STEM Teaching Readiness in Hong Kong: A Decade of Insights From the Modified Theory of Planned Behavior

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Abstract

This study investigates the readiness of primary and secondary school teachers in Hong Kong to implement STEM education, nearly ten years after its formal policy introduction. Grounded in a modified Theory of Planned Behavior (TPB), the research explores five key constructs: attitudes toward STEM, perceived systemic barriers, self-efficacy, affective conditions (as a proxy for intention), and STEM teaching behaviors. A quantitative survey was conducted with 119 teachers using convenience and snowball sampling. The results revealed that attitudes significantly predicted affective readiness ($\beta = 0.544$, $p < 0.001$), and affective readiness in turn strongly influenced actual STEM teaching behaviors ($\beta = 0.592$, $p < 0.001$). Perceived systemic barriers also had a surprising positive influence on behavior ($\beta = 0.303$, $p < 0.001$), suggesting that in certain institutional contexts, constraints may act as creative drivers rather than deterrents. In contrast, self-efficacy was not a significant predictor of intention ($p > 0.05$). The model accounted for 56.9% of the variance in affective readiness and 43.5% in teaching behavior, indicating moderate to strong explanatory power. Additional analysis showed that related training and experience significantly enhanced readiness ($p < 0.05$), regardless of gender or school level. The findings have practical implications for curriculum designers and school leaders, suggesting that professional development should integrate emotional readiness and institutional resilience as central components of STEM implementation strategies.

Keywords: STEM education, teacher readiness, modified Theory of Planned Behavior, structural equation modeling, Hong Kong

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Introduction

In 2015, the Education Bureau (EDB) put forward STEM education in Hong Kong, which was supposed to enhance the competitiveness of students in a more technology-driven world and was thus justified in the Policy Address of the Hong Kong Government (HKSAR, 2014). Over the last decade, EDB has introduced and implemented different policies and initiatives through official guidelines in 2016 (EDB, 2016), and finally establishing the STEM Education Centre in 2017 (HKSAR, 2017) meant for integrating STEM into primary and secondary schooling. This school-based approach (EDB, 2016) places enormous pressure on teachers; it critically depends on their readiness and willingness to successfully integrate various aspects of STEM into their pedagogy. Therefore, besides curricula, effectiveness in STEM education will also depend on how these teachers perceive it; what their capacity is, and whether they are willing to implement it.

The studies that have gone in Hong Kong, despite STEM being emphasized more, have focused on the issues concerning the teachers faced at the EDB rather off their own preparation. These works reported that constraints of time, lack of support by the schools and EDB, inadequate preparation on the part of the EDB, and other unknown factors affecting student engagement (Croucher Foundation, 2016; Lau, 2019; Hong Kong Federation of Youth Group, 2018). The rest dealt with pedagogical aspects: methodologies of teaching (Liang & Fung, 2022; So, 2018), assessment approaches (Ali, 2021; Yip & Chan, 2019), and STEM literacy development (Chang et al., 2021; Kutnick et al., 2020).

The blank in the study both psychologically and contextually in what makes teachers willing to implement STEM education is very crucial. This research, therefore, seeks to fill the gap by determining how far teachers' attitudes, perceived systemic barriers, and self-efficacy predict their affective readiness and resultant pedagogical practice toward STEM. The above objective was conducted using the Theory of Planned Behavior (TPB) model (Ajzen, 1991), which traditionally links attitude, subjective norm, and perceived behavioral control to intention and subsequent behavior. Affective readiness is introduced here with fine calibrations as an important mediator stressing the strong influence of the affective domain on education strategies.

This study will be significant to the extent that it can specify approaches to teacher support, thus realizing the STEM education goals set in Hong Kong. By emphasizing readiness in affective and behavioral aspects, this study provides critical information on how to improve teacher readiness; this, in turn, feeds into the general aim of building a qualified STEM workforce in Hong Kong.

