

Research Article

The relationship between vicarious experience and mathematics achievement: Mediating effects of mastery experience and physical state

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The aim of this study is twofold: one is to examine the relationship between mathematics achievement and three sources of mathematics self-efficacy (social persuasion, vicarious experience, and physical state) separately through mastery experience as a mediator, and the other is to investigate the relationship between vicarious experience and mathematics achievement through physical state and social persuasion as mediators. The sample of this study comprised of 374 eighth-grade students from the Sultanate of Oman. A partial least square structural equation modeling by Smart PLS is employed to evaluate the data. The findings of this study indicate that sources of mathematics self-efficacy can predict mathematics achievement except vicarious experience. Mastery experiences and physical state fully mediate the relationship between vicarious experience and mathematics achievement. However, mastery experiences partially mediate the relationship between SP and mathematics achievement.

Keywords: Mathematics achievement; Self-efficacy; Social persuasion; Psychosocial state; Physical state; Vicarious experience; Mastery experience

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1. Introduction

Mathematics is considered the language of science and knowledge and an essential factor for advancement and progress. It is known as the backbone of scientific advancement. Consequently, mathematics is one of the vital instruments that can be used to deal with various aspects of life. Students confront trouble in learning mathematics, which leads to deficient competence of students in mathematics. The problem of deficient achievement in mathematics remains a major global concern. Therefore, educationalists, politicians, and decision-makers are striving to make a difference in improving students' Mathematics achievement (MA) and have made it their primary concern. Accordingly, researchers have conducted plenty of studies in mathematics education (Karigi, 2015) as attempts to resolve the issue of achievement in mathematics.

For decades, educational researchers have recognized that the ability of the person will direct human conduct, perseverance, and even accomplishment. Therefore, self-efficacy [SE] is one of the aspects that affects human accomplishment (Bandura, 1994). Scholars (Ayotola & Adedeji, 2009; Chang, 2012; Komarraju & Nadler, 2013) have found that SE is an essential element that impacts

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the achievement of students in common and mathematics in particular and stated that SE is deemed as a powerful element for students' learning accomplishment and a key factor of their academic achievement. SE is a vital motivation for learning (Zimmerman, 2000) and supports students' beliefs that they can achieve and obtain a high level of achievement (Galloway et al., 2020) by promoting their confidence through mastery experience (ME), vicarious experience (VE), social persuasion (SP), and physical state (PH), which are called sources of self-efficacy [SSE].

Thus, academic success is influenced by self-efficacy (Schunk, 1985), where prior research has established that low self-efficacy leads to diminished motivation (Al Umairi, 2024) and subsequently poor cognitive performance, impacting overall student achievement (McCullers, 2009). Previous studies (Al Shabibi & Silvennoinen, 2016; Baporikar & Shah, 2012) highlight that weak motivation and academic achievement among Omani students may stem from their low self-efficacy as well (Vellanki et al., 2024).

Accordingly, numerous studies conducted over the past ten years have investigated the direct, indirect, and mediation effects between mathematics self-efficacy [MSE] and its sources. Nevertheless, most of these studies investigated the MSE with its sources or other variables, while a small amount of studies assessed the connection between MA and sources of mathematics self-efficacy [SMSE] (Benaoui, 2016; Loo & Choy, 2013; Yurt, 2014; Zelenak, 2019). Although, the significance to understand how SSE influence on MA, which have indicated by researchers (Benaoui, 2016; Yurt, 2014; Honicke et al., 2023). Most of the studies that were documented or made available online and were conducted over the past ten years specifically intended to explore the association between MA and SMSE (Benaoui, 2016; Loo & Choy, 2013; Yurt, 2014; Zelenak, 2019; Mir & Rasool, 2024). Moreover, these studies have reported that VE, specifically among other sources, has the ability to predict mathematics accomplishment insignificantly or does not have a significant effect on MA. Loo and Choy (2013) examined the correlation between SMSE and MA as well as to investigate the prediction of the foremost SMSE that influence academic accomplishment. They found that VE has an insignificant impact in predicting mathematics achievements and reported that "this result did not support Bandura's hypothesis that each self-efficacy source has some influence of a lesser extent on one or more other sources" (p. 90). Therefore, Loo and Choy's claim contradicts Bandura's postulate. Bandura (1977) stated that "any given method, depending on how it is applied, may of course draw to a lesser extent on one or more other sources of efficacy information" (p.195), which means that all sources operate together to shape people's beliefs about their self-efficacy (Norton, 2015). Consequently, it shows that VE has an indirect impact on MA through more than one sources of self-efficacy (Yurt, 2014). This idea is close to Bandura's postulate, and it needs to be tested. Moreover, Capa-Aydin et al. (2018) recommended investigating the mediation role of ME between the other three SMSE. Therefore, research is necessary to see whether the hypothetical differences amongst the sources can explain interferences targeted at changing self-efficacy perceptions and how the efficacy sources are constructed in other people and achievement fields (Lent et al., 1996). Furthermore, most studies which conducted between SE and its sources, or the studies which conducted between SMSE and MA at past ten years had used regression to analyze their data while little employed structural equation modeling [SEM] (Capa-Aydin et al., 2018). Therefore, to have in-depth understanding of associations between MA and SMSE, this study aims to achieve objectives of investigative the association between MA and three SMSE (SP, VE, and PH) separately through ME as a mediator. Moreover, it also intends to investigate the relationship between MA and VE through PH and SP as mediators and by a PLS-SEM to analyze the data.

2. Theoretical and Empirical Framework

SE indicates a person's belief in his or her ability and competence to achieve a mission or deal with lives challenges (Cambridge Dictionary, 2018) such that a potent feeling of efficacy improves human achievement as well as individual welfare. Bandura (1994) asserted that self-efficacy belief defines the way a person feels, thinks, motivates, and behaves. Hence, self-efficacy beliefs

influence the quality of the person's functioning by influencing their cognitive, motivational, emotional, and decision-making processes and the way they think, whether they think negatively or positively (Bandura, 1994).

