Exploring the Reciprocal Relationship Between Teaching Self-Efficacy and Instructional Behaviors in High School Mathematics Education

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ABSTRACT

This study explores the concept of teaching self-efficacy, which refers to a teacher's confidence in their ability to effectively perform tasks related to mathematics teaching quality. Previous research has highlighted the significance of teaching self-efficacy and instructional behavior beliefs in predicting teacher performance. This study examines the reciprocal relationship between teaching self-efficacy and instructional behaviors using quantitative design with structural equation modeling (SEM) to explore this dynamic. We examine how teachers' confidence in their teaching abilities affects their use of efficacy for instructional strategies, efficacy for student engagement, efficacy for classroom management, instructional clarity, instructional support and feedback, Instructional support for student autonomy, instructional support for cooperative learning and how successful implementation of these strategies impacts their self-efficacy. Data were collected from 625 Grade 12 students in Kampong Cham Province, Cambodia, in 2024, based on their perceptions of their mathematics teachers' teaching behavioral. Findings reveal that targeted professional development focused on both instructional strategies and self-efficacy enhancement can lead to significant improvements in teaching. This research provides practical implications for teacher training and support programs aimed at fostering effective mathematics teaching and significance of these findings were discussed in this paper.

Keyword: teaching self-efficacy, instructional behaviors, mathematics teaching outcome

INTRODUCTION

The quality of mathematics education in high schools profoundly impacts students' future academic and professional success. At the heart of this quality lies the intricate interplay between teachers' beliefs in their own teaching abilities self-efficacy and their actual instructional practices. This introduction delves into the reciprocal relationship between teacher teaching self-efficacy and instructional behaviors within the challenging context of high school mathematics (Bandura, 1993). Understanding how these two factors influence each other is crucial for fostering effective teaching, improving student outcomes, and ultimately, enhancing the overall mathematics learning experience. This study explores the relationship between teaching self-efficacy and instructional behaviors in Cambodia's education sector, aiming to enhance the quality of education and lifelong learning. Teaching self-efficacy is the key importance for both effective teaching and teaching instructional behaviors. Among an array of motivational constructs, teaching self-efficacy (TSE) is recognized as a relevant predictor of teacher effectiveness. TSE is directly related to certain aspects on instructional behaviors (IB) (Teig et al., 2019). To this end, using data from the grade 12 high school students in Kampong Cham Province, Cambodia, this explores to analysis under the framework of structural equation modeling to examine in the reciprocal relationship between teaching self-efficacy and instructional behaviors. Specifically, this study aimed to examine whether among high school students demonstrate a different reciprocal relationship between mathematics teaching self-efficacy and mathematics teaching instructional behaviors. This study uses adapted questionnaires to measure teaching self-efficacy and instructional behaviors. Data were collected from 625 grade 12 math high school students in Kampong Cham Province and answers to research question that confirmatory factor analysis (CFA) and used the causal correlational analysis by structural equation modelling (SEM).

Understanding the intricate relationship between teachers' beliefs and their classroom practices is crucial for enhancing educational outcomes, particularly in subjects like mathematics. Here's a recap of the main results and an introduction to the exploration of the reciprocal relationship between teaching self-efficacy and instructional behaviors in high school mathematics education. The significance of self-efficacy, defined as a teacher's belief in their ability to effectively teach, has been consistently linked to positive instructional behaviors and improved student achievement(Lazarides & Warner, 2020). It is a key factor in how teachers approach challenges, implement teaching strategies, and interact with students. The importance of instructional behaviors is an effective instructional behavior, such as clear explanations, engaging activities, and supportive feedback, are essential for fostering student learning in mathematics (Maulana et al., 2016). These behaviors are influenced by various factors, including teachers' beliefs and confidence.

LITERATURE REVIEW

Teaching self-efficacy

As a key component of Bandura's (1999) social cognitive theory, self-efficacy is defined as an individual's belief in their ability to organize and execute actions required to achieve specific goals (Bandura, 1999). Self-efficacy, defined as "beliefs in person's capabilities to organize and execute the courses of action required to produce given attainments teaching perspective". In the context of education, teaching self-efficacy specifically refers to a teacher's confidence in their ability to implement instructional strategies, manage classrooms, and engage students effectively.

Teaching self-efficacy beliefs have been found to predict the effort people put forth, how well they persevere when faced with obstacles, how effectively they monitor and motivate themselves, what they achieve, and the choices they make in life (Bandura & Wessels, 1997; Bandura, 1999). For this reason, research have been devoting considerable attention to how teaching self-efficacy influences the instructional behaviors, learning motivation and learning approaches, focus on an enhance individuals in academic settings (Usher & Kober, 2012).

