MOTIVATION AND BEHAVIORAL ENGAGEMENT: THE MEDIATING ROLE OF MATHEMATICS SELF-EFFICACY IN PRIMARY EDUCATION

Achmad Hidayatullah[1]✉
Ratno Abidin[1]
Abdul Muqit[2]

[1]Universitas Muhammadiyah Surabaya, Indonesia

[2]State Polytechnic of Malang, Indonesia

✉ achmadhidayatullah@um-surabaya.ac.id

ABSTRACT

The primary objective of this study is to explore the interrelation between motivation, self-efficacy, and behavioral engagement in primary school mathematics learning. This study also examines the mediating role of self-efficacy in the relationship between motivation and behavioral engagement. The research involved 660 fifth and sixth grade students in four schools in Surabaya, Indonesia. The data collected was analyzed using structural equation modeling. The study revealed that motivation is key to enhancing students' self-efficacy and behavioral engagement during mathematics learning. Additionally, self-efficacy was found to be linked with students' behavioral engagement. Furthermore, self-efficacy was identified as a mediator in the relationship between motivation toward mathematics and behavioral engagement during mathematics learning. The study provides valuable insights into these variables in the Indonesian context, particularly in elementary schools for mathematics learning. The research also discusses the implications of the study for teaching practices.

KEYWORDS

Self-efficacy, motivation, behavioral engagement, mathematics learning

HOW TO CITE

Hidayatullah A., Abidin R., Muqit A. (2024) 'Motivation and Behavioral Engagement: The Mediating Role of Mathematics Self-Efficacy in Primary Education', *Journal on Efficiency and Responsibility in Education and Science*, vol. 17, no. 3, pp. 237–246. http://dx.doi.org/10.7160/eriesj.2024.170306

Article history
Received
October 20, 2023
Received in revised form
June 10, 2024
Accepted
August 23, 2024
Available on-line
September 30, 2024

Highlights

- *Students' behavioral engagement was explored in this study.*
- *Motivation is positively associated with self-efficacy and behavioral engagement.*
- *Self-efficacy mediated the association between behavioral engagement and motivation.*
- *There is an indirect association between motivation and behavioral engagement.*

INTRODUCTION

Over the past decade, there has been a growing recognition of the importance of students' behavioral engagement in mathematics education. Behavioral engagement is a critical factor that has been shown to affect students' performance in this subject. It refers to students' active class participation and practice sessions (Orji and Ogbuanya, 2022). Research indicates that those who actively manage their learning and engage in class achieve better results (Chong et al., 2018). Self-determination theory (Ryan and Deci, 2000) suggests that students' motivation is crucial to their outcomes in mathematics education. In other words, when students become motivated, they actively participate in mathematics learning and are more likely to achieve their goals (Józsa et al., 2022; Welesilassie and Nikolov, 2022).

Numerous studies in the literature have explored how motivation and engagement are related. For example, Orji and Ogbuanya's (2022) study in Nigeria found that students with high motivation were more likely to be engaged in their tasks because positive emotions encouraged them during the activity. Similarly, Flunger et al. (2022) discovered that in Germany, students invested greater effort in mathematics lessons when their interest was stimulated due to their high motivation. Additionally, research has suggested that students' behavioral engagement in mathematics learning is closely linked with their self-efficacy. According to self-efficacy theory (Bandura, 1997), those with high confidence and self-judgment about their abilities tend to put greater effort into academic learning and achieve their goals. Conversely, students without self-efficacy have a higher risk of negatively perceiving mathematics (Damrongpanit, 2019). Durksen et al. (2016) recommended that self-efficacy or mathematics agency is crucial in promoting positive motivation and behavioral engagement during mathematics learning.

Previous studies (Durksen et al., 2016; Flunger et al., 2022; Orji and Ogbuanya, 2022) have shed light on the close relationship between students' behavioral engagement, motivation, and self-efficacy in the context of education. However, there is still a gap in understanding the stability of this relationship in the Indonesian context and the mediating role of self-efficacy in the association between motivation and engagement in mathematics learning. To address this gap, our study aims to provide insights into the interplay among students' motivation, self-efficacy, and behavioral engagement during mathematics learning, focusing on primary education. Additionally, we will consider relevant demographic factors, such as age, gender, and grade, to better understand their potential impact on students' outcomes.