Moreover, SE has been fundamental in academic achievement, in general and MA in particular. The perception of self-efficacy creates confidence in students to solve mathematical problems and makes students believe that complex mathematical tasks are possible and easy to solve. The beliefs of self-efficacy also maximize students' efforts to learn very complicated mathematical issues (Kandemir & Akbaş-Perkmen, 2017). Thus, SE is strongly connected with the academic accomplishments of students. As Wernersbach et al. (2014) reported, SE represented a powerful predictor of academic success. There have been numerous studies conducted on SE at various levels of education to examine the relationship between SE and achievement; they confirm that SE is a strong predictor of academic accomplishment (Asakereh & Yousofi, 2018; Kapucu, 2017; Kaya & Bozdag, 2016; Sariçoban & Behjoo, 2016). Moreover, the results of these studies illustrate that SE has a direct and indirect impact on academic accomplishment.

Students build up their self-efficacy beliefs through four sources that involve ME, VE, SP, and PH, and the most influential source among them is ME (Bandura, 1994). The literature has thus confirmed Bandura's viewpoint (Britner & Pajares, 2006; Tschannen-Moran & Hoy, 2007). SSE information is not immediately explained for competency evaluation; people explicate the outcomes of happenings; therefore, their explanations give the knowledge on which evaluations are based. The kinds of knowledge that individuals use to make efficacy decisions and the regulations they utilize to weigh and incorporate them form the foundation in order to do so explanations. Therefore, the choice, incorporation, explanation, and reminiscence of knowledge impact assessments of SE (Pajares, 2005).

2.1. Sources of Self-Efficacy

2.1.1. Mastery experiences

Mastery Experiences is considered a powerful source that creates a strong impression of efficacy (Bandura, 1994). ME is defined as "one's interpretations of his or her own previous, authentic experiences performing a particular task" (Al-awidi & Alghazo, 2012, p. 925). ME implies the direct experience of success and failure (Gao, 2020). The experiences that the person holds play a crucial role in their SE. For instance, the success of a student in any mission in mathematics will produce success experiences in them, and in turn, this will increase their perception of SE will let them achieve more success in the future. While the student who fails in a first mission and fails in the next mission, these failures will generate more fear that eventually make them escape from any task in mathematics. Therefore, this will disable the student from doing any mathematical tasks and, thereby, will break down that student's self-efficacy.

2.1.2. Vicarious experiences

Vicarious experiences are defined as "students' appraisals of their capabilities in relation to the attainments of others" (Chang, 2006, p. 54). VE is deemed the second source of self-efficacy. The one of the methods that can be created the SE with student is that seeing a comparable student to him. Where, seeing a successful comparable student leads to that student's beliefs in himself that he too holds the abilities to learn and successful. Nevertheless, watching others' failures despite excessive effort impacts viewers' decisions as to their personal efficacy and weakens their attempts (Bandura, 1994). Thus, the influence of modeling on perceived SE is reliant on perceived resemblance to the models. Whenever the assumed resemblance increases, the successes and failures of the models become even more convincing (Bandura, 1994).

2.1.3. Social persuasion

The third way to boost students' self-efficacy beliefs is SP, which works by persuading them that they have what it takes to succeed. Verbal persuasion is further used in education systems. This is because it convinces students to believe in their capabilities to cope with difficult conditions (Artino, 2012). Verbal persuasion implies "the verbal judgments that others provide" (Chang, 2006) such as significant people, teachers, and parents. Doing a definite mission with the help of other people encouraging and persuading the student is called SP. For example, when someone persuades another person to perform some tasks, the latter tends to believe they are qualified to perform that mission. Furthermore, in the process of enhancing a sense of efficacy, constructive feedback plays a major role (Akosah et al., 2024). Another source of self-efficacy comes from peer feedback about a student's abilities and completed tasks.

2.2. Physical State

The fourth vehicle of the SSE is physiological and emotional states (PH), for instance, nervousness, tension, stimulation, and feeling. It gives information around efficacy beliefs of the people. Learners assess their level of belief by their emotional state as they monitor or take part in an activity. They further simply expect success when they face positive arousal than when they endure high nervousness, pressure, and strain related to a certain action or field (Britner & Pajares, 2006). Optimistic state of mind improves the sense of self-efficacy, and a pessimistic state of mind weakens it (Bandura, 1994). Thus, individuals who have a high feeling of efficacy see their state of sentimental motivation as an exhilarating helper of accomplishment. However, the persons who are stressed through self-doubts think highly of their stimulation as a weakness. Adverse physical states, or states perceived as adverse, could impede performance and increase the probability of a feeble result, consequently contributing to lesser SE (Britner & Pajares, 2006). Therefore, students measure their level of belief by the emotive state they confront as they observe or participate in an action. They further simply anticipate accomplishment when they face favorable stimulation. Conversely, negative physical states could impede performing and increase the possibility of a low result, thereby causing to reduce SE (Bandura, 1994).

Bandura (1986) defined self-efficacy beliefs as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391). The success of individuals in specific tasks, based on the postulate of social cognitive theory, relies on the beliefs that they hold; they spend more effort to make them happen. There are several types of constructs for example self-esteem, self-concept, outcome expectations, and locus of control that are often confused with SE according to cognitive theorists even though they represent rather distinct constructs. Nonetheless, self-efficacy beliefs indicate particular actions and differ from beliefs related to actions that generate specific results for instance self-concept, self-esteem, locus of control, and result expectations (Van Dinther et al., 2011).