The construct of teaching self-efficacy is divided into three subconstructs: (a) efficacy for instructional strategies (i.e., confidence in applying effective teaching strategies) (Tschannen-Moran et al., 2001) (Tschannen-Moran & Woolfolk Hoy, 2002), (b) efficacy for classroom management (i.e., confidence in managing the classroom) (Tschannen-Moran et al., 2001, 2007), and (c) efficacy for student engagement (i.e., confidence in engaging students in learning tasks) (Tschannen-Moran & Woolfolk Hoy, 2002) . According to (Williams & Rhodes, 2016), teachers can build their teaching self-efficacy through four sources of information: mastery experiences, vicarious experiences, verbal persuasion, and physiological arousal.

Mastery experiences, provided through direct teaching experience, are no doubt a source of teaching self-efficacy. Besides mastery experiences, studies found that vicarious experiences are also a source of teaching self-efficacy (Tschannen-Moran et al., 2007). Vicarious experiences are also provided through practical teaching experience, but in a less direct way in which teachers learn from observing models of teaching. While there is a general belief that mastery experiences exert greater impact on teacher's teaching self-efficacy than vicarious experiences, even though both sources share practical teaching in nature, studies on their impacts revealed that these sources impact experienced and novice teachers differently (Tschannen-Moran et al., 2007). Verbal persuasion has to do with verbal interactions that a teacher receives about his or her performance and prospects for success from important others in the teaching context, such as administrators, colleagues, parents, and members of the community at large (Tschannen-Moran et al., 2007). Psychological and emotional arousal also adds to a feeling of capability or incompetence. The feelings of joy or pleasure a teacher experiences from teaching a successful lesson may increase her sense of efficacy, yet high levels of stress or anxiety associated with a fear of losing control may result in lower self-efficacy beliefs (Tschannen-Moran et al., 2007).

According to self-efficacy theory (Bandura, 1999), past experiences of success or failure impact people's self-efficacy (Williams & Rhodes, 2016). In this sense, teachers' successful teaching experiences strengthen their teaching self-efficacy whereas their failed teaching experiences weaken it. Indeed, mastery experiences are the most influential teaching self-efficacy source (Da'as et al., 2021), which is supported by several studies (Fackler et al., 2021). SDT-based learning environments seem to encourage the development of teaching self-efficacy of teachers. In SDT, people are not motivated to take actions until their fundamental needs for autonomy, competence, and relatedness are met (Ryan, 2024), whereas, in self-efficacy theory, people do not perform actions unless they believe that they are capable to do so (Williams & Rhodes, 2016). However, how a social context fulfils people's needs is likely to foster their self-efficacy. For instance, positive feedback provided to satisfy the need for competence (Ryan & Deci, 2024) can also function as the verbal persuasion source of self-efficacy (Da'as et al., 2021). In this respect, teachers can enhance their teaching self-efficacy when their teacher educators provide constructive feedback to support their need for competence (Pitkäniemi et al., 2024);. Another relationship between the two motivational theories can be seen when teacher educators support teachers' need for relatedness through promoting cooperative learning. In so doing, teachers can engage in group work, peer discussion, peer teaching, and peer feedback, which results in the four sources of teaching self-efficacy (Sabanci et al., 2023). However, little is known about how SDT-based instructional behaviors improve teachers' teaching self-efficacy (Bandura, 1999). Researchers have extensively examined the impact of teaching self-efficacy on instructional behaviors, student motivation, and academic performance (Usher & Kober, 2012).

Instead of merely listing these constructs, briefly discuss their significance efficacy for instructional strategies reflects a teacher's ability to adapt lessons to students' needs, ensuring effective knowledge transfer. Efficacy for classroom management involves maintaining order and fostering a conducive learning environment. Efficacy for student engagement pertains to motivating and actively involving students in the learning process (Tschannen-Moran & Woolfolk Hoy, 2002) .

Instructional behaviors

Instructional behaviors are teaching styles or physical education utilizes effective teaching as the underpinnings of appropriate instruction behaviors and, ultimately student learning action (Borich, 1974) . Defines an effective physical education teacher as one who: meets the unique needs of all learners by selecting from a wide variety of instructional approaches that are student centered, provides maximal opportunity to practice tasks, teaches in small groups of students, limits competition, and utilizes appropriate amounts and types of equipment and space to promote self-directed learning (Morris, 2019). One theory that has been linked to students' motivation for learning is self-determination theory (SDT) (Ryan, 2024), which posits that people are motivated to take actions towards psychological growth when they perceive that their basic psychological needs for autonomy (i.e., a sense of ownership in their actions or behaviors), for competence (i.e. the feeling of mastery), and for relatedness (i.e. a sense of belonging and connectedness) are satisfied (Ryan, 2024). The construct of instructional behavior is divided into four subconstructs: (a) instructional clarity (e.g., instructional clarity is one of the most important prerequisites for instructors to engage in teaching activities, and it is a critical component of effective teaching (Blaich et al., 2016), Instructional clarity was defined as a teacher's ability to explain or otherwise assist students in thoroughly understanding the material (Blaich et al., 2016), (Metcalf & Education, 1992), (Maulana et al., 2020). This study refers to the teaching that is easy to understand in terms of clear responses to students' queries, linking new lessons to past knowledge, and attempting to integrate what is taught with students' daily experiences in mathematics class. In this sense, instructional clarity in the current study also contains teachers' activation of students' thinking. (b) instructional support and feedback (e.g., active process where a teacher provides guidance, assistance, and constructive criticism to students during their learning process (de Kleijn & Education, 2023), (c) Instructional support for student autonomy (e.g., teaching practices that actively encourage students to take ownership of their learning by providing choices, explaining rationales behind tasks, soliciting student input,

