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Research Article:

The Interaction Effects of School Location and Teaching Experience on Self-Efficacy Perceived by the Primary Science Teachers Towards Integrated STreAM Teaching

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ABSTRACT

Integrated science, technology, engineering and mathematics (STEM) is expanded to integrated STrEAM, where the "r" denotes the amalgamation of reading and writing elements to bridge the gap between STEM disciplines. Since integrated STrEAM is a new approach, it is pivotal to gauge the teachers' self-efficacy in executing integrated STrEAM teaching. Therefore, this cross-sectional survey design reports on the effect of school location and years of teaching experience on the self-efficacy of primary science teachers towards integrated STrEAM teaching. For this purpose, the STrEAM Teaching Self-Efficacy Scale (STSES) was administered to 200 primary science teachers throughout the nation. The STSES consists of five subscales: STrEAM instructional strategies self-efficacy, STrEAM classroom management self-efficacy, STrEAM community involvement self-efficacy, STrEAM student engagement self-efficacy, and STrEAM outcome expectancy. Data obtained from the STSES survey was analysed using two-way Multiple analysis of variance (MANOVA) to identify the effects of school location and years of teaching experience towards self-efficacy perceived by the primary science teachers towards integrated STrEAM teaching. The findings show that school location and years of teaching experience significantly affect the self-efficacy perceived by the primary science teachers towards integrated STrEAM teaching. School location and years of teaching experience also have a significant interaction effect (Wilks' lambda = 0.860, $F(15, 519) = 1.950$, $p < 0.005$) on primary science teachers towards integrated STrEAM teaching. The finding of this study is resourceful for the STEM stakeholders and policy makers to design the STrEAM teaching materials for training the teachers.

Keywords: Integrated STrEAM teaching, self-efficacy, school location, teaching experience

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INTRODUCTION

Science, technology, engineering and mathematics (STEM) is essential in preparing students for future transdisciplinary career demands and solving complex issues emerging in climate change, energy, health, energy declination, and water resources management (Nadelson & Seifert, 2017). Not only policymakers but also business and industry organisations endeavour to upgrade STEM skills to meet current future economic challenges (Capri et al., 2012; NRC, 2014). One avenue of exploration in STEM education focuses on the interdisciplinary and transdisciplinary curriculum (Costantino, 2018). The expansion of integrated STEM to STEAM education allows learners to demonstrate creativity and innovation to find an optimal solution to a problem (Park et al., 2016). STEAM education is gaining traction in many nations. However, implementing it is extensively is debatable (English, 2013). This postulates that the art element alone is not sufficient to maximise the notion of integrated STEM but still requires a comprehensive approach.

The scope of interdisciplinary permits integrated STEM education to be extended to integrated STrEAM. To serve the purpose of this study, the "r" in integrated STrEAM refers to the reading and writing element. Integrated STEM needs to be complemented by infusing reading and writing into the curriculum to make learning relevant to the students' lives (Schreiner & Sjøberg, 2004). The research has indicated that pupils at the primary level face difficulties understanding the content of a subject because of the complex and high-density information (Oliveira, 2015). The needs of the learners are to engage themselves with the real world, which reflects the transdisciplinary nature that indirectly requires the integration of reading and writing element. The current STEM education in matriculation also emphasises bridging the gap between the STEM disciplines and making learning relevant and meaningful to the students (Law et al., 2021). Therefore, integrating the reading and writing (r) element into integrated STEM will bridge the gap between the four disciplines and make learning meaningful and feasible.

The teachers' self-efficacy needs to be gauged to ensure they are prepared to embrace the STEM reform (Geng et al., 2019). Most teachers often focus on the STEM knowledge and skills they are comfortable teaching (Kelley et al., 2020) and are not confident in integrated STEM teaching. Therefore, when teachers lack confidence in STEM teaching, it will affect the students' exposure to experiencing a full breadth of STEM knowledge (Kelley et al., 2020). Teachers' self-efficacy is a significant factor in students' learning (Nadelson et al., 2012). Teachers feel less knowledgeable and comfortable teaching in a subject area outside of their expertise affecting their self-efficacy and confidence in teaching an integrated STEM curriculum (Stohlmann et al., 2012).

Many factors influence the self-efficacy of the teachers in teaching integrated STrEAM. The most prominent factors that have been associated with the teachers' self-efficacy in teaching integrated STrEAM are the teaching experience of the teachers and the school's location (Durowoju & Onuka, 2015). Knoblauch and Chase (2015) stated a strong relationship between the teachers' location and their self-efficacy in teaching a new technique. Teachers' self-efficacy and the location of the schools are closely associated, where the self-efficacy of the teacher varies depending on the specified situations (Dellinger et al., 2008). Parallel to this, another study has documented that the school environment plays a vital role in teachers' self-efficacy (Wilson et al., 2020).

The teachers who have been teaching for different periods perceive the different levels of self-efficacy in teaching (Hoy & Woolfolk, 1993; Imants & De Brabander, 1996). An empirical study conducted by Woo and Ashari (2019) proved a positive correlation between years of teaching and the teachers' self-efficacy in Malaysia in implementing STEM education. The interaction between school location and teaching experience towards teaching self-efficacy is still being researched. Considering the research gap, the purpose of this study was to measure the interaction effect of school location and teaching experience on primary science teacher's self-efficacy towards integrated STrEAM teaching from Malaysian context.

