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Implementing Integrated STEM Teaching in Design and Technology: Teachers' Knowledge and Teaching Practices

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Abstract

Malaysia has emphasized the integration of Science, Technology, Engineering, and Mathematics (STEM) in Technical and Vocational Education and Training (TVET) to ensure the supply of manpower in the industry meets the requirements of Digital 4.0. However, teachers' teaching practices in the classroom were found to be the cause of the declining number of students taking STEM subjects in secondary schools. Teachers' knowledge is important to ensure an integrated STEM teaching can be implemented effectively. Knowledgeable teachers in STEM discipline will increase confidence to apply integrated STEM in teaching and learning (T&L). This study was conducted to examine the level of teachers' knowledge and its relationship with STEM teaching practices among Design and Technology teachers. This quantitative study involved 375 Design and Technology teachers from 99 of secondary schools on the East Coast of Malaysia. This quantitative study using stratified random sampling technique to determine the sample. The questionnaire consisting 61 items distributed online via Google Form. Descriptive analysis and Pearson correlation were performed using *Statistical Package for Social Science* version 26.0. The analysis showed that Design and Technology teachers' level of knowledge is high with a score of M = 3.20 and SD = 0.35, while the integrated STEM teaching practices are at a moderate level with a score of M = 2.97 and SD = 0.46. Furthermore, knowledge on integrated STEM teaching practices among Design and Technology teachers exhibited a moderate and significant positive relationship with a score of $r = 0.356$ and $p<0.05$. The findings indicated that teachers do implement integrated STEM teaching practices but not comprehensively and consistently. They are in the knowledge development phases in understanding the STEM concept and implementing it in the Design and Technology curriculum. Furthermore, STEM teaching has yet to be part of their teaching culture. They require time to adapt STEM teaching into their existing teaching practices. Therefore, teachers need additional support from school administrators, departments, and the Ministry of Education (MOE) to participate in "hands-on" and "minds-on" courses related to STEM T&L. Further research is needed on integrated STEM teaching practices using

different approaches involving engineering design process to fill the gap in teaching practices among Design and Technology teachers.

Keywords: Teacher's Knowledge, Integrated STEM Teaching Practice, Design and Technology

Introduction

The transformation of education outlined in the Malaysian Education Blueprint 2013-2025 introduced STEM education to provide students with STEM knowledge and acquired skills to face the challenges in the real world. Scholars differ in defining integrated STEM education, and there has yet to be an exact definition for the general public (Shernoff et al., 2017). According to Shaughnessy (2013), STEM education is problem-solving learning through collaborative mathematical and scientific concepts and procedures involving engineering design and the use of appropriate technology. STEM education relates to teaching and learning (T&L) approaches that involve two or more STEM disciplines in a subject (Kelly & Knowles, 2016). Bryan et al (2016) described integrated STEM education as T&L that includes scientific and mathematical disciplines in lessons and combines them with engineering practices and design through technological applications. Although there are various definitions of STEM education, its concept is implemented according to the country's model of education system. The MOE (2016) definition of STEM education involves a T&L concept that integrates four disciplines, which are science, technology, engineering, and mathematics, by applying them in real-world contexts.

The national STEM education goal is to educate students to become productive citizens through STEM knowledge, literacy, and skills (Ismail et al., 2019). Singapore has included STEM disciplines in its curriculum to produce human resources in STEM fields, such as engineers, biotechnologists, and scientists (Farhana et al., 2017). The United States also applies STEM education in TVET for the preparation of a skilled and professional workforce for Industry 4.0. STEM education has the potential to motivate students in their studies to engage in STEM-related activities for their future careers (Margot & Kettler, 2019). Recognizing the importance of STEM in TVET, the Design and Technology curriculum is drawn up to teach students the skills of designing and producing products in line with the needs of the modern industry (MOE, 2019). Students are not only taught to become technology users but also given the opportunity to create new ideas to solve problems in the real world.

Accordingly, the government has taken several steps to empower STEM education in the Design and Technology curriculum through several policies. Among the policies that support STEM education are the National Science, Technology and Innovation Policy, the Malaysian Education Blueprint 2013-2025, Vision 2020, and the 60:40 policy (STEM: non-STEM). In addition, several STEM strengthening initiatives were introduced, including STEM+ club activities, school lab competitions, STEM education colloquium, STEM teacher training, STEM education roadshows, STEM curriculum, and STEM awareness and infographics (MOE, 2017). Teachers play an essential role as implementers of the new curriculum in their teaching practices to make STEM education successful. This is because the curriculum quality in the education system closely relates to teachers' teaching practices (Baharin & Osman, 2018). Integrated STEM teaching practices are considered a relevant and practical T&L approach in today's education. An integrated STEM approach involving inquiry-based learning, problem-solving, and project-based learning is an effective T&L approach (Voet & De Wever, 2016).