Literature Review and Hypotheses Development

STEM Education and Teacher Readiness

The successful implementation of STEM education depends on teachers’ readiness, a multifaceted construct that significantly influences educational outcomes. Wu et al. (2022) emphasized that the teachers’ readiness to adopt STEM education is a critical determinant of the success of STEM education because it directly affects their ability to integrate elements of STEM into their teaching practices. Rafferty et al. (2013) describe readiness in three dimensions: cognitive, affective, and behavioral. In STEM education context, cognitive readiness means teachers’ knowledge of STEM concepts and pedagogy; affective readiness includes attitudes, emotions, and motivation related to STEM teaching; while behavioral readiness covers the actual classroom practices of the teachers-including both the frequency and quality of activities related to STEM subjects. The present study will address affective and behavioral readiness since they have a more immediate impact on the success of STEM teaching and are fields where actionable insights for teacher support can be gained. Measuring cognitive readiness is equally important, though it takes up a lot of resources and time and is typically dealt with via formal training programs. Since this study was small-scale in nature, the focus on the affective and behavioral dimensions leads to a more in-depth exploration of the mental and practical motivators of STEM instruction among teachers in Hong Kong.

Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) is one of the most articulated and influential models in explaining and predicting human behavior. According to Ajzen (1991), behavior is a function of three primary dimensions: attitudes toward the behavior, subjective norms, and perceived behavioral control. Altogether they determine intention which is the immediate antecedent for action. Therefore, it has been extensively applied in educational research to investigate teachers' intentions and behaviors regarding teaching-related practices, technology adoption, and professionalization. For example, Dunn et al. (2018) applied TPB to explore teachers' intentions toward ongoing professional development. They found strong predictive elements in control and attitude for workers' willingness to support new work practices. In another study by Teo et al. (2016), it was found that an individual's attitude towards technology and the perceived behavioral control of teachers significantly influences their intention of using technology for teaching. Subjective norms may pose negative or less positive effects on the same. In terms of STEM education, TPB has been proved useful in predicting in-service teachers' and preservice teachers' intentions to adopt STEM teaching. Wu et al. (2022) revealed that both attitudes and perceived behavioral controls have a direct influence on STEM teaching intentions whereby perceived usefulness, self-efficacy among others act as indirect factors. For example, Li et al. (2019) applied TPB to less conventional STEM areas like the integration of STEM with physical education where all three TPB constructs served as positive predictors of teachers' intention highlighting the model's adaptability across different educational settings.

This study adapts and implements TPB to fit in with the focus on STEM readiness of Hong Kong teachers by emphasizing affective condition as a primary driver. In traditional models of TPB, behavioral intention mediates between behavior and its antecedents; here, in this modified model, affective condition is inserted in the mediating role between attitudes, systemic barriers, self-efficacy, and STEM teaching behaviors (see Table 1). This is quite consistent with previous studies that have found educational contexts to be sensitive to affective variables. For example, Teo et al. (2016) found that technology usage was most strongly influenced by attitude toward technology which is an affective component; it again underlines how emotions weight behavior. Though TPB applications to STEM education have increased, knowledge gaps in affective and behavioral determinants of STEM teaching readiness remain, particularly in Hong Kong where concerns about resource constraints and high-stakes educational settings seem to localize.

Table 1
Research Constructs of Modified TPB

Construct	TPB construct	Definition
Att_STEM	Attitude towards the Behavior	Directly measures teachers' attitudes of teaching STEM.
Perceived Systemic Barriers (PSB)	Subjective Norm	Captures perceived pressures from the teachers that discourage STEM teaching.
Self-efficacy	Perceived Behavioral Control	Reflects teachers' confidence in their ability to plan and deliver STEM lessons.
Affective conditions	Behavioral Intention	Measure teachers' emotional engagement and eagerness, translating into an intention to teach STEM (intrinsic motivation).

