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Mediating effect of mathematics cognitive domain in the relationship between mathematics self-efficacy and mathematics achievement

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Abstract

The aim of the current study is to investigate the relationship between mathematics self-efficacy and mathematics achievement through cognitive domain as mediator. The sample of the study consisted of 374 eighth-grade students, 180 females and 194 males from the Sultanate of Oman. A partial least squares structural equation modeling used to analyze the data. The findings of current study revealed that self-efficacy has a direct effect on mathematics achievement, and indirect effect through cognitive domain. Cognitive domain partially mediate the relationship between self-efficacy and mathematical achievement.

Keywords: cognitive domain, mathematics self-efficacy, mathematics achievement

INTRODUCTION

Mathematics is one of the essential subjects in the school, whereby it is a matchless subject, and an integral part of the school curriculum (Gafoor & Kurukkan, 2015). Also, it is one of the thinking tools, which promote the students to use their minds to think deeply and logically around the phenomenon surrounding them (Ihendinihu, 2013). Although mathematics is of great significance in life, students find it difficult to absorb the subject. This has led to students' poor achievement in the field of mathematics, which remains a major concern worldwide. Hence, educators, politicians, and decision-makers have sought reforms for improving students' achievements in mathematics, identifying it as a priority. Scholars have carried out numerous studies in the field of mathematics education (Karigi, 2015), specifically on poor achievement in mathematics and ways to resolve this issue (Daso, 2013; Mbugua et al., 2012), in an attempt to develop achievement in mathematics.

Poor academic performance is defined "as a school achievement below the expected for a given age, cognitive skills, and schooling" (Siqueira & Gurge-Giannetti, 2011, p. 79). Poor academic performance in mathematics returns to countless of reasons entwined, two of these factors are cognitive domain and self-efficacy (Marat, 2005).Where, academic performance is affected by both self-efficacy and cognitive domain (Vrugt et al., 1997). Self-efficacy is the belief in one's abilities to accomplish, organize and perform a task successfully (Ersanlı, 2015). Thus, self-efficacy has the ability to have influence on the confidence of the students in their belief about their capabilities. Accordingly, this generates confidence among students to understand lessons, to solve educational problems, and to select the most difficult courses. Moreover, "perceived self-efficacy influences level of performance by enhancing intensity and persistence of effort" (Bandura et al., 1977, p. 125). Hence, engaging students in lessons and facing difficulties learning and overcome, help them to achieve high level of academic performance (Safaria & Ahmad, 2013). Therefore, raising the level of students' self-efficacy beliefs are significant for uplifting their academic performance (Jungert & Rosander, 2010). On the other hand, low self-efficacy beliefs lead to poor academic performance (McCullers, 2009). People with low self-efficacy are doubted their capabilities; hesitate from difficult tasks, give up quickly in the face of difficulties, and while facing the difficult tasks, they concentrate on the hindrances they will encounter, and all types of contrary outcomes rather than concentrate on how to perform successfully (Bandura, 1994). Self-efficacy also has a positive relationship with the cognitive domain (Jongen et al., 2015). Self-efficacy shows that intellectual confidence that might affect the cognitive learning abilities and understanded learning abilities of a person (Kang et al., 2019).

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Contribution to the literature

- This study uniquely enhances our understanding of the indirect relationship between mathematics self-efficacy and mathematics achievement through cognitive domains.
- The current study found that mathematics self-efficacy partially indirectly influences mathematics achievement, suggesting that partial mediation highlights the importance of an intermediate variable in explaining the overall effect.
- The proposed model in the current study serves as a practical tool to enhance math performance by leveraging sources of self-efficacy—mastery experience, vicarious experience, verbal persuasion, and emotional state—to influence various cognitive domains, which subsequently improve student achievement.

Cognitive domain is the thinking skills for processing information, constructing meaning, and applying knowledge (Apple & Ellis, 2015). It involves knowledge and the development of intellectual skills (Sulaiman et al., 2017). Through cognitive domain, students learn main skills which enable them to deal with knowledge, its comprehension, application and creation (Hielkema et al., 2012). Bloom identified main the levels of cognitive domain as sides of learning mathematics (Son et al., 2017), where learners go up across every level of the Bloom's taxonomy, beginning from simple learning, to gaining deeper knowledge on a subject, with every level essential to the development of the following (Persaud, 2018). This in turn to increase the level of students' academic performance, where the cognitive domain has a positive relationship with academic performance (Chowdhury & Shahabuddin, 2007; Maraghi et al., 2018).

In contrast, the literature stated conflict in the point of view regarding the relationships between each of mathematics self-efficacy, mathematics achievement, and cognitive domain, where Oyuga et al. (2019) stated that self-efficacy beliefs impact on the education surroundings for school-age kids, and students who were additional self-efficacious were capable of execute at advanced levels than those with lesser levels of self-efficacy beliefs, irrespective of cognitive capability. Also, Bouffard-Bouchard et al. and Gunderson et al. (as cited in Oyuga et al., 2019) stated that self-efficacy and cognitive capability are separate constructs of one another. Although, an individual's feeling of efficacy can enhance cognitive achievement through cognitive, affective, or motivational processes (Zahodne et al., 2015). As well as self-efficacy shows that intellectual confidence may affect the cognitive learning abilities of a person (Kang et al., 2019).

Moreover, several studies have been conducted on self-efficacy, and cognitive domain to investigate their role in increasing the level of a student's performance. For instance, according to DeCoster (2017), academic self-efficacy is a major operator of motivation, which leads to cognitive education processes (Slavin, 2010); cognitive capabilities further exemplify the founding factor of education and action achievement (Kanfer & Ackerman, 1989). However, according to the literature review, the role of the mechanisms of cognitive domain as mediator between the relationship of mathematics self-efficacy and mathematics achievement, has not been presented in earlier works.

The current study will introduce an explanation of how self-efficacy contributes to the development of students' achievement in mathematics by examining the relationships between self-efficacy, the cognitive domain, and mathematical achievement. In addition, it will explain the potential role of the cognitive domain in the relationship between mathematics self-efficacy and mathematics achievements, as well as the relationships between these variables and each other. Where, understanding the potential indirect relationship between mathematics self-efficacy and mathematics achievement through the cognitive domain is significant for all who are interested in teaching and learning mathematics. This is because it will provide a basis for how all these variables work with each other, namely self-efficacy, cognitive domain, and mathematical achievement, in order to enhance students achievement in mathematics.

LITERATURE REVIEW

Self-Efficacy

Self- efficacy is defined "a personal belief in one's capability to organize and execute courses of action required to attain designated types of performances" (Artino, 2012, p. 67). Self-efficacy is considered a key factor of learning and performance (Komarraju & Nadler, 2013) .Since, self-efficacy mirrors a student's perceived competence with attention to tasks in the academic domain (Komarraju & Nadler, 2013). Self-efficacy has the ability to help students to infuse the capability to successfully solve a task ,to learn an activity, to perform behaviors at intended levels, and to influences students' option of effort, persistence, tasks, and achievement (Hasan et al., 2014). Self-efficacy has the capability to help a person to determine quantity of effort need to spend on the task and how long they will persevere when experiencing hard (Moores & Chang, 2009). For example, students have goals and changing levels of self-efficacy for learning, when they engage in a task, they acquire new skills and evaluate their learning progress (Van Dinther et al., 2011). Thus, understanding of progress during learning support self-efficacy and advance learning (Schunk, 2001).

Moreover, Cicei et al. (2012) pointed out that academic self-efficacy is related to academic success. Since, the higher academic self-efficacy is strongly connected to improvement of performance, retention, and persistence in the face of adversity (Habel, 2009). The highly efficacious students are confident about what they can achieve (Moores & Chang, 2009), and they participate in the activities in depth interest and will cover again quickly from the obstacle (Husain, 2014). In addition, higher self-confident students are more persistent, even in the case of achievement difficulties, comparison with their peers who's less confident (Guntern et al., 2017). They set themselves challenges and are committed to achieving them, they are working harder to avoid failure (Behjoo, 2013). While students who do not have confidence on their abilities are less than the students with high self-efficacy participate in term of: "willing", "work stiffer", "insist longer", "show greater interest in learning", and "achieve at higher levels" (Wentzel & Miele, 2016). The researchers report that self-efficacy is considered as a powerful factor for students' learning performance and a key factor of their academic achievement (Chang, 2012; Komarraju & Nadler, 2013).