THEORETICAL FRAMEWORK

Motivation and Behavioral Engagement

Intrinsic motivation is a psychological process that stimulates an individual's interest in solving a specific problem or engaging in a particular activity based on their autonomy and competency (Latorre-Cosculluela et al., 2022). It signifies that an activity's performance is driven by self-satisfaction rather than external factors (Guay et al., 2010). When students possess high levels of intrinsic motivation, they are likely to learn mathematics with more autonomy. Researchers have observed that students become intrinsically motivated when they develop a fondness or positive sentiments towards an object (Cho and Perry, 2012). On the other hand, engagement refers to the degree of participation and involvement of students in educational practices (Durksen et al., 2017; Chiu, 2022). Literature review showed different types of academic engagement, such as emotional engagement, behavioral engagement, and cognitive engagement (Fredricks, Blumenfeld and Paris, 2004). Using different points of view, Skinner, Kindermann, and Furrer (2009) argued that engagement may consist of emotional engagement, behavioral engagement, and disaffected behavioral and emotional engagement. In the present study, we emphasized behavioral engagement, which many researchers agree on. Behavioral engagement refers to students' participation and involvement during academic activities (Skilling, Bobis and Martin, 2021).

Behavioral engagement plays a crucial role in students' academic outcomes in mathematics classrooms (Chiu, 2022). However, the factors that drive behavioral engagement are still being studied. Previous research has shown that behavioral engagement is closely linked to a student's motivation. When students feel motivated, they are more likely to participate actively in mathematics learning, such as solving problems, sharing their ideas, and participating in group discussions. Chiu (2022) suggested that when students feel more competent and autonomous, they become more engaged in learning. Durksen et al. (2017) reported that a student's motivation drives their behavioral engagement during mathematics learning, leading to an increase in interactions between students and teachers.

Similarly, Xia et al. (2022) found that the level of students' motivation was positively correlated with their engagement in mathematics learning. However, there is a lack of empirical investigation into this relationship for primary education in Indonesia. There is a shortage of information on the extent to which students' motivation towards mathematics and their behavioral engagement are associated, especially in the Indonesian context. Therefore, our study aimed to investigate students' motivation and behavior during mathematics learning in primary education in Indonesia. Based on previous research, we hypothesized a positive association between motivation and engagement in mathematics learning among primary education students.

The Role of Self-efficacy in Behavioral Engagements

Most of the previous study-defined self-efficacy definitions refer to Bandura's (1997) work, which described self-efficacy as individual judgments' of their performance to organize and execute a course of action on academic tasks to achieve success (Chao, McInerney and Bai, 2019). Students' self-efficacy are the individuals' convictions and expectations of what they can accomplish in certain situations (Xie, Yang and Xiao, 2022). There are a variety of constructs to measure personal beliefs depending on the purpose of the research.

The role of self-efficacy cannot be overstated in academic settings. These beliefs determine students' approach, perseverance, and effort when encountering obstacles (F. Pajares, 2003; Xie et al., 2022). Studies reveal that students with strong self-efficacy perform better and are more motivated (Usher and Pajares, 2009; Chong et al., 2018; Gao, 2020; Trautner and Schwinger, 2020). This is because their personal convictions enable them to maintain their efforts and persist in challenging situations. Additionally, students' level of self-confidence can even fuel their interest in mathematics (Jiang et al., 2022). When students believe in themselves, they are more likely to engage actively in class and put in the necessary effort and energy.

Previous studies (Archambault, Janosz, and Chouinard, 2012; Kareem, Thomas and Nandini, 2022; Orji and Ogbuanya, 2022) established a correlation between mathematical beliefs and engagement behavior. Metallidou and Vlachou (2007) have found that individuals with strong self-efficacy are better at regulating their cognitive engagement during mathematics learning. Additionally, Skaalvik et al. (2015) observed that self-efficacy was linked to students' intrinsic motivation and effort, which led to help-seeking behavior when faced with difficulties. Kareem et al. (2022) have investigated the relationship between self-efficacy, teacher and student attitudes, and engagement in mathematics learning. Similarly, Orji and Ogbuanya (2022) discovered that students with high self-efficacy were more involved in learning activities. However, there is a lack of research on the role of self-efficacy in students' engagement, especially in primary education. Therefore, our research aims to explore the relationship between self-efficacy and students' engagement in mathematics learning.

