RESEARCH ARTICLE

Development of a STEM Self-Efficacy Scale for Malaysian Primary School Children: A Validity and Reliability Study

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Abstract: This study aims to examine the psychometric properties of the Malay language version of the STEM Efficacy for Children Scale (SECS). This initiative involved 389 primary school children aged 10–11 in Klang Valley, Selangor, Malaysia. Exploratory factor analysis (EFA) was conducted to identify the underlying factors within 16 items in SECS, followed by confirmatory factor analysis (CFA) to determine the model and reliability of the scale. Based on EFA, SECS managed to capture three factors related to STEM, namely, efficacy in learning science and mathematics, as well as efficacy in the application of engineering. SECS obtained a high Cronbach's alpha index (>0.8), and CFA confirmed that the model provided a good fit for the data collected. The average variance extracted demonstrated that all constructs in the model were >.50, while the composite reliability was >.80. These findings verify that the scale obtained good internal consistency. Therefore, the analysis proved that SECS is considered reliable and valid in capturing STEM efficacy among primary school children. The scale is expected to offer useful insights for educators, schools, and the government in their policy planning and execution concerning STEM teaching and learning at the primary school level.

Keywords: STEM education, primary school, efficacy, STEM Efficacy for Children Scale (SECS), confirmatory factor analysis (CFA), exploratory factor analysis (EFA)

INTRODUCTION

The 4th Industrial Revolution (4IR) demands a strong emphasis on science and technology across many disciplines. This revolution motivates individuals to have a solid foundation in STEM, especially with regards to problem-solving, negotiating, critical thinking, socially managing people, and creativity (Majid, 2018). Globally, STEM is referred to as an abbreviation of four main disciplines: science, technology, engineering, and mathematics. In the past few years, STEM-related industries have constantly been touted to be the primary driver of economic success in the future. Therefore, STEM jobs are increasing more rapidly compared to their non-STEM counterparts (Langdon et al., 2011). A data analysis of the labor force in Australia revealed that employment in STEM-related jobs grew 1.6 times more than non-STEM-related jobs between 2013 and 2018 (Australia Government, Department of Education, Skills and Employment, 2020). This indicates that STEM-related jobs are growing faster than other jobs. Therefore, there is a need for the Malaysian government to transform the education system, especially in the area of interdisciplinary approaches to STEM subjects.

Integrated STEM education allows for innovative instructions of mainstream science subjects. This is vital, since students are known to be more actively involved in learning something that is problem based, contextual, project based, collaborative, and inquiry based (Chong, 2019). This technique encourages students to connect social sciences with humanities by applying theories and concepts with practical learning in the real world (Scepanovič, 2019). STEM education has also been seen as an enabler by the Malaysian government to nurture high-quality individuals with STEM capabilities and 21st-century skills as demanded by the industry (Adnam et al., 2018; Bahrum et al., 2017; Jayarajah et al., 2014; Ministry of Education [MOE], 2013). However, the former Minister of Education, Dr. Maszlee Malik, lamented that the number of Malaysian students enrolled in the STEM stream in 2018 had decreased as compared to previous years (Lau, 2019). This will trigger the demand for graduates to fulfill STEM employment to exceed supply.

Students who hesitate to pursue STEM streams in school and be engaged in the coursework needed for STEM careers have a close connection to their level of self-efficacy in mathematics and science (Falco & Summers, 2019). According to Bandura (1997), self-efficacy refers to the students' judgement of their ability in organizing and executing the desired actions to achieve goals. Self-efficacy is widely recognized to be an influential determinant in affecting an individual's behavioral change across vast aspects. Falco and Summers (2019) pointed out that students are more likely to avoid STEM-related goals if they have low self-efficacy. For example, students tend to shy away from science and mathematics-related tasks or problem-solving that involves using engineering design processes. These students also tend to believe in low outcome expectations. For instance, they believe they will perform poorly in science and mathematics.

Findings of past literature related to STEM efficacy have been a remarkable mediator in determining students' STEM performance, intention to opt for a STEM degree, and STEM career decision (Falco & Summers, 2019; Van Aalderen-Smeets et al., 2019). Empirical studies have substantiated that students with high efficacy tend to persist more towards achieving their academic goals, taking the risk to try setting higher expectations and others (Bandura, 1997; Pintrich & de Groot, 1990). Besides, these students were found to display better self-regulation skills, like being flexible and emotionally intelligent, and have better adaptive and organization skills (Jamali et al., 2017).

