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Research Article

Role of mathematics motivation in the relationship between mathematics self-efficacy and achievement

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The current study intended to investigate the mediation role of mathematics motivation through the relationship between mathematics self-efficacy and mathematics achievement. The sample of the study consisted of 374 eighth-grade Omani students, 180 females and 194 males. PLS-SEM was used to investigate the direct effect between mathematics self-efficacy and mathematics achievement and indirect effect between mathematics self-efficacy and mathematics achievement through mathematics motivation as a mediation. This study showed that the mathematics motivation did not meditate the relationship between mathematics self-efficacy and mathematics achievement.

Keywords: Mathematics achievement; Mathematics motivation; Mathematics self-efficacy

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1. Introduction

Mathematics is considered an important subject because it involves arithmetic and logic, which are the building blocks of science and technology. Additionally, the education of mathematics is considered paramount, relatively for nations with a leading position in science and technology. Therefore, scholars around the world are striving to improve mathematics achievement by identifying factors that contribute to students' success. The differences in mathematics achievement lie in the various educational systems and learning theories as well as the prospects of the educators, parents, and students themselves (Wei & Dzeng, 2014).

Psychological factors like self-efficacy [SE] play a vital role in student performance. Some studies (Chang, 2012; Komarraju & Nadler, 2013) argue that SE is considered a powerful key factor in a student's learning achievement and AA. Moreover, it also helps students believe that they can succeed (Akosah et al., 2024). SE is defined as an person's belief that he or she can be successful in completing a task (Cambridge Dictionary, 2018). It is an individual's belief in or self-confidence about their capability of accomplishing a task (Liu & Koirala, 2009). Therefore, SE helps students believe that they can succeed (Akosah et al., 2024).

The literature reveals that mathematics self-efficacy [MSE] correlates positively with mathematics achievement [MA] (Evans, 2015; Meral et al., 2012). The self-efficacy of an individual impacts how they approach a task and how persistent they are in completing it. This means that SE

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influences students' academic motivation as well. Many researcher (Pajares & Urdan, 2006) have found that SE impacts the motivation to learn mathematics.

Among the psychological factors that influence students' AA is motivation. Success in a students' AA is related to an increase in their motivation (Oksuz, 2015). Numerous studies have concluded that motivation plays a crucial role in a student's achievement (Abdurrahman & Garba, 2014; Haider et al., 2015). Motivation influences achievement because it can arouse and sustain the curiosity and interest of learners.

Motivation can be classified into three different aspects: intrinsic [IM], extrinsic [EM], and amotivation [AM] (Hussien et al., 2012). Intrinsic motivation is a behaviour that comes from within an individual. Intrinsic motivation involves the student's request to participate in learning for their own sake. For example, those who are intrinsically motivated participate in academic missions since they perceive these missions as important and because they enjoy doing them (Middleton & Spanias, 1999). However, there is another type of motivation, known as EM, which refers to behaviour influenced by external factors such as money, fame, grades, and praise. Hence, students with EM focus on rewards or avoiding punishment (Middleton & Spanias, 1999). AM is the third type of motivation. According to Vallerand (2001), AM refers to "a lack of intentionality and thus the relative absence of motivation", which refers to the absence of both IM and EM in a person. AM is linked to boredom, poor concentration, poor psychosocial adjustment, high perceived stress in school, and school dropout (Boyd, 2018). These three types of motivation influence a student's academic motivation, which, in turn, influences their achievements.

SE has an impact on the student's motivation as it helps determine the goals that students set, how much effort they expend on the goal, how long they preserve, and how resilient they are to failure (Bandura, 1994). The most exciting aspect of learning is motivation. It is a source of human energy and a basis for the formation of the habits, tendencies, and practices of an individual. Pakdel (2013) states that motivation is a group of procedures that stimulate, guide, and promote human behaviour toward achieving goals and performance.

Therefore, a student's AA is influenced by certain variables that increase or decrease the level of their AA, such as SE and motivation, where has a positive relationship with AA (Chowdhury & Shahabuddin, 2007; Maraghi et al., 2018). Several studies (e.g. Goodman et al., 2011) have shown a correlation between motivation and achievement. Moreover, several studies (e.g. Sartawi et al., 2012; Skaalvik et al., 2015) have illustrated motivation and SE are positively correlated.

According to the aforementioned argument, mathematics motivation [MM] is associated with increased or decreased MA. On the one hand, On the one hand, Doménech-Betoret et al. (2017) stated that academic self-efficacy is a significant internal source of motivation. According to Bandura (1989), self- beliefs of efficacy can improve or weaken performance through their effects on motivational intervening procedures. Although there is a lot of evidence to support the direct effects of self-efficacy beliefs on academic achievement, there aren't many studies that have looked into the motivational mechanisms that mediate the relationship between self-efficacy and achievement. These studies are important to understand because they help explain how and why self-efficacy influences students' academic achievement and help design instructional strategies and programs to raise academic achievement (Doménech-Betoret et al., 2017). Therefore, the issue that the current study attempts to unveil is as follows: Does mathematics motivation play a mediation role between MSE and MA? In other words, is MSE relocating its impact on MA through MM? Therefore, knowing how MM contributes to the relationship between MSE and MA can help us to understand how MSE is able to affect MA.

2. Theoretical Framework

2.1. Self-efficacy Theory (SET)

The SET is part of the social cognitive theory of personality by Bandura (1994). Through cognitive, decisional processes, affective, and motivational, SE beliefs influence a person's excellence level. In particular, an individual's beliefs in their efficacy affect whether they think negatively or positively, through self-enabling methods. These efficacy beliefs affect how well individuals motivate themselves and persist in confronting obstacles through the targets they give themselves, their expectations, and the causal reference for their accomplishments and disappointments (Bandura, 2012).

The social cognitive theory of self-efficacy explains how SE influences the motivation of learners and clarifies that SE influences a student's motivation through (i) choices of activities; (ii) the effort expended; (iii) persistence; and (iv) interest (Wentzel & Miele, 2009).

2.2. Self-determination Theory (SDT)

The SDT summarizes how people are motivated in three ways—innate, universal, and psychological needs. According to theory, if competency, connection, and autonomy needs are met, individuals can also become self-determined (Deci & Ryan, 2000). These three psychological desires—competence, relatedness, and autonomy—motivate an individual to indulge in a certain behaviour and intellectual nutriments that are desirable for psychological health and welfare. When these needs are satisfied, good after-effects such as welfare and growing occur; this drives people to be motivated, fruitful, and cheerful (Ryan & Deci, 2017).

The SET and SDT are established on the philosophy that individuals are agents of their behaviours. Agency, particularly concerning an internalist viewpoint, implies that human beings have complicated internal constructions that permit them to make choices regarding their actions (Sweet et al., 2012). Under the SET, individuals act when they think they are competent and efficient to achieve a goal. While SDT theoreticians assume that feelings of ability are important, they believe that autonomy is more influential. People who feel autonomous in their work are more likely to carry on and sustain their behavior, which makes self-determined motivation a critical component of agent motivation. Since the power of agency varies in every one of these theories, the role of SE(competence) in behaviour is also distinct (Sweet et al., 2012).