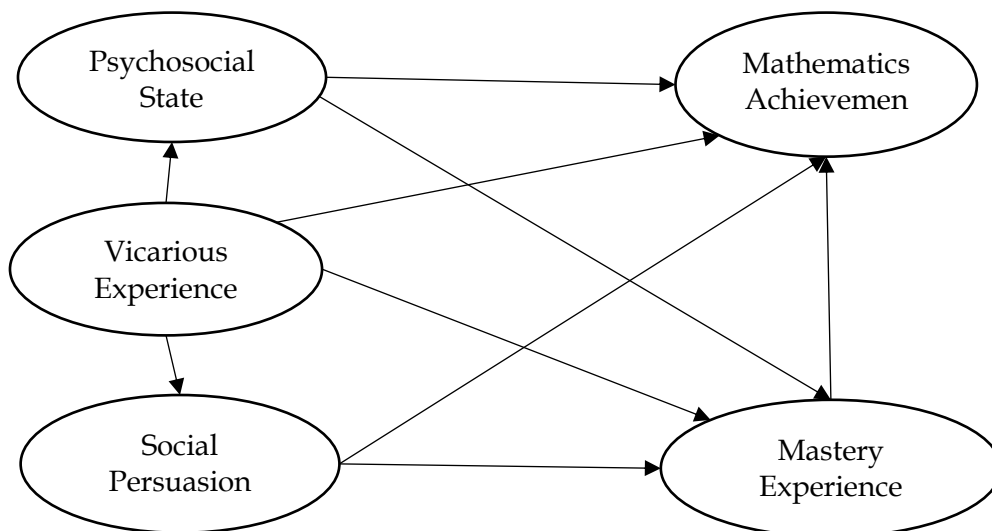
SE has its traits that distinguish it from other constructs. Usher and Urdan (2016) mentioned that SE indicates task- and context-specific, future-oriented, and anticipated consequences. Scholars often assume that SE is domain and task specific. Consequently, when students are questioned about their SE in a specific field, they should be shown tangible missions (Siefer et al., 2021). SE is linked to a particular activity to resolve trouble instead of an overall assessment of an individual's personal competency (Siefer et al., 2021). Overall, SE impacts the degree to which individuals engage in future preparation (Azizli et al., 2015). Students who are further future-orientated have a better capability to define objectives and create projects for their achievement (Elissa & Bandura, 1999). SE is different from outcome expectancy (Usher & Urdan, 2016). Outcome expectancy concerns the extent to which one believes that a specific result will be realized. Conversely, SE concerns the belief that one can effectively carry out the behavior necessary to make an outcome (Brown et al., 2014). SE impacts the path of work individuals pick, which in turn impacts what they anticipate as an outcome of their activities. SE can consequently be sighted as a prelude to the anticipated result of a person's activities. A person who has high SE

usually anticipates a positive result, although this is not always the situation. In conditions where persons do not feel they have control of the results of their behaviors, for instance, in work settings that take part in discriminatory assessment systems, no amount of SE will guarantee a positive result Bandura (Usher & Urda, 2016). A high school student who has a great feeling of academic efficacy and yet may not apply to a respected college since they might not anticipate being accepted. These instances demonstrate that SE and result anticipations can affect behavior separately (Usher & Urda, 2016).

Scholars have conducted many studies on the SSE to investigate the relationships between these sources with each other, SE and AM. Capa-Aydin et al. (2018) investigated the association between other SSE and chemistry self-efficacy for cognitive skills through ME as a mediator on 397 high school students using SEM. They found that ME directly affected chemistry self-efficacy and mediated the relationship between chemistry self-efficacy and two of its sources (SP and PH); moreover, VE directly affected chemistry self-efficacy, though no mediation was obtained for VE. The 50% of variance that represented impacts in chemistry self-efficacy for cognitive skills (direct and indirect) was explained by ME. Loo and Choy (2013) investigated the greatest predictor of MSE among its sources by hierarchical linear regression analysis; their results showed that ME was a salient predictor. Moreover, they found no significant effect of the other three sources in terms of the ability to predict academic achievements even though there was a correlation between SSE and MA. In a study involving 350 seventh-grade students, Yurt examined the relationship between MA and SMSE; she analyzed the data via multiple linear regressions. Yurt's findings showed that there exists a linear relation between MA and SMSE; VE had a no significant effect on MA. Benaoui (2016) explored the extent to which SE and its sources correlate with student performance in mathematics. He used regression, chi-squared test, and ANOVA to analyze the data. The outcomes revealed that VE and SP were statistically insignificant. From above, we conclude that the following: (i) SSE and MA are correlated, (ii) the common VE did not have an important impact on MA, (iii) There was no effect of ME on the relationship between VE and chemistry self-efficacy for cognitive skills, and (iv) the common method used to analyze data was regression.

Figure 1

The Postulated Theoretical Model



2.3. The Current Study

The number of documented online studies that address SSE and their influences on each other and is large in comparison with the number of documented online studies that address the relationships with SMSE and MA. Hence, aim of the present study is to examine the relationship between MA and three SMSE (SP, VE, and PH) separately, through ME as mediator. It also

investigates the relationship between MA and VE through PH and SP as mediators using different techniques to analyze data, specifically using PLS-SEM through Smartpls (3.3.2). Primarily, this study strives to introduce an explanation regarding the relationship between VE and achievement in mathematics. Some studies reported that “vicarious experience did not predict the mathematics achievement” (Benaoui, 2016; Loo & Choy, 2013; Yurt, 2014; Zelenak, 2019) and others claim that “this result did not support Bandura’s hypothesis that each self-efficacy source has some influence of a lesser extent on one or more other sources” (Loo & Choy, 2013). Conversely, Bandura (1977) reported that “any given method, depending on how it is applied, may of course draw to a lesser extent on one or more other sources of efficacy information” (p.195).

Present study investigated the mediation role of ME between (VE, SP, and PH) and MA, and the role of VE on MA through ME, SP, and PH. Thus, more specifically, this study strived to test the five following hypotheses:

Ha₁: Mastery experience mediates the effect of the contribution between social persuasion and mathematics achievement [SP → ME → MA].

Ha₂: Mastery experience mediates the effect of the contribution between physical state and mathematics achievement [PH → ME → MA].

H0₃: Mastery experience does not mediate the effect of the contribution between vicarious experience and mathematics achievement [VE → ME → MA].