Research Model and Hypotheses

This study attempts to identify factors that influence the teaching intentions of Hong Kong primary and secondary teachers, as well as their actual teaching behavior toward STEM, through the application of a modified TPB framework. Therefore, this research tries to explore how teachers' attitudes, external pressure, and perceived control on their capability to perform influence their readiness to embrace STEM practices. Insights into effective STEM education in Hong Kong can be drawn from this exploration. The conceptual model of this research derived from the modified TPB model is displayed in Figure 1. The investigation is guided by the following hypotheses:

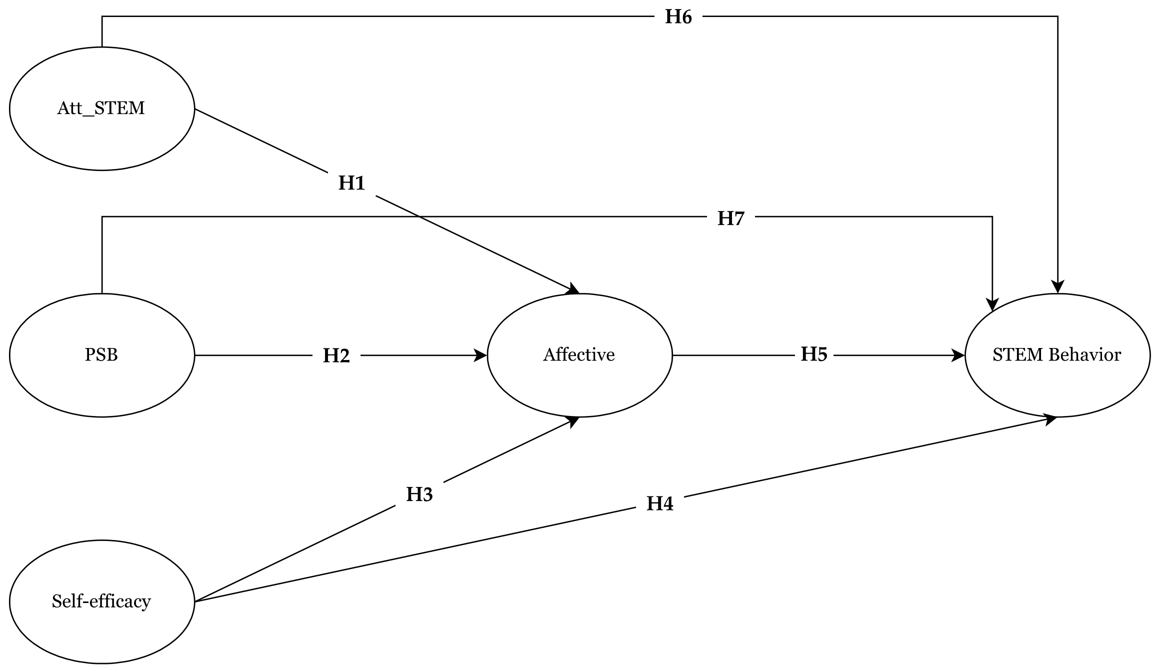
- **H1:** Teachers' attitudes toward STEM education (Att_STEM) positively influence their affective conditions.
- **H2:** Perceived systemic barriers (PSB) negatively influence teachers' affective conditions.
- **H3:** Teachers' self-efficacy positively influences their affective conditions.
- **H4:** Teachers' self-efficacy positively influences their STEM teaching behaviors.
- **H5:** Teachers' affective conditions positively influence their STEM teaching behaviors.
- **H6:** Teachers' attitudes toward STEM education (Att_STEM) indirectly influence their STEM teaching behaviors through affective conditions.
- **H7:** Perceived systemic barriers (PSB) indirectly influence teachers' STEM teaching behaviors through affective conditions.