Self-efficacy as a Mediator Between Motivation and Behavioral Engagement

According to previous research studies, students' level of self-efficacy has a direct relationship with their motivation

(Chang et al., 2014) and engagement (Metallidou and Vlachou, 2007; Archambault, Janosz and Chouinard, 2012; Orji and Ogbuanya, 2022) during math learning. When students believe they possess a high proficiency in mathematics, they are more engaged in regulating their learning strategies (Metallidou and Vlachou, 2007). Correspondingly, Walker et al. (2006) suggested that self-efficacy predicts students' engagement. Y. Jiang and Zhang (2023) also found that self-efficacy positively correlates with behavioral engagement in mathematics.

Moreover, students' beliefs concerning their ability in math, which include their beliefs about problem-solving in math, self-regulated learning, and ability during math learning, are closely linked to their motivation (Walker, Greene and Mansell, 2006; Voica, Singer and Stan, 2020; Orji and Ogbuanya, 2022). For instance, Skaalvik et al. (2015) reported that students' beliefs about their ability in math are closely related to their intrinsic desire for math. When students derive pleasure from working with mathematics, their beliefs about their ability to solve problems in math increase. Orji and Ogbuanya (2022) also suggested that individuals with good motivation hold high self-efficacy. On the other hand, low motivation levels have been associated with low judgment levels of individuals' math learning ability (Habók et al., 2020). However, prior studies did not identify the mediation of self-efficacy for the relationship between motivation and behavioral engagement in math learning, particularly in primary education. Given that self-efficacy enhances students' engagement in math learning and is correlated with motivation, this study assumes that self-efficacy could mediate the relationship between attitude and intrinsic motivation during math learning.

Gender and Grade

In the literature reviews, demographic data such as gender and grade level were analyzed in relation to students' academic performance outcomes. Some studies found that gender and grade level could influence these outcomes (Hidayatullah and Csíkos, 2023b, 2023a). For example, Skaalvik and Skaalvik (2013) discovered that motivation and effort were correlated differently depending on gender and grade level. Additionally, Li (2019) observed that female students displayed more strategic self-regulated learning compared to male students. Similarly, Hidayatullah and Csíkos (2023c) determined that the association between cognitive and non-cognitive factors, including motivation, beliefs, and achievement, varied according to grade level. The authors noted that the path coefficient between motivation and achievement was stronger in sixth and fifth grades. Later, Hidayatullah and Csíkos (2023b) found that students differ in mathematical beliefs according to their gender and level of study. Accordingly, this study aims to investigate the consistency of the structural relationship among motivation, self-efficacy, and behavioral engagement during mathematics learning.

Present Study

This research focuses on investigating the mediating role of self-efficacy in the association between motivation and engagement in mathematics learning. As the researcher discussed earlier, although several previous studies have investigated the link between motivation and engagement (Metallidou and Vlachou, 2007; Kareem, Thomas and Nandini, 2022; Orji and Ogbuanya, 2022), the empirical research on the relationship between the two in mathematics learning, especially for primary education are scarce. In reality, students from developing countries like Indonesia suffer from mathematics scores (Chen et al., 2018) and scary of mathematics learning. Surabaya is one of the urban areas in Indonesia, and most of the students in this area come from middle-class families. The schools mostly have been supported by the internet and computers for education.

Furthermore, some empirical investigations also showed the connection between motivation and self-efficacy (Chang et al., 2014; Jiang et al., 2014; Skaalvik, Federici, and Klassen, 2015; Jiang and Zhang, 2023); the intermediation relations among the variables mentioned above have hardly been studied. Whether or not self-efficacy mediated the relationship between motivation and engagement during mathematics learning is still unexplored. Therefore, our study proposed the model association among the variables above. Our hypotheses below guide our investigation. Figure 1 depicts our model hypothesis:

1. Motivation is expected to be positively associated with behavioral engagement and self-efficacy toward mathematics.
2. Self-efficacy toward mathematics is expected to mediate the relationship between motivation and behavioral engagement.
3. The association between motivation, behavioral engagement, and self-efficacy differs according to grade and gender preferences.