Therefore, teachers' teaching practices need to be prioritized to ensure successful implementation of integrated STEM education (Baharin & Osman, 2018).

Problem Statement

STEM learning is viewed as lacking in encouragement at all levels of education in Malaysia. Every year, student enrolment in STEM in secondary schools is declining (Baharin & Osman, 2018). This issue affects the quality of student achievement in STEM subjects, and unfortunately, teachers have been highlighted as one of the causes (MOE, 2013). As a result, the government strives to empower STEM education through teacher competence in teaching practices (MOE, 2020).

Teachers' teaching practices still employ a teacher-centered approach, which obstructs the development of higher-order thinking skills (HOTS) (MOE, 2013). Previous studies reported that integrated STEM teaching practices among teachers are still at a moderate level (Mahmud et al., 2018), incomprehensive (Mustafa et al., 2017), and unable to meet students' needs (Siew et al., 2015). The decline in students' academic performance is also linked to teachers' guidance methods, which do not suit the students' abilities (Losius et al., 2018; Nasir et al., 2019). As a result, students cannot understand teachers' teaching presentations, are unmotivated, lack confidence, and are uninterested in STEM (Chang & Park, 2014; Farhana & Othman, 2017; Nasir et al., 2019). Previous studies also reported that teachers' integrated STEM teaching practices are moderate due to the lack of pedagogical knowledge of STEM content and discipline (Nistor et al., 2018; Masingan & Sharif, 2019; Jekri & Han, 2020). Teachers also have a moderate level of content knowledge, pedagogical knowledge, and skills in implementing STEM T&L (Tajul & Azahar, 2018). As a result, teachers who lack knowledge in integrated STEM teaching, will less confidence in teaching it in the classroom (Margot & Kettler, 2019).

Research Objective

The objectives of the study are as follows

1. To identify integrated STEM teaching practices and knowledge among Design and Technology teachers.
2. To determine the the relationship between knowledge and integrated STEM teaching practices among Design and Technology teachers.

Literature Review

a. Integrated STEM Teaching Practices

STEM education was introduced in the curriculum through the Malaysian Education Blueprint 2013-2025 by emphasizing the 4Cs: communication, collaboration, creativity, and critical thinking. STEM education is a lifelong learning concept that involves learning science, technology, engineering, and mathematics formally (curriculum), non-formally (co-academic), and informally (indirect learning) at every student's age level (MOE, 2017). STEM T&L focuses on HOTS, collaborative, problem-based, project-based, and inquiry-based learning (Ismail et al., 2019). Integrated STEM education began in the United States in the 1990s as an effort to provide its citizens with jobs in the STEM field. Not to be left behind, Malaysia has also begun to show interest and seriousness in STEM education with the main goal of improving students' academic performance, producing students who are STEM literate, and fostering students' interest and confidence in STEM to prepare them for a

challenging work environment (Baharin & Osman, 2018). Therefore, teachers play a critical role in ensuring students' success in STEM learning through their teaching practices.

Teaching practice refers to something that teachers often do and becomes a habit in the classroom (Depaepe & König, 2018). A teaching practice involves planning, which includes the selection of teaching strategies, methods, and approaches, as well as the provision of teaching aids that can influence student achievement (Pei et al., 2018). An integrated STEM teaching practice is an approach in T&L to apply STEM knowledge, skills, and values through environmental exploration, problem-solving, and project-based learning activities in real-world contexts (MOE, 2016). Teachers' teaching practices in the classroom should align with students' needs in the 21st century. In general, there are three approaches to implementing integrated STEM teaching (MOE, 2016): the inquiry approach, problem-based learning, and project-based learning. Problem-based learning and project-based learning involve an inquiry learning approach (Farhana, 2019). The inquiry learning approach, using the 5Es of the T&L model, is suitable as the main focus in integrated STEM teaching practices among Design and Technology teachers during the T&L process. This is because Design and Technology learning utilizes the three approaches to improve higher-order thinking and 21st-century learning skills.