Methodology

Research Design

This study adopted a quantitative research approach and conducted a structured survey questionnaire to assess the readiness of primary and secondary teachers in Hong Kong towards the implementation of STEM education. Four main questions guided this research: (1) How do attitudes toward STEM, perceived systemic barriers, and self-efficacy shape the affective readiness of Hong Kong teachers?; (2) How do affective readiness and self-efficacy influence STEM teaching behaviors among Hong Kong teachers?; (3) Do attitudes toward STEM and perceived systemic barriers indirectly affect STEM teaching behaviors through affective readiness? And (4) Are there significant demographic differences in these factors? The above-used approach allowed for the orderly examination of mental and practical elements related to the practice of teaching STEM within a modified TPB framework.

Figure 1
Research Conceptual Model



Sampling and Data Collection

The data were collected through an online survey, which yielded a total of 119 valid responses from teachers in primary and secondary schools in Hong Kong. Sampling utilized convenience and snowball methods, taking advantage of the researcher's personal network to disseminate the survey. This method provided easy access to a diverse yet manageable sample within the limitation of a small-scale study. The demographic information, including gender, years of teaching experience, school level, and STEM-related qualifications of the respondents, was collected to present their complete profiles.

Survey Instrument

The instrument used for the survey comprised 49 items initially designed to measure the related constructs. Items for attitudes toward STEM education, which is abbreviated here as Att_STEM, were adopted from the Teachers' Attitudes towards STEM Education and Teaching (TASET) Scale (Papagiannopoulou & Vaiopoulou, 2024). Items for self-efficacy and affective conditions were taken from the TRi-STEM Scale (Papagiannopoulou et al., 2023). Based on previous research and contextual needs, perceived systemic barriers (PSB) and STEM teaching behaviors were added as new subscales. The survey used a 5-point Likert scale in measuring responses. A pilot test was conducted with one primary school teacher and one secondary school teacher so that adjustments could be made regarding the clarity of the items and their proper structure before they would be fully deployed. Detailed references to the adapted scales can be found in Table 2.

Data Analysis

Two different methodologies were applied to analyze data in answering the posed research questions. First, Partial Least Squares Structural Equation Modeling (PLS-SEM) carried out in

SmartPLS 4.1.1.2 was used to test the proposed relationships of the modified TPB model along with its direct and indirect effects between constructs. Second, demographic comparisons were run using Mann-Whitney U tests in JASP 0.19, chosen due to non-normality and small sample size (n = 119). All software applications made available easily conducted analyses that were appropriately powerful to ensure finding valid results. Strict adherence to ethics, including informed consent as well as data anonymity was ensured during the entire research process.

Table 2
Scale Adapted for Survey Item Generation

Construct	Scale adapted	Reference
Attitude towards STEM (Att_STEM)	Teachers' Attitudes towards STEM Education and Teaching (TASET) Scale	(Papagiannopoulou & Vaiopoulou, 2024)
Perceived Systemic Barriers (PSB)	New subscale concluded from research result	Lau (2019); Hong Kong Federation of Youth Group (2018); Croucher Foundation (2016)
Self-efficacy	Tri-STEM Scale	(Papagiannopoulou et al., 2023)
Affective conditions	Tri-STEM Scale	(Papagiannopoulou et al., 2023)
STEM Behavior	New subscale	/

Results

Results are outlined in three parts: the evaluation of the measurement model, structural model analysis, and comparative analysis of demographic differences. These will indicate the reliability and validity of the data, the predictive relationships within the modified TPB framework, and the variations across teacher demographics in Hong Kong.

Measurement Model Evaluation

The measurement model evaluation began with an assessment of survey items. The item evaluation of the measurement model to ensure robustness through item retention was conducted according to the recommendations of Sarstedt et al. (2021) with items having factor loadings of 0.57, retaining at least three items per construct, to assure structural integrity. This procedure subsequently led to the final selection of 28 items that were used in the data analysis to be reported. Composite Reliability (CR) and Average Variance Extracted (AVE) were computed for reliability and validity and are reported in Table 3. All CR values are greater than 0.7 (Hair et al., 2019) establishing good internal consistency among the constructs. The high CR values were again confirmed, allowing the second form of convergent validity to have AVE values at or above the 0.5 criterion, underestimating by two constructs, in an exploratory study of this nature. The square roots of AVE generally exceeded inter-construct correlations, but some HTMT values exceeded 1.0 (see Table 4), suggesting potential overlap. However, the overall statistics affirm the data's suitability for PLS-SEM analysis and warrant a cautious interpretation of the findings.

