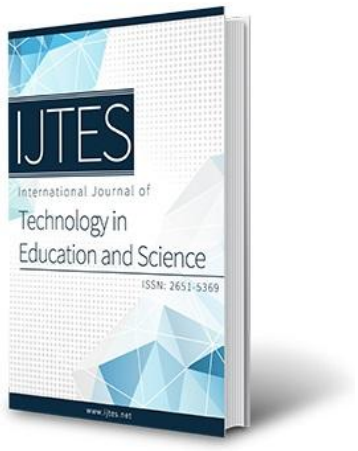

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STEM Education: Pre-Service Teachers' Knowledge, Attitude, Practice Intention, and Possible Challenges

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STEM Education: Pre-Service Teachers' Knowledge, Attitude, Practice Intention, and Possible Challenges

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Abstract

STEM (science, technology, engineering, and mathematics) education has been acknowledged that it could prepare students for the twenty-first-century workforce. Thus, pre-service teachers on the verge of entering the educational milieu are actively urged to incorporate it into their upcoming pedagogical classroom. Pre-service teachers' prospective classroom practice apropos of STEM education can be determined by their knowledge, attitude, practice intentions, and the challenges they will face. This study therefore investigates these four dimensions among Cambodian pre-service teachers. The study also sought to examine the affiliation among three earlier dimensions. A survey was conducted to gather data from 82 pre-service teachers in their second year of the teacher education program at Teacher Education College in the Kingdom of Cambodia. The survey consisted of both close-ended and open-ended questions. The result revealed that pre-service teachers' knowledge, attitude, and practice intention toward STEM education were at medium and slightly above the medium levels. The study also revealed a positive correlation among these triple dimensions. On top of that, pre-service teachers reported the possible challenges including internal challenges, external challenges, and student-related challenges when integrating STEM education in their prospective classroom. The study would offer insight into how to boost the levels of pre-service teachers' practice intention, possibly resulting in the integration of STEM education into their forthcoming classrooms.

Introduction

STEM (science, technology, engineering, and mathematics) education, originally introduced in the United States, has been widely adopted in various educational reform initiatives across multiple nations (Ültay, 2022). Numerous nations have launched comparable initiatives after examining the STEM education movement in the United States (Kulakoglu & Kondakci, 2023). Meanwhile, STEM education has been the subject of extensive research by scholars worldwide in recent years. A body of literature has also acknowledged that it has the potential to make a significant contribution to human development under the skills required in the twenty-first century (e.g. Arafat et al., 2024; Baran et al., 2021; Çavaş et al., 2024; Eshaq, 2024; Ghazali et al., 2024; Günbatar &Bakırcı, 2019). The rationale behind the significance of STEM education pertains to its relevance in modern education, prospective professional pursuits, and overall livelihood (Amran et al., 2021). STEM education represents a comprehensive

framework for cultivating highly skilled and knowledgeable professionals (Morales et al., 2022). It aims to equip students with the necessary skills and knowledge to succeed in the future by integrating scientific concepts with real-world applications (Firat, 2020; Le & Bui, 2021). That is, STEM education offers a significant benefit in its employment of interdisciplinary methodologies for problem-solving activities and projects which fosters the development of students' autonomy and collaboration skills (Vlasopoulou et al., 2021). Such skills are of significance for people in the 21st century and thus many nations including Cambodia have prioritized STEM education by incorporating it into their policy agendas. In the interim, pre-service teachers, who are on the path to becoming teachers, are anticipated to integrate STEM education into their forthcoming classroom instruction.

In Cambodia, STEM education has also caught the attention of educational personnel and other stakeholders. STEM education has been acknowledged that it has enhanced national economic growth, as it has been believed to help equip students with the necessary skills for the contemporary labor market. Therefore, the STEM education program has been included as the main agenda in most of Cambodia's education policies for secondary education. For instance, it was embedded in the *Education Strategic Plan 2019-2023* among the other five-year plan sub-sectors (see the Ministry of Education, Youth and Sports [MoEYS], 2019). Accordingly, MoEYS (2019) set the goal of enhancing and broadening the scope of science disciplines and STEM education to align with the 21st-century skills frameworks. In 2015, the Royal Government of Cambodia through MoEYS launched the New Generation School (NGS) program which focused on STEM subjects. The NGS program aims to enhance Cambodia's education system by implementing STEM education, enabling it to successfully compete with other education systems in the ASEAN region (MoEYS, 2016). In a similar vein, MoEYS (2021) noted that enhancing STEM education would give students the skills they need to succeed in a STEM-driven world and it would also prepare Cambodia's STEM graduates for Industry 4.0 at the school level.