Based on the theoretical framework for social cognitive career, Ekmekci et al. (2019) described self-efficacy as being among the most remarkable psychological constructs that influence students' career decisions. Scholars have found that self-efficacy influences the decisions and attitudes of students as well as their understanding of the effects that certain acts or behaviors are likely to entail. Eventually, it will determine to what extent the students perceive a particular academic domain to be useful or interesting (Bandura, 1986; Wigfield & Eccles, 2002). Empirical research has also discovered that students who pursue degrees related to STEM are strongly associated with their higher efficacy in STEM-related subjects and involvement in STEM learning environment programs (Mohd Shahali et al., 2019; Rivera & Li, 2021). Ekmekci et al. (2019) suggested that motivational factors such as efficacy help to foster high expectations towards students' lives. These students will decide to pursue STEM-related courses and careers, as they believe that STEM education or careers can help them to achieve such life attainments. Based on the literature, this current study aims to develop the STEM Efficacy for Children Scale (SECS) to examine young Malaysian children's efficacy towards STEM learning.

Literature Review

Bandura (1997) defined self-efficacy as an individual's judgment on self-competencies in managing and executing the desired behaviors to accomplish predefined goals. Zimmerman (1995) complemented that self-efficacy is not a personal character, implying neither physical nor psychological traits. It refers to "an individual's appraisal of one self's abilities in accomplishing certain events" (pp. 203–204). Past studies have constantly agreed that self-efficacy is a prominent factor causing a person's behavioral change across many aspects. In the educational context, the role of self-efficacy is widely recognized to be the strongest determinant for students' school performance. A recent meta-analysis performed by Richardson et al. (2012) reported that self-efficacy was the strongest predictor for students' academic outcomes as compared to the other 11 factors examined in their study.

The existing efficacy studies have signified the need to differentiate when assessing general efficacy and specific efficacy concerning particular academic domains, for example, self-efficacy in STEM learning (Lent et al., 1996; Luo et al., 2020). In line with Bandura's conceptualization, these authors described that efficacy beliefs are not a single disposition but multidimensional, in which it connects to different domains of operating. Bandura (1997) agreed that a person who feels efficacious in sports may not have the same efficacy degree in academics. A person who reports possessing self-efficacy in English may have varied outcome from his or her efficacy in science.

In STEM education, self-efficacy is usually associated with individuals' goals towards STEM-based construct in a single discipline. For instance, efficacy in science (Britner & Pajares, 2006; Lent et al., 1996; Lin & Tsai, 2013), efficacy in technology (Compeau & Higgins, 1995; Kukul et al., 2017;), efficacy in engineering (Mamaril et al., 2016), and efficacy in mathematics (Kranzler & Pajares, 1997; Pampaka et al., 2011; Randhawa et al., 1993). There also exist instruments developed to capture self-efficacy in multiple STEM disciplines. For example, efficacy in mathematics and science (Falco & Summers, 2019; Maltese & Tai, 2011; Mohd Shahali et al., 2019), in studying STEM-related subjects (biology, chemistry, physics, science, and mathematics; Meng et al., 2014), and in science, mathematics, engineering, and technology (Razali et al., 2017). All these mentioned instruments are valid for secondary and tertiary education levels, but none have been designed for younger learners.

Similarly, the current review on the use of STEM-related instruments in the local environment has found that most of the existing measures are adapted or designed to be used among the secondary and tertiary populations. These include the adapted version of the STEM Education Quality Framework (originally developed by Dayton Regional STEM Center, Ohio, 2011) used by Meng et al. (2014) to measure Form Four students' STEM perception (for instance, STEM integration in academics, accountability in STEM activities, application in engineering design and others) in Malaysian secondary schools. Lin and Tsai (2013) and Wong et al. (2019) developed the Science Learning Self-Efficacy Questionnaire (SLSE) and used it to examine secondary school students' STEM competencies in Selangor via five domains: (i) conceptual understanding, (ii) higher-order thinking skills, (iii) practical work, (iv) daily applications, and (v) science communication. Razali et al. (2017) used a 12-item instrument adapted from Unfried et al. (2015) to measure Form Four students' confidence level towards STEM in four domains: science, mathematics, engineering, and technology. Among these measures, there is only one instrument developed by Lin and Tsai, which was specifically focused on self-efficacy (in science), whereas the remaining emphasized on other STEM aspects or combined measuring efficacy with other STEM-related constructs. Moreover, Lin and Tsai's instrument was designed for students aged 16 to 17 in upper secondary schools, whereby certain abstract STEM concepts contained in the scale might be beyond younger learners' understanding.