LITERATURE REVIEW

The Transition from Integrated STEM to Integrated STrEAM

It is indisputable that the definition of STEM is still in a state of ambiguity (Moore et al., 2014; Stohlmann et al., 2012). The definition of integrated STEM education that appears apt in highlighting the integration is the initiative to amalgamate science, technology, engineering, and mathematics within the same class or lesson grounded on the connections between the subjects and real-world problems (Kelley & Knowles, 2016; Stohlmann et al., 2012). Integrated STEM is also defined as an interdisciplinary approach that blurs the lines between the four disciplines (Wang et al., 2011). Kennedy and Odell (2014) postulate integrated STEM to teach the students beyond what the disciplines have to offer when they are in silos.

One of the elements in "Framework for STEM Integration in the Classroom" stated that real-world problems are interdisciplinary beyond just the STEM disciplines (Moore et al., 2016). Parallel to this, integrated STEM has been expanded to STEAM education to integrate arts and design (Costantino, 2018). STEAM education has been advocated in countries like Korea to uplift students understanding of science content through their arts, innovation and creativity (Jho et al., 2016). However, advocates for STEM education have cautioned about having an A (arts) in the STEM education lexicon. This indicates a loop in expanding integrated STEM education with arts alone, insufficient to cater to the transdisciplinary nature.

English (2016) indicates that the engineering discipline is ideal for developing a design-based problem that buttresses STEM disciplines and literacy. Reading and writing are essential in corroborating proficiency in other disciplines (Wilkinson et al., 2018). As the STEM fields have become increasingly prominent, reading and writing enormously affect children's development and evolution in science, technology, engineering, and mathematics disciplines, which have been recognised at the primary level, pushing educators to provide high-quality reading materials (Popov & Tinkler, 2017). Reading is essential in STEM, characterised by a high density of information (Fang, 2004). Reading materials as texts with STEM themes is seen as one the best ways for pupils to build literacy skills, including reading, writing, and reasoning with the language and text while grasping STEM content (Pearson et al., 2010). Pupils exposed to complex STEM discipline contexts can understand the vocabulary and how the reading material is structured (Palincsar et al., 2001). Moreover, high-quality STEM reading content can efficiently enhance students' inquiry experience and grasp of science concepts. Therefore, the scope of interdisciplinary permits integrated STEM to be extended to STrEAM, in which the "r" refers to the reading and writing element. Integrated STrEAM will bridge the gap between the four STEM disciplines and guide the teachers to have seamless teaching.

STrEAM Teaching Practices

The integrated STrEAM teaching is exhibited through the STrEAM practices employed by the science teachers. Practices in integrated STrEAM are the cornerstone of students' learning. The practice is the amalgamation of knowledge and skills where it enhances the understanding and development in the disciplines of science, technology, engineering, and mathematics disciplines (Nathan & Pearson, 2014). Integrated STrEAM practices will be guided by STEM practices practised in various teaching and learning activities.

One of the most common and widely used practices in STEM education is problem-based learning (Stearns et al., 2012). Problem-based learning (PBL) is an approach that provides a meaningful learning situation that focuses on finding a solution to a problem extracted from a real-world situation (Lou et al., 2011) and issues fabricated (LaForce et al., 2016). Project-based learning (PjBL) has also been widely used in teaching STEM integration. This strategy is based on self-direction and collaboration and has a multidisciplinary orientation (Mills & Treagust, 2003). According to Kennedy and Odell (2014), teachers who conduct STEM lessons should integrate and supported by relevant learning outcomes to engage the students in meaningful learning.

The engineering and engineering design practice has been widely used in integrated STEM. Engineering design is about designing and evaluating a solution for an identified problem in real life (Kennedy & Odell, 2014). Align to this, NRC (2014) has postulated the engineering design process as a method that utilises mathematical and scientific knowledge to solve real-world and complex problems. Engineering design is seen as paramount in STEM integration because it accentuates students' ability in solving complex and real-world problems (English et al., 2013). Several models have been developed to promote the expansion of engineering design in STEM to elaborate on the engineering design process. The next practice, which has been widely used is inquiry-based learning. Inquiry-based learning consists of scientific inquiry and engineering design, promoting meaningful hands-on activities using real-life situations to provide students with opportunities to discover new knowledge (Nadelson & Seifert, 2017). The inquiry is also described as a fluid process where the outcome obtained does not culminate, but it keeps on changing (Purzer et al., 2015). Inquiry-based learning creates authentic problem-based questions to be derived, and it is a cyclic process of learning by doing and developing the skill to "learn how to learn" (Blessinger & Carfora, 2015). They have also pointed out that inquiry-based learning is often oriented around learning by doing. It is often intertwined with which suits STEM disciplines in nature. It is driven by an investigation to address the questions or find solutions to a problem.