Past studies found that integrated STEM teaching practices are inconsistent and have not reached a satisfactory level. Diana and Kamisah (2018) found that inquiry teaching practices among science teachers are at a moderate level with a mean score of (M = 3.63, SD = 0.13). The study reported that teachers adopt the inquiry teaching approach in 21st-century learning but to a minimal extent. Teachers lack understanding of the actual concept in inquiry-based teaching. Thus, it cannot be practiced often in 21st-century T&L. There is also a moderate, negative, and significant relationship between teachers' knowledge and attitude toward inquiry teaching practices ($r = -0.52$, $p = 0.004$). The score indicates that although teachers' level of knowledge and attitude are low, they still apply inquiry-based teaching practices in T&L at a minimal rate. There is a possibility that teachers are less prepared in terms of knowledge and attitude to use the T&L approach.

b. Teachers' Knowledge

Integrated STEM teaching practices are influenced by teachers' knowledge. Shulman (1986) explained that teachers who master content knowledge are able to deliver content with various teaching methods, and experience in the subjects they teach will contribute to effective teaching. Integrated STEM teaching practices can be improved if teachers have good STEM T&L knowledge (Jekri & Han, 2020). Some of the knowledge that teachers need to be experts include basic STEM education knowledge (Fatahiyah & Diyana, 2020; Sulaiman et al., 2022), content knowledge, pedagogical knowledge, and pedagogical content knowledge (Masingan & Sharif, 2019; Margot & Kettler, 2019; Loh et al., 2020). Teachers who have knowledge and understanding of STEM education can implement Design and Technology T&L using suitable pedagogical methods and approaches (Tajul & Azahar, 2018). Previous studies found a significant relationship between knowledge and teachers' teaching practices in the classroom (Diana & Kamisah, 2018; Aziz et al., 2020). Thus, teachers' knowledge is important to ensure integrated STEM teaching can be implemented effectively. Teachers who are knowledgeable in STEM discipline can also increase confidence (Nadelson et al., 2013) and apply integrated STEM in T&L frequently (Nadelson & Seifert, 2017).

Rahmat and Kutty (2019) conducted a study about the knowledge and skills in implementing Design and Technology T&L. The findings showed that the teachers' knowledge is at a medium level with a mean score of M = 3.57, while their skills are at a high level with a mean score of M = 3.79. Their moderate knowledge could be because they are trying to master every topic since the Design and Technology subject is a new curriculum. On the other hand, their high skill level could be due to their proficiency in pedagogy, such as sketching, handling tools and materials, and workshop management and safety, acquired when they taught Living Skills subjects.

Amira and Irdayanti (2019) examined teachers' knowledge of green technology in Design and Technology subjects. The findings showed that their knowledge of green technology is high, with a mean score of (M = 4.06, SP = 0.276). The teachers emphasize the concept of developing environmentally friendly products while instilling a recycling culture among students. They are aware that students are trained to apply technological tools and environmental values in their product learning when teaching Design and Technology.

Jekri and Han (2020) conducted a study on 129 science teachers to identify their level of knowledge and integrated STEM teaching practices in the classroom. The results found that 96 teachers admitted to having implemented STEM T&L with moderate frequency, followed by 26 teachers who admitted to having implemented STEM T&L with low frequency, and a small number of teachers stated that they implemented STEM T&L with high frequency. The findings also showed that 70 teachers chose moderate knowledge of STEM T&L characteristics while 80 teachers chose moderate knowledge of STEM T&L elements, and 62 teachers chose low knowledge of STEM teaching strategies. In conclusion, the level of implementation of STEM T&L among teachers is moderate because they lack the knowledge to integrate STEM disciplines in teaching, lack facilities and infrastructure in schools, and have limited time allocation in STEM T&L.

In general, STEM knowledge is related to the theories, concepts, principles, ideas, and understanding of teachers to integrate STEM disciplines in T&L. Fatahiyah and Diyana (2020) found that the implementation of integrated STEM teaching is closely related to teachers' readiness in terms of their knowledge and attitudes toward STEM. The results found that teachers' basic STEM education knowledge is high, with a mean score of M = 3.85. Researchers believed that after several years of the implementation of STEM education in Malaysia, teachers' knowledge of STEM education has begun to increase due to the exposure received from various parties.