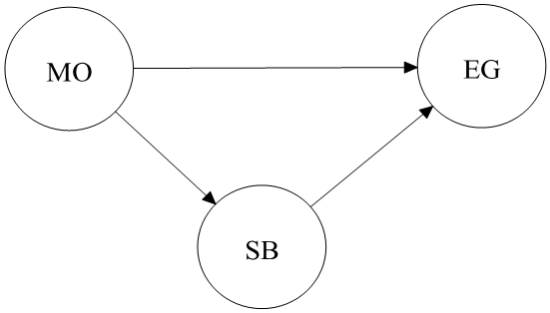

Figure 1: Hypothesis structural model of the relationship between attitude (ATM), self-efficacy (SFM), and intrinsic motivation (IMT) toward mathematics

METHODS

Participants

This cross-sectional study occurred in Surabaya, the capital city of East Java Province, Indonesia, in the first semester of 2022. Surabaya is an urban city in Indonesia, where students in the schools are from different socio-economic statuses. Six hundred sixty students (336 = boys, 324 = girls) from four schools participated in the present study. Three hundred and fifty students were from fifth grade, and three hundred and ten were from sixth grade. Students in these schools are of a variety of social and economic backgrounds. Participants ranged from 9-12 years old, with a mean age of 10.73 (SD = 0.70). Table 1 summarizes our demography's participants.

Characteristic	Full sample	Percentage
Gender		
Boys	336	50.9%
Girls	324	49.1%
Grade		
Fifth	350	53%
Sixth	310	47%
Age		
9 years	9	1.4%
10 years	244	37 %
11 years	317	48 %
12 years	90	13.6 %

Table 1: the sample structure

Instruments

In the present study, our study asked students to complete 28-item questionnaires for attitude, intrinsic motivation, self-efficacy about mathematics, and three items about their background (e.g., gender, grade, and age). All of these questionnaires were administered using the paper pencil-based test.

Motivation toward mathematics. Five items were adapted from the Academic Self-Regulation Questionnaire. The English version was adapted by Rubach and Bonanati (2021). This questionnaire related to the questions about students' enjoyment of mathematics lessons. For instance, "I learn mathematics because mathematics is fun for me" and "I learn mathematics because I want to know new things." The items of this questionnaire were rated using a five-point Likert scale (1 = strongly disagree to 5 = Strongly agree).

Self-efficacy. In the present study, we adapted six-item self-efficacy in mathematics from the academic efficacy scale (Dorman and Adams, 2004) teacher support, investigation, task orientation, cooperation, equity, involvement, personal relevance, shared control, student negotiation. This scale has been used to measure the extent to which students' beliefs about their capability in mathematics learning. For example: "I'm certain that I can master the skills taught in math this year " and "Even if the math is hard, I can learn it." These questionnaires were rated using a five-point Likert scale of 1-5 (1 = strongly disagree to 5 = strongly agree).

Behavioral Engagement. In the present study, five items of behavioral engagement were adapted from the students' engagement questionnaire (Kong, Wong and Lam, 2003). For instance, "I always take part in mathematics discussion in class" and "I concentrate when my teacher explains mathematics concepts." These items were rated using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The validity of the behavioral engagement instrument was confirmed by performing a confirmatory factor analysis.

Data Analysis

In the present study, SPSS and Mplus 8 versions were performed to analyze the data. There are three steps to analyze the data. Two of them involved structural equation modeling analysis. In the first step, confirmatory factor analysis (CFA) was performed to confirm the validity of each questionnaire. Following this step, Cronbach's alpha was used to confirm the reliability of the questionnaire. In the second step, descriptive statistical analysis was used to explain the mean result of each variable as well as their correlations. In the third step, full structural equation modeling (SEM) analysis was performed to identify the association among variables and the mediation of self-efficacy for the relationship between motivation and engagement. Following this step, structural equation modeling was also performed to analyze the mediation of each type of self-efficacy about math (mathematics self-efficacy, problem-solving self-efficacy, and self-efficacy for self-regulated learning) for the relationship between motivation and engagement. During the model analysis, students' gender, age, and grade were included as variable controls.

Several parameters were used to gain the fit model. Maximum likelihood was used as a parameter estimate, and an absolute value loading factor of .40. Five good fit indices were used to measure the quality of the model: Tucker-Lewis's index (TLI) and comparative fit index (CFI), Chi-square, the Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Squared Residual (SRMR). According to Hu & Bentler (1999), the value of CFI and TLI should be close to or greater than .90, SRMR value less than .08 (Hu and Bentler, 1999), and RMSEA value less than or equal to .10 (MacCallum, Browne and Sugawara, 1996; Hooper, Coughlan and Mullen, 2008). Chi-square statistics are reported (Hooper, Coughlan and Mullen, 2008) to assess a model fit. We evaluated the convergent data by calculating the average variance extracted (AVE). The coefficient value for AVE should be > 0.5. The discriminant validity was evaluated using the Forner Larcker criterion, where the root of

AVE should be greater than the correlation among latent variables constructs (Hair et al., 2019b).

