

Levels of Self-Efficacy and Motivation among Pre-Service Teachers in Implementing STEM Education

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ABSTRACT

Teacher self-efficacy and motivation play a vital role in preparing future educators to effectively implement STEM education. This study aimed to determine the levels of self-efficacy and motivation among pre-service teachers in implementing STEM education. A quantitative survey design was employed involving 102 pre-service teachers from a public university in Malaysia. Data were collected using a 32-item questionnaire and analysed using descriptive statistics, Cronbach's alpha reliability analysis and normality analysis. The findings revealed that the respondents demonstrated high levels of self-efficacy and generally high levels of motivation in implementing STEM education. The instrument exhibited excellent reliability for self-efficacy ($\alpha = 0.940$) and good reliability for motivation ($\alpha = 0.876$). These findings indicate that pre-service teachers possess the confidence and motivation required to support the effective implementation of STEM education. The study highlights the importance of sustaining teacher education programmes that strengthen pre-service teachers' self-efficacy and motivation to support the effective implementation of STEM education.

Keywords: pre-service teachers, self-efficacy, motivation, STEM education, teacher education

INTRODUCTION

Pre-service teachers are important agents in the successful implementation of STEM education as their future teaching practices shape students' learning experiences in science, technology, engineering and mathematics (STEM). Their self-efficacy, defined as their confidence in performing teaching-related tasks, together with their motivation to engage in STEM instruction which influences how effectively they implement the STEM curriculum.

STEM education is widely recognised as an essential approach to preparing learners for scientific, technological and economic challenges in the twenty-first century. In Malaysia, concerns regarding students' participation and performance in STEM-related disciplines have led to greater emphasis on strengthening STEM education through curriculum improvement and teacher development (Ministry of Education Malaysia, 2014). As future educators, pre-service teachers require strong self-efficacy to confidently implement STEM teaching practices. According to Bandura (1997), teachers with higher self-efficacy are more likely to persevere when encountering challenges and setbacks. Similarly, Tschannen-Moran and Woolfolk Hoy (2001) emphasised that teacher self-efficacy encompasses confidence in instructional strategies, classroom management and student engagement, all of which contribute to effective teaching practices.

Teacher motivation is another important factor influencing effective STEM implementation because it affects teachers' engagement, persistence and professional performance. According to Ryan and Deci (2000), intrinsic motivation refers to engaging in an activity because it is inherently interesting or enjoyable, whereas extrinsic motivation refers to engaging in an activity to achieve separable outcomes such as recognition or career advancement. They further explained that extrinsic motivation exists along a continuum of internalisation rather than being simply the opposite of intrinsic motivation. Therefore, teacher education programmes should foster intrinsic motivation while simultaneously providing supportive learning environments that encourage sustained professional growth. Furthermore, teacher motivation has been recognised as an important contributor to effective classroom practices and school improvement (Ofoegbu, 2004).

Understanding the levels of self-efficacy and motivation among pre-service teachers is important because these attributes influence teachers' readiness to implement STEM education effectively. Examining these levels provides valuable information for teacher education programmes to identify strengths and areas requiring further professional support before pre-service teachers enter the teaching profession. Such information can assist teacher education institutions in designing appropriate training and professional development initiatives to better prepare future teachers for effective STEM instruction.

Therefore, this study aims to determine the levels of self-efficacy and motivation among pre-service teachers in implementing STEM education. The findings are expected to provide useful insights for teacher education institutions in strengthening teacher preparation programmes and enhancing the readiness of future teachers to implement STEM education effectively.

LITERATURE REVIEW

Teachers' Self-efficacy

Teacher self-efficacy is widely recognised as an important factor influencing teachers' confidence in planning, organising and delivering effective instruction. Teachers with higher self-efficacy are generally more confident in managing classroom activities and implementing appropriate instructional strategies (Shah, 2023). In addition, Emiru and Gedifew (2024) reported that teacher self-efficacy was positively associated with student learning engagement, suggesting that confident teachers are more likely to create supportive learning environments that encourage active student participation.

Bandura (1997) Social Cognitive Theory explains that individuals with stronger self-efficacy beliefs tend to set more challenging goals, invest greater effort and demonstrate higher levels of persistence when facing difficulties. Within the educational context, Tschannen-Moran and Woolfolk Hoy (2001) further emphasised that teacher self-efficacy comprises confidence in instructional strategies, classroom management and student engagement. Although teachers' self-reported efficacy beliefs may not always correspond directly with observed classroom practices (Poulou et al., 2019), self-efficacy remains an important psychological attribute that supports effective teaching and professional development.