Table 3
Cronbach Alpha, Rho-A, Composite Radiality and AVE Values for Internal Consistency Reliability and Validity Analysis

Construct	Cronbach's alpha	Rho-A	CR	AVE
Affective	0.538	0.532	0.765	0.522
Att_STEM	0.639	0.647	0.785	0.480
PSB	0.550	0.582	0.761	0.520
STEM Behavior	0.773	0.776	0.841	0.470
Self-efficacy	0.686	0.703	0.808	0.516

Table 4
Results of the Discriminant Validity Analysis

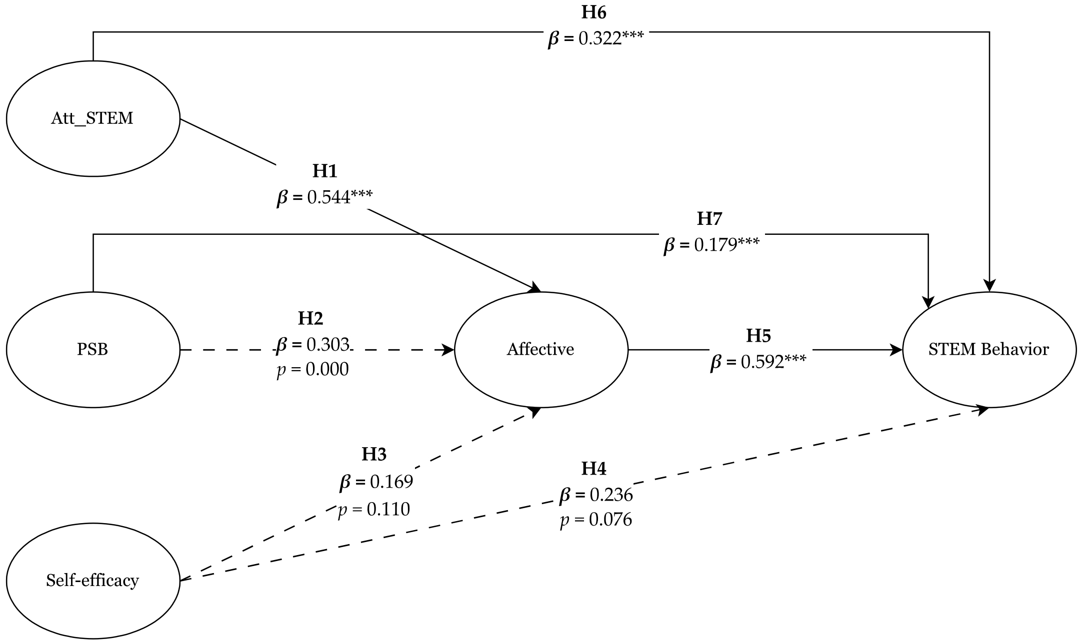
	Affective	Att_STEM	PSB	STEM Behavior	Self-efficacy
Affective	**0.722**	1.132	0.758	0.997	0.657
Att_STEM	0.681	**0.693**	0.375	1.000	0.674
PSB	0.426	0.215	**0.721**	0.451	0.402
STEM Behavior	0.648	0.697	0.270	**0.686**	0.528
Self-efficacy	0.412	0.425	0.039	0.380	**0.718**

Note. The square root AVE values are in bold; the results for the Fornell–Larcker criterion are below the diagonal and those of the Heterotrait–Monotrait ratio are above the diagonal.