In both SDT and SET, individuals are seen as agents of their behaviors (Sweet et al., 2012). Moreover, there are several theoretical similarities between the SDT and SET that including the fundamental psychological necessity to feeling capable and recognized self-efficacy. First, equal structures participate in chasing a target and its achievement. Second, SDT and SET are "obstetric" in the feeling that they encourage behavioural commitment, studying, and gaining ability. No one is a consequence of itself. The SDT and SET are theoretically differentiated from behavioural outcomes, and the two are conceptualized as process-based in the sense of mother nature, fostering behavioural perseverance and increasing throughout time and introducing pertinent experience. Finally, equally are cyclical in the feeling when a person's demand for recognized competency is met or when a person senses self-efficiency in a specific behavioural field, everyone becomes robust, and thus, the ability to perform the related behaviour is improved once more. It is obvious, however, that a person able to be effective for behaviours do not meet the requirement for competency, and thus, self-efficiency and sensed competency should not be unnecessary for one another (Rodgers et al., 2014).

2.3. Interactions among Variables

SE is the main determining factor of achievement. Moreover, the four sources of SE influence AA (Loo & Choy, 2013). Mastery experience (ME) is the first source of SE and plays a key role in increasing or decreasing AA (Akendita et al., 2024). This is because ME carry on with their success or failure. Through vicarious experience (VE), learners acquire information about their abilities by observing other people, particularly colleagues who offer appropriate contrast opportunities, which leads to an increased influence on the AA of students (Hasan et al., 2014). Social persuasion (SP) is the third source of SE that influences students' achievement. Positive persuasive feedback leads to higher self-efficacy; it, in turn, brings about an increase in the achievement of students (Hasan et al., 2014). Physiological state is the fourth source of SE that influences a student's achievement. A positive state of mind empowers a person's SE belief. This, in turn, leads to an increase in their achievements. SE beliefs are the cause of a superior performance as it impacts an individual's thought processes, motivation, and behaviour. Those with high SE attempt and persist for longer on difficult missions, and expend more effort on them. Moreover, SE beliefs can either improve or inhibit performance based on the impact they have on cognitive, affective, and motivational processes (Bandura, 1989).

Students' SE is crucial to their motivation, as it provides a foundation for motivation (Pajares & Urdan, 2006) and a key to improve motivation in order to continue learning (Margolis & McCabe, 2004). According to Pajares and Urdan (2006), SE has a powerful influence on students' motivation through (i) choices of actions; (ii) the effort spent; (iii) persistence; and (iv) interest. These elements are strongly connected with motivation (Yang et al., 2009). Giving students opportunities to engage in decision-making to choose their activities will provide them with a higher level of motivation (Johnson et al., 2011). According to Bandura (1994), SE contributes to motivation in the following ways: (i) it defines the objectives individuals set for themselves; (ii) it defines the extent of their efforts; (iii) it determines how long they persist when encountering obstacles; and (iv) it determines their openness toward failures.

Learners with IM persist longer and perform well in their academic efforts. Moreover, they earn higher grades in achievement. Such students do more to satisfy themselves rather than in fear of any distinguishable consequences (Ghaonta, 2017; Heyder et al., 2020). On the other hand, learners with extrinsic motivation are inclined to focus on getting rewards and great results, as their actions are governed by external instead of internal elements (Anselme & Hidi, 2024). Thus, students with both intrinsic and extrinsic motivation get higher grades in AA.

In contrast, students with amotivation have poor AA. Studies have shown that amotivation is strongly and adversely linked to poor educational results (Vallerand & Bissonnette,1992). Students who are amotivated seem to lack self-confidence in regulating their process of studying and are inclined to display inappropriate actions in the classroom. Amotivated learners explain failure as a sign of personal weakness of capability and worry that they are unable to do anything to overcome their difficulties (Leroy & Bressoux, 2016). Ferguson (2017) point out that motivation is adversely associated with AA and that the better the AA, the lower the AM.

Current study focuses on the frame outlined in Figure 1 and aims to 1) Identify whether MSE relates to MA, and 2) Identify whether MM mediates the contribution of MSE to MA. In line with this purpose, the following research questions were addressed and hypotheses were tested.

RQ 1) Is there a relationship between MSE and MA?

H$_a$: MSE has a significant effect on MA.

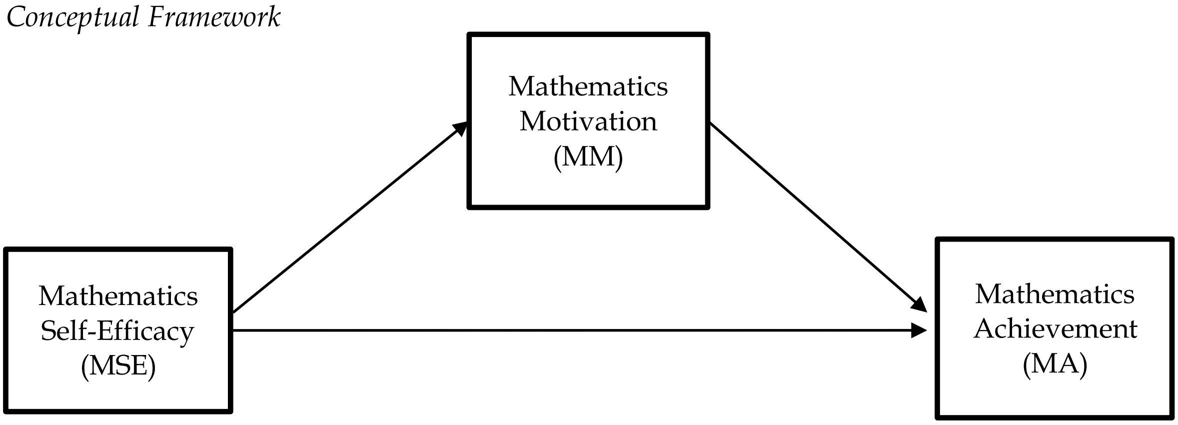
H$_0$: MSE does not have a significant effect on MA.

RQ 2) Does MM mediate the effect of the contribution between MSE and MA?

H$_a$: MM mediates a significant effect on the contribution of MSE to MA.

H$_0$: MM does not mediate a significant effect on the contribution of MSE to MA.

Figure 1
Conceptual Framework



3. Method

3.1. Sample

The population of this study comprised 9358 eighth-grade students, including 4861 boys and 4497 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. Current study used the published tables of sample size determination. 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 9358 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 (9358): 370 ÷ 9358 = 0.0395 ≈ 0.040 = 4%. Hence, the boys' sample was 4% × 4861 = 194.44 or 194, while the girls' sample was 4% × 4497 = 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.

3.2. Instruments

The measurement tools used in the current study were Source of Mathematical Self-Efficacy Scale [SMES], the Mathematics Motivation Scale [MMS], and National Mathematics Achievement Test [MA].