H0₄: Physical state does not mediate the effect of the contribution between vicarious experience and mathematics achievement [VE → PH → MA].

H0₅: Social persuasion does not mediate the effect of the contribution between vicarious experience and mathematics achievement [VE → SP → MA].

3. Method

3.1. Research Design

The current research used causal relationships. This is because the main aim of current study strives to investigate the mediation role of ME between (VE, SP, and PH) and MA, and the role of VE on MA through ME, SP, and PH, and, according to the literature there are number of studies such current study and used causal relationship in order to study the mediation relationship.

3.2. Participants

In the present study, 9358 eighth-grade students from 72 schools in Al Batinah North Governorate were included, with 4861 boys and 4497 girls in the 2018-2019 school year, as reported by the Department of Statistics and Indicators of the Directorate General of Education.

The current study utilized sample size determination tables (Piaw, 2016). With a population of 10,000 and a significance level of .05, 370 respondents were needed. Thus, 370 eighth-grade students (both boys and girls) out of 9358 from public schools in the 2018-2019 school year were invited to participate.

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): $370 \div 9358 = 0.0395 \approx 0.040 = 4\%$. Hence, the boys’ sample was $4\% \times 4861 = 194.44$ or 194, while the girls’ sample was $4\% \times 4497 = 179.88$ 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.

In this study, three boys' and three girls' schools were randomly selected from a pool of 38 and 34 schools, respectively, in the Al Batinah North Governorate. Each school had over 120 eighth-grade students, all of whom were included in the study. A total of 374 students were chosen using simple random sampling, specifically the lottery method. This involved assigning unique numbers to each school, placing the numbers on cards, mixing them in a basket, and randomly selecting a card. The final sample consisted of 194 boys and 180 girls from second-cycle public schools of basic education.

3.3. Data Collection

The tools utilized in current study were the Source of Mathematical Self-Efficacy Scale developed by Usher and Pajares (2009) and the national mathematics achievement test developed by the Ministry of Education of the Sultanate of Oman in the academic year 2018/2019.

3.3.1. Source of mathematical self-efficacy scale

SMES used in middle school students was developed by Usher and Pajares (2009). It has high consistency degree and is used for many studies and in various academic disciplines and can be translated to a different language. SMES consists of 24 items, which are as follows: 6 items (1–6) measure mastery experience (ME), 6 items (7–12) measure vicarious experience (VE), 6 items (13–18) measure social persuasion [SP], and 6 items (19–24) measure physical 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 consisted of 700 students (350 boys and 350 girls) from the eighth grade. The SMES contained 23 items after cross-cultural adaptation and validation because the researcher deleted negative item factor loading from ME contracts as attributed to the difference in culture between the students from the USA and from the Sultanate of Oman. The summary of CFA for SMES scale after adaptation and validation is as follows: (i) 23 items, and the Cronbach's Alpha values(α) of the overall scale were 0.77; (ii) 5 items (1–5) measure mastery experience (ME), and the α value was 0.74; (iii) 6 items (6–11) measure vicarious experience (VE), and the α value was 0.77; (v) 6 items (12–17) measure social persuasion (SP), and the α value was 0.84; (iv); 6 items (18–23) measure physical state (PH) and the α 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.

3.3.2. National mathematics achievement test

The researchers used the national mathematics achievement (MA) 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 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.

3.4. Procedure

The researchers informed the chosen schools and got permission from their administrators to apply the study instruments on eighth-grade students in the school; then the researcher applied instrument of study on the selected students with the help of the school teachers. After that, the researcher asked the Ministry of Education of the Sultanate of Oman for the students' scores on the MA test that was conducted in the second cycle public school of basic education from Al Batinah North Governorate in the academic year 2023/2024. Finally, the researcher analyzed the data and obtained the results.

3.5. Data Analysis

The measurement model of this study includes SMSE, which is a reflective model (Usher & Pajares, 2009). Hence, SMSE was evaluated through two stages which is assessment of the measurement models and assessment of the structural model. Assessment of the measurement has assessed through three aspects: internal consistency, convergent validity and discriminant validity. Internal consistency with criteria to assess by Cronbach's alpha ≥ 0.7 (Taber, 2018) and Composite reliability [CR] ranging between 0.70 and 0.90 range from "satisfactory to good", while the values of 0.95 or more are problematic (Hair et al., 2019). Convergent validity (outer loading and average variance extracted) with criteria to assess by Indicator reliability or outer loading ≥ 0.5 (Hair et al., 2019) and Average variance extracted [AVE] $\geq .5$ (Hair et al., 2019). Discriminant validity with Criteria to assess by Heterotrait-monotrait [HTMT] test < 1 . And HTMT ratio (confidence interval) is not including one.

Henseler et al. (2015) have recommended using HTMT test to assess discriminant validity and the value of HTMT test < 1 to establish discriminant validity. Henseler et al. (2015) stated that HTMT ratio is better for detected the deficiency of discriminant validity. Thus, the confidence interval should not include the value 1 if including one means a lack of discriminant validity. The constructs of study are empirically not different (Hair et al., 2017).

4. Results

Table 1 show the results, α was ≥ 0.7 for four constructs of the model where ME, VE, SP, and PH accounted for 0.824, 0.815, 0.886, and 0.878, respectively. Composite reliability was $0.95 > CR \geq 0.7$. Where, CR for ME is 0.876, CR for VE is 0.864, CR for SP is 0.913, and CR for physiological state is 0.908. Thus, the criterion of internal consistency was fulfilled. It is clear that from Table 1 that, the outer loadings of all items are above 0.5. Moreover, the average variance extracted ≥ 0.5 , ME accounted, vicarious experience, SP, and the physiological state achieved 0.587, 0.517, 0.637, and 0.622, respectively. Therefore, the criteria of convergent validity were achieved.