The fact that STEM self-efficacy among the young learners in Malaysia has not been adequately discussed and deserves better attention reveals the gap this current study seeks to fill. There is a crucial need to have an appropriate instrument to measure their STEM self-efficacy with a sense of locality. Supported by a meta-analysis conducted by Jayarajah et al. (2014), who reflected that efforts taken by local researchers and the Malaysian government in uncovering young learners' challenges in STEM learning were not compatible with those that have been done in upper educational levels. Their analysis showed that local STEM studies investigating STEM issues based on primary school population are severely limited. Moreover, the current STEM research interest in the country seemed to focus more on STEM areas including resources, pedagogy, interest and motivation, and teaching and learning perspectives, but not self-efficacy. Their analysis, which was based on 95 STEM issues in Malaysia dated from 1999 to 2013, revealed that there is no study focusing to research primary school students' STEM self-efficacy. Likewise, a similar issue was also reported by Luo et al. (2020) based on the Hong Kong context. They stated that the instrument designed for young students to measure self-efficacy in STEM is rare in general, where the majority of those existing measures were constructed for elder adolescents and college students.

Western and cross-cultural studies have consistently indicated the vital role of efficacy in fostering students' positive academic expectations in general (Bandura, 1997; Jamali et al., 2017; Pintrich & de Groot, 1990) as well as in the specific STEM learning areas (Falco & Summers, 2019; Jayarajah et al., 2014; Maltese & Tai, 2011; Van Aalderen-Smeets et al., 2019). As discussed earlier, self-efficacy in STEM learning seems to be the key driver for students to decide their enrolment for STEM-based courses or careers. Therefore, this area deserves more attention from the MOE in Malaysia.

To respond to this critical issue, the SECS was developed in this study to close the research gap. The content of the SECS was established with careful consideration. It acknowledges the current STEM content being taught at local primary schools (mathematics, science, and applications in engineering) and also takes into consideration that young learners have limitations in terms of their concentration span and language abilities.

The SECS model introduced in this study was developed with reference to the S-STEM (Student-STEM) instrument formed by the Friday Institute for Educational Innovation (2012). This instrument aims to capture students' self-efficacy in STEM learning and career. The instrument comprised a five-point Likert scale, and the content focused on capturing students' efficacy and career interests towards science (8 items), mathematics (9 items), engineering/technology (9 items), and 21st-century skills (11 items). It was designed as a self-administered survey for students from fourth to twelfth grades (9–18 years old). In the present study, 37 items of S-STEM were adapted and trimmed to 16 items for SECS to measure Malaysian primary school children's efficacy in STEM-based subjects. The number of items was reduced after considering the respondents' concentration span. The language was also simplified, and a translated version of the 16-item SECS was produced to facilitate better understanding among the children when they attempt to answer the questions.

Research Methodology

SECS Instrument

The SECS model was designed for upper primary school children who are studying in a public school, where the STEM curriculum is compulsory. It is intended to measure children's perception of their self-ability in STEM according to the efficacy theory proposed by Bandura (1997). SECS has been adapted and modified from the instrument developed by the Friday Institute for Educational Innovation (2012). It includes three domains to evaluate children's capabilities in managing their learning to accomplish goals towards STEM-related subjects, namely, (i) efficacy in mathematics (7 items), (ii) efficacy in science (4 items), and (iii) efficacy in engineering applications (5 items). All these items use a five-point Likert scale, requiring respondents to choose from five possible responses ranging from 1 = *Never* to 5 = *All the time*. To calculate the efficacy score for each specific STEM domain, the respective items need to be summed up and averaged. To obtain the overall STEM efficacy score, all the items have to be calculated and averaged. The higher the score, the higher the efficacy possessed. The inclusion of the three STEM domains is based on the scope of the STEM program as addressed in the latest Malaysia Education Blueprint 2013–2025; hence, the content of SECS is believed to yield a good sense of locality.

Pilot Study

A pilot study was carried out to assess the feasibility of the initially planned research procedures that were intended to be used in the later actual field data collection. It was executed through several phases. This included Phase 1, which was to establish the SECS content based on the literature. Existing measures relating to STEM efficacy were reviewed, and discussions were made with superiors in the present research committee to identify potential instruments to be adapted. Item inclusion of SECS was done based on the advice of experts in the committee. In Phase 2, permission to adapt, translate, and modify the original instrument was obtained through an online request.

In Phase 3, three interdisciplinary experts from private and public universities were appointed to review the content validity. These experts have substantial research experience specializing in adolescent development and school-based teaching and learning, which include areas such as technology, mathematics, and science. All the experts commented that the instrument was relevant to the topic being studied and should be easily understood by upper primary school children. The experts also gave some feedback to simplify the words used in the questionnaire in order to aid better understanding among the young learners.