Sulaiman et al (2022) studied the level of knowledge, attitude, and readiness of 110 STEM teachers to implement STEM T&L in the classroom. The findings showed that teachers' level of knowledge, attitude, and willingness to implement STEM T&L is moderate. The study reported that 57% of teachers know the method of implementing STEM T&L, while 43% admit they do not know the best method to deliver STEM T&L in the classroom. It was also reported that 45% of teachers do not know how to assess student achievement in STEM education, and 37% do not know the role of teachers in STEM education implementation. The findings showed that the majority of teachers have basic knowledge of how to implement STEM education, but their knowledge of STEM theory is moderate. The study also reported a moderate, positive, and significant relationship between knowledge and willingness to

implement STEM T&L among STEM teachers, with a value of r = 0.571 and p = 0.000. The researchers believed that knowledgeable teachers would increase their willingness to implement STEM T&L. Therefore, teachers' level of knowledge needs to be improved from time to time through courses and training to prepare them for STEM T&L implementation.

c. Research Theory

This study is based on the Theory of Planned Behavior (TPB) developed by Ajzen (1985). This theory is an extension of the Theory of Reasoned Action (TRA) founded by (Ajzen and Fishbein, 1970). According to the TRA, attitude is a personal factor associated with positive or negative feelings or good or bad evaluations in performing a particular intended behavior. Subjective norms are social factors that refer to social pressure in considering whether a particular behavior should be done (Ajzen, 1991). In this theory, intention is a priority, where it becomes a motivational factor that can influence a person's behavior. These two factors, attitude and subjective norms, are interrelated in determining behavior based on intention (Ajzen & Fishbein, 1970; Ajzen & Madden, 1986). According to the TPB, there are three factors that influence a person's behavioral change, determined by his intention, namely attitude, subjective norms, and perceived behavioral control. This theory is adapted in this study to identify teachers' behavior of integrated STEM teaching practices. Therefore, the knowledge factor was set as the subjective norm factor and the integrated STEM teaching practices as the behavior to be studied.

Research Methodology

Research Design

This study used a quantitative approach and employed questionnaires as the instrument to collect data (Creswell & Guetterman, 2019). Questionnaires were deemed practical because they are easy to administer, cheap, reliable, and easy to be completed by the respondents (Cohen et al., 2018). In this study, the researcher wants to identify the knowledge and practice of integrated STEM teaching and their relationship with the variables studied.

Population and Sample

The population in this study consisted of 1785 secondary teachers who teach Design and Technology in East Coast of Malaysia. The sample size was determined using the Cochran (1977) formula. The study assigned 375 respondents from 99 secondary schools to answer the questionnaires. The proportional stratified random sampling technique was used in selecting the study sample because it can increase the potential of the sample to spread widely in the population (Ary et al., 2018).

Research Instrument

A set of questionnaires was used as the research instrument to measure the variables. There are two components in the questionnaire to measure the variables. The first questionnaire was adapted and adopted from Farhana (2019) to measure integrated STEM teaching practices, and the second questionnaire was constructed by the researcher to measure teacher knowledge. The questionnaire contains 61 items distributed online via Google Forms. A pilot study was conducted to test the internal consistency of the instrument. The pilot study showed that the Cronbach Alpha values for the questionnaire items for each variable ranged from 0.73 to 0.95. The reliability exceeded the value of 0.70, which is considered good and acceptable for a field study (Cohen et al., 2018).

Data Analysis

The data was collected and analyzed using the Statistical Package for Social Sciences, SPSS version 26.0. The descriptive statistical analysis involved mean and standard deviation. The interpretation of the mean score was based on a four-point Likert scale, which was divided into three levels, as suggested by (Best, 1997). A Pearson correlation statistical analysis was conducted to identify a significant relationship between knowledge and integrated STEM teaching practices among the Design and Technology teachers. The strength of the relationship between variables was determined by the value of the coefficient, r using the interpretation by (Cohen and Manion, 1994).

Research Finding

a. Integrated STEM teaching practices among Design and Technology teachers

Table 1 shows the mean score and standard deviation to identify the level of integrated STEM teaching practices among the Design and Technology teachers. Overall, the findings show that integrated STEM teaching practices among the Design and Technology teachers are at a moderate level, with an overall mean score of M = 2.97 and SD = 0.46. There are five dimensions to measure integrated STEM teaching practices, namely engagement, exploration, explanation, elaboration, and evaluation. Based on Table 1, the evaluation dimension recorded the highest mean score (M = 3.02, SD = 0.51), indicated at a high level, while the explanation dimension recorded the lowest mean score (M = 2.87, SD = 0.53), indicated at a moderate level. The mean value of engagement and exploration is M = 2.93 and SD = 0.49 and M = 2.98 and SD = 0.48, respectively, which are both at a moderate level. The mean for the elaboration dimension is M = 3.00 and SD = 0.52, which is recorded at a high level.