3.2.1. Source of Mathematical Self-Efficacy Scale

The researcher used the source of mathematical self-efficacy scale to measure students' self-efficacy in mathematics. This scale was constructed by Usher and Pajares (2009) in the USA for middle school mathematics students. Besides, the researcher found various scales to assess mathematical self-efficacy from previous studies. However, the researcher selected SMES constructed by Usher and Pajares (2009). This is because the SMES has some distinctions: (1) SMES had been used in previous studies (Campbell & Stanley, 2015; Chen, 2010; Kandemir & Akbaş-Perkmen, 2017) and is used in different countries such as Taiwan, Turkey, and the USA; (2) SMES has better psychometric properties according to Kandemir and Akbaş-Perkmen (2017), who recommended mathematics teachers in Turkey to use it. Moreover, according to Usher and Pajares (2009), SMES could be adapted for use in other domains and could therefore also be used in a different culture (countries) as used in Turkey and Taiwan.

SMES has been used with middle school students. It was established by Usher and Pajares (2009). It has a high degree of validity and reliability and, it has been used for many studies (Campbell & Stanley, 2015; Chen, 2010; Kandemir & Akbaş-Perkmen, 2017). SMES consists of 24 items, which are as follows: 6 items (1–6) measure Mastery experience [MS], 6 items (7–12) measure Vicarious experience [VE], 6 items (13–18) measure Social persuasions [SP], and 6 items (19–24) measure Physiological state [PH]. 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 researcher 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 consisting of 700 students (379 girls and 321 boys) from the eighth grade. The SMES contained 23 items after cross-cultural adaptation and validation because the researcher deleted one item from ME contract. The summary of CFA for SMES after adaptation and validation is as follows: (i) number of items were 23, and the Cronbach's Alpha (α) values of the overall scale were 0.77; (ii) 5 items (1–5) measure ME, like " I make excellent grades on math tests" , and the α value was 0.74; (iii) 6 items (6–11) measure VE, like " Seeing adults do well in math pushes me to do better", and the α value was 0.77; (v) 6 items (12–17) measure SP, like "Other students have told me that I'm good at learning math", and the α value was 0.84; (iv); 6 items (18–23) measure PH, like "Doing math work takes all of my energy" and the α value was 0.85. The χ^2 = 767.8, df = 224, CFI value was 0.92, SRMR = .0478, and RMSEA = .059, for the 4-factor model.

3.2.2. National mathematics achievement test

The researcher used the National Mathematics Achievement Test in grade eight, which was developed by the Ministry of Education of the Sultanate of Oman in the academic year 2018/2019. National Mathematics Achievement Test is standardized achievement test which means a published, nationally normed test that provides a valid and reliable measure of a pupil's present achievement level in comparison with age or grade level cohorts. Devi and Sharma (2013) define an achievement test as "a test of knowledge or proficiency based on something learned or taught" (p.41).

The national achievement test is a 40-mark test that assesses the knowledge and skills taught by teachers to all students in Oman during their first semester. It measures the content domain and cognitive domain (knowing-applying-reasoning) at rates of 25%, 50%, and 25%, respectively. The content domain consists of rational numbers, algebraic quantities, polynomials, and geometry. The national achievement test consists of three questions, as follows: The first question is multiple-choice and has 8 items and 8 marks; the second question and third question include four sub-questions (A, B, C, and D) with short and long answers, and each question has 16 marks.

Standardized achievement tests are designed to be reliable. because all students are judged based on the same tasks under the same conditions. Standardized tests assess students on a narrow range of skills (mostly a subset of what students learn in math classes) in one type of condition (Allensworth & Clark, 2020). However, it's important to note that while these tests strive for reliability, they are not perfect and can still have some degree of error or inconsistency. Even though, the researchers relied on the consistency of standardized test on y the experts from the Ministry of Education. In addition to reliability, standardized achievement tests are also designed to be valid. Test validity refers to the extent to which the test measures what it is intended to measure. For standardized achievement tests, this means that they should accurately assess the knowledge or skills they are designed to test, and that the results can be interpreted meaningfully in relation to the intended educational objectives.

3.2.3. Mathematics Motivation Scale (MMS)

The researcher used the mathematics motivation scale (MSS) to measure students' motivation to learn mathematics. MSS is constructed by (Hussien et al., 2012) in the UAE. The researcher chose MSS after reading various types of scales that have been used to measure students' motivation for learning mathematics in many studies and found this scale to be more convenient to the nature of this study and more suitable for Omani students. This is because, firstly, the latest motivational research depends on self-determination theory. Second, MMS has acceptable levels of content validity and structure validity, and acceptable levels of internal consistency and temporal stability. Third, MMS was used by Omani scholars (Aldhafri & Alrajhi, 2014) and this gives more credibility to their results. Fourth, according to past studies (Boynton & Greenhalgh, 2004) administering a published questionnaire, which has previously been reliable and valid is recommended for use.

This research, based on recommendations (Boynton & Greenhalgh, 2004), used the MMS to measure students' motivation to learn mathematics. The MMS was constructed by Hussien et al. (2012) and adapted by Aldhafri and Alrajhi (2014) using Omani data. The researcher administered a pre-test on an MMS scale to verify the stability of the scale for this study.

The MMS as constructed by Hussien et al. (2012) consists of 44 items and a four-point Likert scale ("1"= does not describe me at all; "2"= describes me a little; "3"= greatly describes me; "4" = describes me completely), which measures students' motivation to learn mathematics and relies on the SDT. The SDT then helps researcher understand the human motivation behind these actions (Zhang et al., 2016).

Hussien et al. (2012) constructed the MMS using five theoretical subscales: Intrinsic Motivation, Amotivation, Identified Regulation [IR], Introjected Regulation [INR] and External Regulation [ER]. The mathematics motivation scale has 44 items arranged from 1 to 44, randomly representing the five essential subscales of IM, AM, IR, INR and ER with the latter three represent extrinsic motivation.

Intrinsic Motivation is represented by seventeen items in the scale, and accordingly correspond to certain items, (Specifically, items 1,2,3,8,9,10,15,16,21,22,27,28,32,36,37, and 42), like "I study mathematics to learn new things". Similarly, Amotivation is represented by nine items in the scale, and also accordingly correspond to certain items (Specifically, items 7,14,20,26,31,34,39,41, and 44), like "I feel that studying mathematics is a waste of time" . Eight items also represented External Regulation (Specifically, items 6,13,19,25,30,38,40, and 43), like "I study mathematics to satisfy my teacher". Six items then represented Introjected Regulation (Specifically, items 5,12,18,24,29, and 33), like "I study mathematics to prove to myself, that I am able to success". Finally, four items represented Identified Regulation (Specifically, items 4,11, 17, and 23), like "I study mathematics, because it is important to me".

All 44 items reflect the different types of motivation and thus represent the reason students study mathematics. The final total score of the scale represents the degree of student motivation. Hussien et al. (2012) explained that the Cronbach's coefficient α and test-retest reliability coefficient for MMS (N = 1326), IM (α =.90), INR (α = .77), ER (α =.79), and AM (α = .90). However, Hussien et al. (2012) reports that the identified regulatory motivation did not play a role in the MMS.