In Phase 4, the SECS scale in English was translated into the Malay language version. Considering the language ability of the target participants (primary school children), the instrument (in English) was translated into Malay. Malay language is Malaysia's national language and is introduced as a standard curriculum across all public schools. Therefore, the instrument written in Malay was comparatively more user-friendly for Malaysian children in general. The translation process was based on the translation principle technique called "back translation," which is recommended for cross-cultural research (Brislin, 1986). Based on the translation steps suggested by Brislin (1986), and Behling and Law (2000), firstly, a bilingual expert in English and Malay language was appointed to translate the original version of the instrument to the Malay version (Draft 1). Then, a second bilingual expert who had no knowledge of the wordings of the original instrument was roped in to translate the Malay version of the instrument back to English (Draft 2). Next, the original instrument and the two translated drafts were compared.

Both drafts of the instrument were examined for significant dissimilarities. If significant discrepancies occurred between the two drafts, a third bilingual expert would be called in to do the back-translation draft to eliminate the discrepancies. Finally, three psychology experts from local higher education institutes were appointed to inspect the face and content validity of the instrument. The experts rechecked both content and language. To ensure the appropriateness of the items included for measuring the various components, amendments were made based on the feedback given to improve the quality of SECS. To further enhance its applicability within the primary school context, two national primary school teachers who are Malaysians were appointed to review the overall content of SECS for both English and Malay language versions. Their feedback was taken into account to further refine all confusing wordings. In general, their feedback revealed that SECS was straightforward and could be easily understood by primary school children.

Participants and data collection

In the pilot study, 389 upper primary school children aged 10 to 11 were involved. Two national primary schools located in Klang Valley, Selangor, were randomly selected based on the list of schools obtained from the MOE portal (MOE, 2020). The Malay version of the SECS instrument was distributed to the selected children and self-administered with the assistance of several teachers. Parental consent was obtained before any of the children were allowed to be involved in the study. Volunteer pupils who had gained their guardian's permissions were also allowed to participate. The participants were reassured that they had the right to withdraw from the study and that their personal information was solely used for academic purposes and would be kept confidential. Each participant was given 15 to 20 minutes to complete the survey. From a total of 389 respondents, 49.9% (n = 194) were boys and 50.1% (n = 195) were girls. Among them, 71.7% (n = 279) were of the Malay race, 17.5% (n = 68) were Chinese, 7.7% (n = 30) were Indian, and 3.1% (n = 12) were from other ethnic groups. Meanwhile, different respondents were employed in the field study but with a similar sample size and consent procedure.

Procedures

After the data were collected, they were then coded for processing using Statistical Package for the Social Sciences (SPSS) version 22. Normality of the data was checked using the Shapiro–Wilk test, which showed the data to be normal and with the significant value presented as >.05. In addition, a check using boxplot revealed no extreme values in the data gathered.

The exploratory factor analysis (EFA) was performed based on the data from the pilot respondents. The sample size was based on the suggestions by Hair et al. (2010) and Meyers et al. (2017), where a minimum sample size of N = 300 is adequate and would satisfy the requirement for factor analysis. The EFA was employed to confirm that the underlying factors measured the desired variables. It was also used to determine unrelated items that did not fit into the studied constructs. The EFA included conducting a principle component analysis (PCA) on 16 items (STEM Efficacy) with orthogonal rotation (varimax), checking sampling adequacy by using the Kaiser–Meyer–Olkin Test (KMO > .80 indicates sample size is satisfactory), and using Bartlett's Test of Sphericity to check item correlation. Then, EFA was utilized to identify components that displayed eigenvalues over Kaiser's criterion of 1. Next, the internal consistency reliability of the instrument was determined by referring to the Cronbach's alpha coefficient for each construct. Lastly, a field study was conducted to analyze the confirmatory factor analysis (CFA) via statistical software AMOS. This analysis was run to confirm the goodness of fit indexes, convergent validity, and discriminant validity of the SECS model.

Results and Discussions

Findings for the Pilot Study

The EFA was conducted to extract factors for SECS, which comprised 16 items. PCA was performed on these items using the orthogonal rotation (varimax). The analysis verified the sampling adequacy by using Kaiser–Meyer–Olkin, with overall KMO value = .93. According to Kaiser (1974), KMO values within .80 to .90 are considered "great" (Field, 2013). The Bartlett's Test of Sphericity showed that the correlations between items were satisfactorily large enough for PCA, $\chi^2 (120) = 2398.96$, $p < .0001$.

The analysis was carried out to determine the eigenvalues for each component in the data. The results obtained show three components displaying eigenvalues over Kaiser's criterion of 1. The three components in total explained the 58.238% variance. Component 1 (mathematics efficacy) explained 23%, Component 2 (engineering efficacy) 20.4%, and Component 3 (science efficacy) 14.8% of the variance. The communality value for the scale ranged from approximately .5 to .7. Although the suggested communality value is .6 and above, Field (2013) indicated that with a sample size greater than 200, the scree plot can be used to determine the retained factors. Looking at the scree plot, it showed that inflexions would retain three components, and this was consistent with the Kaiser's criterion. Table 1 displays the factor loadings for the three components after rotation.