Furthermore, academic and general self-efficacy are the two main categories into which self-efficacy is divided. Academic self-efficacy refers to a student's assessment of his or her ability to meet educational objectives; it is generally positively correlated with academic achievement; the same goes for subject-specific self-efficacy. Hence, in mathematics, self-efficacy refers to the belief that one can succeed in mathematics by acting and putting forth effort (Yu et al., 2024).

Accordingly, mathematical self-efficacy is systematically related to academic success and mathematical achievement among students (Saher & Akbar, 2024), where the self-efficacy of students in mathematics is closely linked to their performance and learning behaviors (Clemente et al., 2024). For example, when it comes to arithmetic activities, students who have better mathematical self-efficacy typically show more perseverance, effort, and problem-solving abilities. On the other hand, poor mathematics self-efficacy is linked to avoidance strategies, anxiety, and poor performance. Moreover, the self-efficacy of students in mathematics is crucial because it influences their motivation to learn and study the subjects, as well as their performance, effort, and perseverance (Clemente et al., 2024), where self-efficacy influence students' academic achievement by four sources. These four sources are mastery experience, vicariance experience, social persuasion, and emotional and physiological states (Loo & Choy, 2013). Therefore, self-efficacy has the ability to help persons to determine the quantity of effort need to spend on the task and how long they will persevere when experiencing hard (Moores & Chang, 2009).

In addition, self-efficacy is a key determinant of learning. Thus, students who have a high sense of self-efficacy tend to acquire cognitive skills. On the other hand, students with low self-efficacy may try to avoid tasks that require high cognitive skills (Schunk, 1985), where cognitive domain involves the development of mental skills and the acquisition of knowledge (Liman & Ismail, 2015). Bandura (1994) defined cognitive processes as "thinking processes involved in the acquisition, organization, and use of information" (para. 1). Bandura (1994) posit how people gain the information, and mentioned four ways: mastery experiences, vicarious experiences, forms of social persuasion, and physiological indexes (Wentzel & Miele, 2009).

Cognitive Domain

Cognitive domain is a thinking skill for processing information, to help the individual to acquire and uses knowledge. Eshun and Mensah (2013) stated that the cognitive domain deals with all mental processes including perception, memory and information processing by which the learner or the individual acquires knowledge, solves problems, and plans for the future. Using cognitive processes in learning, are influenced on the academic achievement since cognitive processes explain the way of students learning, in terms of what and how (Como & Snow, as cited in Schunk, 1989). The studies of Finn et al. (2014) and Puerta Morales (2015) showed that a strong positive relationship between academic achievement and cognitive ability. Bloom's cognitive domain handles with how a student gain processes and uses the knowledge (Kasilingam et al., 2014). Bloom's method gives space in order to evolvement and precise measurement of students' learning development through each level of behavior (Muldoon et al., 2013). Bloom's taxonomy has helped classrooms to become more student-centered, as it helps our students gain increased awareness and control of their own cognitive development (Athanassiou et al., 2003).

Moreover, TIMSS cognitive domains resembles with Bloom's cognitive domain (Kablan & Kaya, 2013). Gutvajn et al. (as cited in Miscevic-Kadijevic, 2015) stated that TIMSS cognitive domains and Bloom's taxonomy are similar in term of content in that knowing and applying are included in Bloom's knowledge, comprehension, and application levels, whereas reasoning is based on Bloom's analysis, evaluation, and synthesis levels. Moreover, Kind (2013) stated that TIMSS has related to categories in the revised version of Bloom's taxonomy. TIMSS cognitive domains defines as a set of thinking processes that students are likely to use

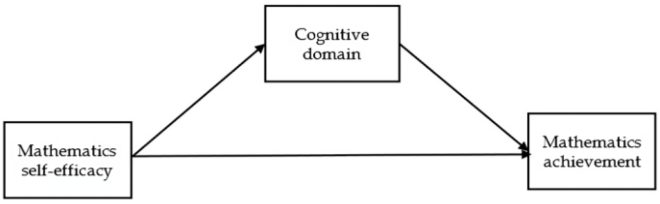

Figure 1. Conceptual framework (Source: Author's own elaboration)

as they engage with the respective subjects content (Martin et al., 2016). In addition, Bloom's taxonomy has common several elements with the cognitive dimension in the TIMSS framework (Pedersen, 2013), where Son et al. (2017) stated that Bloom's taxonomy identified main categories of the cognitive domain as sides of learning mathematics. These categories are regarded as learning goals measured in mathematics assessments, which depict what students are planned to do with mathematics contents. These categories comprise comprehension, application, analysis, synthesis, and evaluation. TIMSS also use these categories as subcategories of three cognitive domains (knowing, applying, and reasoning) in its assessment framework. This means TIMSS mathematics assessment framework is based on Bloom's Taxonomy.

Mathematics Achievement

Mathematical achievement is defined as the ability displayed by the student in the subject mathematics (Pandey, 2017). Mathematics achievement is a worry in many places worldwide (Goforth et al., 2014). This is because, success in mathematics means the nation's success (Hierck & Weber, 2013). The literature mentioned many reasons lead to deficient performance in mathematics by students, where Nizoloman (2013) mentioned that weak of students achievement in mathematics return to numbers of factors such as not interest of students in mathematics; anxiety motivation; reasoning and numerical ability; problem-solving skill; mathematics phobia. Kpolovie et al. (2014) mentioned number of reasons that lead to poor achievement in general like students' attitudes towards school, interest in learning, study habit, attribution, self-efficacy, intelligence, and motivation. Therefore, factors that influence mathematics achievement are variety, and it is differ from one country to another. It depends on the country, the people in that county, and the educational system in that country.

THEORETICAL BACKGROUND FOR THE MODEL

The theoretical background for the model is based on the relationship among self-efficacy, cognitive domain or cognitive process, and academic achievement (**Figure 1**). Where, self-efficacy has a direct and indirect effect on mathematics achievement (Schunk & Bandura, as cited in Urdan & Pajares, 2002, p. 37). Self-efficacy also works as a predictor of the cognitive domain (Hughes et al., 2015), and cognitive domain as a predictor of academic achievement (Finn et al., 2014; Murray, 2013). According to Bandura's (1993) the impacts of self-efficacy beliefs on the cognitive domain or cognitive process takes various forms and can be summarized in three points as follows self-efficacy influences the cognitive domain by

(1) making people set high goals for themselves,
(2) impacting the kinds of expectant screenplays that people build and rehearse, and
(3) maintaining a robust feeling of efficacy in a person, helping them continue being mission-oriented in the face of persistent situational needs, failures, and setback that have substantial effects.

Moreover, self-efficacy impacts on students' academic achievement by mastery experience, vicarious experience, verbal persuasion, physiological arousal as well according to (Hasan et al., 2014). Mastery experience plays a key role in increased or decreased academic achievement (Safaria, 2013). This is because, mastery experiences carry on with their success or failure. Through vicariance experience, learners get knowledge on their abilities by monitoring other persons, in particular colleagues who offering appropriate contrast opportunities (Hasan et al., 2014). This led to an increased influence on the academic achievement of students (Hasan et al., 2014). This led to an increased influence on the academic achievement of students. Moreover, verbal persuasion influences student's achievement. Where positive persuasive feedback heightens self-efficacy, which in turning brings about to a rise in the achievement of students (Hasan et al., 2014). Physiological arousal influences student's achievement. Whereby, a positive state of mind empowers the person's self-efficacy, which, in turn, leads to a rise in the achievement of students. Self-efficacy beliefs are the cause of a superior performance. Since, it impacts thought processes, motivation, and behavior. Where, elevated persons in self-efficacy try difficult missions further frequently, insist lengthier on them, and spend further attempt (Tenaw, 2013).