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and fostering a classroom environment where students feel empowered to make decisions and manage their learning process, ultimately leading to greater intrinsic motivation and engagement (Stefanou et al., 2004), (Elliot et al., 2020), (Skinner et al., 2008). Student motivation revolves around the concept of intentionality (Ryan & Deci, 2020). An intention is a determination to engage in a particular behavior, and it is equivalent to being motivated to act. An example of a student's intention to act might be "I intend to write my paper." Such an intention sometimes originates from within and is fully endorsed by the student's sense of self. When this is so, intentions reflect high autonomy and are associated with autonomous types of motivation (e.g., intrinsic motivation and identified regulation in self-determination theory (Ryan & Deci, 2020). (d) Instructional support for cooperative learning (e.g., actively structuring groups, assigning clear roles, monitoring student interactions, providing feedback, teaching necessary social skills, and facilitating group processing to ensure all students contribute and learn effectively from each other within collaborative environments (Biggs & Rossi, 2021) (Jackson, 2017) (Johnson & Johnson, 2017). Instructional behavior is the way a teacher interacts with students in the classroom to help them learn. It includes how the teacher manages the classroom, how clear their instructions are, and how they distribute control over learning activities (de Kleijn & Education, 2023).

Present study and research questions

This study analyzed the relationship between the perceived teaching self-efficacy reported levels of instructional behaviors. According to the literature, these educational variables have already been researched in the teacher education context, but in separate studies. There should be further research that analyses the relationship between teaching self-efficacy and instructional behaviors related variables simultaneously, especially in developing countries. Furthermore, although previous studies have yielded positive results concerning the associations between these variables, most of them represent the context of developed countries. Results might be different across cultural settings because teaching self-efficacy is context specific. The association between teachers' teaching self-efficacy and instructional behaviors should also be investigated. According to (Hopwood et al., 2024), teachers' successful experiences in understanding science concepts and science teaching techniques significantly contribute to their teaching self-efficacy. These successful learning experiences might be gained through their learning behaviors that are led by curiosity, mastery learning, and challenging learning tasks. Hence, it is possible that how teachers are motivated to learn course content would influence their teaching self-efficacy. Accordingly, we wanted to examine how teacher educators' instructional behaviors, measured through instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning, are associated with teachers' learning motivation and teaching self-efficacy (see **Figure 2**).

Our study addressed the following research questions:

1. What is the relationship between measures of teaching self-efficacy and instructional behaviors? (See answer in **figure 2**)

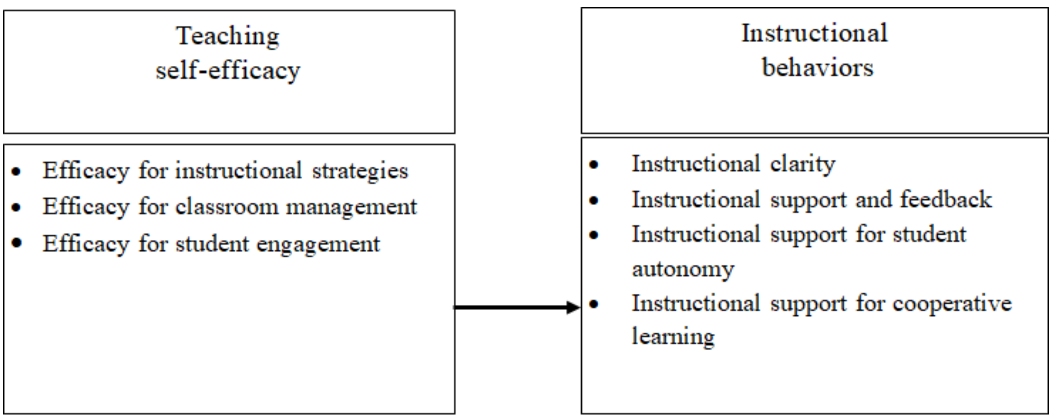

Figure 1. Conceptual model for the relationship between teaching self-efficacy and instructional behaviors.

METHOD

Participants

Selected 625 students for expression their opinion the scale on questionnaire and use correlational design, the sample size is determined based on the recommendation by Hair (Hair et al., 2020). Analysis method is use by confirmatory factor analysis (CFA) and structural equation modelling (SEM).