Self-efficacy

The self-efficacy concept was conceptualised by Bandura (1977) as a judgment of one's capabilities to perform actions that they believe could lead to desired results. Researchers have documented critical links between self-efficacy beliefs and teaching practices (Tschannen-Moran et al., 1998). Teachers' self-efficacy has also been associated with student learning outcomes (Tschannen-Moran et al., 1998). Mastery experience is the power source where when an individual manages to master a particular task, their self-efficacy increase. In contrast, when they fail in the given task, their self-efficacy lowers and impacts their outcome (Sandholtz & Ringstaff, 2014). When they feel incompetent or anxious to teach a designated lesson, their self-efficacy level deteriorates (Tschannen-Moran & Hoy, 2007). Self-efficacy beliefs contribute an essential factor for the success of STEM disciplines (Zeldin et al., 2008). Self-efficacy beliefs may be a proxy for the teacher's knowledge and preparedness for teaching STEM content (Nadelson et al., 2013). Teachers with lower levels of self-efficacy for teaching STEM-related concepts held misconceptions related to fundamental concepts (Schoon & Boone, 1998). Thus, this study specifically addressed and examined primary science teachers' self-efficacy for teaching integrated STrEAM.

Location of Schools

The geographical factor of the school distinguishes the location of the schools whether it is situated in the urban or rural area (Durowoju & Onuka, 2015) Nigeria. Three hypotheses were tested at 0.05 level of significance. Multi-stage sampling technique was adopted in the study. Four Local Government Areas (two urban and two rural. The school location has been defined in the context of school climate (Meristo & Eisenschmidt, 2014). The school climate in terms of the school environment impacts the development of self-efficacy (Wilson et al., 2020). Schools located in urban and rural areas face more constraints in obtaining funding, resources, teacher quality, and disciplinary problems than suburban schools (Knoblauch & Chase, 2015). In rural schools, the students come from immigrant families, a low percentage of educated parents and special needs students (Lowe, 2006). Integrated STrEAM with the integration of reading and writing elements will overcome the teachers' challenges in rural schools. This approach doesn't require the teachers to have a well-equipped classroom but merely bridging the gap between the STEM disciplines with efficiently integrating reading and writing elements. Integrated STrEAM will favour the teachers teaching in urban schools as well as rural schools fairly.

Teaching Experience

In a longitudinal study conducted by Swan and his colleagues (2011), the teachers' self-efficacy in the fifth year of research is higher than the first year of placement in the same school. Novice teachers in well-equipped schools perceive less self-efficacy than the expert teachers teaching in less equipped schools (Chester & Beaudin, 1996). Similarly, in another study conducted by Wolters and Daugherty (2007), it has been proven that teachers in their first year of teaching reported significantly lower self-efficacy for instructional practices and classroom management compared to experienced teachers. An empirical study showed a positive correlation between science teachers' teaching period and science teaching scores (Liu et al., 2008). Moreover, Bandura (1977, 1986) reiterated that mastery experience or performance experience is the most vital source of self-efficacy. Therefore, expanding to integrated STrEAM by adding reading and writing elements is feasible with teachers' teaching experience. The teaching experience ensures teachers utilise the integrated STrEAM accordingly to the needs of the students in comprehending the STEM disciplines. The experience gained by the teachers will assist them in optimising integrated STrEAM at the maximum level.

METHODOLOGY

Research Design and Sampling of the study

This study employed a cross-sectional survey design to obtain the data. The primary science teachers represent the population of the study. The teachers who participated in this study are teaching science at their school. The teachers who participated were trained to teach integrated STrEAM before participating in the survey. The teachers participated in a workshop conducted for three days. In the workshop held on the online platform, the teachers were given a detailed explanation of STrEAM teaching, examples of lesson plans used to teach integrated STrEAM and how it can be used successfully for conducting the teaching and learning activity. After the workshop, the teachers were given three weeks to carry out integrated STrEAM in their teaching and learning activity during a science lesson guided by lesson plans provided to them during the workshop. After three weeks, a session was conducted to let the teachers share their feedback in executing integrated STrEAM teaching and participate in the survey. Therefore, the fairness of the teachers in participating in the survey has been assured.

The samples for this study were obtained using random purposive sampling, a strategy recommended by Onwuegbuzie and Collins (2017). Primary school teachers were randomly invited to participate in the workshop. This informs the probability random sampling. The need for the teachers participating in the workshop to respond to the questionnaire denotes the non-probability purposeful sampling. The survey was participated by 104 (52%) female teachers and 96 (48%) male teachers. 95 (47.5%) of the respondents are from urban schools, whereas 105 (52.5%) teach in rural schools. The respondent varies in teaching experience where 51 (25.5%) teachers have 1 to 5 years of teaching experience, 46 (23.0%) have 6 to 10 years of teaching experience, 54 (27.0%) respondents have 11 to 15 years of teaching experience, and 49 (24.5%) of the teachers have teaching experience of 16 years and above.

Instrument

For this study, the researchers intended to measure the teachers' self-efficacy in various dimensions towards integrated STrEAM teaching. Therefore, we have employed three instruments, Science Teaching Efficacy Belief Instrument (STEBI-A) developed by Enochs and Riggs (1990), Teacher Self Efficacy Scale (TSS) developed by Tschannen-Moran and Hoy (2001) and Teacher Self-Efficacy Scale (TSS) developed by Bandura (1977) to measure the perceived self-efficacy of the primary science teachers towards integrated STrEAM teaching.