To assess the discriminant validity, the researchers ran complete bootstrapping using 5000 resamples according to (Hair et al., 2017), and significant level of .05, to get the results of HTMT. From Table 2, as can be seen in the values of the HTMT test < 1 , and from Table 3, we notice that 1 doesn't fall within the interval range; it can be deduced from this that the four constructs differ empirically. Therefore, discriminant validity was established. Thus, we concluded that measurement model was fulfilled the criteria of evaluation.

Table 2 shows the HTMT values for all pairs of constructs in a matrix format. As can be seen, all HTMT values are clearly lower than the more conservative threshold value of 0.85 (Henseler et al., 2015). Table 3 illustrates the confident interval of the heterotrait-monotrait ratio. The columns labeled 2.5% and 97.5% show the lower and upper bounds of the 95% (bias-corrected and accelerated) confidence interval. Also, Table 3 shows that neither confidence interval includes the value 1.

Table 1

Exhibit of the results summary of (α , CR, AVE, R^2 , Q^2) for (SMES) by SmartPLS3

Constructs	Item	Outer Loading	α	CR	AVE	R^2	Q^2
ME	ME-1	0.842	0.824	0.876	0.587	0.574	0.33
	ME-2	0.74					
	ME-3	0.768					
	ME-4	0.707					
	ME-5	0.769					
VE	VE-1	0.757	0.815	0.864	0.517		
	VE-2	0.782					
	VE-3	0.783					
	VE-4	0.712					
	VE-5	0.7					
	VE-6	0.556					
SP	SP-1	0.8	0.886	0.913	0.637	0.431	0.27
	SP-2	0.839					
	SP-3	0.819					
	SP-4	0.782					
	SP-5	0.775					
	SP-6	0.774					
PH	PH-1	0.774	0.878	0.908	0.622	0.112	0.067
	PH-2	0.707					
	PH-3	0.814					
	PH-4	0.81					
	PH-5	0.797					
	PH-6	0.825					
MA						0.378	0.362

Note. ME: Mastery experience; VE: Vicarious experience; SP: Social persuasions; PH: Physiological state; MA: Mathematics achievement.

Table 2

The heterotrait-monotrait ratio

Construct	ME	MA	PH	SP
MA	0.598			
PH	0.503	0.468		
SP	0.78	0.511	0.431	
VE	0.786	0.486	0.358	0.739

Table 3

The Confident interval of heterotrait-monotrait (HTMT) ratio

Construct	Original Sample (O)	2.50%	97.50%
ME → MA	0.316	0.188	0.434
PH → ME	-0.166	-0.245	-0.091
PH → MA	-0.230	-0.322	-0.137
SP → ME	0.360	0.242	0.468
SP → MA	0.131	0.006	0.256
VE → ME	0.383	0.274	0.495
VE → MA	0.076	-0.054	0.202
VE → PH	-0.335	-0.434	-0.244
VE → SP	0.657	0.592	0.721

As shown in Table 4, the *t*-values for all constructs exceed 1.96, indicating statistically significant results, except for the relationship between VE and MA. Moreover, ME has a large

effect on MA compared to the rest of the sources of self-efficacy. VE significantly impacts ME more than other sources, while PH adversely affects both ME and MA.

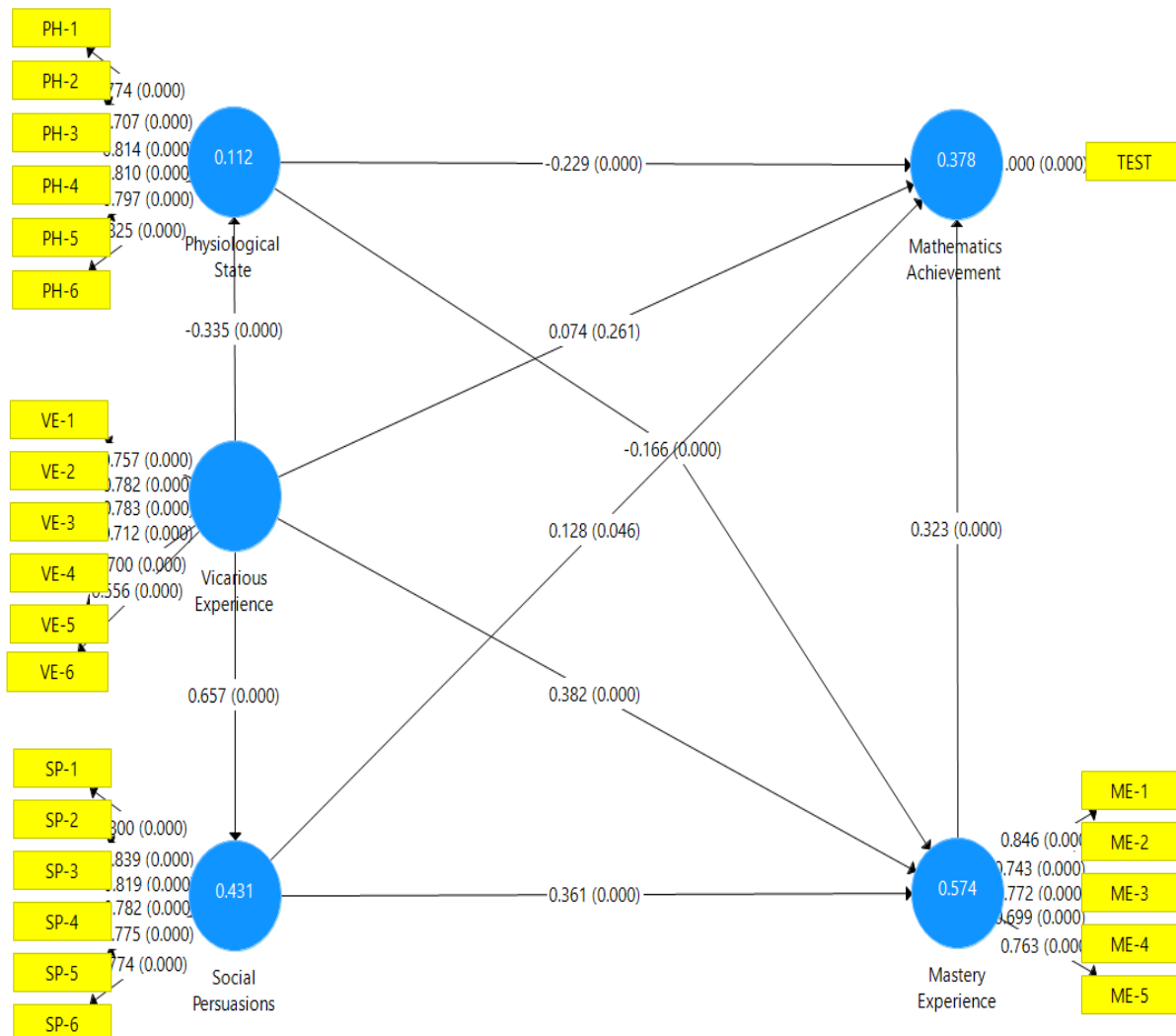
Table 4
The path coefficients (β) between constructs

