significant correlation between the readiness of teachers who taught Sciences, Mathematics and RBT in Kuala Nerus and their knowledge on STEM education and its implementation, r = .571, p = .000. Therefore, the first null hypothesis was rejected. Even though the relationship is significant but with moderate strength. This conveys that those teachers who are

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knowledgeable in STEM education and the methods of its implementation are ready to deliver STEM in teaching and learning processes.

Precisely, by having the knowledge on STEM, it would increase the teachers' readiness to implement STEM. Knowledge and skills are important factors to determine the level of the teachers' readiness and capabilities to implement the innovation in teaching and learning session. Consequently, the level of teachers' knowledge needs to be upgraded by conducting more courses and practices such as LADAP, PLC and particularly programs on STEM so that teachers will always be ready to implement STEM education.

Relationships between Teachers' Readiness in Implementing STEM with Their Attitude

Ho_2: There is no significant relationship between the teachers' readiness in implementing STEM and their attitude towards STEM education.

Analysis using Pearson correlation revealed that there was a significant correlation between the participating teachers' readiness score and the teachers' attitude score on the implementation of STEM, $r = .488$, $p = .000$. Similarly, the second null hypothesis was also rejected. This means that the participated teachers who taught Sciences, Mathematics and RBK in Kuala Nerus, had positive and attitude towards STEM education which may have resulted in their readiness to implement STEM in teaching and learning. However, the strength of the relationship was weak. In conclusion, if teachers' attitude towards STEM is positive, their readiness would be increased.

Briefly, this weak relationship has to be improved by exposing the benefits of the implementation of STEM to all teachers, especially those who are teaching in primary schools in Kuala Nerus so that the perception is more positive and their level of confidence regarding the implementation of STEM in teaching and learning sessions will be improved. Previous studies proved that when the teachers went through training and gained positive experiences in applying any approaches of teaching, their attitude and confidence towards it would be improved (Berliner, 1986).

Relationships between Teachers' Readiness in Implementing STEM with Their Experience

Ho_3: There is no significant relationship between the teachers' readiness in implementing STEM with their experience in teaching STEM education.

Pearson correlation test also revealed a significant correlation between the teachers' readiness to implement STEM education and their experiences in STEM education. The results showed that there was a significant negative relationship between the teachers' scores on readiness on the implementation of STEM education and the teaching experiences, $r = -.720$, $p = .000$. Again, the third, hypothesis was also rejected. Negative correlation means that the less teaching experience a teacher has, the higher his or her readiness to implement STEM education. This informs that novice teachers who taught Sciences, Mathematics and RBT in Kuala Nerus were more prepared to integrate STEM in teaching and learning. This result confirmed the finding of a study done by Nur

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Fatahiyah and Siti Nur Diyana (2020) which found that the novice teachers were more positive and well prepared in the integration of STEM education in their lessons compared to experienced teachers.

The Teachers' Readiness in the Implementation of STEM Education based on Their Knowledge, Attitude and Teaching Experience

Overall, there was a significant relationship between the teachers' readiness in implementing STEM education with their knowledge, attitude and teaching experience but with differences in strength. The correlation showed moderate positive between the teachers' readiness and their knowledge; weak positive between their readiness to implement STEM education and their attitude; and quite strong negative correlation with teaching experiences. This study confirmed the results of studies conducted by the Fullan Educational Change Theory (2001) which stated that the knowledge, skills and attitude were among the biggest factors affecting the level of the teachers' readiness in implementing certain innovation or changes in curriculum. The findings of this study also substantiated the results of studies done by Nur Fatahiyah and Siti Nur Diyana (2020) whereby the novice teachers' readiness to implement STEM education was higher than the experienced teachers. However, acceptance and readiness are also influenced by factors such as support from the school managements, the schools' ecosystems, the facilities of the schools and also support from the community (Fullan, 2001). This research confirmed the position that knowledge and skills are the catalyst in developing the teachers' positive attitude that attributed to the willingness to accept and implement changes in education (Nor Shai'rah, 2015). In addition, teachers who are knowledgeable and skilled in the STEM education would be able to bring the positive changes on the implementation.

CONCLUSION

This study shed some light on the participating teachers' knowledge, attitude and readiness on STEM education and its implementation. It revealed that majority of the teacher participants who taught Sciences, Mathematics and RBT in Kuala Nerus, Terengganu, claimed that they understood the concept of STEM education but did not fully grasped the theories underpinnings STEM. The responsible parties should take note on the large percentage of teachers who still grappling on the methods of delivering STEM education and plan training programs that could enhance teachers' pedagogical competencies in integrating STEM into teaching and learning sessions. Teachers need guidance on how to assess their students' performance in STEM education as well. Furthermore, explanation on their roles as teachers in STEM education should be made clear so that they would be more effective in delivering their responsibilities as teachers of STEM.

Even though many teachers admitted that they lacked pedagogical content knowledge as well as methods of assessing students' performances in STEM, but they had positive attitude towards STEM education and they believed that STEM education is beneficial to their students' future. Moreover, majority of them were ready to be trained in the implementation of STEM in teaching and learning processes; and training programs and monitoring on teachers' training needs

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should be done on regular basis. Having said that, it is also discouraging to know that majority of the teachers were anxious about the implementation of STEM education; thought that STEM education was an added burden to them that is why almost half of the teachers were not comfortable with STEM education. Interestingly, this study gave insight on the novice teachers who were willing and ever ready to implement STEM education compared to the more experienced teachers. Furthermore, readiness to implement STEM in teaching and learning sessions was found to be correlated with teachers' knowledge on and attitude towards STEM education.

However, this study only illustrated a small fraction of reality on the ground on the implementation of STEM education. Therefore, the findings of this study could not be generalized to the whole population of primary school teachers in Malaysia. More research needs to be done to assess the adequacies and pitfalls of STEM education and its implementation in Malaysia so that informed decision could be made to further enhance the effectiveness of STEM education.

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