Bloom's cognitive domain is based on six hierarchically structured categories which are divided into subcategories. Bloom presumption that that to reach a higher objective category it is necessary to master profoundly a lower category (consistency of objectives) (Taťána Karásková, 2014). According to revised Bloom's, students gradient from lower-order (remembering, understanding, and applying) to higher-order (analyzing, evaluating, and creating) (Hao et al., 2024; Liou & Bulut, 2020; Ramdhani & Susanti, 2024; Zana et al., 2022). Thus, students gain knowledge while moving through the cognitive levels. Therefore, according to Bloom, succeeding students at subsequent learning levels rely on mastering the previous level of learning (Lai & Sanusi, 2013).

To sum up, the literature review has focused on the relationship between self-efficacy, the cognitive domain, and academic achievement. Self-efficacy directly and indirectly affects mathematics achievement and predicts the cognitive domain and academic achievement. It influences the cognitive domain by setting high goals, shaping expectations, and maintaining a robust feeling of efficacy. As well, self-efficacy impacts students' academic achievement through mastery experience, vicariance experience, verbal persuasion, and physiological arousal.

Objectives of Study

1. To identify whether mathematics self-efficacy relates to mathematics achievement.
2. To identify whether the cognitive domain mediates the contribution of self-efficacy to mathematics achievement.

The current study has two questions concern of the role of mathematics self-efficacy and cognitive domain on students' achievement in mathematics, in another word the current study will answer the questions regarding to the role of the cognitive domain on mediating effect between the relationship mathematics' self-efficacy and mathematics' achievement. And these two questions are, as follows:

1. Is there a relationship between mathematics self-efficacy, and mathematics achievement?
2. Does cognitive domain mediate effect of the contribution between self-efficacy to mathematics achievement?

To answer research questions the researcher has formulated four hypotheses as following:

H_0. Mathematics self-efficacy does not have a significant effect on mathematics achievement.

H_a. Mathematics self-efficacy have a significant effect on mathematics achievement.

H_0. Cognitive domain does not mediate a significant effect on the contribution of mathematics self-efficacy to mathematics achievement.

H_a. Cognitive domain mediates a significant effect on the contribution of mathematics self-efficacy to mathematics achievement.

METHOD

Research Design

This study used correlation research design. Were, correlation research design is an approach utilized to assess if changes in one or more variable are associated to alterations in another variable(s). This is described to as co-variance. Correlations examine direction, degree, magnitude, and power of the relationships (Sousa et al., 2007). The extremely popular data collection procedures for correlational designs involve surveys, observations, and secondary data. Academic study often mixes several techniques (McLeod, 2018). The researcher used survey method and to collect the data for the research.

Research Population

The population of this study comprised 9,358 eighth-grade students, including 4,861 boys and 4,497 girls, distributed among 72 schools–38 boys' schools and 34 girls' schools, in the 2018-2019 school year from Al Batinah North Governorate, according to the Department of Statistics and Indicators of the Directorate General of Education in the North Governorate.

Sample Size and Sampling Technique

The current study used the published tables of sample size determination (Krejcie & Morgan, 1970, as cited in Piaw, 2016). Thus, if the number of populations is 10,000 and the level of significance is 0.05, then the necessary number of respondents is 370, according to Piaw (2016). Hence, 370 (both boys and girls) out of 9,358 eighth-grade students from second-cycle public schools of basic education in the school year 2018-2019 were encouraged to participate in the current study.

The sample's ratio of participants (boys and girls) was almost equal. The rate of (boys and girls) was calculated by dividing the total sample size (370) by the total population (9,358): $370 \div 9,358 = 0.0395 \approx 0.040 = 4\%$. Hence, the boys' sample was $4\% \times 4,861 = 194.44$ or 194, while the girls' sample was $4\% \times 4,497 = 179.88$ or 180. Adding both recommended sample sizes for boys and girls results in a total suggested participant size of 374, which is close to the earlier recommended size of 370.

Three boys' and three girls' schools were selected randomly out of 38 and 34, respectively, from the second cycle of public schools of basic education in the Al Batinah North Governorate. This is because in each school, the number of eighth-grade students was more than 120, all of whom were included by the researcher in the study sample. The study used a simple random sampling technique, specifically the lottery method, to select a sample of 374 students from the eighth grade. The method involved recording all boys' and girls' schools during the second cycle of public schools in basic education, prescribing each school a unique number, writing these numbers on similar-looking cards, mixing them in a basket, and randomly selecting a card with the chosen school's name. After that, the researcher selected participants from each school randomly. The final sample size included 194 boys and 180 girls from the second-cycle public school of basic education.

Research Instrument, Validity, and Reliability Issues

The measurement tools used in the current study were source of mathematical self-efficacy scale (SMES), the mathematics cognitive domain, and national mathematics achievement.

Source of Mathematical Self-Efficacy Scale

SMES scale has used with middle school students. It was developed by Usher and Pajares (2009). It has a high degree of validity and reliability and, it has used for many studies and in various academic disciplines. SMES scale consists of 24 items, which are as follows: 6 items (1-6) measure mastery experience, 6 items (7-12) measure vicarious experience, 6 items (13-18) measure variable persuasion, and 6 items (19-24) measure physical state. The response format on SMES allows individuals to rate statements with 1 being definitely false and 6 being definitely true, and the respondent can choose any number between 1 and 6.

The researchers adapted and validated the SMES for middle school students using cross-cultural adaptation and validation to be fit for the Omani context using a sample consisted of 700 students (350 boys and 350 girls) from the eighth grade. The SMES scale contained 23 items after cross-cultural adaptation and validation because the researchers deleted negative item factor loading from mastery experience contracts as attributed to the difference in culture between the students from the United States of America and from the Sultanate of Oman. The summary of CFA for SMES scale after adaptation and validation is, as follows:

(1) number of items were 23, and the Cronbach's alpha values of the overall scale were 0.77,

(2) 5 items (1-5) measure mastery experience, and the Cronbach's Alpha value was 0.74,

(3) 6 items (6-11) measure vicarious experience, and the Cronbach's alpha value was 0.77,

(4) 6 items (12-17) measure variable persuasion, and the Cronbach's alpha value was 0.84, and

(5) 6 items (18-23) measure physical state and the Cronbach's alpha value was 0.85.

The Chi-squared/df value was 3.1; CFI value was 0.91, and RMSEA and SRMR value was 0.05 for the 4-factor model.

Mathematics Cognitive Domain

The researchers have developed the mathematics cognitive domain in mathematics to measure grade-eight student's cognitive domain in mathematics, by adopted the questions from mathematics cognitive domain. The researchers have used released mathematics items of TIMSS during prior cycles 2003, 2007, and 2011, to measure components of cognitive domains: knowing, applying, and reasoning, in the current study. In light of that, the researcher developed a blueprint, in order to help him to choose proper items for students and for the aims of the research. The researchers have selected (60) items from TIMSS of previous cycles, which are compatible with the syllabus that students used in grade-eight in the Sultanate of Oman. The cognitive domain in first copy included 60 items. The researchers have conducted difficulty and discrimination analysis for the items of cognitive domain, to check the proper of the items which took from TIMSS of previous cycles, in terms of is it proper or not for students' levels. The researchers excluded all items, which do not fulfillment the stander of difficulty and discrimination levels. The final version of the cognitive domain included 24 items, measuring the three components of the cognitive domains of the students, knowing, applying and reasoning.

Mathematics Achievement

The researchers used national mathematics achievement test in grade eight develop by Ministry of Education in Oman in school year 2018/2019 first semester. Devi and Sharma (2013) defined achievement as "a of knowledge or proficiency based on something learned or taught" (p. 41). Thus, national mathematics achievement test is a of knowledge or proficiency based on something learned or taught in mathematics.

Data Collection and Analysis Procedure

The researcher obtained permission from the Ministry of Education to apply the study instruments in the second cycle of public schools for basic education in Al Batinah North Governorate. After that, the researcher informed the administrators of the selected schools about the aims of the study and its purposes. As well, the students were informed about the study and briefed on the purpose of the study, what is required of them, how to participate if they wish to do so, and the need for their cooperation. Then, the mathematics teachers personally, in addition to the researcher and some teachers, administered the instruments of the study (the source of the mathematics self-efficacy scale and the mathematics cognitive domain test) and were administered to help improve the collection and response rate on the instruments of study. The mathematics cognitive test was taken (80 minutes) without giving a break for students, and the rate responses of students were 100%. After finishing the mathematics cognitive domain test, the researcher and teachers applied a source of mathematical self-efficacy scale to eight graders. They were collected as soon as they were completed by the respondents. This enabled the researcher to obtain a 100% response rate. The researcher requested the national achievement scores of grade-eight students from the Ministry of Education at the end of the first semester of the 2018-2019 school year for research purposes.