Measures

The study measured teaching self-efficacy using subconstructs including three dimensions efficacy for instructional strategy, efficacy for classroom management, and efficacy for student engagement (Tschannen-Moran et al., 2001; Tschannen-Moran & Woolfolk Hoy, 2002). Instructional behaviors were assessed using dimensions such as instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning (Hattie & Timperley, 2007; Jang et al., 2010; Johnson & Johnson, 2008)

Measurement of Teaching Self-Efficacy

The measuring each subconstruct of teaching self-efficacy (i.e., teachers' efficacy for instructional strategy, efficacy for classroom management, efficacy student engagement) (Tschannen-Moran et al., 2001; Tschannen-Moran & Woolfolk Hoy, 2002)

Measurement of Instructional Behaviors

The measuring each subconstruct of instructional behaviors (i.e., teacher's instructional charity, instructional support and feedback, instructional support for student autonomy, instructional support for cooperative learning (Blaich et al., 2016; Chan et al., 2023; DeMonbrun et al., 2017; Maulana et al., 2021; Metcalf & Education, 1992).

Measurement tools:

Commonly used tools include the Study Process Questionnaire (SPQ) (Biggs et al., 2001; Biggs, 1978) , the Learning Process Questionnaire (LPQ) (Biggs et al., 2001; Biggs, 1978). First, the original scales in English were adapted by the researchers and then translated into Khmer by two bilingual Cambodian researchers. Using the translated version, we translated the scales back into English. Before data collection, we compared the Khmer and the English versions of the scales to see if each item was able to match the initial meaning and check with validity (content validity, face validity).

Khmer version of the scales was applied to 36 grade 12 students answer with 63 items to evaluate by pilot test validity and reliability of each item and met face to face with each 36 students to get feedback after answer the all questionnaires. Second, the Khmer version of the scales was applied to 625 grade 12 students answer with 63 items in different high schools in Kampong Cham province (Private, Public School, Urban and Non-urban). Private school (1=36), public school = (7) Urban (4=347), non-urban (3=242).

Main Data Collection and Validation Procedures

Data collection will be check with validity by construct validity (convergent validity, divergent/discriminant validity), factor analysis. Third, after consulting with validity, and then consulting with internal consistency reliability (Cronbach's Alphas, construct/composite reliability) and structural equation modelling (SEM). In this study, we used a self-report method to assess subjective perceptions of the items in each adapted scale, which might lead to response bias. In all the scales, students had to rate each item on a 5-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree").

To make the subconstructs fit into the Cambodian teacher context and to check the construct validity of the model, confirmatory factor analysis (CFA) was conducted. Before the CFA, we checked for normal distribution and multicollinearity. The normal distribution of the data was measured by the skewness and kurtosis of each item (Cohen et al., 2018), (Hair et al., 2024). The most commonly used values for skewness and kurtosis are −1 to +1 and −1.96 to +1.96, respectively (Hair et al., 2024). In this study, the skewnesses and kurtoses of all the items used ranged between -0.01 and + 0.03 and between -0.03 and +0.03, respectively. The multicollinearity occurs when the intercorrelation between variables or items is higher than 0.83 (Kline, 2024).The Shapiro-Wilk test and Kolmogorov Smirnov test, but for sample smaller then 300; Sig.> .05= normal distribution and Z score are -3 and +3= no outliers (Kline, 2024). The multicollinearity occurs when the intercorrelation between variables or items is higher than 0.90 (Kline, 2024). The intercorrelations in the present study ranged between 0.08 and 0.71, which eliminates multicollinearity problems. According to (Hair et al., 2024), construct validity is ensured by assessing convergent and discriminant validities. In so doing, the average variance extracted (AVE), maximum shared variance (MSV), and average shared variance (ASV) were calculated and compared. The AVE should be 0.50 or higher to suggest adequate convergent validity, which means that a set of measured items share a high proportion of variance in the same construct, and the AVE should be greater than the MSV and the ASV to ensure acceptable discriminant validity, which means that the construct is distinct from other constructs (Hair et al., 2024). In this study, the AVEs for the subconstructs were greater than 0.50 and the AVE for each subconstruct was also higher than its MSV and ASV. Moreover, cross-loadings were not allowed to ensure dimensionality and 36 items with factor loadings of lower than 0.50 were removed for desirable internal consistency (Hair Jr et al., 2019). The standardized loadings for the items used ranged between 0.56 and 0.86, exceeding the suggested threshold of 0.50, and the construct reliabilities of the subconstructs ranged between 0.83 and 0.90, exceeding the suggested threshold of 0.70 (Hair Jr et al., 2019).