Howbeit, the growing significance of STEM disciplines has made a need for teachers to revamp the substance and pedagogical approaches of their courses (Lin & Williams, 2016). In this regard, getting teachers ready to adopt an interdisciplinary approach is a major hurdle (Al Salami et al., 2017). In other words, when it comes to integrating STEM education, teachers are confronted with various hindrances (Geng et al., 2019). STEM education necessitates the utilization of design thinking and interdisciplinary knowledge by both teachers and students to devise novel solutions for nascent challenges (Geng et al., 2019). The success of STEM programs rests on what teachers think and how well they know how to adapt their teaching to incorporate STEM concepts (Dong et al., 2020).

As aforementioned, promoting STEM education at all education levels to cultivate qualified human capital for the twenty-first-century workforce has become a main agenda in most Cambodian educational policies (e.g. MoEYS, 2016, 2019, 2021). The study at the higher education level examined STEM enrollment status and discussed key issues to increase students' enrollment in the STEM field (Sovansophal & Shimizu, 2020). In the context of secondary levels, pre-service teachers, who will soon step into their actual classrooms, have been acknowledged to play a crucial role in enhancing the policies to attain their set goals. Pre-service teachers need good knowledge of STEM education and positive attitudes toward this interdisciplinary subject to successfully and effectively integrate it into their future classroom instruction. With these dimensions, they will put a strong effort into

performing their tasks to overcome various challenges they will encounter. Accordingly, the study investigating the levels of their knowledge, attitude, and practice intention of STEM education, the association among these triple dimensions, and the challenges they may face would offer policymakers and other stakeholders a bird's eye view on how to help pre-service teachers integrate STEM education into their upcoming classroom instruction. Nonetheless, based on a review of the existing literature, the study has yet to investigate the dimensions mentioned above among Cambodian pre-service teachers.

The current research therefore aimed to investigate the levels of Cambodian pre-service teachers' knowledge, attitude, and practice intention of STEM education and the association among these dimensions. Furthermore, the study aimed to examine the possible challenges presented by pre-service teachers. To attain the mentioned objectives, the study addressed the following research questions:

1. What are the levels of Cambodian pre-service teachers' knowledge, attitude, and practice intention of STEM education?
2. Do any relationships exist between Cambodian pre-service teachers' knowledge, attitudes, and practice intention of STEM education?
3. What are the possible challenges pre-service teachers may face when integrating STEM into their prospective classrooms?

Literature Review

STEM Education

STEM education is an instructional methodology that integrates multiple disciplines, wherein theoretical knowledge is complemented with hands-on experiences (Le & Bui, 2021). In other words, it is a multidisciplinary method of teaching that draws upon the fields of science, technology, engineering, and mathematics (Altan & Ercan, 2016; Demirkol et al., 2022; Çiftçi et al., 2022; Günbatar & Bakırcı, 2019; Sovansophal & Shimizu, 2020; Stohlmann et al., 2012; Wu et al., 2022) and promotes students' problem-solving skills when engaging with real-world problems (Demirkol et. al., 2022; Stohlmann et al., 2012). Simply put, it focuses on teaching the STEM content of two or more STEM domains (Kelley & Knowles, 2016; Sanders, 2008; Tas & Bolat, 2022; Yang & Baldwin, 2020), bound by STEM activities in an actual setting, to improve students' learning (Kelley & Knowles, 2016). In this sense, integrated STEM education does not always have to include all four STEM subjects (Stohlmann et al., 2012). However, Altan and Ercan, (2016) noted that the best STEM education approach integrates mathematics, engineering, and technology into one STEM discipline, such as science. Since students need ample knowledge and skills to solve the issues they will encounter in real life, one subject alone cannot provide the necessary knowledge and abilities to solve the multidisciplinary problems that arise in real life (Usman et al., 2023).