Data Analysis

After the data collection and prepares it in the way that you can deal with. The researcher did a variety of steps: screened the data by using statistical screening methods to explore the characteristics of the data in terms of the normality of each variable, the presence of outliers, multicollinearity, common method bias, homoscedasticity, and missing-value patterns. Also, the researcher used two ways to handle missing data: listwise deletion and multiple imputations.

The structural equation modeling (PLS-SEM) technique by SmartPLS, was used to analyze the structural relationship, test the hypotheses of the study, analyze the data, and answer the questions of the study. The researcher selected the SmartPLS to analyze the data, because the data does not follow the assumptions of regression in terms of linearity and normality. The SmartPLS can deal with non-normal and non-linear issues (Sarstedt et al., 2019)

RESULTS

Evaluation of Measuring Model

Analysis of the measurement model includes two stages, first analysis lower-order component (LOCs); second analysis higher-order component (HOC). Researchers firstly analyzed the LOCs of model which has two constructs (cognitive domain and mathematics self-efficacy), in terms of

(1) factor loading,

(2) internal consistency (Cronbach's alpha and composite reliability),

(3) convergent validity (average variance extracted [AVE]), and

(4) discriminant validity according to (Hair et al., 2017).

Factor loading

Outer loading or factor loading is an explains the correlations between observed variables (Salkind, 2010), and loading is ranging between 1 and -1 (Yussif et al., 2016). The outer loading of cognitive domain of all indicators of each construct more than 5 (see **Table 1**), where KN-1 = 0.691, KN-2 = 0.8, KN-3 = 0.711, KN-4 = 0.798; AP-1 = 0.763, AP-2 = 0.719, AP-3 = 0.815, AP-4 = 0.634, AP-5 = 0.75, AP-6 = 0.723, RE-1 = 0.755, RE-2 = 0.728, RE-3 = 0.762, and RE-4 = 0.692. This means that the outer loading of cognitive domain construct met the criteria, where the standardized loading approximations must be 0.5 or higher (Hair et al., 2009). Also, remarkable that from the **Table 1**, the outer loadings of all constructs of source of mathematics self-efficacy are above 0.5, where the outer loadings of all indicators of source of mathematics self-efficacy are above 0.5, where MA-1 = 0.833, MA-2 = 0.738, MA-3 = 0.763, MA-4 = 0.719, MA-5 =0 .777, VE-1 = 0.756, VE-2 = 0.774 , VE-3 = 0.781, VE-4 = 0.72, VE-5 = 0.699, VE-6 = 0.57, SP-1 = 0.802, SP-2 = 0.838, SP-3 = 0.82, SP-4 = 0.782, SP-5 = 0.78, SP-6 = 0.767, PH-1 = 0.769, PH-2 = 0.716, PH-3 = 0.817, PH-4 = 0.807, PH-5 = 0.795, and PH-6 = 0.825.

Table 1. Outer loading, composite reliability, Cronbach's alpha, AVE for cognitive domain and sources of mathematics self-efficacy

Constructs	Item	Outer loading	α	CR	AVE
Cognitive domain	KN-1	0.691	0.742	0.838	0.565
	KN-2	0.800			
	KN-3	0.711			
	KN-4	0.798			
	AP-1	0.763	0.829	0.876	0.542
	AP-2	0.719			
	AP-3	0.815			
	AP-4	0.634			
	AP-5	0.750			
	AP-6	0.723			
	RE-1	0.755	0.716	0.824	0.54
	RE-2	0.728			
	RE-3	0.762			
	RE-4	0.692			
Self-efficacy	MA-1	0.833	0.824	0.877	0.588
	MA-2	0.738			
	MA-3	0.763			
	MA-4	0.719			
	MA-5	0.777			
	VE-1	0.756	0.815	0.856	0.519
	VE-2	0.774			
	VE-3	0.781			
	VE-4	0.720			
	VE-5	0.699			
	VE-6	0.570			
	SP-1	0.802	0.886	0.913	0.638
	SP-2	0.838			
	SP-3	0.820			
	SP-4	0.782			
	SP-5	0.780			
	SP-6	0.767			
	PH-1	0.769	0.878	0.908	0.623
	PH-2	0.716			
	PH-3	0.817			
	PH-4	0.807			
	PH-5	0.795			
	PH-6	0.825			

Note. AP: Applying; KN: Knowing; RE: Reasoning; MS: Mastery experience; SP: Social persuasions; VE: Vicarious experience; PH: Physiological state; CR: Composite reliability; α: Cronbach's alpha; & AVE: Average variance extracted

Internal consistency

Composite reliability (CR): It is defined as the overall amount of true score variation is associated to the true score variation (Kline, as cited in Chatvijit-Cook, 2017), it is used to assess reliability, where > 0.7 is recommended and 0.6 deemed acceptable (Chatvijit-Cook, 2017). The analysis of composite reliability has revealed that the composite reliability above 0.7 for both cognitive domain and mathematics self-efficacy, see Table 1. The composite reliability of cognitive domain: knowing (KN), applying (AP), and reasoning (RE) are 0.838, 0.876, and 0.824, respectively. The composite reliability of mathematics self-efficacy constructs as follows: mastery experience (MA), vicarious experience (VE), social persuasion (SP), and physical states (PH) are 0.877, 0.866, 0.913, and 0.908, respectively, and this means that the value of composite reliability of cognitive domain and mathematics self-efficacy meets the criteria of analysis, and the internal consistency of the indicators measuring a given factor is good.

Cronbach's alpha (α): Cronbach's alpha of all constructs namely cognitive domain and mathematics self-efficacy are above 0.7 which means both constructs meet the qualification of reliability, where the Cronbach's alpha of cognitive domain: knowing (KN), applying (AP), and reasoning (RE) are 0.742, 0.829, and 0.716, respectively. Also, the Cronbach's alpha of source of mathematics self-efficacy: mastery experience (MA), vicarious experience (VE), social persuasion (SP), and physical states (PHP) are 0.824, 0.815, 0.886, and 0.878, respectively. composite reliability is a preferred alternative to Cronbach's alpha as a of convergent validity in a reflective model (Garson, 2016).

Convergent validity

Convergent validity is defined "as the agreement among measures that theoretically should be related" (Fried et al., 2007, p. 352), and it is assessed by AVE, which should be above 0.5 (Hariri & Roberts, 2015).

Average variance extracted (AVE): The AVE of both the source of mathematics self-efficacy and cognitive domain for all constructs for both are above 0.5 (see Table 1), where the average variance extracted (AVE) of cognitive domain knowing (KN), applying (AP), and reasoning (RE) are 0.565, 0.542, and 0.54, respectively. As well the AVE of source of mathematics self-efficacy: mastery experience (MA), vicarious experience (VE), social persuasion (SP), and physical states (PH) are 0.588, 0.519, 0.638, and 0.623, respectively. This result achieved after dropped ten items from cognitive domain constructs.

Discriminant validity

Henseler et al. (2015) stated that HTMT ratio is better for detecting the lack of discriminant validity, the Table 2 illustrates the HTMT ratio. To exam HTMT, the researchers used HTMT ratios see Table 2. In order to whether the HTMT values are significantly different from 1, between lower and upper bounds of the 95% (bias-corrected and accelerated) confidence interval, and this request computing bootstrap confidence intervals obtained by running the bootstrapping from (5,000) sub sample. Remarkable that from the Table 2 neither of the confidence intervals involves the value 1 (Hair et al., 2017), which means the discriminant validity is established (Henseler et al., 2016), for both cognitive domain and sources of mathematics self-efficacy.