Reliability and Validity Testing

The CFA results revealed that the measurement model fitted the empirical data very well, $\chi 2$ Baseline model =7710,775, Factor Model = 889,557, $p < 0.001$, Comparative Fit Index (CFI) = 0.954, Tucker-Lewis Index (TLI) = 0.959, Bentler-Bonett Non-normed Fit Index (NFI) = 0.949, Parsimony Normed Fit Index (NFI) = 0.883, Bollen's Relative Fit Index (RFI) = 0.872, Bollen's Incremental Fit Index (IFI) = 0.954, Relative Non-centrality Index (RNI) = 0.954, (RMSEA)=0.030, (RMSEA 90% CI lower bound)=0.026, (RMSEA 90% CI upper bound)=0.034, (RMSEA p-value)=1.000, Standardized root mean square residual (SRMR)= 0.038, Hoelter's critical N (α = .05)=438.574, Hoelter's critical N (α = .01)= 455.864, Goodness of fit index (GFI)= 0.995, McDonald fit index (MFI)= 0.770, Expected cross validation index (ECVI)= 1.852. The SEM results revealed that the measurement additional fitted indices the empirical data very well, Hoelter Critical N (CN), α=0.05=377.897, Hoelter Critical N (CN), α=0.01=393.589, Goodness of Fit Index (GFI)= 0.918, Adjusted Goodness of Fit Index (AGFI)= 0.900, McDonald Fit Index (MFI)= 0.710, Expected Cross-Validation Index (ECVI)= 1.874, Loglikelihood user model (H0) = -26788.812, Loglikelihood unrestricted model (H1) = -26317.113, indicating that the ten subconstructs could match the Cambodian teacher education context.

Teaching self-efficacy

Measures of teaching self-efficacy were adapted from (Skaalvik & Skaalvik, 2016; Tschannen-Moran et al., 1998) (see Appendix A). We tapped teachers' teaching self-efficacy through their perceived efficacy for instructional strategies (5 items, e.g., "my math teacher uses a satisfying teaching method", SD = 0.491, α = 0.620), perceived efficacy for classroom management (5 items, e.g., "My math teacher can control my annoying behavior with other students.", SD = 0.498, α = 0.636), and perceived efficacy for student engagement (5 items, e.g., "My math teacher helps me and other students understand the value of learning", SD = 0.561, α = 0.682). The construct reliabilities for efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement were SD = 0.491, α = 0.620, SD = 0.498, α = 0.636, SD = 0.561, α = 0.682, respectively.

Instructional behaviors

Our measures of instructional behaviors were adapted from multiple studies (Cabrera et al., 2001; Feldman, 1986; Heng & Practice, 2014; Lam et al., 2007; Marsh et al., 2006; Marsh et al., 2012; Norton et al., 2005; Tani et al., 2021) (see Appendix B). We assessed instructional behaviors through teachers' perceptions of teacher educators' instructional clarity (5 items, e.g. "My math teacher explained the purpose of the lesson clearly", SD = 0.529, α = 0.587) (Norton et al., 2002); instructional support and feedback (5 items, e.g. "My math teacher advises me when I have a problem with lesson content or homework.", SD = 0.627, α = 0.558) (Heng, 2014), instructional support for student autonomy (5 items, e.g. "mathematics teacher accept student suggestions when designing assignments", SD = 0.739α = 0.564) (Lam & Aman, 2007), and instructional support for cooperative learning (5 items, e.g. "My math teacher discusses ideas with me and the other students in the group.", SD = 0.504, α = 0.673) (Tani et al., 2021). The construct reliabilities for instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning were SD = 0.529, α = 0.587, SD = 0.627, α = 0.558, SD = 0.739α = 0.564, SD = 0.504, α = 0.673, respectively.

Table 1. Descriptive statistics and Pearson's correlations between latent variables (N = 652).

	EIS	ECM	ESE	IC	ISF	ISSA	ISCL
EIS	—						
ECM	0.233***	—					
ESE	-0.028	0.021	—				
IC	0.286***	0.348***	-0.062	—			
ISF	0.322***	0.283***	-0.061	0.488***	—		
ISSA	0.381***	0.267***	-0.069	0.400***	0.553***	—	
ISCL	-0.031	0.004	0.388***	-0.045	-0.083*	-0.068	—

Note: EIS = Efficacy for instructional strategies, ECM = Efficacy for classroom management, ESE = Efficacy for student engagement, IC = Instructional clarity, SF = Support and feedback, AS = Autonomy support, SCL = Support for cooperative learning, Note. * p < .05, ** p < .01, *** p < .001

Data analysis

Structural equation modelling was conducted to examine the relationship between aspects of teaching self-efficacy and aspects of teaching instructional behaviors. We judged model fit using chi-square (χ2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), standardized Root Mean

Squared Residual (SRMR), and Root Mean Squared Error of Approximation (RMSEA) (Goodboy & Kline, 2017; Hair & Alamer, 2022; Hair et al., 2021; Hair Jr et al., 2021; Hu & Bentler, 1999). With sample sizes of more than 250 and observed variables of 30 or more, the characteristics of model fit are chi-square with significant *p* values, CFI or TLI of above 0.95, SRMR of 0.38 or less with CFI above 0.95, and RMSEA of less than 0.30 with CFI of 0.95 or higher Hair (Hair et al., 2021; Hair Jr et al., 2021; Hu & Bentler, 1999) , suggest that CFI of 0.95 or higher and SRMR of 0.30 or less never reject a correct model. CFI of higher than 0.94 and SRMR of less than 0.06 indicate excellent model fit; CFI of 0.94 to 0.95 and SRMR of less than 0.27 indicate excellent model fit; and CFI of 0.94 to 0.95 and SRMR of 0.031 to 0.038 demonstrate acceptable model fit

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(Smith & McMillan, 2001). RMSEA of less than 0.031 indicates excellent model fit and RMSEA below 0.038 demonstrates acceptable model fit (Goodboy & Kline, 2017).