The body of literature has acknowledged the significance of STEM education in arming students with essential skills and knowledge aligned with the demands of the contemporary world (Amran et al., 2021; Altan & Ercan, 2016; Kelley & Knowles, 2016; Gok, 2022; Holik et al., 2023; Le & Bui, 2021; Morales et al., 2022; Vlasopoulou et al., 2021). Therefore, teachers, particularly pre-service ones who will soon be responsible for classroom

instruction, are expected to incorporate STEM education into their future teaching practices. In addition, we noted that from reviewing the literature the four dimensions of STEM education, namely pre-service teachers' practice intention, their knowledge, attitude, and perceived challenge they may face when integrating STEM education need ample attention, as these dimensions could determine their prospective actual classroom practice. Accordingly, these dimensions are employed as a conceptual framework in this study.

Conceptual Framework

Practice Intention of STEM Education

In this study, the term "intention" pertains to the behavioral intention of pre-service teachers. It is the degree of inclination of pre-service teachers to incorporate STEM-based instructional methods in their prospective classes. Pre-service teachers' practice intention could influence their prospective teaching practice. It holds significant importance for their future professional endeavors (Aydogan et al., 2021). The degree to which teachers want to embrace and put into practice new pedagogical practices is a critical factor in determining whether they will be successful in meeting new educational standards (Can & Higde, 2022). Thus, increasing preservice teachers' intention to integrate STEM education has become imperative. Various factors could predict the level of preservice teachers' practice intention of STEM disciplines. Knowledge, attitudes, and perceived challenges could be the main determinants of the practice intention of STEM education.

Knowledge of STEM Education

In order for teachers to triumphantly and effectively integrate STEM disciplines into their classroom instruction, they must also possess ample knowledge of these interdisciplinary subjects. The knowledge dimension of STEM education pertains to the subject matter knowledge possessed by pre-service teachers and teachers (Günbatar & Bakırcı, 2019). The existing literature has acknowledged that such knowledge is integral to STEM education. Teachers' knowledge of STEM education, how well they understand it, and how they use that information as teachers directly affect how well STEM is taught in their own classrooms (Bell et al., 2018). Insufficient knowledge of STEM education frequently results in diminished confidence and proficiency in teaching (Murphy & Smith, 2012). When a teacher lacks sufficient knowledge, it can result in limited and ineffective learning potential for their students (Bell et al., 2018). Thus, it requires teachers to have strong teaching and subject matter knowledge (Morales et al., 2022). Knowledge of STEM subjects among pre-service teachers may also have an effect on how they evaluate the importance of STEM education (Lin & Williams, 2016). That is, when teachers possess sufficient knowledge of STEM education, they tend to positively perceive the value of STEM education. In addition, the study found that teachers who understand the nature and pedagogy of STEM education are more likely to encounter lower-level intrinsic challenges of STEM teaching, while teachers who use their main discipline to model science, technology, engineering, and mathematical problem situations in integrated STEM learning activities are more likely to encounter higher-level intrinsic challenges (Dong et al., 2020). Teachers who lack the knowledge or are unwilling to learn the concepts are unlikely to support an integrated STEM approach to teaching and learning (Nadelson & Seifert, 2017). In this regard, pre-service teachers' knowledge of STEM education could also reflect their classroom practice intention of STEM education.

Attitude toward STEM Education

Pre-service teachers' attitude toward STEM education is also a piece of the puzzle that could make or break their practice intention. Attitude is a set of values, feelings, and reasons that people have in reaction to their surroundings (Lin & Williams, 2016). Teachers' attitudes toward STEM education were mostly assessed by their ability to generate positive emotions and obtain good STEM education results (Wu et al., 2022) and existing literature indicated that it could determine teachers' practice intentions. There exists a positive correlation between teachers' attitudes and instructional practices (Thibaut et al., 2018). That is, positive attitudes toward STEM education have a positive impact on teachers' behavioral intentions. It could influence their teaching practice and student learning performance (McDonald et al., 2021). In addition, the study indicated that positive attitudes alongside knowledge were indirectly linked to higher subjective norms and perceived behavioral control, which increased STEM teaching intention (Lin & Williams, 2016).