Teachers' Motivation

Teacher motivation plays a fundamental role in sustaining teachers' commitment, engagement and professional growth throughout their careers. Understanding the factors that motivate individuals to pursue teaching has become increasingly important because teacher recruitment and retention continue to present challenges in many education systems (See et al., 2022). Previous studies conducted in different educational contexts have demonstrated that motivations for entering the teaching profession differ according to cultural, educational and personal backgrounds (Suryani et al., 2016, Yuan and Zhang, 2017).

Adiguzel and Karagol (2022) reported that pre-service teachers were primarily motivated by social utility values, including contributing to society, shaping the future generation and promoting social equity. In contrast, external factors such as job transferability, social influence and teaching as a fallback career were

found to be less influential. These findings suggest that intrinsic and socially oriented motivations remain important drivers for individuals entering the teaching profession.

Overall, previous studies have consistently highlighted the importance of self-efficacy and motivation in supporting effective teaching practices and the successful implementation of STEM education. Understanding the levels of these attributes among pre-service teachers is therefore essential, as it provides valuable insights into their readiness to implement STEM teaching and enables teacher education institutions to identify areas requiring further professional support and development.

Theoretical Foundation

This study is underpinned by two complementary theories. The first is Bandura's Social Cognitive Theory in 1997 (Bandura, 1997) which explains that individuals' beliefs about their capabilities influence their behaviours, persistence and performance when carrying out specific tasks. In the context of education, teacher self-efficacy reflects teachers' confidence in planning, managing and delivering effective instruction. The second is the Self-Determination Theory proposed by Ryan and Deci (2000), which explains that teachers' motivation exists along a continuum from intrinsic to extrinsic motivation and influences their engagement, commitment and professional development. Together, these theories provide a theoretical foundation for understanding the levels of self-efficacy and motivation among pre-service teachers in implementing STEM education.

METHODOLOGY

This study employed a quantitative survey design to determine the levels of self-efficacy and motivation among pre-service teachers in implementing STEM education. The population comprised pre-service teachers from a public university in Malaysia who were undertaking their teaching practicum in secondary schools in the Klang Valley, Selangor. Based on the sample size table developed by Krejcie and Morgan (1970), a minimum sample of 97 respondents was considered adequate to represent the population of pre-service teachers at this public university. However, the final sample consisted of 102 pre-service teachers aged between 22 and 26 years. The respondents represented Physics, Biology, Chemistry and Mathematics education programmes. Data were collected online using Google Forms.

The research instrument was adapted from Bandura (1997) for the self-efficacy construct and Goudas et al. (1994) for the motivation construct. The questionnaire consisted of 32 items distributed across seven dimensions: efficacy in influencing curriculum and resources, instructional self-efficacy, disciplinary self-efficacy, intrinsic motivation, identifiable regulation, introjected regulation and external regulation. The original items were retained with minor wording modifications to suit the context of STEM education. Specifically, general references to teaching were revised to reflect STEM teaching and learning without altering the underlying constructs measured by the original instruments.

The questionnaire was administered in English, as the respondents were pre-service teachers enrolled in an English-medium teacher education programme; therefore, no translation procedure was required. Prior to the main study, a pilot study involving 13 pre-service teachers was conducted to evaluate the clarity and reliability of the instrument. The respondents reported that the questionnaire items were clear and easy to understand and no modifications were required following the pilot study.

The collected data were analysed using IBM SPSS Statistics. Descriptive statistics, including frequencies, percentages and mean scores were used to describe the respondents' demographic characteristics and determine the levels of self-efficacy and motivation among pre-service teachers in implementing STEM education. The internal consistency of the research instrument was assessed using Cronbach's alpha. According to George and Mallery (2022), Cronbach's alpha values of 0.90 and above indicate excellent reliability, values between 0.80 and 0.89 indicate good reliability, whereas values of 0.70 and above are considered acceptable.

The normality of the data was evaluated using skewness and kurtosis statistics. Based on Byrne (2016), data are considered approximately normally distributed when the skewness values fall within ± 2 and the kurtosis values fall within ± 7 . The interpretation of the mean scores followed the classification proposed by Moidunny (2009), whereby mean scores of 1.00 – 2.33 indicate a low level, 2.34 – 3.66 indicate a moderate level and 3.67 – 5.00 indicate a high level.

FINDINGS

Demographic Profile

Table 1 presents the demographic profile of the respondents. A total of 102 pre-service teachers participated in this study. Most of the respondents were 24 years old ($n = 90$, 88.2%), while the remaining respondents were aged between 22 and 26 years. Female respondents constituted most of the sample ($n = 72$, 70.6%), whereas male respondents accounted for 30 (29.4%). In terms of academic programme, most respondents were enrolled in the Bachelor of Education (Hons.) Science Education (Physics) programme (31.4%), followed by Biology (25.5%), Chemistry (23.5%) and Mathematics (19.6%).