Table 1. Details of the distribution of the original items obtained from various sources

Original instrument	Authors	Subscale	Items
Teacher Self-Efficacy Scale (TSS)	Tschannen-Moran and Hoy (2001)	Efficacy for instructional strategies	EIS1 EIS2 EIS3 EIS4 EIS5 EIS6 EIS7 EIS8
TSS	Tschannen-Moran and Hoy (2001)	Efficacy for classroom management	ECM9 ECM10 ECM11 ECM12 ECM13 ECM14 ECM15 ECM16
TSS	Tschannen-Moran and Hoy (2001)	Efficacy for student engagement	ESE17 ESE18 ESE19 ESE20 ESE21 ESE22 ESE23 ESE24

(Continue on next page)

Table 1 (continued)

Original instrument	Authors	Subscale	Items
Science Teaching Efficacy Belief Instrument (STEBI-A)	Enochs and Riggs (1990)	Science teaching outcome expectancy	STOE4 STOE5 STOE6 STOE7 STOE8 STOE9 STOE10 STOE14 STOE17 STOE18 STOE19
TSS	Bandura (1977)	Efficacy for enlist community involvement	EECI1 EEC12 EECI3 EECI4

The researchers modified the original items, which sounded more general to the specified items, to ensure the items measure the teacher's self-efficacy on integrated STrEAM teaching. The item "How well can you provide appropriate challenges for very capable students" was modified as "I can provide appropriate challenges for very capable students in doing integrated STrEAM activities". The adapted items have undergone exploratory factor analysis (EFA) to ascertain the factors, and the items for each factor are relevant and applicable to the factor structure. The analysis suggested five factors and 30 items. Upon finalising the factors and items, the instrument was sent to six STEM education experts for content validity. The Item Content Validity Index (I-CVI) obtained for this instrument was 0.85 to 1.00. I-CVI's acceptable value is 0.78 for 6 to 10 raters (Polit & Beck, 2006).

The five factors ascertained for this questionnaire are STrEAM instructional strategies self-efficacy, STrEAM classroom management self-efficacy, STrEAM student engagement self-efficacy, STrEAM community involvement self-efficacy, and STrEAM outcome expectancy. The first factor, the STrEAM instructional strategies self-efficacy, consists of seven items that gauged the ability to use various assessment strategies, crafting good questions, differentiation, and alternative approaches in integrated STrEAM teaching. The second factor is STrEAM classroom management self-efficacy comprises of seven items. It evaluated the teacher's perceived efficacy in establishing classroom rules and routines, controlling disruptive behaviour, and making their expectations clear to the students. The third factor obtained is STrEAM student engagement self-efficacy, consisting of seven items. It measured the ability of the teachers to ensure the students think creatively and critically improve students' understanding and value learning of integrated STrEAM teaching. The fourth factor is STrEAM community involvement self-efficacy comprises four items. It measures the involvement of higher education institutes, STEM-related professionals and non-governmental organisations (NGOs) in upsurging integrated STrEAM teaching. The fifth factor is the STrEAM outcome expectancy consists of five items, and it gauges the teachers' expectation of their integrated STrEAM teaching on their students. The adapted questionnaire was named STrEAM Teaching Self-Efficacy Scale (STSES). The questionnaire uses a five-point Likert scale ranging from 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree to evaluate teachers perceived self-efficacy towards integrated STrEAM teaching (refer Appendix A).

Pilot Study

A pilot study was conducted to identify the reliability of the instrument before conducting the actual study the total of 120 primary science teachers participated in the pilot study, and they did not participate in the actual study. Since integrated STrEAM is an approach that the teachers have not utilised, they were given a detailed description of integrated STrEAM teaching. In the description, the teachers were catered with the definition of integrated STrEAM, how reading and writing elements accommodate STEM disciplines, and how integrated STrEAM can be integrated into teaching and learning activity. The pilot study participants were ensured to comprehend the detailed description and watch a video on how integrated STrEAM is utilised to deliver a lesson on "Energy" before attempting the survey. The Cronbach alpha value was computed for all five subscales and the overall scale. The alpha value obtained ranged from 0.81to 0.86 for the five subscales (STrEAM instructional strategies self-efficacy = 0.813; STrEAM classroom management self-efficacy = 0.86; STrEAM community involvement self-efficacy = 0.83; STrEAM student engagement self-efficacy = 0.84; STrEAM outcome expectancy = 0.84) and the overall scale 0.89. Overall, STSES has demonstrated high internal consistency with Cronbach alpha, and the value obtained more than 0.80 is adequate (Nunnally, 1978).

DATA ANALYSIS

The obtained data were analysed using IBM Statistical Packages for Social Science (IBM SPSS) software version 24. Quantitative data from STSES were analysed to obtain mean and standard deviation. Two-way multivariate analysis of variances (MANOVA) was used to determine the effects of school location and teaching experience on all five subscales in STSES. Further in-depth analysis (post hoc) was carried out when the interaction effects were significant. Before that, the data were checked for meeting the assumptions.