Table 2. HTMT Inference and HTMT Inference interval for cognitive domain and sources of mathematics self-efficacy

	O	Mean	2.50%	97.50%
KN -> AP	0.888	0.889	0.827	0.945
RE -> AP	0.818	0.817	0.735	0.895
RE -> KN	0.744	0.745	0.658	0.829
SP -> MS	0.780	0.783	0.696	0.842
SP -> PH	0.431	0.432	0.312	0.530
VE -> MS	0.831	0.834	0.739	0.899
VE -> PH	0.406	0.406	0.287	0.513
VE -> SP	0.767	0.766	0.688	0.836

Note. AP: Applying; KN: Knowing; RE: Reasoning; MS: Mastery experience; SP: Social persuasions; VE: Vicarious experience; PH: Physiological state; & O: Original sample

Table 3. Fornell-Larcker of cognitive domain

	AP	KN	RE
AP	0.736		
KN	0.704	0.752	
RE	0.633	0.549	0.735

Note. AP: Applying; KN: Knowing; & RE: Reasoning

Table 4. Fornell-Larcker of source of mathematics self-efficacy

	MS	PH	SP	VE
MS	0.767			
PH	-0.432	0.789		
SP	0.673	-0.386	0.799	
VE	0.671	-0.330	0.653	0.720

Note. MS: Mastery experience; SP: Social persuasions; VE: Vicarious experience; & PH: Physiological state

Also, the researcher used the criteria of Fornell-Larcker to assess discriminant validity of the two constructs of the current study. Whereby, the criteria of the Fornell–Larcker said "for any latent variable, the square root of AVE should be higher than its correlation with any other latent variable" (Garson, 2016, p. 67). The Fornell-Larcker criteria helps to identify if the square root of the AVE is greater than any of the inter construct correlations.

As be seen from the Table 3, the rows of Table 3 explains the square root of AVE, the applying square root of AVE = 0.736, and is the highest compared to knowing and reasoning. The square root of AVE of knowing is 0.752 and is the highest compared to applying and reasoning. The square root of AVE of reasoning and is the highest compared to applying and knowing. Thus, the cognitive domain met the Fornell-Larcker criterion.

As be seen from the Table 4, the rows of Table 4 explains the square root of AVE, the mastery experience square root of AVE = 0.767, and is the highest compared to physiological state, social persuasions and vicarious experience. The square root of AVE of physiological state

Table 5. AVE and CR second order

Second order composite model	CR	AVE
Cognitive domain	0.894	0.856

Note. CR: Composite reliability; AVE: Average variance extracted

is 0.789, and it is the highest compared to mastery experience, social persuasions, and vicarious experience. The square root of AVE of social persuasions is 0.799, and it is the highest compared to mastery experience, physiological state and vicarious experience. The square root of AVE of vicarious experience is 0.72 and it is the highest compared to mastery experience, social persuasions, and physiological state. Thus, the cognitive domain met the Fornell-Larcker criterion.

Therefore, both the source of mathematics self-efficacy and cognitive domain met the Fornell-Larcker criterion, thus the source of mathematics self-efficacy and cognitive domain fulfilled criterion of discriminate validity.

To sum up, the measurement model of the present study has met all criteria regarding construct validity, and we will proceed to the next step.

Second order assessment: First assessed the construct validity for the cognitive domain reflective-reflective construct. The evaluation of the measurement quality of second-order constructs has two stages. In the first stage, the suitability of the first-order constructs is assessed using the suitable quality criteria for reflective constructs, this is because the first-order constructs are all reflective. In the second stage, the evaluation of the second-order constructs is accomplished from the relations between lower-order constructs and higher-order constructs (Duarte & Amaro, 2018). The researchers has evaluated second-order contract in terms of, in terms of

(1) convergent validity, and

(2) composite reliability

(3) loadings, and

(4) discriminant validity (Sarstedt, Ringle, et al., 2019).

Table 5 shows the value of AVE and CR, they have met criteria of construct validity, with respect the loading and discriminant validity, both already are evaluated (see **Table 1**) regarding to loading and see **Table 2** regarding to discriminant validity. Loading and discriminant validity have achieved the criterions of validation.

Second, assess the second-order formative construct (mathematics self-efficacy) validation. The second-order construct (reflective formative) is precisely measured by using each of the first-order common factors' manifest variables, this is the very commonly used approach for assessing higher-order constructs in PLS (Van Riel et al., 2017). The literature stated different ways in order to evaluate the second-order construct, where Sarstedt et al. (2019) stated that evaluate the second-order construct need to explain the relationships between higher-order and lower-order components as collinearity, and the significance and relevance of the weights. Considering the results obtained from analysis as display in **Table 6**,

Table 6. The significance and relevance of the weights of sources of mathematics self-efficacy

Construct	Scale items	β	M	SD	t-value	P	2.5%	97.5%	P
MS	MS-1 <- SE	0.092	0.091	0.004	25.023	0	0.082	0.096	0
	MS-2 <- SE	0.071	0.071	0.004	17.054	0	0.063	0.079	0
	MS-3 <- SE	0.078	0.078	0.005	15.927	0	0.068	0.085	0
	MS-4 <- SE	0.069	0.070	0.003	21.112	0	0.059	0.075	0
	MS-5 <- SE	0.077	0.078	0.004	19.729	0	0.069	0.081	0
PH	PH-1 <- SE	-0.062	-0.061	0.004	14.231	0	-0.069	-0.053	0
	PH-2 <- SE	-0.050	-0.047	0.006	8.719	0	-0.058	-0.040	0
	PH-3 <- SE	-0.060	-0.059	0.005	13.096	0	-0.069	-0.049	0
	PH-4 <- SE	-0.066	-0.065	0.006	11.859	0	-0.074	-0.057	0
	PH-5 <- SE	-0.066	-0.066	0.004	15.654	0	-0.072	-0.054	0
	PH-6 <- SE	-0.062	-0.062	0.005	12.267	0	-0.069	-0.050	0
SP	SP-1 <- SE	0.081	0.080	0.003	23.426	0	0.074	0.087	0
	SP-2 <- SE	0.085	0.085	0.004	23.353	0	0.076	0.091	0
	SP-3 <- SE	0.081	0.081	0.004	21.616	0	0.075	0.088	0
	SP-4 <- SE	0.075	0.076	0.004	17.872	0	0.066	0.081	0
	SP-5 <- SE	0.068	0.068	0.004	17.146	0	0.059	0.074	0
	SP-6 <- SE	0.081	0.082	0.004	19.334	0	0.072	0.088	0
VE	VE-1 <- SE	0.069	0.069	0.004	17.355	0	0.060	0.076	0
	VE-2 <- SE	0.084	0.084	0.004	23.891	0	0.076	0.088	0
	VE-3 <- SE	0.080	0.080	0.003	28.472	0	0.073	0.085	0
	VE-4 <- SE	0.064	0.064	0.004	15.169	0	0.056	0.070	0
	VE-5 <- SE	0.067	0.066	0.004	15.615	0	0.059	0.075	0

Note. SE: Self-efficacy; MS: Mastery experience; SP: Social persuasions; VE: Vicarious experience; PH: Physiological state; M: Sample mean; SD: Standard deviation; t-value: t-statistics; Sign: p-values; & $p < 0.05$

Table 7. VIF of second construct of self-efficacy

Formative constructs (mathematics self-efficacy)	VIF
Mastery experience (MS)	2.367
Physiological state (PH)	1.257
Social persuasions (SP)	2.151
Vicarious experience (VE)	2.200

the outer weights of all constructs of source of mathematics self-efficacy are significant. Therefore, the convergent validity of sources of mathematics self-efficacy fulfilled. **Table 6** shows the confident interval, which gives more confidence with respect to the significant weight, where zero did not show between the lower and higher values of confidence interval (Tehseen et al., 2017). The multicollinearity is a fundamental assessment for any formative measurement model relates to establishing, in term of whether multicollinearity is present among the formative components (Thornton et al., 2014). **Table 7** explain the VIF values of the second construct (sources of mathematics self-efficacy)is lower than 5, which mean the collinearity is not an issue between the construct and formative indicators (Hair et al., 2016; Tehseen et al., 2017).