Table 1 Demographic profile of respondents (N = 102)

Variable	Category	Number of Respondent, N	Percentage, %
Age	22	3	2.9
	23	7	6.9
	24	90	88.2
	25	1	1
	26	1	1
Gender	Male	30	29.4
	Female	72	70.6
Programme	Physics	32	31.4
	Biology	26	25.5
	Chemistry	24	23.5
	Mathematics	20	19.6

Reliability Analysis

As presented in Table 2, the self-efficacy construct recorded a Cronbach's alpha coefficient of 0.946, indicating excellent internal consistency, whereas the motivation construct obtained a Cronbach's alpha coefficient of 0.876, indicating good internal consistency. Since both coefficients exceeded the recommended threshold of 0.70 (Hair et al., 2022), the instrument demonstrated satisfactory internal consistency and was considered reliable for the main study.

Table 2 The Cronbach's alpha coefficients

Construct	Number of Item	Cronbach's Alpha	Interpretation
Self-efficacy	16	0.946	Excellent
Motivation	16	0.876	Good

Normality Analysis

Table 3 presents the skewness and kurtosis values for all questionnaire items. The skewness values ranged from -2.549 to -0.121 , while the kurtosis values ranged from -1.330 to 6.559 . Although four questionnaire items recorded skewness values slightly below the recommended threshold of -2 , all kurtosis values were within the acceptable range (Byrne, 2016). The negative skewness values indicate that respondents generally selected the higher response categories. Overall, the data were considered sufficiently normal to support subsequent parametric analyses.

Table 3 Skewness and kurtosis values

Section	Question	Skewness	Kurtosis
A. Efficacy in Influencing Curriculum and Resources	A1. I can influence decisions related to the curriculum used in my STEM classes	-0.727	-0.423
	A2. I can have a say in the selection of instructional materials for my STEM classes	-0.698	-0.565
	A3. I can influence the allocation of resources (e.g., technology, equipment) for my STEM classes.	-0.825	1.348
	A4. I can advocate for professional development opportunities related to STEM education.	-1.959	6.559
B. Instructional Self-Efficacy	B1. I am confident in my ability to explain complex STEM concepts clearly to my students.	-0.748	0.24
	B2. I am confident in my ability to create engaging and effective lesson plans for STEM subjects.	-0.588	-0.678
	B3. I am confident in my ability to use a variety of teaching methods to cater to different learning styles in my STEM classes.	-0.446	-0.516
	B4. I am confident in my ability to assess student understanding of STEM concepts effectively.	-0.892	-0.293
	B5. I am confident in my ability to integrate technology effectively into my STEM lessons.	-0.892	-0.293

	B6. I am confident in my ability to differentiate instruction to meet the needs of all students in my STEM classes.	-0.38	-0.544
	B7. I am confident in my ability to keep my STEM lessons current with the latest advancements in science and technology.	-0.156	-1.33
C. Disciplinary Self-Efficacy	C1. I am confident in my ability to manage student behaviour effectively in my STEM classes.	-0.88	0.385
	C2. I am confident in my ability to create a positive and respectful learning environment in my STEM classes.	-1.48	1.295
	C3. I am confident in my ability to de-escalate conflict situations effectively in my STEM classes.	-0.182	-0.864
	C4. I am confident in my ability to enforce classroom rules and expectations consistently in my STEM classes.	-0.868	-0.021
	C5. I am confident in my ability to motivate students who are struggling in STEM subjects.	-1.295	1.12
D. Intrinsic Motivation	D1. I find teaching STEM subjects to be intellectually stimulating.	-1.851	2.46
	D2. Teaching STEM allows me to use my creativity and come up with new ways to explain concepts.	-1.214	0.412
	D3. I enjoy the challenge of helping students understand complex STEM topics.	-1.692	2.99
	D4. Seeing students "get it" and succeed in STEM subjects motivates me.	-2.549	6.071
E. Identifiable Regulation	E1. I believe teaching STEM can make a positive impact on students' lives.	-2.396	5.207
	E2. Becoming a STEM teacher allows me to contribute to society in a meaningful way.	-1.552	2.77
	E3. I am motivated by the idea of inspiring students to pursue careers in STEM fields.	-1.478	1.724
	E4. Teaching STEM allows me to share my passion for science, technology, engineering, and math with	-2.092	3.727