Construct	β	M	SD	t	p	f^2	Total Effect
ME → MA	0.323	0.322	0.064	5.034	<.01	0.072	0.323
PH → ME	-0.166	-0.166	0.04	4.168	<.01	0.054	-0.166
PH → MA	-0.229	-0.23	0.048	4.784	<.01	0.067	-0.282
SP → ME	0.361	0.36	0.058	6.239	<.01	0.164	0.361
SP → MA	0.128	0.13	0.063	2.023	.043	0.012	0.245
VE → ME	0.382	0.385	0.056	6.803	<.01	0.192	0.675
VE → MA	0.074	0.073	0.064	1.15	.26	0.004	0.453
VE → PH	-0.335	-0.34	0.048	6.935	<.01	0.127	-0.335
VE → SP	0.657	0.659	0.033	19.833	<.01	0.758	0.657

Note. M: Sample Mean; SD: Standard deviation; t-value: T-Statistics; The effect size (f^2) allows evaluation of an exogenous (independent) construct's contribution to an exogenous (dependent) latent variable's R^2 value (Hair et al., 2016). The criteria of (f^2): $f^2 = 0.35$ (strong effect), $f^2 = 0.15$ (moderate effect), and $f^2 = 0.02$ (weak effects) (Hair et al., 2016).

Assessment of the measurement model is presented in Figure 2.

Figure 2
Assessment of the Measurement Model



As can be seen in Figure 2, significant path coefficients (β) between MA and each source of mathematics self-efficacy (ME, SP, and PH): (ME \rightarrow MA, $\beta = 0.361$; $p < .05$); (SP \rightarrow MA, $\beta = 0.361$; $p < .05$); (PH \rightarrow MA, $\beta = -0.229$; $p < .05$); (VE \rightarrow MA, $\beta = 0.074$; $p > .05$), which means self-efficacy influences mathematics achievement. In other words, sources of mathematics self-efficacy (ME, SP, and PH) can predict mathematics achievement, except vicarious experience. These results are consistent with past studies. On the other hand, insignificant path coefficients (β) between MA and VE (VE \rightarrow MA, $\beta = 0.074$; $p > .05$), this result is consistent with (Yurt, 2014). In addition, significant path coefficients between each (VE, SP, and PH) and ME are: [VE \rightarrow ME] ($\beta = 0.382$, $p < .05$); [PH \rightarrow ME] ($\beta = -0.166$, $p < .05$); [SP \rightarrow ME] ($\beta = 0.361$, $p < .05$), which means that (VE, SP, and PH) influence ME. PH influences MA and ME negatively, and these results are consistent with (Usher & Pajares, 2006). As shown in Table 5, social persuasion influences mathematics achievement indirectly through mastery experience [SP \rightarrow ME \rightarrow MA] ($\beta = 0.117$, $p < .05$); vicarious experience influences mathematics achievement indirectly through mastery experience [VE \rightarrow ME \rightarrow MA] ($\beta = 0.382$, $p < .05$); psychosocial state influences mathematics achievement indirectly through mastery experience [PH \rightarrow ME \rightarrow MA] ($\beta = -0.054$, $p < .05$); and vicarious experience does not influence mathematics achievement indirectly through social persuasion [VE \rightarrow SP \rightarrow MA] ($\beta = 0.084$, $p > .05$). Although there are significant relationships between VE \rightarrow SP and SP \rightarrow MA. Vicarious experience influences mathematics achievement indirectly through the physiological state [VE \rightarrow PH \rightarrow MA] ($\beta = 0.077$, $p < .05$).

Table 5

The results of specific indirect effect

Constructs	Indirect Effect (β)	M	SD	t-value	p	VAF
PH \rightarrow ME \rightarrow MA	-0.054	-0.053	0.015	3.675	<.01	0.14
SP \rightarrow ME \rightarrow MA	0.117	0.116	0.029	4.012	<.01	0.47
VE \rightarrow ME \rightarrow MA	0.124	0.124	0.032	3.82	<.01	
VE \rightarrow PH \rightarrow MA	0.077	0.078	0.019	4.008	<.01	0.5
VE \rightarrow SP \rightarrow MA	0.084	0.086	0.043	1.964	0.053	0.38

Note. VAF (Variance Accounted Formula): To estimate the size of indirect effect, the (Hernández-Perlines, Moreno-García, & Yañez-Araque, 2016; Iacobucci, Saldanha, & Deng, 2007; Mehmood, Liang, & Gu, 2018; Preacher & Kelley, 2011), used VAF, which implies the size of the not direct effect in relation to the overall effect (direct effect + indirect effect): $VAF = (a*b) / (a*b + c)$. 'a' means the path coefficient between the mediator and independent construct, 'b' means the path coefficient between the dependent construct and the mediator, 'c' means the path between the dependent construct and the independent construct.