Analysis of Structural Model

Relationship between mathematics self-efficacy and mathematics achievement

Table 8. The results of direct path coefficients (β) of the mathematics self-efficacy, cognitive domain and mathematics achievement

	β	M	SD	t-value	p
SE -> CD	0.574	0.577	0.031	18.402	0
CD -> MT	0.676	0.674	0.036	18.527	0
SE -> MT	0.215	0.215	0.040	5.437	0

Note. MT: Mathematics achievement; CD: Cognitive domain; SE: Mathematics self-efficacy; M: Sample mean; SD: Standard deviation; t-value: t-statistics; Sign: p-values; & $p < 0.05$

To answer research question one, the researcher has analyzed path coefficients between self-efficacy and mathematics achievement. **Table 8** displays the results of path coefficients (β) of the mathematics self-efficacy and mathematics achievement. The β-value measures the direct effect of the predictor variable on the response variable (Path Analysis, 2024), and it explains "whether the relationships between the constructs are positive or negative and whether they are statistically significant" (Yussif et al., 2016, p. 162). The β-value helped to identify the relationship between self-efficacy and mathematics achievement.

Figure 2 illustrates regression weight (β) or path coefficient (β), remarkable that from the **Table 8**, there is a positive and significant direct effect between self-efficacy and mathematics achievement, significant (β = 0. 0.213; $p < 0.05$). Accordingly, the current study rejected the null hypothesis $\mathbf{H_0}$, which stated that mathematics self-efficacy is not significant effect on mathematics

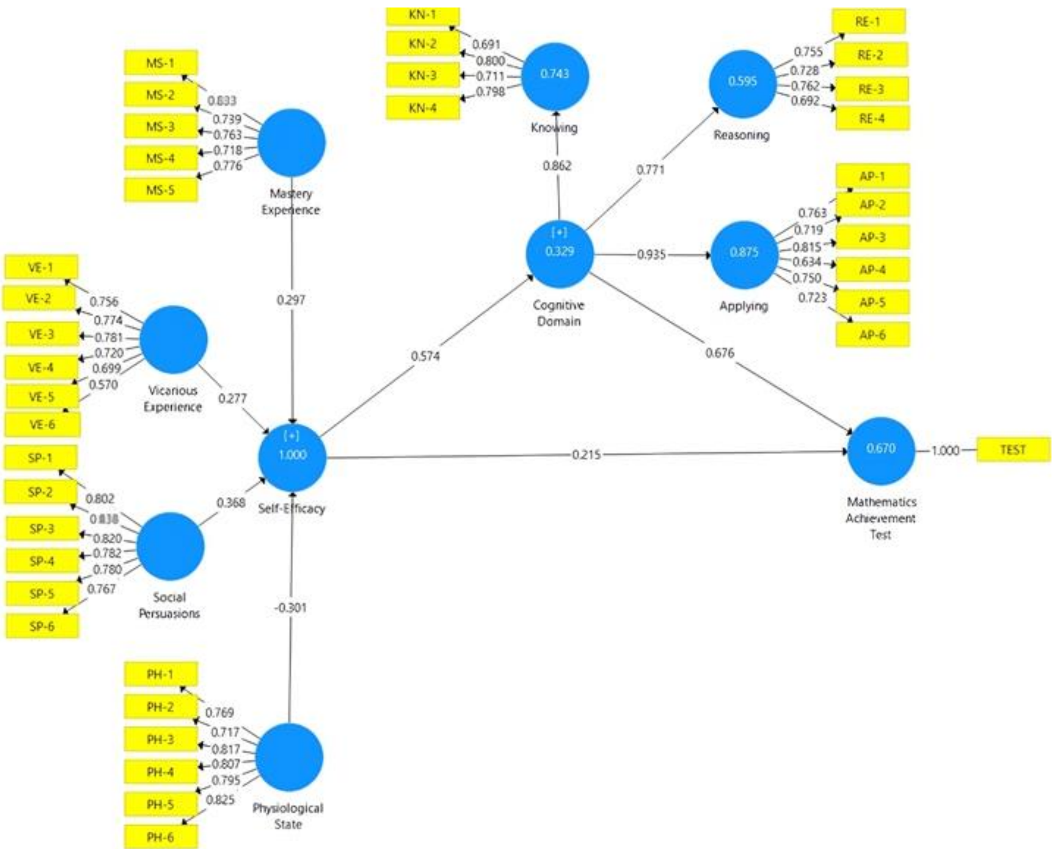

Figure 2. Measurement model (Source: Author's own elaboration)

Table 9. The results of indirect path coefficients (β) of the mathematics self-efficacy, cognitive domain and mathematics achievement

	β	M	SD	t-value	p
SE -> CD -> MT	0.388	0.389	0.029	13.271	0

Note. MT: Mathematics achievement; CD: Cognitive domain; SE: Mathematics self-efficacy; M: Sample mean; SD: Standard deviation; t-value: t-statistics; Sign: p-values; & $p < 0.05$

achievement, and accepted alternative hypothesis $\mathbf{H_1}$, which stated that mathematics self-efficacy significant effect to mathematics achievement.

Cognitive domain mediate effect of the contribution between mathematics self-efficacy to mathematics achievement

To answer the research questions, the researcher analyzed the structural model in terms of direct and indirect effect. The researcher analyzed the relationship between mathematics self-efficacy, cognitive domain, and mathematics achievement. The results obtained from the current study explain that

(1) self-efficacy has a positive and significant relationship with cognitive domain with a t-value = 18.402, β = 0.574, and $p < 0.05$, see **Table 8**,

(2) cognitive domain showed also a positive and significant relationship with mathematics achievement with a t-value = 18.527, β = 0.675, and $p < 0.05$, see **Table 9**,

(3) self-efficacy illustrates a positive and significant relationship with mathematics achievement, with a t-value = 5.437, β = 0.215, and $p < 0.05$.

Secondly, the researcher has analyzed the mediation effect, it is striking that from the **Table 9**, the indirect effect is positive and significant between mathematics self-efficacy and the mathematics achievement: β = 0.388; t = 13.271; $p < 0.05$. This result means that there is a mediation relationship between mathematics self-efficacy and mathematics achievement through cognitive domain.

However, remarkable that from **Table 8**, there is an existing significant relationship between each of

(1) self-efficacy and cognitive domain,

(2) cognitive domain and mathematics achievement,

(3) self-efficacy and mathematics achievement, and

(4) mathematics self-efficacy and mathematics achievement through cognitive domain has a positive and significant relationship (see **Table 9**).

The type of mediation, in this case, is called a partial mediation (MacKinnon et al., 2007; Rucker et al., 2011). The obvious from the results that the mediation effect does not remove direct effect totally given that relation between self-efficacy and mathematics achievement accumulate β = 0.215; t = 5.437; $p < 0.05$. Although, mediation takes place ,even not full mediation, where partial mediation happens when the noted relationship between the independent and dependent variable is lower with the addition of the mediation impact (Fowler-Brown et al., 2013).

To estimate the scope of indirect effect (Iacobucci & Duhachek, as cited in Hernández-Perlines et al., 2016) offer the VAF (variance accounted for) formula, which refers the size of the indirect effect in relation to the total effect (direct effect + indirect effect): VAF = (a1b1)/(a1b1 + c') ,thus resulting in value of 0.643 (64.3%) is larger than 20% and less than 80%, which affirms that partial mediation is existing (Kuo & Hou, 2017). The type of partial mediation is complementary, where in a complementary partial mediation, each of direct and indirect effects is significant and both takes the same pattern positive or negative (Sheko & Spaho, 2018) (**Figure 3**).

Thirdly, coefficient of determination (R2), R2 as a measure of model fit, and it is defined as the square of the correlation coefficient between observed and predicted values in a regression(Alexander et al., 2015). The" R2 represents the amount of variance in the endogenous constructs explained by all the exogenous constructs linked to it" (Hair et al., 2017, p. 175). **Table 10** clarify the R2 ,as you can see from **Table 10** the R2 of cognitive domain account 0.329, which means that mathematics self-efficacy explains 30.29% of the variance of cognitive domain, and the remaining 69.71% was influenced by other variables.

The R2 of mathematics achievement, 0.670; mathematics self-efficacy explained 67% of the variance of mathematics achievement, and the remaining 33% was influenced by other variables. In addition, "the R2 value ranges from 0 to 1 with higher levels indicating higher levels of predictive accuracy" (Hair et al., 2017, p.199). The R2 values of "0.75, 0.50, or 0.25 for the endogenous construct can be described as respectively substantial, moderate, and weak" (Hair et al., 2017, p. 208). Accordingly, R2 of cognitive domain is weak. R2of mathematics achievement is moderate.