Challenges in Integrated STEM Education

The integration of STEM disciplines has posed many significant challenges for teachers and other educational stakeholders. The efforts to enhance STEM education entail teachers' involvement (Rahman et al., 2022). The crucial responsibility of teachers is to proficiently and innovatively incorporate STEM education within their instructional practices (Amran et al., 2021). Teachers must deliberately teach STEM subjects to help students apply STEM knowledge to real-world challenges (Kelley & Knowles, 2016). Such responsibility presents significant hindrances for many teachers, as they are expected to possess expertise and proficiency in both STEM and creative domains (Amran et al., 2021). In addition, the interdisciplinary nature of the STEM curriculum and the prevailing conventional school structure also present instructional challenges for teachers (Dong et al., 2020) because integrated STEM education requires many materials and resources for students to design, express, test, and revise solutions to real-world problems (Stohlmann et al., 2012). The study indicated that when school administrators were unable to provide the required resources, teachers faced difficulties in effectively implementing STEM education (Gok, 2022). The lack of STEM education implementation experience can be another challenge. The study revealed that having limited experience was one of the perceived challenges addressed by prospective teachers (Navy & Kaya, 2020). A Review of empirical studies by Wan et al. (2021) found that teachers faced time, support, and resource restrictions, worried about their competence and topic expertise, and considered students' developmental differences and safety.

Briefly, for pre-service teachers to effectively and successfully incorporate STEM education into their impending classroom instruction, they must possess sufficient knowledge of this interdisciplinary subject and exhibit a positive attitude towards it, as this could influence their practice intention. Furthermore, the hurdles they would encounter would also throw a wrench in their plans to implement STEM education. To that end, the research is necessary to identify all of these dimensions and their association with one another to provide policymakers and other stakeholders with insight to assist pre-service teachers in integrating STEM education into their forthcoming classroom instruction.

Methods

Design

Creswell and Creswell (2018) define research designs as the various types of inquiry within qualitative, quantitative, and mixed methods approaches that offer precise guidance for the procedures involved in a research study. The current study adopted a quantitative method with a correlational study. A correlational study is a research design that seeks to investigate the affiliation between two or more variables and does not intend to manipulate or control the variables. The present study aimed to examine the correlation among the three variables, viz. pre-service teachers' knowledge, attitudes, and practice intention of STEM education. The current study could also be categorized as a convergent mixed-method design. In this type of design, the researcher gathers both types of quantitative and qualitative data concurrently and subsequently incorporates the data into the interpretation of the overall findings (Creswell & Creswell, 2018). In the study, data was obtained using both quantitative and qualitative methods using a single-phase survey questionnaire. In addition, to investigate the possible challenges that pre-service teachers may encounter, the study also intended to see if the challenges reported in open-ended questions also included their knowledge of STEM education, one of the dimensions in close-ended questions.

Participants

This study's participants were 82 Cambodian pre-service teachers enrolled in the second year of a Teacher Education Program at a Teacher Education College in the Kingdom of Cambodia. Table 1 presents the participants' genders and majors, including Frequency Count (F. Count) and Percentage (%).

Table 1. Participant's Demographic Information (N=82)

Category	Details	F. Count	%
Genders	Male	26	31.70
	Female	56	68.30
Majors	Mathematics	23	28.00
	Physics	25	30.50
	Chemistry	13	15.90
	Biology	21	25.60

As seen in Table 1, among 82 participants, 26 or 31.70% are males, and 56, or 68.30 are females. The participants were registered in various majors including Mathematics (N=23 or 28%), Physics (N=25 or 30.50%), Chemistry (N=13 or 15.90%), and Biology (21 or 25.60%).

Instruments

A survey presented in *Google Forms* was utilized to collect the data. The survey consisted of both close-ended and open-ended questions. The study utilized a set of close-ended questions to assess three distinct variables: knowledge, attitude, and practice intention of STEM education. These survey questions were sourced from the