To address our research questions, we assessed the direct path coefficients between three subconstructs of teaching self-efficacy and five instructional behaviors.

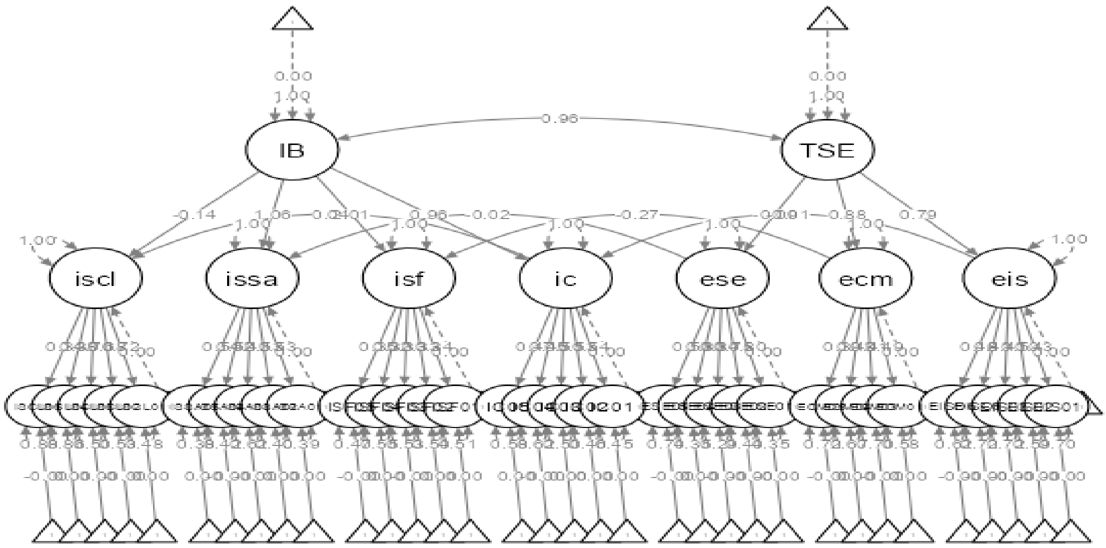

Figure 2. Standardized coefficients for model the relations between their perceptions of teaching self-efficacy (teachers' efficacy for instructional strategy, efficacy for classroom management, efficacy student engagement) and instructional behaviors (teacher's instructional charity, instructional support and feedback, instructional support for student autonomy, instructional support for cooperative learning), N=652

Note. * p < .05, ** p < .01, *** p < .001

RESULTS

Table 1. Descriptive statistics and Pearsons, flag significant correlations between sub-constructs of TSE and IB (EIS = Efficacy for instructional strategies, ECM = Efficacy for classroom management, ESE = Efficacy for student engagement, IC = Instructional clarity, SF = Support and feedback, AS = Autonomy support, SCL = Support for cooperative learning, Note. * p < .05, ** p < .01, *** p < .001). Figure 1 Conceptual model for the relationship between teaching self-efficacy and instructional behaviors. Figure 2. Standardized coefficients for model the relations between their perceptions of teaching self-efficacy (teachers' efficacy for instructional strategy, efficacy for classroom management, efficacy student engagement) and instructional behaviors (teacher's instructional charity, instructional support and feedback, instructional support for student autonomy, instructional support for cooperative learning), N=652. Table 2. presents the significant direct and indirect effects of teaching self-efficacy on instructional behaviors. As shown in Table 2, the perception of efficacy for instructional strategy, efficacy for classroom management, efficacy student engagement was positively associated with teachers' instructional behaviors (ß = 0.89). The perception that teacher educators promote cooperative learning was associated positively with teachers' instructional charity, instructional support and feedback, instructional support for student autonomy, instructional support for cooperative learning (ß= 0.84). Among the four measures of efficacy for instructional strategy, efficacy for classroom management, efficacy student engagement while instructional charity, instructional support, feedback, instructional support for student autonomy was the most important determinant of instructional support for cooperative learning. The overall fit of the final model was excellent $\chi2$ (7710,77, Factor Model = 889,557, *p* < 0.001, (CFI) = 0.954, (TLI) = 0.959, (NFI) = 0.949, Parsimony Normed Fit Index (NFI) = 0.883, Bollen's Relative Fit Index (RFI) = 0.872, (IFI) = 0.954, Relative Non-centrality Index (RNI) = 0.954, (RMSEA)=0.030, (RMSEA 90% CI lower bound)=0.026,

(RMSEA 90% CI upper bound)=0.034, (RMSEA p-value)=1.000, Standardized root mean square residual (SRMR)= 0.038, Hoelter's critical N (α = .05)=438.574, Hoelter's critical N (α = .01)= 455.864, (GFI)= 0.995, (MFI)= 0.770, (ECVI)= 1.852. The SEM results revealed that the measurement additional fitted indices the empirical data very well, Hoelter Critical N (CN), α=0.05=377.897, (CN), α=0.01=393.589, (GFI)= 0.918, (AGFI)= 0.900, (MFI)= 0.710, (ECVI)= 1.874, Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Perceptions of instructional strategies, efficacy for classroom management, and efficacy for student engagement were positively correlated with perceptions of instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning respectively.