RESULTS

Before conducting two-way MANOVA, the data were checked for the multivariate normality and homogeneity of variance-covariance. The Kolmogrov Smirnov test for normality were significant ($p>0.05$). Therefore, the assumption of multivariate normality is not violated. The homogeneity of variance-covariance matrices was tested using Box's M test of equality of covariance. Box's M value of 9.22 with a p-value of 0.18 ($p>0.05$) indicates that variance-covariance were assumed to be equal. As the assumption was met, two-way MANOVA was performed to investigate the differences between the means score of the five subscales STrEAM instructional strategies self-efficacy, STrEAM classroom management self-efficacy, STrEAM student engagement self-efficacy, STrEAM community involvement self-efficacy, and STrEAM outcome expectancy. The results of the two-way MANOVA showed that years of teaching experience (Wilks' lambda = 0.05, F (15, 519) = 67.54, p<0.005) have a significant effect on the self-efficacy of primary science teachers towards integrated STrEAM teaching.

Table 2. Result of two-way MANOVA (years of teaching experience*integrated STrEAM teaching)

Subscale	Sum of squares	df	Mean	F	Sig.
STrEAM instructional strategies self-efficacy	23566.61	3	7855.54	1060.66	0.00
STrEAM classroom management self-efficacy	13631.32	3	4543.77	703.42	0.00
STrEAM student engagement self-efficacy	10213.33	3	3404.44	664.28	0.00
STrEAM community involvement self-efficacy	22671.80	3	7557.29	743.72	0.00
STrEAM outcome expectancy	9848.31	3	3282.77	526.25	0.00

The results of the two-way MANOVA indicated school location (Wilks' lambda = 0.72, F (5, 188) = 14.51, p<0.005) also have a significant effect on the self-efficacy of primary science teachers towards integrated STrEAM teaching as shown in Table 3.

Table 3. Result of two-way MANOVA (school location*integrated STrEAM teaching)

Subscale	Sum of squares	df	Mean	F	Sig.
STrEAM instructional strategies self-efficacy	508.52	1	508.52	68.67	0.00
STrEAM classroom management self-efficacy	273.73	1	273.73	42.38	0.00
STrEAM student engagement self-efficacy	140.17	1	140.17	27.35	0.00
STrEAM community involvement self-efficacy	333.78	1	333.78	32.85	0.00
STrEAM outcome expectancy	152.64	1	152.64	24.47	0.00

The result obtained from two-way MANOVA tabel 4 indicated years of teaching experience and school location also have a significant interaction effect (Wilks' lambda = 0.86, F (15,

519) = 1.950, $p < 0.005$) on the self-efficacy of primary science teachers towards integrated STrEAM teaching. Since the interaction effect appears to be significant further analysis was performed to determine which subscales of the integrated STrEAM exhibited significant interaction effects between years of teaching experience and school location.

Table 4. Multivariate findings for each subscale in STSES

Subscale	Sum of squares	df	Mean	F	Sig.
STrEAM instructional strategies self-efficacy	167.72	3	55.91	7.55	0.00
STrEAM classroom management self-efficacy	62.13	3	20.71	3.21	0.00
STrEAM student engagement self-efficacy	56.29	3	18.76	3.66	0.01
STrEAM community involvement self-efficacy	147.64	3	49.21	4.84	0.00
STrEAM outcome expectancy	85.09	3	28.37	4.55	0.00

Since significant interaction effects were noticed in the five subscales, further analysis was performed to identify whether the results favoured urban or rural school science teachers and their years of teaching experience. Table 5 shows the two-way MANOVA results indicated the school location is statistically significant to all five subscales of STSES.

Table 5. Multivariate findings for school location*each subscale in STSES

Subscale	Location	Mean	Sig.
STrEAM instructional strategies self-efficacy	Urban	29.54	0.00
	Rural	25.01	0.01
STrEAM classroom management self-efficacy	Urban	23.24	0.00
	Rural	19.84	0.00
STrEAM student engagement self-efficacy	Urban	19.74	0.04
	Rural	17.19	0.00
STrEAM community involvement self-efficacy	Urban	29.59	0.01
	Rural	25.70	0.00
STrEAM outcome expectancy	Urban	19.80	0.02
	Rural	17.18	0.00

Science teachers from urban schools have higher self-efficacy towards integrated STrEAM teaching than their counterparts. This can be observed in all five subscales, where all the mean scores of urban schools' science teachers are more elevated than rural schools' science teachers.

Two-way MANOVA results also show that year of teaching experience is statistically significant to all five subscales of STSES (refer to Table 6).

Table 6. Multivariate findings for years of teaching experience*each subscale in STSES

Subscale	Years of teaching experience	Location	Mean	Sig.
STrEAM instructional strategies self-efficacy	1–5 years	Urban	14.91	0.00
		Rural	11.39	0.00
	6–10 years	Urban	22.17	0.00
		Rural	22.13	0.00
	11–15 years	Urban	33.32	0.00
		Rural	28.62	0.00
	>16 years	Urban	44.92	0.00
		Rural	40.39	0.01
STrEAM classroom management self-efficacy	1– 5 years	Urban	11.91	0.00
		Rural	9.39	0.00
	6–10 years	Urban	18.43	0.00
		Rural	18.00	0.02
	1–15 years	Urban	25.64	0.00
		Rural	22.35	0.00
	>16 years	Urban	34.92	0.00
		Rural	31.78	0.00
STrEAM student engagement self-efficacy	1–5 years	Urban	9.78	0.03
		Rural	7.96	0.00
	6–10 years	Urban	15.78	0.00
		Rural	15.91	0.00
	11–15 years	Urban	21.68	0.00
		Rural	19.35	0.01
	>16 years	Urban	29.96	0.00
		Rural	27.26	0.00