4.1. Evaluation of the Structural Model

R^2 is a measure of model fit (Alexander et al., 2015). The " R^2 represents the amount of variance in the endogenous constructs explained by all the exogenous constructs linked to it" (Hair Jr et al., 2017, p.175). R^2 value ranges from 0 to 1 with higher levels showing elevated levels of predictive accuracy (Hair et al., 2017).

Table 1 shows that, R^2 of each of the ME, MA, and SP had moderate explanatory power, while the physiological state had weak explanatory power, where, R^2 of ME was $R^2 = 0.574$. This means that the total of variance of the ME construct which can be explained by the VE, SP, and PH explained 57.4% of the variance of the ME. In other words, VE, SP, and PH explained 57.4% of the variance of the ME, and the remaining 42.6% was influenced by other variables. Furthermore, the R^2 of MA was $R^2 = 0.378$, the ME, VE, SP, and PH clarified 37.8% of the variance of the MA, and the remaining 62.2% was influenced by other variables. R^2 of SP was 0.431, VE explained 43.1% of the variance of the SP, and the remaining 56.9% was influenced by other variables. R^2 of PH was 0.112, VE explained 11.2% of the variance of the SP, and influence of different variables accounted for 88.8% of the variance.

The predictive relevance (Q^2) is defined as "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).

In Table 1, the values of cross-validity redundancy Q^2 are all more than zero, where “the resulting Q^2 values larger than 0 indicate the path model’s predictive relevance for a particular dependent construct” (Hair Jr et al., 2017). Accordingly, Q^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large relevance respectively for a particular endogenous latent variable (Hair et al., 2017). Thus, ME represented large relevance for vicarious experience, SP, and physiological state. Similarly, MA represented large relevance for vicarious experience, SP, and physiological state, and ME. SP represented medium relevance for vicarious experience, while physiological state represented small relevance for vicarious experience.

4.2. Hypothesis Testing

To test the first research hypothesis (H_{a1}), the researchers analyzed the relationship between SP, ME, and MA. As can be seen in Table 4, the path coefficients (β) the relationship between SP and ME was significant [SP \rightarrow ME] ($\beta = 0.361$, $t = 6.239$, $f^2 = 0.164$; $p < .05$) with a total effect 0.36; the relationship between ME and MA was significant [ME \rightarrow MA] ($\beta = 0.323$, $t = 5.034$, $f^2 = 0.072$; $p < .05$) with a total effect 0.323; also the relationship between SP and MA was significant [SP \rightarrow MA] ($\beta = 0.128$, $t = 2.023$, $f^2 = 0.012$; $p < .05$) with a total effect 0.245. Furthermore, we noticed that in Table 5, the indirect effect between SP and MA through ME was significant [SP \rightarrow ME \rightarrow MA] ($\beta = 0.117$, $t = 4.012$, $p < .05$) with the size of indirect effect (VAF) was 0.47 (47%), which was more than 20% and less than 80%. Thus, ME was represented in this case as a partial mediation (Hernández-Perlines, Moreno-García, & Yañez-Araque, 2016; Kuo & Hou, 2017). Therefore, H_{a1} was rejected because even though there was mediation, it was partial. And we concluded that the analysis did not support the hypothesis (H_{a1})

To test the second research hypothesis (H_{a2}), the researchers analyzed the relationship between PH, ME, and MA. The relationship between physiological state and ME was significant [PH \rightarrow ME] ($\beta = -0.166$, $t = 4.168$, $f^2 = 0.054$, $p < .05$) with a total effect (-0.166); also, the relationship between SP, physiological state, and MA was significant [PH \rightarrow MA] ($\beta = -0.229$, $t = 4.784$, $f^2 = 0.067$; $p < .05$) with a total effect (-0.282), and we noticed from Table 5 that the indirect effect between PH and MA through ME was significant [PH \rightarrow ME \rightarrow MA] ($\beta = -0.054$, $t = 3.675$, $p < .05$), and the size of indirect effect (VAF) was 0.14 (14%), which was less than 20%. Thus, ME was not represented in this case as a partial mediation. Thus, hypothesis H_{a2} was rejected. And we concluded that the analysis did not support the hypothesis (H_{a2})

To test the third research hypothesis (H_{03}), the researchers analyzed the relationship between VE, ME, and MA. The relationship between VE and ME was significant [VE \rightarrow ME] ($\beta = 0.382$, $t = 6.803$, $f^2 = 0.192$, $p < .05$) with a total effect 0.675, and this is consistent with study of Capa-Aydin et al. (2018); also, the relationship between VE and MA was insignificant [VE \rightarrow MA] ($\beta = 0.074$, $t = 1.15$, $f^2 = 0.004$, $p > .05$); we noticed from Table 5 that the indirect effect between VE and MA through ME was significant [VE \rightarrow ME \rightarrow MA] ($\beta = 0.124$, $t = 3.82$, $p < .05$). Thus, ME in this case represented a partial mediation. Therefore, H_{03} was rejected; thus, ME mediates the effect of the contribution between VE and MA. And we concluded that the analysis did not support the hypothesis (H_{03}).

To test the fourth research hypothesis (H_{04}), the researchers analyzed the relationship between VE, PH, and MA. The relationship between VE and physiological state was significant [VE \rightarrow PH] ($\beta = -0.335$, $t = 6.935$, $f^2 = 0.127$, $p < .05$) with a total effect (-0.335); also, the relationship between physiological state and MA was significant [PH \rightarrow MA], as well the relationship between VE and MA was insignificant [VE \rightarrow MA]. We also noticed from Table (5) that the indirect effect between VE and MA through Physiological state was significant [VE \rightarrow PH \rightarrow MA] ($\beta = 0.077$, $t = 4.008$, $p < .05$). Hence, PH represented in this case a mediation which means VE affects MA through physiological state. Thus, hypothesis H_{04} was not confirmed. And we concluded that the analysis did not support the hypothesis (H_{04}).