The MMS was constructed based upon responses from 1,481 UAE students from grades 4 through 12 (Aldhafri & Alrajhi, 2014). Hussien et al. (2012) pointed out that content and structure validity of the MMS are acceptable. Aldhafri and Alrajhi (2014) used the MMS to measure the motivation of eighth-grade students and ran the MMS on Omani data before using the scale; they found that the internal consistency coefficients for intrinsic motivation (α = .92) and extrinsic motivation (α = .85) showed good reliability evidence.

3.3. 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 motivation Scale) and were administered to help improve the collection and response rate on the instruments of study. the mathematics motivation scale was taken (44 minutes) without giving a break for students, and the rate responses of students were 100%. After completing the mathematics motivation scale, the researcher and teachers administered a mathematical self-efficacy scale to eighth graders, which took 24 minutes. 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.

3.4. 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).

4. Results

4.1. First Analysis of the Evaluation of Measuring Model

Analysis of the measurement model included two stages: first analysis of the lower-order component [LOC] and second analysis of the higher-order component [HOC].

HOC is a common structure explaining the whole implicit LOC in an HCMs (Hair et al., 2017). Meanwhile, LOCs are 'a subdimension of the HOC in an HCMs' (Hair et al., 2017, p. 296). Moreover, HCMs comprise an extra abstract HOC which are associated to two or more LOCs in either a reflective or formative way.

4.1.1. First analysis of the LOCs

The researcher first analysed the LOCs of both constructs (SMES and MMS) in terms of the following areas: (1) Factor loading; (2) Internal consistency; (3) Convergent validity; and (4) Discriminant validity.

(1) Factor loading (FL) — explains the correlation between observed variables (Salkind, 2010). Notably, Table 1 shows that the factor loadings of all constructs of the SMES are above 0.5, indicating that the factor loadings of the SMES have met the corresponding criteria. This is after the researcher dropped one item from the SMES (Specifically, from the vicarious experience construct) due to 0.3 being the lowest FL for maintaining an item in the allotted factor (Nayeri et al., 2019). Considering the results obtained from Table 3, all factor loadings of the MMS are notably above 0.5, except for the FL of one item (IM-4) in Intrinsic Motivation, which is 0.491. Ultimately, the FL of all constructs of this study is good, allowing the researcher to move to the next step in the analysis of the measurement model.

(2) Internal consistency — IC evaluates (Cronbach's (α), and Composite reliability [CR] and is a form of reliability used to judge the consistency of results across items on the same test. "It determines whether the items measuring a construct are similar in scores" (Hair et al., 2017, p. 320). In both Tables 1 and 3, the values of Cronbach's *a* for each component of the SMES and MMS are above 0.7, which is an acceptable value according to Taber (2018). This explains the results of CR for both SMES and MMS. The CR values for each component of the SMES and MMS are above 0.7. These results seem good according to the criteria of Malhotra (2010). Thus, the internal consistency of both MMS and SMES is also good.

(3) Convergent validity — CV is the agreement among measures that theoretically should be related. It is assessed by calculating the Average Variance Extracted [AVE],which is the degree to which a latent construct explains the variance of its indicators, and should be above 0.5 (Hariri & Roberts, 2015). From Table 1, the AVE of all components of the SMES is above 0.5, which means that the SMES achieved CV. Also, Table 3 illustrates that after dropping four items from external regulation and eight items from intrinsic motivation, the AVE of all components of the MMS is above 0. 5. Thus, Both SMES and MMS fulfil the criteria of Convergent validity.

Table 1
Results Summary for Reflective Measurement Models of Source of Mathematics Self-efficacy scale (SMES)

Constructs	Latent variable (LV)	Indicator (I)	*CV* Factor Loading (FL)/ Outer loading	*CV* AVE	*IC* α	*IC* CR	*DV* HTMT confidence interval does not include 1
			>0.5	**> 0.5**	**> 0.6**	**> 0.6**	
Source Of Mathematics Self-Efficacy(SMES)	ME	ME_1	0.832	0.588	0.824	0.877	Yes
		ME_2	0.738				
		ME_3	0.762				
		ME_4	0.719				
		ME_5	0.777				
	PH	PH_1	0.769	0.623	0.878	0.908	Yes
		PH_2	0.716				
		PH_3	0.817				
		PH_4	0.807				
		PH_5	0.795				
		PH_6	0.825				
	SP	SP_1	0.802	0.638	0.886	0.913	Yes
		SP_2	0.838				
		SP_3	0.82				
		SP_4	0.782				
		SP_5	0.78				
		SP_6	0.767				
	VE	VE_1	0.751	0.564	0.807	0.866	Yes
		VE_2	0.794				
		VE_3	0.794				
		VE_4	0.707				
		VE_5	0.704				

Table 2
The Fornell–Larcker Criterion for the SMES

	ME	PH	SP	VE
ME	0.767			
PH	−0.432	0.789		
SP	0.673	−0.386	0.799	
VE	0.687	−0.354	0.662	0.751

Note. Mastery experience=(ME); Vicarious experience=(VE); Social persuasions =(SP); Physiological state= (PH).

Table 3
Results Summary for Reflective Measurement Models of Mathematics Motivation scale

Constructs	LV	I	CV		IC		DV
			FL	AVE	α	CR	HTMT confidence interval does not include 1
			>0. 5	**> 0. 5**	**> 0.6**	**> 0.06**	
Mathematics Motivation Scale (MMS)	AM	AM_1	0.613	0.535	0.891	0.912	Yes
		AM_2	0.784				
		AM_3	0.759				
		AM_4	0.786				
		AM_5	0.701				
		AM_6	0.723				
		AM_7	0.768				
		AM_8	0.741				
		AM_9	0.691				
	ER	ER_1	0.597	0.543	0.72	0.824	Yes
		ER_2	0.763				
		ER_3	0.834				
		ER_4	0.733				
	IM	IM_2	0.797	0.506	0.857	0.889	Yes
		IM_6	0.764				
		IM_7	0.734				
		IM_8	0.79				
		IM_5	0.798				
		IM_1	0.569				
		IM_3	0.682				
		IM_4	0.491				
	INR	INR_1	0.736	0.545	0.83	0.877	Yes
		INR_2	0.71				
		INR_3	0.772				
		INR_4	0.831				
		INR_5	0.598				
		INR_6	0.761				
	IR	IR_1	0.781	0.544	0.719	0.826	Yes
		IR_2	0.69				
		IR_3	0.665				
		IR_4	0.803				

Note. AM: Amotivation; ER: External regulation; IM: Intrinsic Motivation; INR: Introjected regulation; IR: Identified regulation; CV: Convergent validity; DV: Discriminant validity; IC: Internal consistency; HTMT: Heterotrait-monotrait ratio; AVE: Average variance extracted; α: Cronbach's alpha; I: Indicator; LV: Latent variable; FL: Factor Loading.