The reliability test was used to determine the internal consistency of the scale. Based on Table 1, SECS had

Table 1

Exploratory factor analysis (EFA) results for the STEM efficacy scale (N = 389)

	Items	Factor loading	Corrected items-total correlations	α
A)	**Mathematics efficacy**			0.856
1	Succeed in math	.787	0.547	
2	Do advanced work in math	.712	0.604	
3	Handle math with ease compared to other subjects	.709	0.475	
4	Good at math	.643	0.636	
5	Get good grades in math	.640	0.615	
6	Succeed with a career that uses math	.621	0.595	
15	Able to use math to invent useful things	.533	0.583	
B)	**Engineering efficacy**			0.820
11	Good in creating new stuff	.803	0.577	
12	Capable in tasks that involve manipulating machines	.729	0.587	
13	Good at building and fixing things	.536	0.520	
14	Be successful in a career in engineering	.509	0.582	
16	Use creativity and innovation in your future work	.489	0.609	
C)	**Science efficacy**			0.839
7	Succeed with a career that uses science	.778	0.601	
8	Perform in science tasks	.713	0.674	
9	Handle science with ease compared to other subjects	.675	0.610	
10	Do advanced work in science	.455	0.656	

high reliability, as reflected by the Cronbach's alpha obtained for each component: mathematics efficacy (7 items) was .86, science efficacy (4 items) was .83, and engineering efficacy (5 items) was .83. The corrected item-total correlation for all items across all components ranged from .489 to .674, which were all beyond the suggested limit of at least .40 (Field, 2013).

Findings for the Field Study

CFA was conducted to examine the model fit of SECS. The analysis was performed using IBM SPSS Amos 24. The total sample size used for CFA was *N* = 389. The following procedures presented the pooled CFA for the SECS model, including the three constructs of mathematics, science, and engineering efficacies. CFA started with examining the unidimensionality of the model, followed by investigating the model fitness, and then convergent validity and discriminant validity of the model. The unidimensional aspect was checked, and all the measured items showed loading > .50. In addition, all of them loaded significantly to their respective constructs, indicating that the unidimensional was achieved (Awang, 2015; Hair et al., 2010). According to Hair et al. (2010), for model fitness, it is essential to report a minimum: (i) one absolute index [ratio of chi-square and the degrees of freedom (χ^2/df), root mean square error of approximation (RMSEA) and goodness-of-fit index (GFI)], (ii) one incremental index [adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), Tucker-Lewis index (TLI), normed fit index (NFI) and Incremental Fit Index (IFI)], and (iii) one parsimony index for the test [parsimonious goodness-of-fit index (PGFI) and parsimonious normed fit index (PNFI)]. For the present study, the fitness indexes showed that the model was a good fit. The relative chi-square test which is chi-squared statistic divided by the degrees of freedom (CMIN/DF) was 2.532 (< .50), as recommended by Bentler (1990). Other fit indexes like GFI (.927), RMSEA (.063 < .80 as recommended by Byrne [2016]), NFI (.921), IFI (.950), TLI (.937), CFI (.950), AGFI (.896), PCFI (.649), and PNFI (.736) altogether showed that the model was a good fit (Hair et al., 2010). Since the model achieved the required fitness indexes, it can be concluded that the construct validity had been achieved. A decision was made to drop one item from the mathematics efficacy (Item 7) due to lower factor loading (<.60), as suggested by Awang (2015). After the deletion, the model fit showed slight improvement. The new SECS model (Version 2) with 15 items is presented in Figure 1 below.

Convergent validity is achieved when all the items load significantly to their respective constructs. Therefore, this study also computed average variance extracted (AVE) and composite reliability (CR) to verify the convergent validity of the SECS model