Fourthly, Q^2 = 0.362 of mathematical self-efficacy constructs, and Q^2 = 0.653 of mathematics achievement , and Q^2 = 0.128 of cognitive domain as you can see from the **Table 11**. This results explain that the model has empirically ability to collect data and reconstructed with the help of the model and the parameters of PLS-SEM. Whereby, the predictive relevance (Q^2) is "assesses the predictive validity through the blindfolding procedure in which data is omitted for a given block of indicators and then the omitted part is predicted based on the calculated parameters" (Tehseen et al., 2017, p. 55). Where, the resulting Q^2 values bigger than 0 imply the path model's predictive relevance for a specific dependent construct (Hair et al., 2017). The outline of the Q^2 values as following Q^2 values of 0.02, 0.15, 0.35 represent small, medium, and large relevance for a specific endogenous latent variable (Hair et al., 2017).

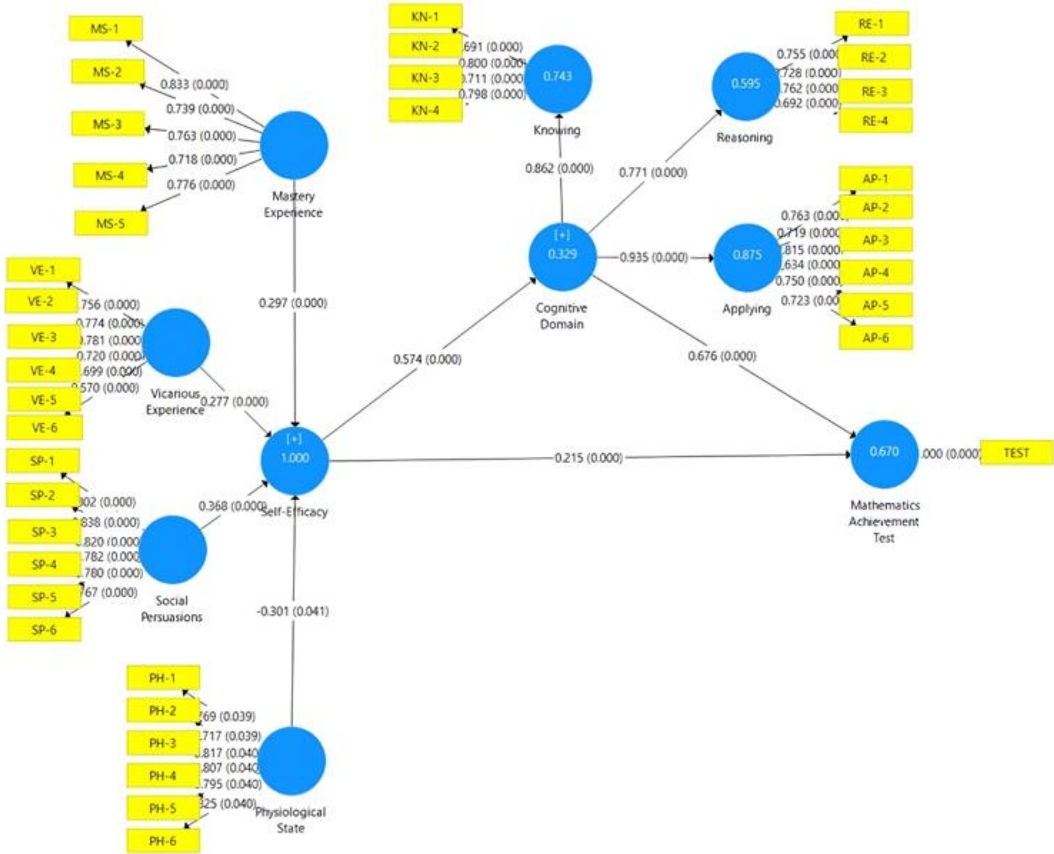

Figure 3. Scope of indirect effect (Source: Author's own elaboration)

Table 10. Exhibited the results of R^2

	R^2
Cognitive domain (CD)	0.329
Mathematics achievement (MT)	0.670

Table 11. The value of Q^2 of source of mathematics self-efficacy, mathematics achievement, and cognitive domain

	SSO	SSE	Q^2
Cognitive domain	5,236.00	4,567.160	0.128
Mathematics achievement	374.00	129.631	0.653
Mathematics self-efficacy	8,228.00	5,245.84	0.362

The result in **Table 11** of Q^2 values explain that of the source of mathematical self-efficacy constructs and mathematics achievement are largely predictive relevance. However Q^2 value of cognitive domain is medium predictive relevance.

Fifthly, **Table 11** explanation the effect size (f^2), which clarifies the range of relative effect of a particular variable on the whole explained variance by assessing the shifting in R2 (Schweisfurth, 2012). The criteria of f^2 according to Cohen as cited in (Henseler et al., 2016) f^2 = 0.35 indicates strong effect, f^2 = 0.15 indicates moderate effect, and f^2 = 0.02 indicates weak effects. The remarkable that from **Table 11** cognitive domain → mathematics achievement was accounted for higher effects, at 0.925.

Sixthly , the model goodness-of-fit is ed by SRMR which mean standardized root mean square residual

Table 12. Exhibited the results of f^2

Contracts	f^2
Cognitive domain → Mathematics achievement	0.925
Self-efficacy → Mathematics achievement	0.094
Self-efficacy → Cognitive domain	0.495

(Hernández-Perlines & Mancebo-Lozano, 2016). The SRMR below 0.1 and or 0.08 indicate a good fit model (SmartPLSGmbH, 2019) (**Table 12**).

DISCUSSION

Relationship Between Mathematics Self-Efficacy and Mathematics Achievement

The findings of this study have shown that there is a significant and positive relationship between mathematics self-efficacy and mathematics achievement. This result is consistent with previous studies which explain the positive relationship between self-efficacy and mathematics achievement (Ayotola & Adedeji, 2009; Dullas, 2010; Jaafar & Ayub, 2010; Liou & Bulut, 2020). Accordingly, the current study rejects the null hypothesis $\mathbf{H_0}$, which stated that mathematics self-efficacy does not have a significant effect on mathematics achievement. The positive relationship between mathematics self-efficacy and mathematics achievement returns to impact self-efficacy on students. According to the literature, self-efficacy beliefs play a significant role in learning outcomes in mathematics, as per social cognitive theory. These beliefs influence a person's decision to carry out actions and can determine their effort, time spent dealing with problems, and perseverance in various situations. Students with high self-efficacy are successful in their learning activities and complete tasks well. Research has shown that self-efficacy can determine student learning outcomes (Mahmudah, 2024). Where, students with high self-efficacy usually have greater levels of academic motivation (Wang et al., 2018), which encourages students to persist, diligent to learn, facing difficulties, and accept a challenge, until they achieve a high level of academic achievement. The high level of self-efficacy with the individual as well leads to an increase in the amount of work and period that person is ready to dedicate to the mission, and this drives to higher achievement (Moores & Chang, 2009) because understanding progress during learning supports self-efficacy and advance learning (Schunk, 2001). Also, self-efficacy can cultivate in students the ability to solve tasks successfully, to learn actively, to perform behaviors at intended levels, and to influence the potential of students to try in mathematics (Hasan et al., 2014).

Besides, students obtain their self-efficacy from so-called sources of self-efficacy. The social cognitive theory developed by Bandura (1986), as cited in Clemente et al. (2024), offers a foundation for comprehending the principles behind the development of mathematics self-efficacy. Bandura identified the sources of self-efficacy that help to development of mathematics self-efficacy, as follows:

(1) mastery experience or achievement accomplishments,

(2) vicarious experience or indirect experiences,

(3) social persuasions or verbal conviction, and

(4) emotional and physiological states (Bandura & Adams, 1977).

The sources of mathematics self-efficacy are playing a key role in terms of helping students to believe in their efficacy. Each of these sources helps students to build up their self-efficacy and according to their capability and the source which each students derives from it this self-efficacy. Although the percentage of impact of the sources of self-efficacy on students' self-efficacy is different and not stable. It depends on different variables, such as context, gender, race, and region. However, most studies agree that the two strongest sources of mathematics self-efficacy are mastery experience and social persecution (Butz & Usher, 2015; Perez, 2014), which is also confirmed in this study.