To test the fifth research hypothesis (H_{05}), the researchers analyzed the relationship between VE, SP, and MA. The relationship between VE and SP was significant [VE \rightarrow SP] ($\beta = 0.657$,

$t = 19.833$, $f^2 = 0.758$, $p < .05$) with a total effect 0.657; also, the relationship between SP and MA was significant. However, as shown in Table 5, the indirect effect between VE and MA through SP was insignificant [VE→SP→MA]. Thus, there was no indirect effect between VE and MA through SP as well as partial mediation or full mediation. Thus, hypothesis H0₅ was confirmed. And we concluded that the analysis supports the hypothesis (H0₅).

5. Discussion

The study has yielded several findings, as follows: ME and PH mediate fully the relationship between VE and MA; ME did not mediate the relationship between both PH and MA, and SP and MA; SP did not mediate the relationship between VE and MA.

5.1. Mastery Experience, Social Persuasion, and Mathematics Achievement

The current study investigated the mediation role of ME between three other sources and MA as recommended by past studies (Capa-Aydin et al., 2018) and investigated the influence of VE on MA through ME, SP, and PH. It used a different technique for analysis data, specifically, SEM through Smart PLS (3.3.2). SMSE and MA are significantly interrelated in current study, and these sources are correlated (Loo & Choy, 2013; Yurt, 2014). Thus, Bandura's social cognitive theory is confirmed. Moreover, the current study confirmed the findings of past studies that the strongest source that affected MA was ME (Chen, 2010; Loo & Choy, 2013a; Yurt, 2014) in significant relations with other self-efficacy sources. This study showed that VE and SP have a high-level significant relationship with ME, and this is consistent with literature (Yurt, 2014). The results indicate that VE, SP, and PH, predict ME, and SP and PH predict VE (Usher & Pajares, 2006a, 2009; Yurt, 2014).

5.2. Mastery Experience, Physical State, and Mathematics Achievement

The results indicate that ME, SP, and PH predict MA, whereas VE does not. The findings of present study are consistent with those of previous ones that investigated the relationships between SMSE and MA (Kaya & Bozdog, 2016; Kudo & Mori 2015; Loo & Choy, 2013; Yurt, 2014). This study showed that ME failed to mediate the relationship between PH and MA, while it partially mediated the relationship between SP and MA, which implied that the impact of SP is transmitted not just by ME but by another variable to MA; conversely, Capa-Aydin et al. (2018) discovered that ME completely mediated the relationship between SP and chemistry self-efficacy. Hence, the differences between this study and Capa-Aydin et al. (2008), may rely on the context. Thus, physiological state conveyed its influence on MA via ME as the encouragement that students receive from others who admire or who they know and respect; students explain it as within successful experiences and it successively mirrored on their self-efficacy (Capa-Aydin et al., 2018).

5.3. Mastery Experience, Vicarious Experience, Social Persuasion, Physical State, and Mathematics Achievement

Another result of current study was that ME and PH mediate the effect of the contribution between VE and MA. Yurt (2014) justified the reason why VE did not predict mathematic achievement—VE influence students' mathematics achievements indirectly through other sources of mathematics self-efficacy. She further justified that by displaying the point of view of Bandura and Schunk in which the lack of a significant impact of VE on mathematics performance is not consistent with the theoretical justifications Bandura (1977) reported that "any given method, depending on how it is applied, may, of course, draw to a lesser extent on one or more other sources of efficacy information" (p.195), and this contradicts Loo and Choy (2013): "this result did not support Bandura's hypothesis that each self-efficacy source has some influence of a lesser extent on one or more other sources" (p. 90). Therefore, the current study confirmed the point of view of Bandura empirically that VE did not predict MSE directly, while it predicted MSE indirectly through ME and PH as full mediation. Thus, this is a result of integrating indirect experiences or ME formed during monitoring other students in their direct experience. The

positive indirect experience impacts the sentimental state and makes a good impression on students which in turn impacts positively on their self-efficacy, while bad indirect experience creates a worse feeling which reflects on students' self-efficacy and weakens it.

6. Limitation and Future Research Directions

There are some limitations that should be accounted for when explaining the current study results. First, this study was conducted on the Arabic environment, specifically the Sultanate of Oman. The results are of boys and girls together during the analysis of the data. The sample of the current study comprised of eighth grade public school. The present study used the international mathematics achievement test which was prepared by the Ministry of Education of the Sultanate of Oman. The finding of this study is theoretical; hence using true experimental design is necessary to see results in reality. Moreover, the present study should be replicated in another disciplines and contexts. Moreover, the limitations of present study need to be addressed to assess whether the results will be the same or different context. In addition, for future studies, it is important to examine the relationship between vicarious experience, social persuasion, physiological state, and mathematical self-efficacy through the role of mastery experience as a mediator.

7. Implication

This paper will help psychologists and researchers as it paves the way for more research on Bandura's postulate that "any given method, depending on how it is applied, may, of course, draw to a lesser extent on one or more other sources of efficacy information" (p.195). It focuses more on SSE especially VE in future researches. For educators, this paper will help them by taking their attention to the vital role of VE in the achievement of mathematics. This is because the role of the VE was not clear in terms of how it impacted students' MA. For parents, this paper will be useful for learning about the use of SSE, particularly VP, to instill confidence in their children in learning generally and in mathematics specifically.

8. Conclusion

A primary objective of present study was to examine the role of ME as a mediator between (VE, SP, and PH) and MA separately, and the relationship between VE and MA through ME, VP, and PH. The crucial finding of this study is that ME and PH mediate fully the relationship between VE and MA. Thus, this confirmed Bandura hypothesis "any given method, depending on how it is applied, may, of course, draw to a lesser extent on one or more other sources of efficacy information" (Bandura, 1977, p. 195), which means that all sources operate all together to shape person's beliefs concerning their SE (Norton, 2015). Thus, mathematics VE has influenced students' mathematics achievements indirectly through other SMSE; ME, and PH.

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