Procedure

In the first step, the instruments were translated into Indonesian. Three experts and two mathematics teachers reviewed the items questionnaire before the researcher administered it. Each school principal was contacted, and a letter of permission was sent to the schools about the research. Then, 28 classes were randomly selected from six primary schools in Surabaya. Finally, 851 students participated in the present study. Data were gathered using paper-pencil tests.

RESULTS

Descriptive Statistic

Table 2 describes the descriptive statistics, internal reliability, and correlation of the latent variables. Most latent variables have good reliability according to the coefficient value of Cronbach alpha (range from 0.43-0.81) and internal reliability (range from.70-.84). Table 2 indicated that students have high motivation, high behavioral engagements, and moderate self-efficacy in mathematics learning according to the main result, ranging from 3.61-3.97 on a 5-point Likert scale. The skewness ranges from -.34 to -.65, and kurtosis ranges from.21 to.73, indicating the data was distributed normally (Kline, 2005).

Variables	M	SD	alpha	Skewness	Kurtosis
1. Motivation	3.96	.71	.84	-.58	.50
2. Self-efficacy	3.61	.74	.81	-.34	.21
3. Behavioral engagement	3.95	.67	.70	-.65	.73

Table 2: Descriptive statistics and correlation of each variable

Convergent Validity and Discriminant Validity

Confirmatory factor analysis was performed to confirm the construct validity of the questionnaire. With maximum likelihood parameter estimate, our instruments gained the good fit model, χ^2 (df = 100) = 385.29, p < .001, CFI = .93, TLI = .91, RMSEA = .06, SRMR = .04. Table 3 shows the convergent validity of the questionnaire. For the indicators reliability, loading factors > .70 are suggested and loading factors > .40 are acceptable (H_o, 2006; Kwong-Kay Wong, 2013). The result showed that the factors loading ranges from .35 to .81. The composite reliability (CR) for motivation, behavioral engagement, and self-efficacy was good, .84, .70, and .81, respectively. As suggested by Hair et al. (2019a), the composite reliability (CR) cut-off value should be higher than .70. Although the result shows that only the motivation construct obtained score of AVE was higher than .50, the score value of CR for self-efficacy and behavioral engagement was around .70, indicated that the indicators consistently measuring the latent variables. In other words, our items were internally consistent or convergent (Hair et al., 2019b).

Latent variables	Items	Loading factor	AVE	CR
Motivation			.52	.84
	M1	0.72		
	M2	0.78		
	M3	0.81		
	M4	0.69		
	M5	0.59		
Behavioral engagement			.33	.70
	EG1	0.68		
	EG2	0.68		
	EG3	0.43		
	EG4	0.51		
	EG5	0.52		
Self-Efficacy			.43	.81
	SE1	0.70		
	SE2	0.68		
	SE3	0.75		
	SE4	0.67		
	SE5	0.57		
	SE6	0.51		

Note. CR = composite reliability, AVE = average variance extracted

Table 3: Convergent validity and reliability of the construct

Furthermore, we evaluated the discriminant validity of the latent variables.by comparing the AVE score and the correlation between factors. Fornell and Larcker (1981) suggested that the root of AVE should be higher than the correlation between factors, indicating discriminant validity. The result showed that the correlation among the latent variables was weaker than the root AVE (see Table 4). Therefore, the structural equation modelling evaluation can be employed to evaluate the structural relationship among the aforementioned variables.

Variables	1	2	3
4. Motivation	(.72)		
5. Self-efficacy	.59**	(.66)	
6. Behavioral engagement	.70**	.53**	(.57)

*Note: *significant at the level.05 (p <.05), ** significant at the level 001 (p <.001). Diagonal data are the root of the average variance extracted.*

Table 4: Discriminant validity

SEM Evaluation

Our hypothesis proposed self-efficacy to mediate the relationship between attitude and intrinsic motivation. However, in the first step, we evaluated the normality data. We accept the criteria skewness +/- 3, and kurtosis +/ 8 can be considered as normal distribution (Kline, 2005). The Skewness and Kurtosis data indicated that our data was normal. Then, we performed structural equation modeling. Our model was not ideal, χ^2 (df = 101) = 436.53, p < .001, CFI = .91, TLI = .89, RMSEA = .07, SRMR = .05. We modified it to find the fit model (See figure 2) χ^2 (df = 100) = 385.29, p < .001, CFI = .93, TLI = .91, RMSEA = .06, SRMR = .04. The model suggested that motivation was positively associated with behavioral engagement (β = .79, p < .001) and self-efficacy about mathematics (β = .70, p < .001). Self-efficacy was positively related to behavioral engagement (β = .19, p < .001). In comparison, the indirect effect of motivation on behavioral engagement through self-efficacy was weaker than the direct effect (β = .13, p < .001).