Relationship Between Mathematics Self-Efficacy and Cognitive Domain

Findings of this study demonstrated that mathematics self-efficacy has a positive and significant relationship with the cognitive domain; these findings are compatible with studies of (Finn et al., 2014; Puerta, 2015). Whereby self-efficacy plays an essential role in learning and students who have a great sense of self-efficacy inclined to acquire cognitive skills; while students with minimal self-efficacy prevent missions requiring high cognitive skills (Schunk, 1985). Bandura (1994) defined cognitive processes as thinking processes involved in the acquiring, organizing, and usage of knowing. The feeling of efficacy in individuals can improve cognitive achievement through cognitive, affective, or motivational processes (Zahodne et al., 2015). Bandura (1993) point of view on the impacts of self-efficacy beliefs on cognitive domain takes a diversity of shapes and can be summarized in three points as follows: self-efficacy influences cognitive domain by

(1) making people place for themselves high the goals,

(2) impact the kinds of anticipant screenplays of people build and rehearse, and

(3) keeping person a robust feeling of efficacy to continue mission-oriented in the countenance of persistent situational desires, fails, and hindrances that possess considerable reflections.

Relationship Between Cognitive Domain and Mathematics Achievement

Another finding of this study is that the cognitive domain shown a positive and significant relationship with mathematical achievement. This result is backed by prior studies (Finn et al., 2014; Puerta Morales, 2015; George, 2023; Kliziene et al., 2022). Where the cognitive domain are the thinking ability for processing information, to help the individual to acquire and use knowledge. Bloom's cognitive domain emerged from the presumption that a lower category must be mastered profoundly to achieve a higher objective category (Taťána Karásková, 2014). In other word, according to Bloom's cognitive hierarchy of levels, the successive levels are cumulative and build upon one another by incorporating the previous levels (Furst, 1981 as cited in Liou & Bulut, 2020). Whereby, different levels of Bloom help students move through the process of learning from the most fundamental level (remembering and understanding) to the more complex level (evaluating and creating) to master the content knowledge (Giesen, 2013), during which the students acquire new knowledge. Where, the greater learners' progress on Bloom's taxonomy pyramid, the better level of learning that can be attained (Carpenetti, 2017), hence increases the level of achievement.

Relationship Between Mathematics Self-Efficacy and Mathematics Achievement Through Cognitive Domain

This study was primarily conducted to explore the indirect relationship between mathematics self-efficacy and mathematics achievement through the cognitive domain. It should be observed that, based on the findings of this study, the mediation effect did not eliminate the direct impact of self-efficacy on the mathematics achievement. The mediation took place however, partially. Partial mediation occurs when the observed relationship between the independent and dependent variable is weaker after the inclusion of the mediation effect (Fowler-Brown et al., 2013). Therefore, this study accepted the null hypothesis $\mathbf{H_0}$, which stated that the cognitive domain do not mediate a significant effect of the contribution of mathematics self-efficacy to mathematics achievement.

Students' cognitive domain is significantly affected by their self-efficacy. Where, the literature stresses that self-efficacy plays an important role in improving cognitive domain, which in turn impacts the cognitive domain of students positively (Saher & Akbar, 2024). According to Wentzel and Miele (2009), Bandura (1993) described how people gain information about their efficacy, which then affects their cognitive domain, and mentioned the four ways through which people gain this information: mastery experiences, verbal persuasions, vicarious experiences, and physiological states. Mastery experiences "include the acquisition of knowledge, and skill development" (McCampbell, 2015, p. 20). Subsequently, mastery knowledge gives the learner more confidence to learn more and to achieve more success. Thus, self-efficacy helps a learner to graduate from one level of learning to another and achieve more success. Past achievement and mastery experiences are primary factors influencing the expectation of success (Gorges & Göke, 2015). In addition, vicarious experiences play a main role in the cognitive domain. Under this source of self-efficacy, learning occurs indirectly, not by the learner's actions, but through the learner's observation (McCampbell, 2015). Vicarious learning refers to learning from models with regard to the required knowledge and abilities to complete a mission (Bandura, as cited in Gao, 2020). The quality of learning is dependent on the model being observed, their perceived expertise, the similarity of the model with the learner, and the ability of the learner to envision themselves as the model (McCampbell, 2015). Besides, regarding the cognitive processes, learners with greater levels of general self-efficacy find it easier to visualize success scenarios, whereas those with lower levels of general self-efficacy are more likely to imagine scenarios in which they fail to fulfill the required mission (Wilde & Hsu, 2019). Further, verbal persuasions include the feedback and messages that the learner receives. Encouraging letters promote learners to boost their trust in their academic abilities (Bandura, as cited in Lau et al., 2018). Verbal persuasions also influence a student's cognitive domain (acquisition of knowledge) through feedback, where feedback from the teacher can work as a verbal persuasion. For example, the instructor can encourage learners to refer to their failures to a lack of attempt and promote students to attempt trickier (Siegle & McCoach, 2007). Moreover, the teacher's inquiries can be perceived as verbal persuasion from the teachers in that learners can develop a belief in their capabilities to complete mathematical missions (Prabawanto, 2018). When individuals are persuaded verbally that they can achieve or expert a mission, they are further likely to carry out the mission (Hayden, 2013). This will help students to feel efficient and push them to acquire knowledge. Furthermore, physiological states, such as pressure, fear, weakness, and temper, help individuals acquire knowledge about their self-efficacy (Schunk & DiBenedetto, 2016). Physiological states influence students to acquire knowledge, where students clarify their physiological states as an indicator of their academic ability as they evaluate their accomplishments (Lau et al., 2018). Therefore, the students sense of self-efficacy in each level of bloom's cognitive domain (knowledge, understanding, application, analysis, synthesis, and evaluation) give students stimulate to move gradually from lowest to higher level until the students achieved high level in bloom's cognitive domain.

Implications

The results of the current study have significant for students, teachers, and researchers. Where the finding of the current study indicated that self-efficacy has a direct effect on student's achievement. Moreover, the cognitive domain has a mediate partially the effect between self-efficacy and mathematics achievement. self-efficacy is an agentic motivational orientation which powers perseverance in the

(1) front of difficulties,

(2) increases intentionality and long-term planning, and

(3) promotes self-regulation and self-correcting actions.

Thus, strong academic achievement is connected with raised confidence and possibly promotes students to take greater liability for successful task completion because self-efficacy relates to person's faith of his abilities to complete a task (Zhang et al., 2015). Pogoy et al. (2015) stated that student's achievement in mathematics highly influence by cognitive domain ,thus cognitive domain can help students to make a good basic level in mathematics (Dong et al., 2017). In the case of the cognitive domain as a partial mediation, there is a clear implication that other indirect effects could be examined and empirically (Rucker et al., 2011). According to

Preacher and Kelley (as cited in Rucker et al., 2011), "partial versus full mediation might be viewed as an indication of the importance of an intermediate variable in explaining the total effect" (p. 361). Thus, the cognitive domain has a key role in students' achievement in mathematics that should be taken into consideration. Moreover, the results of the current study contribute to the benefit of teaching mathematics through a focus on promoting self-efficacy of students because self-efficacy reflected on improving cognitive domain which help students to improve their mathematics achievement.

Limitation

This study has some limitation. The sample of the current study is eight-grade students (boys and girls) in Oman. The cognitive domain test has adopted by the released items of TIMSS former cycles 1999, 2003, 2007, 2011, 2015. Mathematics achievement is the national mathematics achievement test, which was prepared by Al Batinah North Governorate.

CONCLUSION

To conclude, the findings of the current study may be important in terms of understanding the relationship between self-efficacy and mathematics achievement through the cognitive domain as mediation. The study indicated that self-efficacy has a direct effect on mathematics achievement, and it has an indirect effect on mathematics achievement through a cognitive domain. Moreover, the cognitive domain mediates partially the relationship between the mathematics self-efficacy and mathematics achievement. Accordingly, it is important to take consideration of cognitive domain during teaching mathematics and when designing mathematics curriculum. In addition, the replicate this study in different countries for verifying the role of the cognitive domain as a mediation between self-efficacy and mathematics' achievement.

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