work of Wijaya et al. (2022). The knowledge dimension comprises four items (1 to 4); attitude consists of two items (5 &6) and practice intention (behavioral intention) encompasses the last three items (see Table 3). This survey questionnaire was tested for consistency, reliability, and validity by Wijaya et al. (2022). The results indicated that all constructs met the criteria of recommended values (see Wijaya et al., 2022). In the study, the researchers did not retest for the reliability and validity of the survey because they slightly modified very few terms to make them align with the Cambodian context. That is, the terms "lower and upper secondary school" were substituted for "junior and senior high school" in items 1 to 3 about Knowledge of STEM education. For example, in item 1 we change "*I am familiar with science knowledge (chemistry/physics/biology) at the junior and senior high school levels*" to "*I am familiar with science knowledge (chemistry/physics/biology) at lower and upper secondary school levels*". To investigate the challenges that pre-service teachers may encounter when implementing STEM pedagogy, the researchers incorporated an open-ended inquiry into their survey "*In your opinion, what are the possible challenges you may face when integrating STEM education in your future classes?*"

Data Analysis

Statistic Package Social Science 22.0 (SPSS 22.0) was adopted to analyze the data obtained from close-ended questions regarding three dimensions of STEM education: knowledge, attitude, and practice intention. Coding was adopted to analyze the qualitative data obtained from open-ended questions regarding the challenge of integrating STEM education. Since manual coding is more time-consuming, even for data from a small number of respondents, Creswell and Creswell (2018) recommended the researcher(s) use computer software to assist in coding. Accordingly, MAXQDA Software was also adopted to assist in coding. Then, Frequency count (F. count) and percentage (%) were utilized to present the data concerning participants' demographic information. Mean (M), Standard Deviation (SD), and Pearson Correlation were used to present the quantitative data. Finally, the common themes of the qualitative data were presented descriptively with some excerpts of participants' responses. In addition, to guarantee participants' confidentiality, pseudonyms (Participants 1, 2, 3, etc.) were used to report the findings.

Results

What are the levels of Cambodian pre-service teachers' knowledge, attitude, and practice intention of STEM education?

The first research question sought to examine the pre-service teachers' knowledge, attitude, and practice intention. Table 2 indicates the results of three dimensions of STEM education rated by 82 Cambodian pre-service teachers.

Table 2. Results Regarding Three Dimensions of STEM Education

STEM Education Dimensions	M	SD
Knowledge	3.27	.59
Attitude	3.80	.81
Practice Intention	3.56	.83

As seen in Table 2, the results revealed that Cambodian preservice teachers' attitudes toward STEM education (M=3.80; SD=.81) and practice intention of STEM education (M=3.56; SD=.83) were slightly above the medium level. They had almost a medium level of knowledge (M=3.27; SD=.59). Therefore, this suggested that their knowledge of STEM education was not sufficient.

Table 3 presents the results from all items concerning the pre-service teachers' Knowledge (items 1-4), attitudes (items 5&6), and practice intention (items 7-9).

Table 3. Results from All Items of Three Dimensions (N=82)

No	Items	M	SD
1	I am familiar with science knowledge(chemistry/physics/biology) at lower and upper secondary school levels.	3.87	.681
2	I am familiar with technology-related knowledge at the lower and upper secondary school level.	3.38	.826
3	I am familiar with the knowledge of engineering (STEM) at the lower and upper secondary school levels.	2.46	.878
4	I am familiar with mathematics knowledge at the lower and upper secondary school levels.	3.40	.980
5	Using STEM learning is a good idea.	3.83	.927
6	Using STEM learning makes teaching and learning activities interesting.	3.91	.905
7	I enjoy using STEM learning when teaching.	3.67	.861
8	I will use STEM learning at every teaching opportunity.	3.40	.914
9	I will recommend STEM learning to my teacher friend.	3.73	.890

According to data shown in the table, pre-service teachers rated the lowest in item 3 regarding the knowledge of engineering (STEM) (M=2.46; SD=.878). However, they scored the highest in item 6 (M=3.91; SD=0.905), followed by item 1 (M=3.87; SD=.681) and item 5 (M=3.83; SD=.980).

Are There Any Relationships among Cambodian Pre-Service Teachers' Knowledge, Attitudes, and Practice Intention of STEM Education?