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Table 6 (continued)

Subscale	Years of teaching experience	Location	Mean	Sig.
STrEAM community involvement self-efficacy	1–5 years	Urban	14.61	0.00
		Rural	12.25	0.01
	6–10 years	Urban	23.30	0.00
		Rural	23.48	0.00
	11–15 years	Urban	32.86	0.00
		Rural	29.08	0.00
	>16 years	Urban	44.88	0.01
		Rural	40.48	0.00
STrEAM outcome expectancy	1–5 years	Urban	10.26	0.00
		Rural	8.18	0.01
	6–10 years	Urban	15.48	0.00
		Rural	16.00	0.00
	11–15 years	Urban	21.79	0.00
		Rural	19.04	0.00
	>16 years	Urban	29.92	0.03
		Rural	17.18	0.00

Since there was a significant result in the five subscales of STSES on integrated STrEAM teaching, a post hoc Bonferroni test was conducted to identify which period of teaching experience had significant effects among the five subscales. Table 7 shows the post hoc test (Bonferroni) results across the teaching experience period. The post hoc test showed that all the five subscales, STrEAM instructional strategies self-efficacy, STrEAM classroom management self-efficacy, STrEAM community involvement self-efficacy, STrEAM student engagement self-efficacy, and STrEAM outcome expectancy, had a significant effect between teaching experience of 1 to 5 years, 6 to 10 years, 11 to 15 years, 16 years and above.

Table 7. Post hoc tests (Bonferroni) across the teaching experience period

Subscales	(I) Years of teaching experience	(J) Years of teaching experience	Sig.
STrEAM instructional strategies self-efficacy	1–5 years	6–10 years	0.00
		11–15 years	0.00
		More than 15 years	0.00
	6–10 years	1–5 years	0.00
		11–15 years	0.00
		More than 15 years	0.00
	11–15 years	1–5 years	0.16
		6–10 years	0.00
		More than 15 years	0.01
	16 years and above	1–5 years	0.15
		6–10 years	0.25
		11–15 years	0.05
STrEAM classroom management self-efficacy	1–5 years	6–10 years	0.00
		11–15 years	0.00
		More than 15 years	0.00
	6–10 years	1–5 years	0.02
		11–15 years	0.01
	`	More than 15 years	0.05
		1–5 years	0.66
	11–15 years	6–10 years	0.00
		More than 15 years	0.00
		1–5 years	0.07
	16 years and above	6–10 years	0.00
		11–15 years	0.03

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Table 7 (continued)

Subscale	(I) Years of teaching experience	(J) Years of teaching experience	Sig.
STrEAM community involvement self-efficacy	1–5 years	6–10 years	0.00
		11–15 years	0.00
		More than 15 years	0.01
	6–10 years	1–5 years	0.04
		11–5 years	0.00
		More than 15 years	0.00
	11–15 years	1–5 years	0.01
		6–10 years	0.03
		More than 15 years	0.02
	16 years and above	1–5 years	0.00
		6–10 years	0.00
		11–15 years	0.00
STrEAM student's engagement self-efficacy	1–5 years	6–10 years	0.03
		11–15 years	0.00
		More than 15 years	0.00
	6–10 years	1–5 years	0.01
		11–15 years	0.02
		More than 15 years	0.04
	11–15 years	1–5 years	0.00
		6–10 years	0.00
		More than 15 years	0.00
	16 years and above	1–5 years	0.01
		6–10 years	0.00
		11–15 years	0.00

(Continue on next page)

Table 7 (continued)

Subscale	(I) Years of teaching experience	(J) Years of teaching experience	Sig.
STrEAM outcome expectancy	1–5 years	6–10 years	0.00
		11–15 years	0.02
		More than 15years	0.00
	6–10 years	1–5 years	0.01
		11–15 years	0.02
		More than 15 years	0.00
	11–15 years	1–5 years	0.01
		6–10 years	0.02
		More than 15 years	0.00
	16 years and above	1–5 years	0.00
		6–10 years	0.03
		11–15 years	0.00

DISCUSSIONS

From the previous research, it is evident that the teachers' self-efficacy significantly influences their teaching practices. Various attempts have been made to identify the factors that influence teachers' self-efficacy and teaching practices in the specific subject matter. Gender, age, service training and job satisfaction are not the factors that impact the teachers' self-efficacy, but the seniority and weekly lesson loads are the driving factors that influence self-efficacy (Yenice, 2009). Specifically, this study was aimed to investigate the existence of interaction effects between the location of the school and teaching experiences on primary science teachers' self-efficacy towards integrated STrEAM teaching. Science teachers from urban schools from all periods of teaching experience exhibited higher mean scores for all five subscales. The obtained mean scores increased to a great extent through the teaching experience for all the subscales. However, the mean score differs marginally for the subscales STrEAM classroom management for the teaching period 6 to 10 years. On the contrary, science teachers from rural schools from all periods of teaching experience obtained lower mean scores for all five subscales. Parallel to the finding of this study, the past researchers corroborated the self-efficacy of the teachers' increases with teachers' experience (Wolters & Daugherty, 2007). Bandura (1977) posits through mastery experience source of efficacy that the teacher's expertise in teaching a specific subject matter will facilitate higher self-efficacy.