Table 2. Direct, indirect, and total associations for Figure 2.

				95% C.I. (β)				
Type	Effect	Estimate	SE	Lower	Upper	β	z	p
Indirect	Efficacy for instructional strategies ⇒ Instructional support feedback ⇒ Instructional clarity	0.09618	0.01800	0.06091	0.13146	0.08922	5.3446	9.06e0-8
	Efficacy for instructional strategies ⇒ Instructional support student autonomy ⇒ Instructional clarity	0.04694	0.01589	0.01580	0.07808	0.04354	2.9542	0.00314
	Efficacy for instructional strategies ⇒ Instructional support cooperative learning ⇒ Instructional clarity	-1.72e−4	8.61e-4	-0.00186	0.00152	-1.60e−4	-0.2002	0.84135
	Efficacy for classroom management ⇒ Instructional support feedback ⇒ Instructional clarity	0.07807	0.01646	0.04581	0.11033	0.07341	4.7433	2.10e0-6
	Efficacy for classroom management ⇒ Instructional support student autonomy ⇒ Instructional clarity	0.02626	0.00985	0.00696	0.04556	0.02470	2.6672	0.00765
	Efficacy for classroom management ⇒ Instructional support cooperative learning ⇒ Instructional clarity	8.64e-6	3.17e-4	-6.12e−4	6.29e-4	8.12e-6	0.0273	0.97822
	Efficacy for student engagement ⇒ Instructional support feedback ⇒ Instructional clarity	-0.01802	0.01172	-0.04100	0.00496	-0.01912	-1.5368	0.12435
	Efficacy for student engagement ⇒ Instructional	-0.00785	0.00509	-0.01783	0.00214	-0.00833	-1.5403	0.12348

	support student autonomy ⇒ Instructional clarity							
	Efficacy for student engagement ⇒ Instructional support cooperative learning ⇒ Instructional clarity	0.00285	0.01321	-0.02305	0.02874	0.00302	0.2154	0.82947
Direct	Efficacy for instructional strategies ⇒ Instructional clarity	0.08873	0.03948	0.01134	0.16611	0.08230	2.2471	0.02463
	Efficacy for classroom management ⇒ Instructional clarity	0.21366	0.03755	0.14006	0.28725	0.20092	5.6900	1.27e0-8
	Efficacy for student engagement ⇒ Instructional clarity	-0.03587	0.03405	-0.10261	0.03086	-0.03807	-1.0536	0.29208
Total	Efficacy for instructional strategies ⇒ Instructional clarity	0.23168	0.04047	0.15236	0.31099	0.21490	5.7252	1.03e0-8
	Efficacy for classroom management ⇒ Instructional clarity	0.31800	0.03991	0.23978	0.39621	0.29904	7.9683	1.55e-15
	Efficacy for student engagement ⇒ Instructional clarity	-0.05889	0.03441	-0.12633	0.00855	-0.06249	-1.7116	0.08698

Note. Confidence intervals computed with method: Standard (Delta method)

Note. Betas are completely standardized effect sizes

*p < .05; **p < .01.

DISCUSSION

This study examined the relationship between perceived teaching self-efficacy (instructional strategies, classroom management, and student engagement) and teachers' self-reported instructional behaviors (instructional clarity, support and feedback, autonomy support, and cooperative learning support). As previously discussed, few studies have examined the impact of teaching self-efficacy on instructional behaviors. Furthermore, research on the direct relationship between teaching self-efficacy and instructional behaviors remains limited.

We found teaching self-efficacy play a significant role in instructional teachers' behaviors to educators during their education course. Consistent with the results of prior studies (Black & Deci, 2000; Ciani et al., 2014; Federici et al., 2015; Jurik et al., 2014; Lazarides et al., 2020), we found that teachers are intrinsically motivated to learn in a learning context where teacher provide instructional strategies, efficacy for classroom management, and efficacy for student engagement and clear instruction, instrumental support and constructive feedback, autonomy support, and support for cooperative learning. Among these instructional behaviors, however, instructional support and feedback appeared to be the most important predictor of intrinsic learning motivation. This might be because teacher educators' provision of instrumental support and constructive feedback could help teachers to effectively learn the content taught and complete their assignments. If so, their need for competence or effective learning was directly supported, which subsequently drove their teaching behaviors towards their curiosity, mastery learning, and challenging learning tasks. We also found that instructional clarity exerts a significant and positive effect