Table 1
Integrated STEM Teaching Practices among Design and Technology Teachers

Dimension	M	SD	Interpretation
Engagement	2.93	0.49	Moderate
Exploration	2.98	0.48	Moderate
Explanation	2.87	0.53	Moderate
Elaboration	3.00	0.52	High
Evaluation	3.02	0.51	High
Integrated STEM teaching practices	**2.97**	**0.46**	**Moderate**

b. Knowledge among Design and Technology Teachers

Table 2 below shows the mean score and standard deviation to identify the level of knowledge among the Design and Technology teachers. Overall, the findings show that teachers' knowledge is at a high level, with an overall mean score of M = 3.20 and SD = 0.35. There are four dimensions to measure knowledge: basic STEM education knowledge, content knowledge, pedagogical knowledge, and pedagogical content knowledge. Based on Table 2, the pedagogical knowledge dimension recorded the highest mean score (M = 3.20, SD = 0.35), indicated at a high level, while basic STEM education knowledge recorded the lowest mean score (M = 3.14, SD = 0.43), indicated at a high level. The dimensions of content knowledge and pedagogical content knowledge are both indicated at a high level, with mean scores of M = 3.15 and SD = 0.46 and M = 3.18 and SD = 0.43, respectively.

Table 2

Knowledge among Design and Technology Teachers

Dimension	M	SD	Interpretation
Basic STEM education knowledge	3.14	0.43	High
Content knowledge	3.15	0.46	High
Pedagogical knowledge	3.33	0.45	High
Pedagogical content knowledge	3.18	0.43	High
Knowledge	**3.20**	**0.35**	**High**

c. Relationship between Knowledge and Integrated STEM Teaching Practices among Design and Technology Teachers.

A Pearson correlation analysis was conducted to identify the relationship between knowledge and integrated STEM teaching practices among the Design and Technology teachers. Table 3 shows the Pearson correlation coefficient between the knowledge and integrated STEM teaching practices variables. The findings show that there is a significant relationship between knowledge and integrated STEM teaching practices ($r = 0.356$, $p<0.05$), with a moderate positive strength (Cohen & Manion, 1994). The finding explains that there is a positive relationship, with a moderate strength, between knowledge and integrated STEM teaching practices among the Design and Technology teachers.

Table 3
Correlation between Variables

Independent Variable	Integrated STEM Teaching Practices (Pearson's correlation coefficient, r)	Interpretation Relationship
Knowledge	0.356	Moderate Positive Relationship

** Correlation is significant at the 0.01 level (2-tailed)

Discussion

a. Integrated STEM Teaching Practices among Design and Technology Teachers

Based on the results, the integrated STEM teaching practices among Design and Technology teachers in secondary schools in the East Coast of Malaysia are at a moderate level. The findings are in line with the findings of several previous studies on STEM teachers, which indicate that STEM teaching in secondary schools is still average (Mahmud et al., 2018; Diana & Kamisah, 2018; Pei et al., 2018; Jekri & Han, 2020; Fatahiyah & Diyana, 2020). This situation is similar in the United States, where teachers take several decades to understand STEM education implementation in their curriculum to implement good teaching practices (Kelly & Knowles, 2016). Thus, it is not surprising if the implementation of STEM education in Malaysia is still at a moderate level because the integration of STEM disciplines in the Design and Technology curriculum can be considered new in our education. The findings clearly showed that teachers have been practicing integrated STEM teaching based on their knowledge and ability. Design and Technology teachers are still unable to implement integrated STEM teaching in depth. The reason could be due to the constraints faced in schools, such as time, resources, and materials to implement STEM well. In addition, the readiness of teachers and students also affects teachers' teaching practices. Teachers require time to transition from teaching single subjects to teaching subjects across the curriculum by integrating STEM disciplines into their teaching (Margot & Kettler, 2019). Besides that, several teachers are

worried about implementing integrated STEM teaching due to fear of increasing workload (Sulaiman et al., 2022). Thus, teachers need help from the government, parents, students, and society to develop their knowledge and improve their practices and confidence to implement STEM teaching in the classroom.