For the STrEAM classroom management self-efficacy subscales, both urban and rural teachers have marginally higher self-efficacy. The urban science teachers (mean score 23.24) were slightly higher than their rural counterparts (mean score 19.84). Aligning to the finding of this study, teachers with a higher level of mastery experience had higher classroom management self-efficacy (Wilson et al., 2020). Similar to this study, the beginning urban teachers have higher self-efficacy because they are behaviourally focused (Reupert & Woodcock, 2010). However, the marginal difference is because the classrooms in rural areas are smaller, and the students exhibit fewer discipline problems (Lowe, 2006). Therefore, the science teachers feel confident in managing the students efficiently. The relationships between the teachers and the students in rural areas are closer than students in urban schools, and the teacher efficiently manages the students (Knoblauch & Chase, 2015). Similar results were also reported by Martin (1997) that rural teachers can manage the classroom to a certain extent because the class size is small and can control the students better. However, the result contradicts another empirical study indicating that teachers' classroom management self-efficacy declines after their mid-career because they become repressive and hardly adapted to students' lives (Wubbels et al., 2006). Parallel to this finding, it has been revealed that the more experienced the teacher is, the classroom management self-efficacy declines because the teacher becomes less friendly and tends to be strict.

For the subscale STrEAM community involvement self-efficacy, the mean score of the urban teachers across the teaching experience is slightly higher than the rural teachers. The findings of this study indicate that the community involvement among urban schoolteachers is higher than the rural schools. This is because the teachers in the urban schools are regularly involved in the activities organised by governmental and non-governmental organisations such as the Association of Science, Technology, and Innovation (ASTI) and Teach for Malaysia. These governmental and non-governmental institutions directly collaborate with primary science teachers to conduct activities. The community involvement comprising of educators, researchers, and corporate community partners is proven to increase the self-efficacy perceived by the teachers (Kelley & Knowles, 2016).

Teachers' self-efficacy exerted on student achievement is closely linked to classroom quality and practices (Goddard & Goddard, 2001). Bouncing teachers' self-efficacy is critical in producing effective teachers (Lumpe et al., 2012). Many studies have indicated that the facilities and amenities obtained by the teachers play a vital role in upsurging the primary science teacher self-efficacy in teaching STrEAM education. The schools located in rural areas need to be equipped with sufficient technology amenities such as tablets and laptops to lift the self-efficacy perceived by the teachers in STrEAM teaching. The factor of inadequate technology assistance is the contributing factor of low self-efficacy of the teachers in all the subscales. The approaches and teaching strategies play a paramount role in intensifying the self-efficacy of primary science teachers. There was a gap between urban and rural primary science teachers' self-efficacy in conducting integrated STrEAM teaching. Teachers in rural schools possess lower self-efficacy in teaching integrated STrEAM, probably because they are not exposed to STrEAM practices extensively. Therefore, the teachers need to be provided Teacher Development Programme (TDP) related to integrated STrEAM practices. TDP programmes promote knowledge development, students' learning, and the teaching method, thus increasing their self-efficacy (Blonder et al., 2014). The TPD programmes will assist the teachers in planning their teaching and learning activities to support collaborative thinking and teamwork.

The teaching and learning activities should be prepared to reflect twenty-first-century skills, especially in rural schools. Moreover, considering the location of the schools, the approaches and strategies used by the primary science teachers need to vary to cater to the different needs of the students. Thus, the teachers from the rural areas need to be given more training to teach integrated STrEAM. The current TPD programmes in Malaysia emphasise exposing the teachers to various teaching and learning activities. Less focus is given to the teachers in executing the activities successfully. The teachers exhibit lower self-efficacy in teaching integrated STrEAM because they are only exposed to STEM concepts but not to the execution of the practices. In most circumstances, the TPD programmes are conducted by the District Education Offices and State Education Departments by appointing experienced teachers to train the science and mathematics teachers to teach integrated STEM. It will be more efficient if the National STEM centres conduct more TPD programmes with the collaboration with NGOs related to STEM organisations and STEM-related professionals to expose the teachers to executing the integrated STrEAM teaching.

CONCLUSIONS

The study's findings denote the necessity of tapping the self-efficacy perceived by the teachers in utilising the instructional strategies, managing the class, engaging the students and involving community-related bodies in teaching integrated STrEAM across the years of teaching experience and school location. The pivotal role of the primary science teachers' self-efficacy in teaching integrated STrEAM is undeniable in lifting the profile of the industrial revolution. Therefore, the teachers' self-efficacy needs to be explicitly upsurged to ensure the new integrated approach bridges the gap between the four disciplines. When the teachers' self-efficacy is lifted despite the teaching experience and location of the school, the integrated STrEAM can be executed at the highest notch. The teachers will have the opportunity to ensure that equity in STEM disciplines is obtained by utilising STrEAM teaching practices efficiently in the future. This study proposes involving primary science teachers frequently in Professional Learning Community (PLC) to lift the self-efficacy of novice teachers and teachers teaching at rural schools to be on par with their counterparts. This study also informs the stakeholders and policymakers to cater resources and sufficient training to all primary science teachers. Parallel to this, the findings of this study may suggest the need for an integrated STrEAM teaching guide to upsurge the self-efficacy of the primary science teachers in planning their teaching and learning activities.