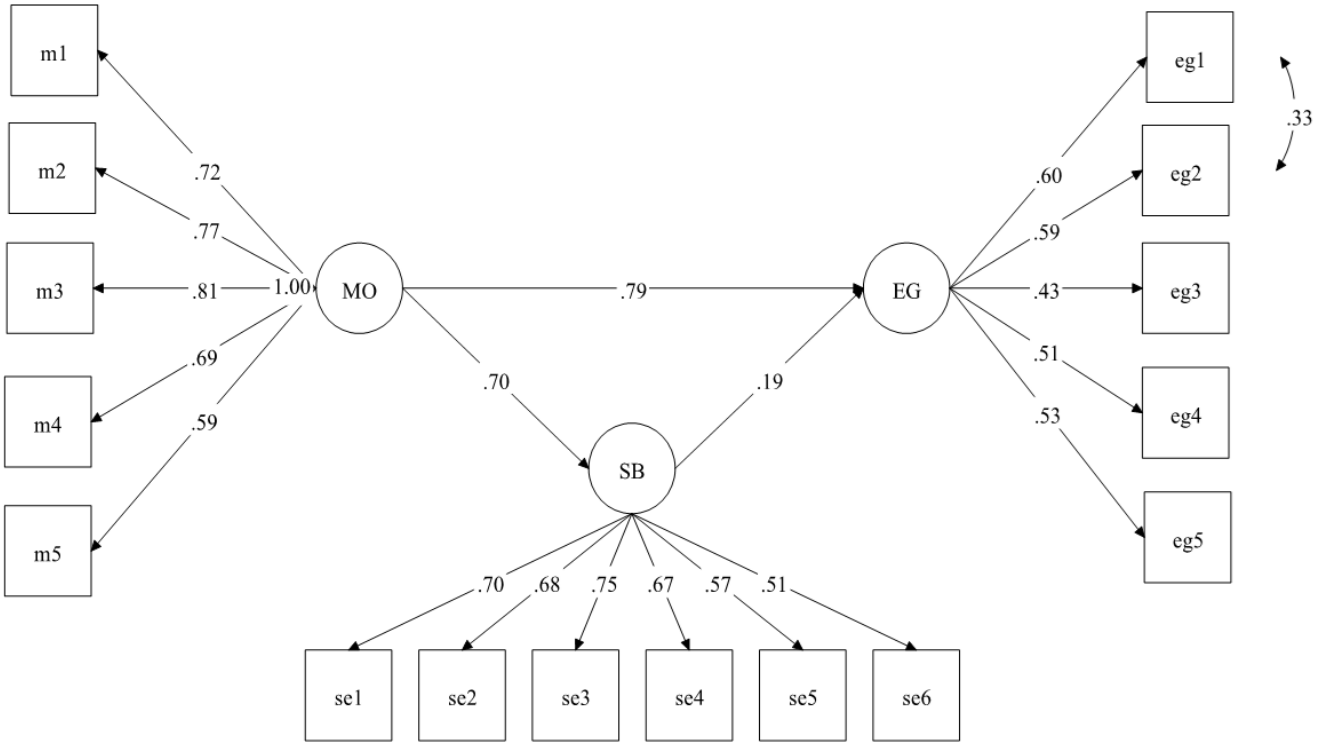

Figure 2: the mediation of self-efficacy (SB) with standardized coefficient

We further examined the association and the intermediation between latent variables by performing a bootstrapping approach. We calculated the direct association among these variables with a 95% confidence interval through bootstrapping 5,000 samples. The association between motivation and behavioral engagement was .79 (95% CI = [.66, .94]). Motivation was also positively associated with self-efficacy .75 (95% CI = [.54, .88]). Self-efficacy was directly associated with behavioral engagement .16 (95% CI = [.03, .28]). Self-efficacy positively mediated the relationship between motivation and behavioral engagement .13 (95% CI = [.03, .23]). Table 5 summarizes the bootstrapping result for the relationship among these variables.