	others.		
F. Introjected Regulation	F1. I feel pressure to become a STEM teacher because it aligns with my family's expectations.	-0.121	-1.184
	F2. Choosing to teach STEM fulfils a sense of obligation I feel towards my community.	-0.902	0.681
	F3. Teaching STEM is a way for me to prove my intelligence and abilities.	-1.553	2.514
	F4. Becoming a STEM teacher will make me feel good about myself.	-1.445	1.22
G. External Regulation	G1. I am motivated to become a STEM teacher because of the job security and benefits offered.	-0.929	-0.023
	G2. The potential salary of a STEM teacher is a major factor in my decision to pursue this career.	-0.176	-0.902
	G3. I am attracted to the potential for long breaks and holidays associated with the teaching profession.	-0.961	-0.09
	G4. The prestige associated with being a teacher motivates me to pursue a career in STEM education.	-0.372	-1.103

Levels of Self-Efficacy and Motivation

The results showed that the respondents demonstrated a high level of self-efficacy across all questionnaire items. The mean scores ranged from 3.97 to 4.68, indicating that the respondents generally agreed with the statements related to efficacy in influencing curriculum and resources, instructional self-efficacy and disciplinary self-efficacy. The highest mean score was recorded for Item C2 ($M = 4.68$), while the lowest mean score was observed for Item C3 ($M = 3.97$). Overall, the findings indicate that the respondents possessed a high level of self-efficacy in implementing STEM education.

Similarly, the results showed that the respondents demonstrated moderate to high levels of motivation across the questionnaire items. The mean scores ranged from 3.26 to 4.85, indicating that the respondents generally agreed with the statements measuring their intrinsic motivation, identified regulation, introjected regulation, and external regulation towards implementing STEM education. The highest mean score was recorded for Item D4 ($M = 4.85$), whereas the lowest mean score was observed for Item F1 ($M = 3.26$). Overall, the findings suggest that the respondents possessed a generally high level of motivation in implementing STEM education.

DISCUSSION

This study examined the levels of self-efficacy and motivation among pre-service teachers in implementing STEM education. The findings revealed that the respondents demonstrated high levels of self-efficacy and generally high levels of motivation. These findings suggest that the respondents possessed the confidence and psychological readiness required to implement STEM education effectively during their teaching practicum. Consistent with Bandura's (1997) Social Cognitive Theory, teachers with stronger self-efficacy are more likely to persevere when facing instructional challenges, adopt effective teaching strategies, and

remain committed to achieving learning goals. The high level of self-efficacy observed in this study therefore indicates that the respondents were generally confident in their ability to plan, manage and deliver STEM instruction effectively.

The findings also indicate that the respondents demonstrated generally high levels of motivation to implement STEM education. From the perspective of Self-Determination Theory (Ryan & Deci, 2000), motivation should not be viewed as a single construct but rather as a continuum ranging from autonomous to controlled forms of motivation. In the present study, respondents reported high motivation across the different motivational dimensions, suggesting that they possessed both personal interest and recognised the value of becoming STEM educators. Such motivation is important because teachers who are internally motivated are generally more likely to sustain their commitment, engage in continuous professional learning and implement innovative teaching practices.

Among the motivation items, the highest mean score was recorded for the statement referring to the satisfaction of seeing students succeed in STEM subjects, whereas the lowest mean score was associated with family expectations. This pattern suggests that the respondents were primarily motivated by educational and professional values rather than by external pressure. According to Self-Determination Theory, lower endorsement of externally regulated motives may reflect a greater degree of autonomous motivation, which is generally associated with more positive teaching behaviours, greater persistence and higher professional engagement (Ryan & Deci, 2000). These findings therefore suggest that the respondents' motivation to implement STEM education was driven more by personal commitment and meaningful professional goals than by external expectations.

Overall, the findings contribute to the growing body of literature on pre-service teacher preparation by demonstrating that future teachers possess both the confidence and motivation necessary to support STEM education. These findings highlight the importance of teacher education programmes in sustaining pre-service teachers' self-efficacy and autonomous motivation through meaningful practicum experiences, reflective practice, mentoring and continuous professional support.

LIMITATION AND FUTURE RECOMMENDATION

This study has several limitations that should be considered. The respondents were drawn from a single public university in Malaysia, which may limit the generalisability of the findings. In addition, the study relied on self-reported questionnaire data, which may be subject to respondents' perceptions and social desirability bias. Although the sample size was adequate for this study, future research should involve larger and more diverse samples from multiple institutions. Future studies could also examine the relationship between pre-service teachers' self-efficacy and motivation in implementing STEM education to provide a more comprehensive understanding of their readiness to implement STEM education.

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