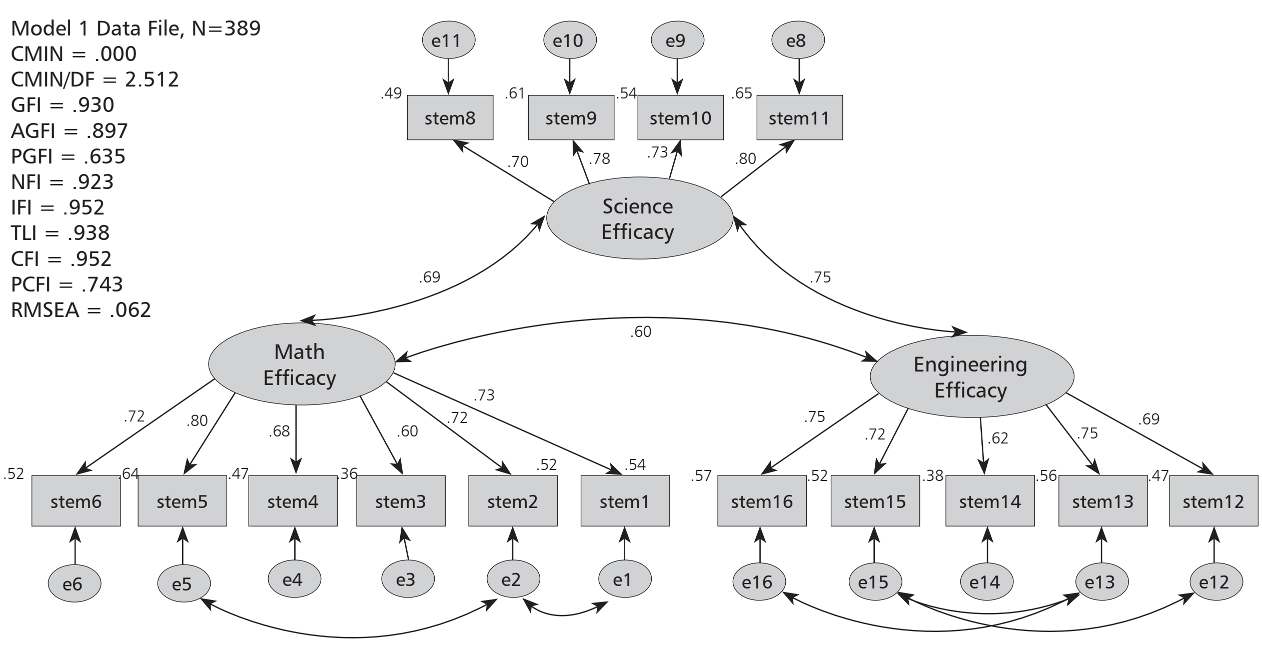

Figure 1. Confirmatory Factor Analysis of SECS with Amos

Table 2

Descriptive statistics, construct reliability, AVE estimates, and squared correlation coefficient

	Variable	M	SD	Composite construct reliability	1	2	3
1	Science effiacy	3.082	0.918	0.840	**.568**		
2	Math efficacy	3.224	0.834	0.859	.476	**.505**	
3	Engineering efficacy	2.944	0.886	0.833	.503	.360	**.501**

(Version 2). The AVE and CR values were computed via Microsoft Excel. The analysis verified that the scale had good convergent validity, as all the items obtained factor loadings ranging from .60 to .80, which were above the threshold value of 0.5 as suggested by Hair et al. (2010). All the three constructs generated CR values of above .80, where Hair et al. (2010) indicated that CR values of .7 and above signify adequate convergent validity. CR for mathematics efficacy was .86, science efficacy was .84, and engineering efficacy was .83. The AVE values for all constructs were >.50, indicating adequate convergent validity (Awang, 2015; Hair et al., 2010). In addition, AVE for mathematics efficacy was .505, science efficacy was .568, and engineering efficacy was .501. Since the model achieved the desired AVE value of .50 and CR of .80 for all constructs, the SECS model was said to have attained convergent validity.

The analysis continued with a determination of the discriminant validity of the model. According to Awang (2015), determining the discriminant validity is a two-step process. Firstly, check the item redundancy in the model by using the discrepancy measure called modification indices (MI). In the present model, five redundant pairs as "free parameter estimate," which displayed MI values > 13.0, were constrained. Two of the redundant pairs were from mathematics efficacy (e1 and e2, e2 and e5), and three pairs were from the engineering efficacy (e12 and e15, e13 and e16, e 13 and e15). Secondly, check whether the constructs are highly correlated. Based on Fornell and Larcker (1981) and Hair et al. (2010), when two constructs are correlated at $r \geq .90$, it has violated the discriminant validity. Awang (2015), however, suggested that the two constructs should not be correlated at .85 and above. In the present model, all the constructs were correlated with r values below the threshold suggested by the experts (see Figure 1). Therefore, it can be concluded that the model had achieved discriminant validity.

DISCUSSION

The purpose of this study is to establish and validate the SECS to primary school students in a local context. Based on the present studies and the national STEM curriculum implemented in the education setting, three possible factors relating to STEM self-efficacy were identified, namely, (i) mathematics efficacy, (ii) science efficacy, and (iii) engineering efficacy. Using content and face validity followed by reliability process, a total of 15 items were selected and had a good fit with the specified parameters.