Path	Standardized Estimate	Bootstrapping 95% CI	
		Lower Limit	Upper limit
Direct effect	.79	.66	.94
Motivation → Behavioral engagement	.70	.54	.88
Motivation → Self-efficacy	.75	.64	.87
Self-efficacy → Behavioral engagement	.16	.03	.28
Indirect effect			
Motivation → Self-efficacy → Behavioral engagement	.13	.03	.23

Table 5: Total, direct, and indirect effects

Furthermore, we performed the multigroup analysis to evaluate whether or not the association and the intermediation between these variables are stable across gender and grade-level studies. We found the fit model for the association among these variables in different in terms of grade level, χ^2 (df = 224) = 570.71, $p < .001$, CFI = .91, TLI = .91, RMSEA = .06, SRMR = .05. Motivation positively associated with behavioral engagement in grade 5 and grade 6, the path regression was (β = .74, $p < .001$) and (β = .64, $p < .001$), respectively. Self-efficacy is positively associated with behavioral engagement in grade 5 (β = .14, p = .02) and grade 6 (β = .17, p = .03). Self-efficacy has positively mediated the relationship between motivation and behavioral engagement in both grade 5 and grade 6, (β = .12, p = .02) and (β = .17, p = .03), respectively.

With respect to the association between motivation, behavioral engagement, and self-efficacy based on gender, the structural equation modeling consistently fit across gender χ^2 (df = 224) = 246.78, $p < .001$, CFI = .91, TLI = .91, RMSEA = .06, SRMR = .06. The differences between boys and girls in term of association between variables mentioned above have been identified. The direct association between motivation associated with behavioral engagement was stronger for boys (β = .87, $p < .001$) than for girls' students (β = .69, $p < .001$). In comparison, the direct association between self-efficacy and behavioral engagement was significant for girls (β = .27, p = .01) but not for boys (β = .12, p = .11). At the same time, the mediating role of self-efficacy in the relationship between motivation and behavioral engagement was only significant for girls β = .20, p = .01) but not for boys (β = .09, p = .10).

DISCUSSION

The main focus of this study was to investigate the structural model that describes the association between motivation, self-efficacy, and behavioral engagement in mathematics learning. Overall, the association and the mediation among the variables mentioned above were significant. This study contributed to the unpacking relationship among motivation, self-efficacy, and behavioral engagements for primary education in the Indonesian context.

Our study found that motivation was directly associated with self-efficacy and behavioral engagements. This finding supports hypothesis 1. What we found in the present study is consistent with the prior research (Chiu, 2022; Durksen et al., 2017), which suggested that the level of students' motivation would produce their involvement and active participation during mathematics learning. According to self-determination theory, students' motivation is the result of autonomy, relatedness, and competence support, which the teachers provide (Deci and Ryan, 2008; Chiu, 2022). When students became motivated, they were more willing to participate actively in mathematics learning. Our finding also showed that motivation was associated with self-efficacy in mathematics learning. This finding aligns with Skaalvik et al. (2015) and Hidayatullah and Csíkos (2023), who found a positive association between the two in mathematics learning. Orji and Ogbuanya (2022) argued that those with good motivation tend to have more confidence in judging their ability during mathematics learning. On the contrary, when students have less motivation, their beliefs about their capabilities decrease (Habók et al., 2020).

Our study also revealed that self-efficacy in mathematics learning positively mediated the association between motivation toward mathematics and behavioral engagement during mathematics learning. This finding supported the second hypothesis. Our finding is also consistent with Orji and Ogbuanya (2022) and Skaalvik et al. (2015), who suggested that beliefs in mathematics learning have been found to be the result of motivation. When students have good motivation, their beliefs also increase (Usher and Pajares, 2009; Chong et al., 2018; Gao, 2020; Trautner and Schwinger, 2020) and, in turn, promotes students' behavioral engagement during mathematics learning (Metallidou and Vlachou, 2007; Archambault, Janosz and Chouinard, 2012). According to social cognitive theory (Bandura, 2001), when students hold strong beliefs about their capability, they put much effort into being active and involved in academic learning. Therefore, prompt students' active participation during mathematics learning cannot be separated from motivation and self-efficacy.