Since fewer studies are conducted on the interaction between school location and years of teaching experience, this study will be a touchstone for more research to find the interaction between school location and teaching experience in global settings as this is an international agenda. Moreover, integrated STrEAM teaching is still at the embryonic stage. Therefore, more empirical research needs to be conducted to teach integrated STrEAM teaching practices in the future effectively. Specifically, more research needs to be done on amalgamating reading and writing elements into STEM disciplines to ensure integrated STrEAM is executed uniformly in the global setting. Although this study shows that primary science teachers from urban schools and experienced teachers perceive higher self-efficacy than their counterparts, generalisations cannot be made to the whole population as the sample is too small (Chew et al., 2013). Therefore, studies involving a larger sample size involving several nations is recommended to measure the teachers' self-efficacy in teaching integrated STrEAM.

Implementing interdisciplinary teaching is a huge challenge encountered by the majority of the STEM educators globally (Nadelson & Seifert, 2017; Park et al., 2016). The study is informative for the STEM practitioners from different countries that experience this sort of challenge. Firstly, this study introduces the amalgamation of reading, writing and art elements within the STEM disciplines as a platform for integration. It is recommended that STEM educators contextualise reading, writing and arts activities according to the needs of one country to investigate further how the integration of the three components facilitates interdisciplinary STEM teaching. Secondly, the study proposes perceived self-efficacy of the teachers is instrumental for the successful implementation of STrEAM teaching. The literature strongly denotes that self-efficacy is context-specific (Nadelson et al., 2013; Geng et al., 2019). Since the role of self-efficacy is context-specific further study is recommended to structure the curriculum for teacher professional development courses to train the teachers in STrEAM.

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APPENDIX A

STrEAM Teaching Self Efficacy Scale (STSES)

5 = Strongly Agree; 4 = Agree; 3 = Neutral; 2 = Disagree; 1 = Strongly Disagree

Item	Statement	Scale				
STrEAM Instructional Strategies Self Efficacy						
A1	I can use a variety of assessment strategies when conducting integrated STrEAM teaching.	5	4	3	2	1
A2	I can provide alternative explanations or examples when students are confused during integrated STrEAM teaching.	5	4	3	2	1
A3	I can craft good questions for my students during integrated STrEAM teaching.	5	4	3	2	1
A4	I can implement alternative strategies during integrated STrEAM teaching.	5	4	3	2	1
A5	I can respond to difficult questions from my students during integrated STrEAM teaching.	5	4	3	2	1
A6	I can gauge student comprehension of what I have taught during integrated STrEAM teaching.	5	4	3	2	1
A7	I can provide appropriate challenges for very capable students during integrated STrEAM teaching.	5	4	3	2	1
STrEAM Classroom Management Self Efficacy						
B1	I can control disruptive behaviour during integrated STrEAM teaching.	5	4	3	2	1
B2	I can ensure students follow classroom rules during integrated STrEAM teaching.	5	4	3	2	1
B3	I can calm a disruptive or noisy student during integrated STrEAM teaching.	5	4	3	2	1
B4	I can establish a classroom management system with each group of students during integrated STrEAM teaching.	5	4	3	2	1
B5	I can keep a few problem students from running an entire lesson during integrated STrEAM teaching.	5	4	3	2	1
B6	I can make my expectation clear about student behaviour during integrated STrEAM teaching.	5	4	3	2	1
B7	I can establish routines to keep activities running smoothly during integrated STrEAM teaching.	5	4	3	2	1
STrEAM Student Engagement Self Efficacy						
C1	I can get students to believe they can do well in schoolwork during integrated STrEAM teaching.	5	4	3	2	1
C2	I can help students value learning during integrated STrEAM teaching.	5	4	3	2	1
C3	I can motivate students who show low interest in schoolwork during integrated STrEAM teaching.	5	4	3	2	1

C4	I can improve the understanding of a student failing in integrated STrEAM.	5	4	3	2	1
C5	I can help my students to think critically during integrated STrEAM teaching.	5	4	3	2	1
C6	I can foster student creativity during integrated STrEAM teaching.	5	4	3	2	1
C7	I can get through the most difficult students during integrated STrEAM teaching.	5	4	3	2	1
STrEAM Student Engagement Self Efficacy						
D1	I can get non-governmental organisations (NGOs) involved during integrated STrEAM teaching.	5	4	3	2	1
D2	I can get religious bodies to be involved during integrated STrEAM teaching.	5	4	3	2	1
D3	I can get business bodies to be involved during integrated STrEAM teaching.	5	4	3	2	1
D4	I can get higher education institutes (IPTA / IPTS) involved during integrated STrEAM teaching.	5	4	3	2	1
STrEAM Outcome Expectancy						
E1	I am responsible for my students to perform better during integrated STrEAM teaching.	5	4	3	2	1
E2	I believe my students perform better during integrated STrEAM teaching because I exerted a little extra effort.	5	4	3	2	1
E3	My effectiveness in conducting integrated STrEAM teaching influences the students' achievement with low motivation.	5	4	3	2	1
E4	If I can increase my effort in integrated STrEAM teaching, I can see changes in my students' achievement.	5	4	3	2	1
E5	I feel I'm responsible for my students' competence in comprehending integrated STrEAM.	5	4	3	2	1