(4) Discriminant validity — The discriminant validity of a scale is tested by determining whether the items or measurements do not measure any other structure. For Zaiț and Bertea (2011), DV presumes that items must correlate more amongst themselves compared to other items from other structures that are theoretically assumed to not correlate. The Fornell–Larcker criterion was applied to determine the DV of the three constructs herein. In Table 2, the square root of AVE of all the constructs of the SMES is higher than its correlation with any other latent variable in the same construct. The same also applies for MMS in Table 4. This means that both SMES and MMS meet the Fornell–Larcker criterion and thus, fulfil the DV.

However, according to Hair et al. (2017), the Fornell-Larcker criterion performs very poorly. Instead, a new criterion was proposed by Henseler et al. (2015) to assess discriminant validity: the Heterotrait-monotrait ratio [HTMT]. HTMT is the mean of all correlations of indicators across constructs measuring different constructs relative to the (geometric) mean of the average correlations of indicators measuring the same construct (Hair et al., 2017). HTMT criteria are available in SmartPLS (v.3.2.8) complete bootstrap. Henseler et al. (2015) suggested using HTMT to assess discriminant validity wherein an HTMT value of <1 acceptably established discriminant validity. They further argued that the HTMT ratio is better in detecting the shortage of discriminant validity. Thus, the researcher herein used both criteria— Fornell–Larcker and HTMT ratio— to ensure that the discriminant validity was fulfilled. A complete bootstrapping of the used 5000 resamples according to Hair et al. (2017) was conducted, which needed to be significant at the 0.05 level to get the results of HTMT test. Table 5 exhibits the results of the HTMT ratio of both SMES and MMS. Notably, Table 5 shows that the HTMT ratio of all constructs is below one, which means that DV is founded for both SMES and MMS (Henseler et al., 2016). Thus, both SMES and MMS fulfil the condition of DV.

Table 4
The Fornell–Larcker Criterion for MMS

	AM	*ER*	*IM*	*INR*	*IR*
AM	0.731				
ER	0.530	0.737			
IM	−0.369	−0.237	0.711		
INR	−0.327	−0.049	0.571	0.738	
IR	−0.383	−0.179	0.723	0.663	0.737

Note: AM: Amotivation; ER: External regulation; IM: Intrinsic Motivation; INR: Introjected regulation; IR: Identified regulation.

Table 5
The Heterotrait-Monotrait (HTMT) Ratio for SMES, and MMS

CONSTRUCT		*Original Sample (O)*	*Sample Mean (M)*	*2.50%*	*97.50%*
MMS	ER → AM	0.651	0.66	0.543	0.759
	IM → AM	0.4	0.405	0.331	0.494
	IM → ER	0.312	0.327	0.206	0.405
	INR → AM	0.369	0.376	0.259	0.449
	INR → ER	0.133	0.17	0.114	0.143
	INR → IM	0.66	0.657	0.581	0.759
	IR → AM	0.469	0.456	0.398	0.564
	IR → ER	0.25	0.274	0.176	0.336
	IR → IM	0.891	0.889	0.827	0.938
	IR → INR	0.856	0.855	0.75	0.93
SMES	PH → ME	0.503	0.497	0.421	0.582
	SP → ME	0.78	0.784	0.665	0.838
	SP →PH	0.431	0.433	0.32	0.533
	VE → ME	0.831	0.831	0.732	0.899
	VE → PH	0.406	0.414	0.295	0.523
	VE → SP	0.767	0.772	0.662	0.822

Note. AM: Amotivation; ER: External regulation; IM: Intrinsic Motivation; INR: Introjected regulation; IR: Identified regulation; MMS: Mathematics Motivation Scale; ME: Mastery experience; VE: Vicarious experience; SP: Social persuasions; PH: Physiological state; SMES: Sources of Mathematics Self-Efficacy Scale.

4.1.2. Second analysis of the HOC

This stage includes evaluating the higher-order component for both MMS and SMES, which is reflective-formative. Here, HOC was evaluated in terms of the following: (1) Nomological validity, (2) Discriminant validity, (3) Multicollinearity (VIF), (4) Indicator Weights, and (5) Convergent validity which is their significance and relevance.

(1) Nomological validity refers to relationships between the formative structure and the other structures in the path model that are robust and substantial are perfectly supported in literature (Duarte & Amaro, 2018). The researcher selected the SMES and MMS based on previous studies, which likewise used the SMES and MMS in the same field. Additionally, these former studies have verified the validity and reliability of said scales.

(2) Indicator Weights, and their significance and relevance is where the analysis of the significance of the external weight of every indicator detects the comparative significance, whereas factor loading reflects the absolute significance (Duarte & Amaro, 2018; Tehseen et al., 2017). The researcher herein evaluated the relevance of indicator weights for all constructs of the HOC using SmartPLS (v.3.2.8) bootstrapping (Hair et al., 2017). Considering the findings obtained from the analysis in Tables 6 and 7, the external weights of all constructs of the HOC of both SMES and MMS are significant. Tables 6 and 7 show the confidence interval for both SMES and MMS respectively, thereby providing more confidence with respect to the significant weight where zero did not show between the lower and higher values of confidence interval for both SMES and MMS (Tehseen et al., 2017).

Table 6

The Testing of Significance of Weight and Confident Interval for SMES

Construct	*Indicators*	*O*	*M*	*SD*	*t*	*p*	*95% CI*
ME	ME-1 → SE	0.092	0.091	0.004	25.023	<.05	[0.082, 0.096]
	ME-2 → SE	0.071	0.071	0.004	17.054	<.05	[0.063, 0.079]
	ME-3 → SE	0.078	0.078	0.005	15.927	<.05	[0.068, 0.085]
	ME-4 → SE	0.069	0.07	0.003	21.112	<.05	[0.059, 0.075]
	ME-5 → SE	0.077	0.078	0.004	19.729	<.05	[0.069, 0.081]
PH	PH-1 → SE	−0.062	−0.061	0.004	14.231	<.05	[−0.069, −0.053]
	PH-2 → SE	−0.05	−0.047	0.006	8.719	<.05	[−0.058, −0.04]
	PH-3 → SE	−0.06	−0.059	0.005	13.096	<.05	[−0.069, −0.049]
	PH-4 → SE	−0.066	−0.065	0.006	11.859	<.05	[−0.074, −0.057]
	PH-5 → SE	−0.066	−0.066	0.004	15.654	<.05	[−0.072, −0.054]
	PH-6 → SE	−0.062	−0.062	0.005	12.267	<.05	[−0.069, −0.05]
SP	SP-1 → SE	0.081	0.08	0.003	23.426	<.05	[0.074, 0.087]
	SP-2 → SE	0.085	0.085	0.004	23.353	<.05	[0.076, 0.091]
	SPI-3 → SE	0.081	0.081	0.004	21.616	<.05	[0.075, 0.088]
	SP-4 → SE	0.075	0.076	0.004	17.872	<.05	[0.066, 0.081]
	SP-5 → SE	0.068	0.068	0.004	17.146	<.05	[0.059, 0.074]
	SP-6 → SE	0.081	0.082	0.004	19.334	<.05	[0.072, 0.088]
VE	VE-1 → SE	0.069	0.069	0.004	17.355	<.05	[0.06, 0.076]
	VE-2 → SE	0.084	0.084	0.004	23.891	<.05	[0.076, 0.088]
	VE-3 → SE	0.08	0.08	0.003	28.472	<.05	[0.073, 0.085]
	VE-4 → SE	0.064	0.064	0.004	15.169	<.05	[0.056, 0.07]
	VE-5 → SE	0.067	0.066	0.004	15.615	<.05	[0.059, 0.075]

Note. O: Original Sample; M: Sample Mean.