The second research question was to investigate the affiliation (if any) in the three triple dimensions of STEM education. According to Holcomb (2016), the value of Pearson *r* from .00 to .24 indicates weak or no correlation; .25 to .49 indicates moderate correlation; .50 to .74 shows moderately strong correlation; .75 to .99 indicates strong correlation; and -1 or 1 indicates perfect correlation. As seen in Table 4, all three dimensions indicated positive relationships. That is, practice intentions were moderately associated with knowledge (Pearson r=.459) and attitude (Pearson r=.710). In addition, knowledge had also moderately strong affiliation with attitude (Pearson *r*= .610). In other words, when teachers possessed a higher level of knowledge and a positive attitude toward STE education, they would also have a higher level of practice intention of STEM education. In addition, pre-service teachers' good knowledge of STEM education also reflected their positive attitude. Therefore, improving either

dimension among preservice teachers could also enhance the others. For instance, developing a positive attitude toward STEM education could increase their level of practice intention.

Table 4. The Relationship between Knowledge, Attitude, and Practice Intention (N=82)

		Knowledge	Attitude	Practice Intention
Knowledge	Pearson Correlation	1	.610**	.459**
	Sig. (2-tailed)		.000	.000
Attitude	Pearson Correlation	.610**	1	.710**
	Sig. (2-tailed)	.000		.000
Practice Intention	Pearson Correlation	.459**	.710**	1
	Sig. (2-tailed)	.000	.000	

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

What Are the Possible Challenges Pre-Service Teachers May Face when Integrating STEM into Their Prospective Classes?

The final research question was to explore the challenge that pre-service teachers may face when integrating STEM education. An open-ended question "*In your opinion, what are the possible challenges you may face when integrating STEM education in your future classes?*" was used to collect the data from 82 preservice teachers. 79 pre-service teachers responded to this question. Four main themes were found including internal challenges, external challenges, and student-related challenges.

Internal Challenges

Internal challenges comprised teachers' knowledge of STEM education and experience in integrating STEM disciplines. The study revealed internal factors including teachers' knowledge of STEM the possible challenge reported by most pre-service teachers. For instance, P 25 responded to this, "I think the main problem is that I am not clear about STEM Education..." In addition, they thought that they did not have experience in STEM education, as seen in P 43's response, "I don't have experience in integrating STEM education, so it can be difficult for me…"

External Challenges

External challenges include the lack of experimental material and time support, poor internet access, and lack of technological resources. Pre-teachers identified the scarcity of resources as the primary challenge in integrating STEM subjects into their prospective classroom instruction, as seen in what P 31 responded, "I think the lack of materials for the experiment because integrating STEM needs a lot of materials". In addition, pre-service teachers reported time support as another challenge. They mentioned that incorporating STEM disciplines into their upcoming teaching resulted in them being unable to complete the lessons within the allotted time. For instance, P 75 remarked, "If we integrate STEM subjects in our teaching, we will not finish the lesson on time". Some pre-

service teachers also mentioned poor school infrastructures consisting of internet access technological resources, and support from communities, especially in rural areas. For instance, P58 reported that the lack of internet access and technology resources was the challenge "I think the challenge I may face will be a lack of access to the internet and other tech tools".

Student-Related Challenges

The third theme was student-related challenges including student learning engagement, collaboration among their peer, and students' levels of knowledge. They were concerned about student engagement when integrating STEM education into their teaching. STEM education might be unfamiliar to many Cambodian students, "Students may not enjoy learning activities with STEM integration as it is new to most of them" (P18). In addition, they also postulated that some students might not collaborate with their peers when they are assigned group work, "I think when we assign the group work; some students will not collaborate with other members. They may prefer working individually…" (P4). Some pre-service teachers also mentioned the mixed ability classes, as seen in the excerpt of P66, "I think I will face some difficulties such as the different levels of student's knowledge in one class...".

Discussion

The result revealed that pre-service teachers' knowledge of STEM education was at the medium level and their attitudes and practice intention toward STEM education were slightly above the medium level. Teachers' knowledge of and attitude toward STEM education can determine the effective integration of this interdisciplinary subject (Al Salami et al., 2017; Çavaş et al., 2024). Teachers' knowledge of STEM education would directly affect how well STEM is taught in their classrooms (Bell et al., 2018). If pre-service teachers lack sufficient knowledge of STEM education and possess a negative attitude toward it, they will not integrate STEM education into their upcoming classroom instruction successfully and effectively and thus negatively influence students' performance and achievement. In addition, their practice intention to implement STEM education could determine their actual practice in their prospective classroom. Pre-service teachers' practice intention reflects their future professional endeavors (Aydogan et al., 2021). The current study indicated that pre-service teachers' practice intention was slightly above the medium level. The pre-service teachers' intention to teach STEM subjects increased after taking the methods course (Karisan et al., 2019). Therefore, the findings of the current study suggested STEM education professional development was needed for pre-service teachers. Furthermore, the teacher education program coordinator or other stakeholders should consider revising the teacher education program to ensure that pre-service teachers are adequately equipped with the necessary knowledge of STEM education. This would boost pre-service teachers' level of practice intention, possibly resulting in integrating STEM disciplines effectively into their future classrooms.