The SECS content validity was determined by assigning three experts in to assess the instrument. They confirmed that all initial 16 items in SECS were relevant to the appointed constructs. To determine the internal reliability, EFA was conducted and suggested the scale with a total of 16 items to fall into three factors, namely, mathematics efficacy, science efficacy, and engineering efficacy. Further analysis in CFA with 15 items showed that all the three factors were correlated reasonably; hence, discriminant validity was achieved. The model fit indexes also suggested the SECS model with 15 items was a very good fit. Investigation on the generated composite reliability confirmed the earlier EFA reliability test, which indicated all the three STEM efficacy constructs obtained high CR values. This reliability indication implied that the SECS scale, which was used for Malaysian upper primary school students, had strong internal consistency. The newly developed SECS using the Malay language version was expected to fill the research gap by presenting a trustful measure to investigate young students' STEM efficacy, with a good sense of locality.

STEM efficacy among the young population deserves focused attention; hence, it can be a main effect contributing towards the local students' interest in STEM subjects and STEM career future plans (Chong, 2019; Jayarajah et al., 2014; Uitto, 2014). Additionally, efficacy has continually been reassured as an excellent determinant for academic success in the STEM field (Falco & Summers, 2019; Jamali et al., 2017). Therefore, increasing students' STEM self-efficacy is crucial, and this initiative is relevant to be initiated during early schooling. Underpinned by the theoretical thoughts of Bandura (1997), self-efficacy seems to be the motivational driver that fosters learning interest, attitudes, and academic achievement among students (Ekmekci et al., 2019; Wigfield & Eccles, 2002). Based on this understanding, positive beliefs on self-capabilities tend to encourage better initiatives among students in making their choices and prompt challenges concerning various goals related to STEM learning. Therefore, a better understanding of STEM efficacy among children is essential to help gain insights into ways to nurture young Malaysians to meet future industry demands and face global challenges.

Besides, considering that the English language can be challenging for primary school children, this instrument was translated into the Malay language. A quality translation was performed to generate a translated version of the SECS model. Three translators who are psychology experts with bilingual competence (English and Malay languages) were appointed for the translating effort by using the "back translation" technique as recommended by Brislin (1986). The SECS model was then reviewed by two local primary school teachers, one male and one female, before the pilot study was conducted to ensure that the language and content were friendly for primary school children.

The adaptation process of SECS was carefully planned, implemented, and embedded with cultural sensitivity in order to determine cross-cultural equivalence in both instruments (Tran et al., 2017). In contrast, Van de Vijver and Leung (2011) mentioned that there could be potential bias, as the measurement items do not possess the same meaning (for example, due to the error of translation) within and across cultures. Therefore, such cross-cultural comparison is not convincing as such a difference may be caused by errors in translation but not through differences between cultures. The data collected with SECS can be used to reveal the STEM efficacy among local primary school children. This result is important in order to gain comprehensive insights into the attitudes and interests of young Malaysians towards STEM. Furthermore, it provides an understanding of the children's learning efficacy in STEM-related subjects like mathematics and science and also their interest and perceptions in applying STEM concepts and engineering-related tasks.

Limitation of the present study includes its sample profile that only focused on children aged 10 to 12 years old or upper primary school students in Malaysia. The study's validity and reliability could be varied if the sample consisted of lower primary school students as well. Moreover, the present sample was selected from public schools located in fully urbanized regions. Therefore, it is unsure whether the same result could be obtained if the study is duplicated in the context of private schools or rural local regions in a marginalized population. Besides, the present SECS model only included measuring three STEM efficacy dimensions, namely, mathematics, science, and engineering, with 15 items due to the concern of the concentration ability of young adolescents.

Future research may extend the development of SECS by covering students' efficacy in the use of technology. With the COVID-19 pandemic affecting more than 91% of students worldwide, the provision of STEM-related learning technology would provide valuable education to those students who are unable to attend school physically (UNESCO, 2020; Zhu & Liu, 2020). During a pandemic, online learning plays a vital role for delivering lessons and exploring students' technological capabilities. According to the World Bank (2020), children are now more exposed to technology and have a higher degree of expertise in digital literacy than teachers and parents. This can be communicated to students in order for them to develop their efficacy in technology based on their belief in their ability to interact with and use technology during the learning process. Nevertheless, more research on the validity of the self-efficacy scale of online technologies among elementary school students, on the other hand, may be very timely.

CONCLUSIONS

An ample number of items normally used to measure STEM efficacy were explored in this study.