(3) Multicollinearity is an essential attribute when assessing formative assessment models (Duarte & Amaro, 2018). It identifies if there is multicollinearity between the formative components (Thornton et al., 2014). Table 8 explains the VIF values of the HOC for both SMES and MMS constructs. These values are less than 5, indicating that there is no issue of collinearity (Hair et al., 2017; Tehseen et al., 2017).

Table 7
The Testing of Significance of Weight and Confident Interval for MMS

Construct	*Indicators*	*O*	*M*	*SD*	*t*	*p*	*95% CI*
AM	AM-1 → MMS	-0.044	-0.043	0.005	8.167	<.05	[−0.052, −0.034]
	AM-2 → MMS	-0.056	-0.056	0.004	13.019	<.05	[−0.062, −0.048]
	AM-3 → MMS	-0.056	-0.054	0.004	13.107	<.05	[−0.063, −0.047]
	AM-4 → MMS	-0.065	-0.064	0.004	14.991	<.05	[−0.07, −0.057]
	AM-5 → MMS	-0.05	-0.051	0.005	10.424	<.05	[−0.058, −0.039]
	AM-6 → MMS	-0.062	-0.062	0.004	16.06	<.05	[−0.069, −0.052]
	AM-7 → MMS	-0.063	-0.063	0.004	14.708	<.05	[−0.071, −0.056]
	AM-8 → MMS	-0.061	-0.061	0.005	13.268	<.05	[−0.068, −0.055]
	AM-9 → MMS	-0.059	-0.058	0.004	16.172	<.05	[−0.068, −0.051]
ER	ER-1 → MMS	-0.026	-0.026	0.007	3.58	<.05	[−0.033, −0.016]
	ER-2 → MMS	-0.039	-0.039	0.007	5.836	<.05	[−0.045, −0.027]
	ER-3 → MMS	-0.048	-0.048	0.006	8.196	<.05	[−0.056, −0.036]
	ER-4 → MMS	-0.042	-0.043	0.006	7.661	<.05	[−0.053, −0.032]
IM	IM-2 → MMS	0.033	0.035	0.005	6.849	<.05	[0.025, 0.042]
	IM-3 → MMS	0.076	0.077	0.004	19.631	<.05	[0.069, 0.084]
	IM-4 → MMS	0.071	0.072	0.005	15.073	<.05	[0.063, 0.079]
	IM-5 → MMS	0.038	0.038	0.005	8.249	<.05	[0.029, 0.046]
	IM-6 → MMS	0.074	0.074	0.004	19.093	<.05	[0.066, 0.081]
	IM-7 → MMS	0.07	0.07	0.004	18.783	<.05	[0.064, 0.076]
	IM-8 → MMS	0.07	0.07	0.004	15.938	<.05	[0.061, 0.076]
	IM-9 → MMS	0.073	0.074	0.004	17.929	<.05	[0.067, 0.082]
INR	INR-1 → MMS	0.068	0.068	0.004	19.046	<.05	[0.055, 0.071]
	INR-2 → MMS	0.049	0.049	0.005	9.58	<.05	[0.048, 0.066]
	INR-3 → MMS	0.069	0.068	0.004	15.4	<.05	[0.053, 0.066]
	INR-4 → MMS	0.074	0.074	0.004	19.546	<.05	[0.059, 0.075]
	INR-5 → MMS	0.063	0.062	0.004	14.22	<.05	[0.036, 0.061]
	INR-6 → MMS	0.054	0.055	0.005	9.92	<.05	[0.061, 0.075]
IR	IR-1 → MMS	0.075	0.075	0.004	21.303	<.05	[0.066, 0.081]
	IR-2 → MMS	-0.044	-0.043	0.005	8.167	<.05	[0.054, 0.069]
	IR-3 → MMS	-0.056	-0.056	0.004	13.019	<.05	[0.044, 0.062]
	IR-4 → MMS	-0.056	-0.054	0.004	13.107	<.05	[0.066, 0.082]

Note. O: Original Sample; M: Sample Mean.

Table 8
The VIF of the Second Construct of MMS and SMES

Formative constructs	*VIF values*
SMES	
ME	2.367
PH	1.257
SP	2.151
VE	2.199
MMS	
AM	1.669
ER	1.533
IM	2.534
INR	2.006
IR	2.646

(4) Discriminant validity forwards that the constructs are properly differentiated from each other if the correlation between the formative and every other construct is less than 0.70 (Duarte & Amaro, 2018). In Table 9, the correlations between the formative constructs for both the SMES and MMS are lower than 0.70, meaning that the constructs in both SMES and MMS vary adequately from each other. Therefore, the criteria related to the discriminant validity of HOC of SMES and MMS construct is fulfilled.

Table 9

The correlations between the formative construct and all the other constructs MMS and SMES

Formative constructs	*Correlation*
SMES	
ME	.29
PH	−.304
SP	.373
VE	.272
MMS	
AM	−.441
ER	−.124
IM	.335
INR	.256
IR	.179

(5) Convergent validity (both indicator reliability and the AVE) (Sarstedt et al., 2019), which has already been evaluated for both SMES and MMS (see Tables 1 and 3). Results in Tables 1 and 3 show that the HOC of both SMES and MMS fulfilled the qualifications laid out by convergent validity.

In sum, the HOC for both SMES and MMS fulfilled the criteria of evaluation of higher-order constructs. Notably, the important criterion of evaluating a higher-order construct is required to explain the connection between the HOC and LOCs as weights, along with evaluating their significance and relevance, collinearity and convergent validity.

4.1.3. Evaluation of the structural model

The assessment of the structural model includes the following five criteria: (1) coefficients of determination (R^2), (2) predictive relevance (Q^2), (3) size and significance of path coefficients, (4) f^2 effect sizes (Hair et al., 2017).

To response to the first research question, the researcher first analysed the path coefficients (β) between MSE and mathematics achievement. The findings are displayed in Table 10. By measuring the β-value, we measure the direct impact of the predictor variable on the response variable. The β-value helps identify the relationship between MSE and the mathematics achievement.

Figure 2 illustrates the path coefficient (β). As seen in Table 10, there is a positive and significantly direct impact between MSE and MA ($\beta = 0.472$; $t = 8.594$; $p < .005$). This is because SE is a key determinant of achievement, and its four sources influence AA (Loo & Choy, 2013). Furthermore, extent literature argues that, MSE has a positive relationship with mathematics achievement, hence said conclusion coincides with earlier studies (Evans, 2015; Meral et al., 2012). Accordingly, this study rejected the null hypothesis H_0, which argues that MSE does not have a significant effect on MA. Instead, and accepting the alternative hypothesis H_a, which arguing that MSE does have a significant effect on MA.