Structural Model Analysis

The structural model analysis was carried out to see how the five underlying constructs within the adjusted TPB framework relate to each other predictively and to put an implicit emphasis on how they influence behaviors pertaining to STEM teaching. The model turned out to have a moderate degree of explanatory as well as predictive power accounting for an R^2 value of 0.435 with Q^2 being 0.336 for STEM teaching behaviors. The results of hypothesis testing are explicitly detailed in Figure 2 and Table 5. While H1, stating a positive influence of attitudes toward STEM on improving affective conditions, is successfully validated by a standardized beta weight of 0.544 ($p < 0.001$), signifying a strong emotional impact. The hypothesis that perceived systemic barriers would negatively relate to affective conditions (H2) is not supported, but rather the converse is true, as it stands at ($\beta = 0.303$, $p < 0.001$). Therefore, H2 is rejected. Other such related hypotheses, H3: self-efficacy positively influences affective conditions ($\beta = 0.169$, $p = 0.110$), and H4: self-efficacy positively influences STEM behavior ($\beta = 0.236$, $p = 0.076$), are also not supported due to very wide and large p-values. H5. It was strongly supported that affective conditions drive STEM teaching behaviors ($\beta = 0.592$, $p < 0.001$). Indirect effects, H6 and H7, attitudes influence behaviors via affective conditions ($\beta = 0.322$, $p = 0.003$) and barriers as well ($\beta = 0.179$, $p = 0.001$). Four of the seven hypotheses turned out to be significant. The limited role of self-efficacy was a notable finding.

Figure 2
Hypothesis Testing Results



Note. The dotted line indicates the hypothesis that is rejected. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Comparative Analysis

The Mann-Whitney U test was used for the comparative analysis of demographic differences because of the non-normal distribution within a small sample size in each grouping ($n < 30$). Table 6 shows that gender, in all constructs, had no significant difference, which means that the readiness level is the same for both genders. There was a significant difference in teaching experience; self-efficacy was scored higher in senior teachers (6+ years) ($p = 0.020$), and secondly, the secondary teachers had more self-efficacy compared to them. STEM diploma teachers performed better than their counterparts without STEM diplomas in the following constructs: Att_STEM ($p = 0.030$), self-efficacy ($p < 0.001$), affective condition ($p = 0.043$), and STEM teaching behaviors ($p = 0.003$). STEM training has more general effects where the results are significant in Att_STEM, self-efficacy, affective condition (all at $p < 0.001$), and STEM teaching behaviors ($p = 0.012$). Likewise, teachers with STEM coordination experience showed better results in STEM ($p = 0.006$), self-efficacy ($p < 0.0l$), and affective ($p = 0.015$). Note that barriers did not show any demographic variation, showing a barrier perception that was uniform through the sample. These findings clearly indicate an investment by the training and experience to upgrade the readiness.

Table 5
Results of Hypothesis Testing

	Hypothesis	*β*	T Statistics	*p* values	Result
H1	Teachers' attitudes toward STEM education positively influence their affective conditions.	0.544	5.610	0.000	Supported
H2	Perceived systemic barriers negatively influence teachers' affective conditions.	0.303	4.883	0.000	Rejected
H3	Teachers' self-efficacy positively influences their affective conditions.	0.169	1.600	0.110	Rejected
H4	Teachers' self-efficacy positively influences their STEM teaching behaviors.	0.236	1.773	0.076	Rejected
H5	Teachers' affective conditions positively influence their STEM teaching behaviors.	0.592	4.497	0.000	Supported
H6	Teachers' attitudes toward STEM education indirectly influence their STEM teaching behaviors through affective conditions.	0.322	3.015	0.003	Supported
H7	Perceived systemic barriers indirectly influence teachers' STEM teaching behaviors through affective conditions.	0.179	3.184	0.001	Supported

Discussions

This study critical insights into the readiness of Hong Kong primary and secondary teachers for the implementation of STEM education. Results attitudes, emotions, barriers, self-efficacy, and demographic factors within the modified TPB framework. Results findings with existing literature to bring about theoretical and practical implications within the context of educational landscapes in Hong Kong.