The development of SECS has undergone a thorough validation process, where pretesting was conducted to gain experts' verification on the measuring content, pilot testing with EFA was performed to filter items with low loadings, and field study testing via CFA was used to check for model fitness, convergent validity, reliability, and discriminate validity of the instrument. All the findings proved that SECS is a valid and reliable tool for capturing primary school children's STEM efficacy within a local context. An effective tool allows teachers and schools to trace students' competency level and likelihood towards STEM-related tasks, which in turn will enable the affected schools to implement the necessary intervention plans to cultivate their students' efficacy in order to retain their interest in STEM. It is believed that identifying students' STEM efficacy using the appropriate instrument will be an advantage in retaining students' interest in STEM and their willingness to choose STEM-related subjects, including to determine their career choices in STEM.

Acknowledgment

This paper would not have been possible without the strong support of the coresearchers from Universiti Putra Malaysia (UPM). The authors would also like to express their deepest gratitude to the reviewers for their insightful feedback, which improved this paper a lot.

Declaration of Ownership

This report is our original work.

Conflict of Interest

None.

Ethical Clearance

This study was approved by our institution.

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APPENDIX 1

SECS in Malay Language Version

Keberkesanan Akademik Diri Dalam STEM
(Sains, Teknologi, Kejuruteraan dan Matematik)

Pernyataan berikut menjelaskan bagaimana anda fikir mengenai pembelajaran tentang STEM subjects (Sains, Teknologi, Kejuruteraan dan Matematik). <u>BULATKAN NOMBOR YANG MENCERITAKAN YANG TERBAIK MENGENAI DIRI ANDA</u>**.** Nilai nombor yang semakin kecil menunjukkan pernyataan yang paling sedikit menceritakan mengenai anda. Nilai nombor yang semakin besar menceritakan paling banyak mengenai anda. **<u>Bulatkan HANYA SATU jawapan sahaja bagi setiap pernyataan.</u>**

1= Tidak Pernah 2=Jarang 3= Kadang-kadang 4=Kerap 5= Sentiasa

Sejauh manakah anda…						
i)	dapat menguasai subjek matematik?	1	2	3	4	5
ii)	berfikir bahawa anda boleh mencapai kerjaya dengan menggunakan ilmu matematik *(contoh: guru matematik, kejuruteraan, dll)*?	1	2	3	4	5
iii)	dapat menguasai matematik dengan mudah jika dibanding dengan subjek yang lain?	1	2	3	4	5
iv)	berfikir bahawa anda boleh melakukan kerja lanjutan dalam bidang matematik? *(contoh: mengguna matematik untuk mengurus kewangan, meramalkan nilai urus niaga, dll.)*	1	2	3	4	5
v)	boleh skor gred yang baik dalam subjek matematik?	1	2	3	4	5
vi)	berfikir bahawa anda bagus dalam pembelajaran matematik?	1	2	3	4	5
vii)	boleh menggunakan ilmu matematik dalam mencipta sesuatu yang berguna? *(contoh: mencipta formula matematik baru, program computer, dll)*	1	2	3	4	5
viii)	berfikir bahawa anda boleh melaksanakan tugas dalam bidang sains? *(contoh: menjalankan kerja amali Sains, tugasan reka cipta, dll.)*	1	2	3	4	5
ix)	berfikir bahawa anda boleh mencapai kerjaya dengan menggunakan ilmu sains *(contoh: menjadi Saintis, ahli kimia, dll)*?	1	2	3	4	5
x)	berfikir bahawa anda boleh menguasai subjek Sains dengan mudah jika dibandingkan dengan subjek yang lain?	1	2	3	4	5
xi)	berfikir bahawa anda boleh melakukan kerja lanjutan dalam bidang sains? *(contoh: mengunakan prinsip saintifik untuk membina & mengubasuai sesuatu)*	1	2	3	4	5
xii)	berfikir bahawa anda pandai dalam mereka cipta barang-barang baru? *(contoh: mencipta pelan, reka bentuk baharu, dll)*	1	2	3	4	5
xiii)	beranggapan bahawa anda pandai dalam membina dan memperbaiki sesuatu barang? *(contoh: mengubah fungsi atau membaiki basikal, radio, dll.)*	1	2	3	4	5
xiv)	berfikir bahawa anda berupaya menyelesaikan tugas-tugas yang berkaitan dengan manipulasi mesin.	1	2	3	4	5
xv)	berfikir bahawa anda mampu menjalankan tugas-tugas yang diamanahkan mengikut wkreativiti dan inovasi kendiri *(contoh: mereka bentuk baru, mengubahsuai pelan/ prosedur kerja,dll)*	1	2	3	4	5
xvi)	berfikir bahawa anda boleh berjaya dalam bidang kejuruteraan? *(contoh: membina bangunan, kereta, robot, dll).*	1	2	3	4	5