Table 10

The results of path coefficients of MSE and MA

Construct	*O*	*M*	*SD*	*t*	*p*
MSE → MA	0.472	0.47	0.055	8.594	< .05

Note. O: Original Sample; M: Sample Mean; MSE: Mathematics self-efficacy; MA: Mathematics achievement.

Figure 2
Structural Model

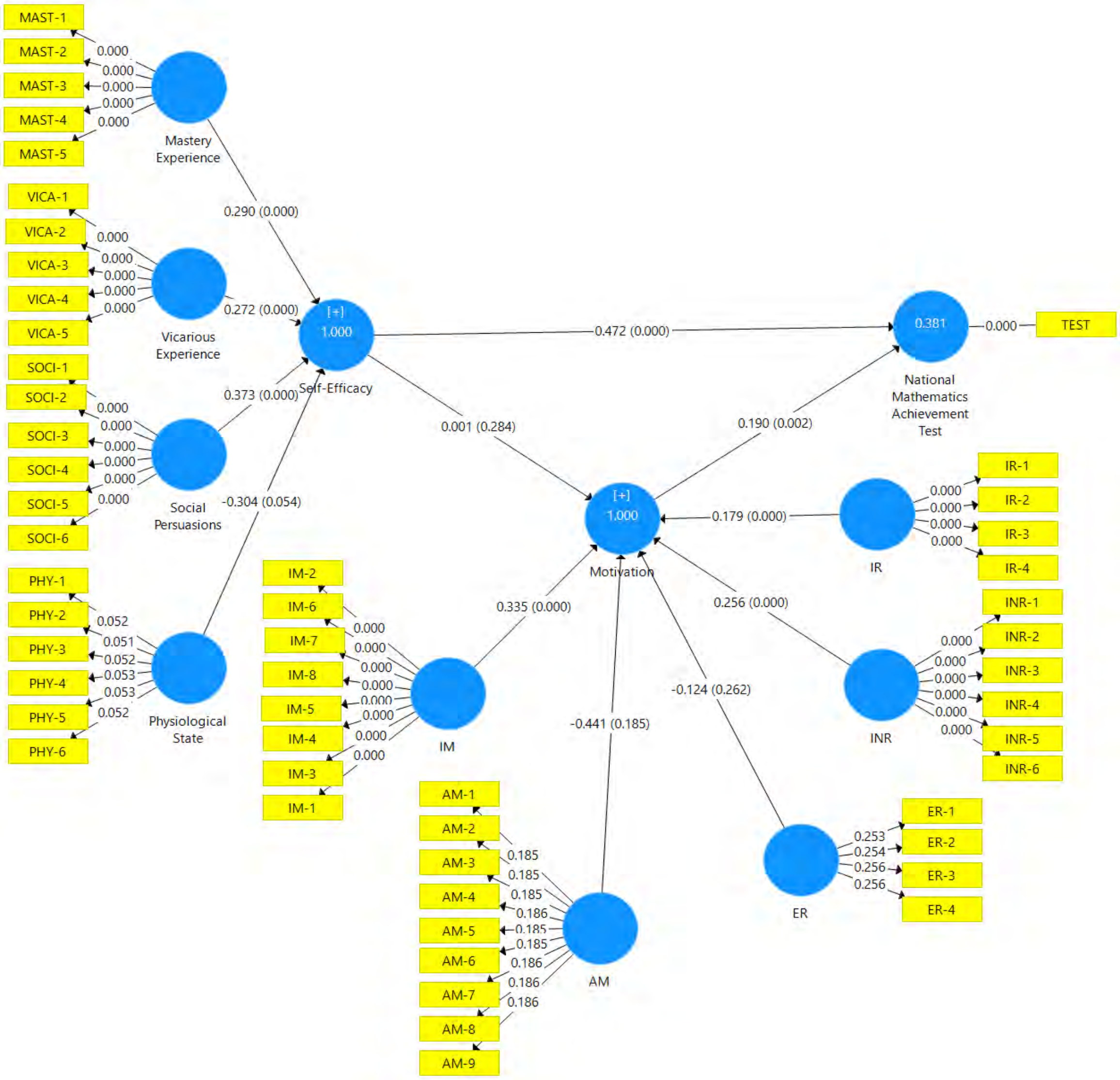


Figure 2 illustrates the result of R^2, which is a measure of model fit. Model fit is defined as the square of the correlation coefficient among observed and expected values in a regression (Alexander et al., 2015). R^2 is the variance in endogenous constructs that are described by each exogenous construct that is related to it (Hair et al., 2017).

As seen from Figure 2, the R^2 for mathematics achievement is 0.381. An R^2 of 0.381 indicates the amount of variance of the MA constructs and is described by the MSE construct variable explaining 38.1% of the variance of the MA. Essentially, MSE explains 38.1% of the variance of the MA and the remaining 61.9% is influenced by other variables. Moreover, the R^2 value of 0.381 indicates that the model is moderate in terms of model fit according to Chin (1998).

Predictive relevance (Q^2) is defined as an index that "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). A Q^2 value larger than 0 indicates the predictive significance of the path model for a specific dependent construct (Hair et al., 2017). The outline of the Q^2 values are as follows: for a certain endogenous latent variable, Q^2 values of 0.02, 0.15, and 0.35 reflect small, moderate, and great significance, respectively (Hair et al., 2017).

Table 11 reveals the values of Q^2. The Q^2 value of the MSE construct is 0.362, while that of MA is 0.657. These results clarified that the model has the empirical ability to collect data and reconstruct it using the model and the parameters of PLS-SEM. The result of the Q^2 values explains that both MSE constructs, and MA are largely predictive.

Table 11
The value of Q^2 of MSE and MA

	SSO	*SSE*	*Q^2 = (1-SSE/SSO)*
MSE	8,228.00	5,245.88	0.362
MA	374	128.262	0.657

Note. MSE: Mathematics self-efficacy; MA: Mathematics achievement; SSE: Sum of the squared prediction errors; SSO: Sum of the squared observations.

Moreover, the effect size (f^2) of MSE→ MA is 0.196. This indicating that the magnitude of the relationship between SE and MA is a medium impact size (f^2). The effect size (f^2) allows the assessment of the contribution of an exogenous construct to the R^2 value of an endogenous latent variable (Hair et al., 2017). The criteria of (f^2), according to Cohen (1988) is as follows: an f^2 of 0.35 shows a strong effect, an f^2 of 0.15 implies a moderate effect, and an f^2 of 0.02 implies a weak impact (Hair et al., 2017).

In terms of second research questions, Table 12 shows that there is an existing significant relationship between each of (1) MM and MA; and (2) MSE and MA and insignificant relationship between MSE and MM; Furthermore, the outcomes of this study explain that the indirect effect between MSE and MA through MM showed an insignificant relationship (t=0.918775; β = 0.000231; p > .05; Table 13). This means that there is no mediating relationship between MSE and MA conducted through MM. Therefore, the current study accepts the null hypothesis H_0, stating that MM does not mediate a significant effect on the contribution of MSE to MA. Conversely, it also rejects the alternative hypothesis H_a, which states that MM mediates a significant effect on the contribution of MSE to MA.