The study also indicated that pre-service teachers' practice intention of STEM education was associated with their knowledge and attitude. Teachers' attitudes toward STEM education were predicated on favorable performances, resulting in a positive impact on their behavioral intentions (Wijaya et al., 2022). Moreover, stronger STEM teaching intention was found to be associated with levels of positive attitudes and knowledge (Lin & Williams,

2016). Thus, the result of the current study suggested that developing pre-service teachers' knowledge of STEM education and positive attitudes toward this interdisciplinary subject could enhance their practice intention of STEM education.

Finally, pre-service teachers raised some possible challenges, viz. internal challenges, external challenges, and student-related challenges. Internal challenges include lack of knowledge and experience in implementing STEM education. External challenges encompass a lack of time, materials, internet access, and technological resources. Student-related challenges included levels of learning engagement, collaboration, and students' different levels of content knowledge. The findings correspond to the existing literature and studies. The implementation of integrated STEM education frequently necessitates a substantial array of materials and resources (Stohlmann et al., 2012). Various factors in the educational environment exert an influence on instructional methodologies, either through direct or indirect means (Thibaut et al., 2018). The existing study hereof found that teachers struggled to successfully integrate STEM instruction because the school administrators did not give them resources (Gok, 2022). Another study revealed that prospective teachers perceived limited experience as a challenge (Navy & Kaya (2020). Moreover, teachers need to develop both skills and attitudes toward interdisciplinary teaching (Al Salami et al., 2017). The other study indicated that teachers who had knowledge of STEM education were more likely to encounter lower-level intrinsic challenges of STEM teaching (Dong et al., 2020). The current study suggested that the mentioned challenges could negatively affect pre-service teachers' practice intention. Therefore, providing training for pre-service teachers on STEM education is needed to equip them with sufficient knowledge of STEM education so that they can overcome such challenges. In addition, the training has the potential to bring about a change in teachers' behavior and practices (Bon & Inpin, 2024). The training should allow pre-service teachers to be exposed to hands-on experience concerning STEM integration so that they can really get their feet wet in the realm of STEM education.

Conclusion and Implication

Cambodian pre-service teachers' knowledge of STEM education was at a medium level and their attitude and practice intention were slightly above the medium level. Additionally, there was a positive relationship between these three STEM education dimensions. That is to say, the finding apropos of the relationship between their knowledge of STEM education and their attitude towards these interdisciplinary subjects suggested that as teachers gain a greater level of knowledge in STEM education, their attitude towards STEM education became more positive. Finally, pre-service teachers discussed some of the hindrances they might face when implementing STEM education in their future classrooms. These encompassed a lack of resources, time, efficient knowledge, and experience in the integration of STEM education, as well as students' reduced engagement and collaboration, and varying levels of content competency.

This study would provide valuable guidance for the teacher education program coordinator in offering appropriate professional development opportunities for pre-service teachers. This would enable them to gain the necessary knowledge of STEM education. The acquisition of such knowledge would have the potential to enhance their positive attitudes, subsequently fostering an increase in their practice intention ultimately yielding positive

outcomes in their future classroom practices. Regarding the possible challenges they raised, this study had the potential to provide valuable insights for other stakeholders into helping Cambodian pre-service teachers overcome the challenges, which could motivate them to integrate STEM disciplines into their upcoming classroom instruction.

Future Work

This study identified certain areas that warrant further investigation. The present study utilized a survey instrument as its data collection tool. Therefore, future research may adopt qualitative methods such as interviews to enhance the effectiveness of the study. Furthermore, future research could replicate this study with the same participants after they gain some practical experience in the classroom.

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