Limitations and suggestions for future research

Like most studies, this study had some practical limitations. First, perceptions of teaching self-efficacy and instructional behaviors did not come directly from teacher educators, but from teachers. Future research should take both teacher educators' and teachers' perceptions to avoid subjective responses regarding teaching self-efficacy and instructional behaviors. Second, the respondents in this study were math teachers in Kampong Cham Province, Cambodia, which might lead to a conclusion issue. Thus, replication studies should be conducted with grade 12 math teachers. Third, teachers' academic achievement has been found to be an outcome of their learning motivation (Rivkin et al., 2005) and a predictor of their teaching self-efficacy (Chesnut & Burley, 2015). However, it was not included into the model in this study. Further research should take into account teachers' academic achievement to see if it can mediate the relationship between behaviors of teaching self-efficacy and instructional behaviors. Finally, this study is a correlational research design involving quantitative data. Thus, to gain greater insight into the improvement behaviors of teaching self-efficacy and instructional behaviors among teachers, an experimental research design followed by deep interviews should be used to investigate the effects of such instructional behaviors on these self-efficacy outcomes.

CONCLUSION AND SUGGESTIONS FOR PRACTICAL IMPLICATIONS

This study broadens the understanding of determinants of teaching self-efficacy and instructional behaviors among teachers. Our study found that teachers' efficacy for instructional strategies, efficacy for classroom management, efficacy for student engagement. Teachers' instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning have significant and positive influences on teachers' intrinsic teaching motivation. Our findings also show that these teaching self-efficacy and instructional behaviors directly and indirectly contribute to efficacy for instructional strategies, efficacy for classroom management and efficacy for student engagement, instructional clarity, instructional support and feedback, instructional support for student autonomy, and instructional support for cooperative learning. This research suggests that a teaching context that supports teachers' basic psychological needs for autonomy, competence, and relatedness motivates them to effectively teaching significantly enhances their teaching self-efficacy and instructional behaviors.

These findings highlight the need for integrating the above teaching self-efficacy and instructional behaviors into teacher education programs, in order to improve the quality of instruction. In this sense, teachers' learning motivation and teaching self-efficacy should receive greater attention in that these motivational outcomes lead to their teaching and career success. To enhance these outcomes, we recommend that teacher educators should (1) efficacy for instructional strategies (i.e., confidence in applying effective teaching strategies) (2) efficacy for classroom management (i.e., confidence in managing the classroom) (3) efficacy for student engagement (i.e., confidence in engaging students in learning tasks) (4) instructional clarity, (5) instructional support and feedback, (6) instructional support for student autonomy (7) instructional support for cooperative learning. Therefore, teacher education programs should take into account a learning environment that stresses autonomy support, structure, and involvement so as to encourage the establishment of effective teachers for the education system.

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APPENDIX

A. Teaching Self-Efficacy

Efficacy for instructional strategies

In my future classes…………………

- My math teacher uses a satisfying teaching method
- My math teacher has prepared enough teaching materials
- My math teacher inspires me to work together
- My math teacher explains again and again when I and other students do not understand the lesson
- My math teacher asked me questions to motivate me to learn.
- My math teacher can answer my difficult questions with other students

Efficacy for classroom management

In my future classes, . . .

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- My math teacher can control my annoying behavior with other students
- My math teacher led me and other students to obey the classroom rules.
- My math teacher can control emotions when there is a disturbance or a loud noise in the classroom
- My math teacher can control me and other students who disrupt learning
- My math teacher creates a friendly atmosphere in the classroom for me and all students

Efficacy for student engagement

In my future classes, . . .

- My math teacher encourages me and other students who are less interested in learning to re-learn.
- My math teacher helps me and other students understand the value of learning
- My math teacher, can control his emotions when I feel tired of the lessons
- My math teacher gave me the confidence to do my homework well
- My math teacher motivates me to improve my learning weaknesses

Appendix B. Instructional Behaviors

Instructional clarity

In this education course, . . .

- My math teacher explained the purpose of the lesson clearly
- My math teacher explained the content of lesson clearly
- My math teacher explains exactly how to do homework
- My math teacher uses good examples to explain the content lesion and homework assignments
- My math teacher explained the main concepts or theories clearly

Instructional support and feedback

In this education course, . . .

- My math teacher advises me when I have a problem with lesson content or homework
- My math teacher monitoring me and other students to see that we really learned the lesson contents
- My math teacher gives me feedback to motivate me to study hard
- My math teacher gives me constructive feedback on homework
- My math teacher provided feedback that could improve my learning process

Instructional support for student autonomy

In this education course, . . .

- My math teacher decides with me that I should learn
- My math teacher gives me priority in deciding on teamwork
- My math teacher allows me to choose tasks that suit my personal interests
- My math teacher gives me more than one task so I can choose to do what they want to do
- My math teacher accepts my suggestions when I do my homework

Instructional support for cooperative learning

In this education course, . . .

- My math teacher discusses ideas with me and the other students in the group
- My math teacher tried to understand my ideas and the other students in the group
- My math teacher coaches me and the students in the group when we have problems with content, lessons and homework
- My math teacher inspires me to connect with other team members
- My math teacher cooperates with me to elect a team representative for the presentation