Attitudes and Emotions Drive STEM Readiness

A major finding relates to the very important role that attitudes and emotions play in the preparedness of teaching in STEM. The analysis of the structural model showed a very strong positive relationship between attitudes toward STEM and its affective condition, ($\beta = 0.544$, $p < 0.001$), which is in line with Ajzen (1991) within the framework of TPB; affective readiness then significantly impacts on STEM teaching behaviors ($\beta = 0.592$, $p < 0.001$) hence supporting hypothesis H5 as well. These findings support previous studies by Chiriacescu et al. (2023) and Thibaut et al. (2018), where it was found that strong attitudes can directly predict readiness and intention among teachers for STEM education. They also indirectly support Hargreaves (1998) and Wu et al. (2022) who express that emotions form a profound base for teaching practices; Vaiopoulou et al. (2024) reinforces this by pinpointing affective readiness as a dominant readiness influencer on teaching intentions. McLure et al. (2022) in their study argue that teachers' positive emotional and attitudinal readiness not only makes them more prepared but also improves student outcomes by creating better classroom emotional climates and teacher-student relationships. This finding points to the fact that cultivating positive attitudes is of essence to upgrade both the teachers' readiness and their impact in the classroom.

Table 6
Results of Hypothesis Testing

Demographic grouping	Att_STEM	PSB	Self-efficacy	Affective	STEM teaching behavior
Gender	NS	NS	NS	NS	NS
Teaching experience (Junior vs. Senior 6+years)	NS	NS	**p < 0.001** (Senior higher)	NS	NS
School Level (Primary vs. Secondary)	NS	NS	**p = 0.020** (Secondary higher)	NS	NS
STEM diploma (Yes vs. No)	**p = 0.030** (Yes higher)	NS	**p < 0.001** (Yes higher)	**p = 0.043** (Yes higher)	**p = 0.003** (Yes higher)
STEM training (Yes vs. No)	**p < 0.001** (Yes higher)	NS	**p < 0.001** (Yes higher)	**p < 0.001** (Yes higher)	**p = 0.012** (Yes higher)
STEM coordination (Yes vs. No)	**p = 0.006** (Yes higher)	NS	**p < 0.001** (Yes higher)	**p = 0.015** (Yes higher)	NS

Note: NS = Not Significant ($p \geq 0.05$). Significant differences ($p < 0.05$) are highlighted in bold with p-values.

Barriers as Motivators

An unexpected outcome of the study is a positive perceived systemic barrier on affective condition ($\beta = 0.303$, $p < 0.001$) as opposed to the a priori hypothesis of a negative relationship (H2). It does not, therefore, appear that the barriers would rather diminish teaching, such as limited resources, and unclear curriculum guidelines. Such barriers would, therefore, enhance emotional activity—if at all showing resilience or a problem-solving orientation by Hong Kong teachers. This finding is in line with Wu et al. (2022) and Yllana-Prieto et al. (2021) who argue that negative emotions, for example, frustration resulting from systemic challenges, drive teachers to be innovative in their teaching. It is also in line with Thibaut et al. (2019) in that running into barriers leads to seeking professional development on all aspects, thus harboring more positive emotions toward integrated STEM approaches. This indicates that barriers should no longer be perceived as barriers but as motivation in specific educational contexts.

Limited Role of Self-Efficacy

However, self-efficacy showed a relatively weak effect on both affective condition ($\beta = 0.169$, $p = 0.110$) and STEM teaching behaviors ($\beta = 0.236$, $p = 0.076$), so hypotheses H3 and H4 are not supported. This challenges the notion of the TPB that perceived behavioral control is a significant determinant of intentions and behaviors. In the context of Hong Kong, systemic and external factors, such as resource constraints and institutional pressures, may overshadow personal confidence, leaving the question for further research on what contextual factors diminish the role of self-efficacy in STEM education.