b. Knowledge of Design and Technology Teachers

The findings also revealed that the level of knowledge among Design and Technology teachers is high. All dimensions of knowledge, namely basic STEM education knowledge, content knowledge, pedagogical knowledge, and pedagogical content knowledge, recorded a high level. The findings are in line with previous studies that indicate high basic STEM education knowledge among teachers (Sujarwanto et al., 2019; Fatahiyah & Diyana, 2020). Although the teachers' knowledge is high, integrated STEM teaching practices in the classroom are still moderate. Generally, knowledge is critical to ensure teachers can implement integrated STEM teaching effectively. Therefore, as curriculum implementers, teachers should always strive to improve their knowledge according to the current education development and needs (Baharin & Osman, 2018). Teachers need to be proactive to enhance their existing knowledge and strive to obtain new knowledge related to Design and Technology subjects and integrated STEM education. Besides that, teachers should increase their efforts to practice integrated STEM teaching as practice will improve their STEM teaching quality (Nadelson & Seifert, 2017). Teachers who have extensive knowledge of the subjects they teach can deliver knowledge accurately and prevent students from misunderstanding a topic (Koehler et al., 2013).

c. Relationship between Knowledge and Integrated STEM Teaching Practices of Design and Technology Teachers

The study's findings were in line with previous studies, which found a significant relationship between teachers' knowledge and their integrated STEM teaching practices (Diana & Kamisah, 2018; Aziz et al., 2020; Sulaiman et al., 2022). The findings showed that teachers' knowledge is interrelated with their teaching practices in the classroom. In other words, the stronger and more positive the teacher's STEM-related knowledge and pedagogical content knowledge, the better their integrated STEM teaching practice presented in the classroom.

However, this study also showed a moderate relationship of teachers' knowledge, which contributed to the moderate relationship of STEM teaching practices. Therefore, teachers are advised to improve and strengthen their basic STEM education knowledge, content knowledge, pedagogical knowledge, and pedagogical content knowledge. This is because teacher knowledge has a significant relationship with teaching quality (Haron et al., 2021) and effective teaching (Hafizan & Anuar, 2017), which affect student academic achievement (Tchoshanov et al., 2017; Hill & Chin, 2018; Warrah et al., 2020). The moderate relationship between knowledge and integrated STEM teaching practices needs to be improved by ensuring that teachers' knowledge of integrating STEM teaching practices and their readiness to include STEM in their teaching is consistent at a high level (Nadelson & Seifert, 2017). A high level of teacher content knowledge can encourage teachers to deliver clear explanations of Design and Technology content. In addition, STEM pedagogical skills will increase teachers' confidence and willingness to relate STEM learning inside and outside the classroom (Nasri et al., 2020) so that it can be cultured in integrated STEM teaching.

Conclusion and Recommendation

The results of the study showed that teachers' level of knowledge is high while the level of integrated STEM teaching practices is moderate. This indicates that although teachers have adequate knowledge to integrate STEM disciplines in their teaching practices, the practice of STEM itself has not yet been established, comprehensive, and consistent. The findings reflected the actual situation of integrated STEM teaching, which has not yet become a practice among Design and Technology teachers in secondary schools on the East Coast Zone. The level of awareness and readiness for integrated STEM teaching requires attention. Furthermore, the implementation of integrated STEM teaching needs to be improved so that it can become a culture in the classroom. STEM culture involves the process of educating students to become competent in terms of knowledge, skills, and values so they can appreciate and accept STEM education in their learning (Fadzilah et al., 2017). Therefore, teachers need to cultivate STEM in their teaching before it can be applied to students.

The findings provide useful information for stakeholders to take the best action to implement and revise integrated STEM education, especially for the Design and Technology curriculum. The authorities play a significant role in spreading awareness and understanding to teachers on the ways to integrate STEM into T&L by providing adequate training. Although the findings cannot be generalized to all Design and Technology teachers in Malaysia, the issue of moderate integrated STEM teaching practices needs to be taken seriously. Further study needs to explore how teachers implement integrated STEM T&L. This study used the 5E teaching model to investigate integrated STEM teaching practices. However, the Engineering Design Process model is also relevant for future research to investigate integrated STEM teaching practices in Design and Technology.

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