Table 12
The results of the path coefficients of the MSE, MM, and MA

	O	*M*	*SD*	*t*	*p*
MM → MA	0.19	0.193	0.061	3.142	< .05
MSE → MM	0.001	0.002	0.001	1.071	> .05
MSE → MA	0.472	0.47	0.055	8.594	< .05

Note. O: Original Sample; M: Sample Mean; MSE: Mathematics self-efficacy; MA: Mathematics achievement; MM: Mathematics Motivation.

Table 13
The results of the path coefficients of ındirect effect of MSE, MM, and MA

	O	*M*	*SD*	*t*	*p*
MSE → MM → MA	0.000231	0.000375	0.000251	0.918775	< .05

Note. O: Original Sample; M: Sample Mean; MSE: Mathematics self-efficacy; MA: Mathematics achievement; MM: Mathematics Motivation.

5. Discussion and Conclusion

The current study primarily explores the relationship between of MSE and MA through MM a mediating variable. To understand the mechanism here MSE affects achievement in mathematics, we need to understand how these contracts, namely MSE, MA, and MM, interact.

In terms of first research question, a significant and positive relationship has been established between MSE and MA according to the findings of this study. This is because students possess SE, and students with high SE usually have higher levels of academic motivation (Wang et al., 2018). This, encourages them to persist, learn diligently, face difficulties, and accept challenges, until they achieve high levels of AA. A high level of individual SE also leads to an increase in the amount of work and time that that individual is willing to dedicate to the mission. This then drives them to higher levels of achievement (Moores & Chang, 2009), because understanding progress during learning supports both SE and advance learning (Schunk, 2001). Moreover, SE in students cultivate their ability to solve tasks successfully, learn actively, and act at expected levels, thus and influencing their potential to make an effort in mathematics (Hasan et al., 2014).

Moreover, students acquire their SE from the sources of self-efficacy [SOSE]. Bandura identified the SOSE as follows: (1) ME, (2) VE, (3) SP, and (4) PH (Bandura & Adams, 1977). The SMES play a key role in helping students believe in their efficacy. The percentage of the impact of the SOSE on students' SE is different and not stable and instead depends on various variables such as context, gender, race, and region. However, most studies agree that the two strongest SMES are ME and social persuasion (Butz & Usher, 2015; Perez & Ye, 2013), which has also been confirmed herein.

The second objective of the current study was to examine the indirect relationship between MSE and MA through MM. The outcomes of this study show that MM does not mediate the effect of the contribution of MSE to MA. The indirect effect of MSE on MA through MM thus showed an insignificant relationship. Therefore, this study accepted the null hypothesis H_0, which argues that MM does not mediate the relationship between MSE and MA. This conclusion also coincides with the findings of the research conducted by Yildirim (2011).

This may be due to various causes, but is most probably because the SMES beliefs had a weak impact on MSE, in students, which, in turn, led to mathematics self-efficacy's weak influence on student's motivation. The literature clarifies that SOSE beliefs have differing effects on people; it largely depends based on factors such as gender, race region and context (Arslan, 2013; Kaya & Bozdag, 2016; Usher & Pajares, 2006). Therefore, this could be one of the causes which affected the relationship between student's mathematics motivation and MSE.

The current study's outcomes were significant in clarifying that there was, indeed, no mediating role of MM in the relationship between MSE and MA. However, MM does have a strong relationship with both MSE and MA. The current study indicated that MSE has a direct effect on MA. However, its outcomes did not appear to have any indirect effect of the MSE on MA through MM. It is important to replicate this study in different countries and disciplines to verify the results obtained herein.

The paper has some certain limitations. Findings were obtained from schools located in a specific socio-cultural and geographic context, namely eighth grade students (boys and girls) aged 14 to 15 years old from public schools of basic education in Al Batinah North Governorate in Oman. Reiteratively, because the impact of the sources of self-efficacy varies depending on gender, race region, and context (Arslan, 2013; Kaya & Bozdag, 2016; Usher & Pajares, 2006), other contexts might provide other viewpoints on the same issue as well.

The results of mathematics motivation were also obtained through the responses of students on the Mathematics Motivation Scale which has 44 items and was constructed by Hussein et al. (2012). The large number of items in the scale may have also affected the responses of some students: some might have not sustained their focus when responding to the scale, thus affecting their results.

6. Implications

Results of current study show that mathematics motivation did not mediate the relationship between self-efficacy and mathematics achievement. This means that self-efficacy did not notably affect mathematics academic achievement through mathematics motivation. This result coincides with Bandura and Adams (1977) who posits that a student can and will study even though there is a lack of motivation on a specific day because they can regulate, they behaviour (Hoban & Hoban, 2004).

Self-efficacy is thus a motivational orientation agent that (1) empowers and ushers perseverance when facing difficulties; (2) increases intentionality and long-term planning and (3) encourages self-regulation and self-correction. Accordingly, self-efficacy has instead directly affected achievement without relying on motivation. Therefore, self-efficacy might be is the strongest factor affecting students' achievement compared to motivation.

The literature clarifies that the sources of self-efficacy beliefs have different effects on people. Thus, the effect of the sources of self-efficacy vary depending on gender, race region, and context (Arslan, 2013; Kaya & Bozdag, 2016; Usher & Pajares, 2006). This could be one of the causes which likewise affected the relationship between students' motivation and mathematics self-efficacy, thereby leading to the failure of motivation to mediate the relationship between self-efficacy and mathematics achievement. This prompts further investigation on the mediating role of motivation between self-efficacy and achievement by considering factors such as gender, race region, and context.

The study also shows that educators can nonetheless teach their students despite said students lacking motivation; so long as they have good self-efficacy. Because self-efficacy is considered a motivational orientation agent, strong academic achievement is thus related to self-efficacy which, in turn, enhances a person's faith in their capability to complete a mission. Hence, the development of self-efficacy with learners considers a significant factor in mathematics achievement. Therefore, educators must develop self-efficacy in their students by searching for strategies which supplement growth and self-efficacy during teaching sessions.

Moreover, the outcomes of present study encourages succeeding scholars to do further investigation on the relationship between self-efficacy and achievement through academic motivation as mediation, especially through the lens of different, other disciplines. Additionally, the responsibility of the MOE is to focus on self-efficacy in the curriculum and urge educators to consider development of self-efficacy with their students in schools.

The study's results help students to perceive their self-efficacy. Perceived self-efficacy in turn helps students believe in their ability using peer models, benefiting from student concerns, letting students make their own choices, encouraging them to exert effort, and providing them with recommendations. Using peer models involves instructing students to monitor those who solve the mathematical problem on the board in front of their friends, or in those who are in the same class. Allowing students to make their own choices involves them being given the freedom to choose the types of questions they are interested in during class. Capitalizing on students' interests involves adapting mathematics activities that are appropriate for all students in the schoolroom. Helping their attempts involves giving students a chance to try to solve the mathematical problem, which will improve their confidence in solving mathematical problems. Giving students feedback during the mathematics activity will provide them with immediate feedback to modify the task urgently and support students' self-confidence.

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