Training and Experience Boost Readiness

The demographic analysis further indicates that readiness is more associated with training and experience than with gender and grade. Teachers with training in STEM specificity, experience of coordination, or degree exhibit readiness significantly in most of the constructs with values between 0.012 and <0.001. This finding agrees with that of Mohamad Hasim et al. (2022) which shows that there is a statistically significant effect of professional development on STEM readiness. More senior teachers with over six years of experience show more readiness as well, a finding consistent with that of Song and Zhou (2021) who say that teaching experience enhances perceived competence and teaching beliefs.

Implications

Theoretically, these findings extend the TPB by underscoring the critical role of emotions in educational settings. The strong influence of affective condition suggests that TPB could be enhanced by formally incorporating affective factors, as proposed by Perugini and Bagozzi (2001), making it more applicable to teaching contexts. The positive effect of barriers also challenges the typical view within TPB regarding subjective norms as barriers, thus demanding an in-depth exploration regarding teachers' perception of challenges through, perhaps, the Self-Determination Theory (Ryan & Deci, 2000).

The results practically call for targeted interventions in improving STEM readiness. Schools need to invest in workshops which would create a positive perception of STEM and enhance emotional engagement by offering hands-on activities and group work with peers; thus, STEM teaching would be less daunting. The systemic barriers faced by innovation in education can be reformed by individual creative endeavors with solid institutional support. The gap readiness experienced by novice teachers emphasizes the need for a specific program for non-STEM-background new entrants to guarantee equity across the teaching workforce.

Conclusion

The study informed meaningful insights into the readiness of Hong Kong primary and secondary teachers for STEM education. Key results drove that positive attitudes and emotions toward teacher readiness come as the prime concerning the effective teaching of STEM. While attitudes toward STEM proved to be great pre-requisites in affective readiness for STEM teaching, surprisingly, the same attitudes toward systemic barriers positively influenced affective readiness. This is an indicator that it brings out innovation among the teachers. Readiness was most influenced by training and experience, with STEM-trained teachers and those trained in coordination showing better results in all aspects over their counterparts. Effects of self-efficacy were relatively small, perhaps implying that the environment in Hong Kong is more external. The results direct sought targeted training and affective encouragement in moving STEM education forward, providing a blueprint of how stakeholders may enhance initiatives in STEM for this area.

Limitation and Future Research

The study's limitations warrant careful consideration. The small sample size (n = 119) and the unequal demographics restrict generalizability. In addition, the utilization of convenience sampling may result in bias because the participants are more susceptible to sharing similar educational experiences or views, and therefore may distort the findings. The cross-sectional nature limits the potential for determining causality, offering merely a snapshot of readiness at one moment in time. Additionally, omitting cognitive readiness means an incomplete picture of readiness since this aspect is integral to having a full understanding of readiness. The counterintuitive positive effect of systemic barriers to affective readiness must be scrutinized closely since the underlying mechanisms are not well understood in the absence of qualitative data.

Future research needs to address these limitations using larger, more representative samples to increase reliability and representativeness, with the possibility of stratified sampling to ensure balanced demographic representation. Longitudinal research is recommended to examine the development of readiness over time, with insight into causal processes. The integration of cognitive readiness via rigorous evaluations will provide a comprehensive view of teacher readiness. Furthermore, qualitative research approaches, for instance, interviews or focus group discussions, are necessary to investigate the unforeseen positive effects of challenges and therefore reveal the innate sources of teachers' resilience and motivation. These approaches will enrich the comprehension of readiness in STEM education and therefore advise the development of more effective strategies to support teachers in Hong Kong and beyond.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares the use of QuillBot, an AI-assisted writing tool, solely to proofread and refine the manuscript's language by correcting grammar, spelling, and improving clarity. No other AI technologies were used in preparing this work. All research ideas, design, findings, and analyses are original and based on the author's own efforts. After using QuillBot, the author carefully reviewed and edited the manuscript, taking full responsibility for its content. The tool was only used to enhance language, as English is not the author's first language.

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