Surprisingly, our study also revealed that the model relationship between motivation, self-efficacy, and behavioral engagement during mathematics learning was stable based on grade differences. This finding is in line with the previous studies (Hidayatullah & Csíkos, 2023; Skaalvik and Skaalvik, 2013), which find the weight of association among latent variables tends to vary based on the gender and grade level study. This study revealed the same result as the study by Suherman and Vidákovich (2024), which found a variety of weight associations between attitude and mathematics achievement in the SEM evaluation. In this study, the direct association of motivation on self-efficacy and behavioral engagement in mathematics learning was positive in grades 5 and grade 6. The direct association between motivation and behavioral engagement was stronger in grade five. At the same time, the mediation of self-efficacy for the relations between motivation and behavioral engagement was stronger in grade six. Our interpretation for this stage is that students' motivation towards mathematics in grade six decreased. Therefore, to promote their behavioral engagement, they also need the motivation to increase their self-efficacy in mathematics learning. However, a further empirical study is necessary to clarify this speculation for future research.

The data also showed that the model was stable for boys' and girls' students. The differences in the weight association between motivation, self-efficacy, and behavioral engagement have been identified. This study revealed the same result as Skaalvik and Skaalvik (2013), who found significant differences in the association between the effect and motivational aspects in primary education. In the current study, the direct association between self-efficacy and behavioral engagement was significant only for girls, not for boys. Consequently, the mediating role of self-efficacy for the relationship between motivation and engagement was significant only for girls. This finding contradicts Oppermann, Brunner and Anders (2019), who suggested that the association between engagement and self-efficacy was stronger for male students. It can be interpreted that girls might be more inclined to internalize their desire for mathematics and develop a stronger self-judgment about their

ability, generating a stronger association between motivation, self-efficacy, and behavioral engagement than boys' students. However, an additional study is needed to confirm this finding. Our study revealed that motivation and self-efficacy were directly associated with students' behavioral engagement during mathematics learning. However, the effect of motivation was stronger than self-efficacy on behavioral engagements. Self-efficacy also serves as a mediator for the relationship between motivation and behavioral engagements. In other words, when students become motivated to study mathematics, their confidence in their capability to overcome any obstacle in mathematics learning also increases, in turn promoting their involvement during mathematics learning.

LIMITATIONS AND FUTURE RESEARCH

Although this study provided a wealth of data and information, several limitations should be noted. First, the research was a cross-sectional study with the survey, which cannot be stated as a causal relationship between motivation, self-efficacy, and behavioral engagement. Second, this study only measures the mediating role of self-efficacy, and there may be a bi-direction of the relationship among the variables mentioned above. Therefore, a longitudinal study is needed for future research to confirm the causal relationship among these variables. Third, this study emphasized the structural model of non-cognitive factors without investigating the implication for students' achievement and cognitive engagement during mathematics learning. Fourth, in the present study, the data was gathered using self-report, which leaves much space to be improved. In future research, a deep interview is important to strengthen the results of the self-report. This study also investigated the stability of the model based on grade and gender differences. However, there was no conclusion to confirm the differences between the groups. Future research is necessary to clarify why there are differences in the structural relationship among variables mentioned above based on gender and grade differences in the form of a longitudinal study.

CONCLUSION AND IMPLICATION

To summarize, this study's finding showed that motivation and self-efficacy in mathematics learning positively predict students' behavioral engagement. Also, this study revealed that self-efficacy in mathematics learning mediates the relationship between motivation toward mathematics and behavioral engagement in mathematics learning. The findings of this study provide theoretical contributions. This study provided empirical evidence of the relationship between motivation, self-efficacy, and behavioral engagement. The more motivated students to study mathematics, their self-efficacy to study math increased, and they were more likely to participate actively in mathematics, such as always taking part in mathematics group discussions. However, the differences in the association between self-efficacy, motivation, and behavioral engagement by gender in mathematics lessons may encourage the discussion of the relevance of motivation and self-efficacy theory.

These findings have implications for teaching practices. Since the finding of this study told us that motivation and self-efficacy are key factors in promoting students' behavioral engagements, this finding enlightened us that mathematics educators should set the math class to shape students' positive motivation because the positive motivation will elevate self-judgment about the capability to discuss in group work, to solve the mathematical task, and to regulate mathematics learning, then facilitate students' behavioral engagements. Grouping students in mathematics group work may also promote their motivation and beliefs about their mathematics learning ability. Providing autonomy support and encouraging students to be more connected with others, such as their peers in the classroom, will strengthen their motivation toward mathematics. Persuading and appreciating students' work also increases students' motivation and beliefs to do well in mathematics learning.

DECLARATION OF COMPETING INTEREST

No conflict of interest exists.

REFERENCES

Archambault, I., Janosz, M. and Chouinard, R. (2012) 'Teacher beliefs as predictors of adolescents' cognitive engagement and achievement in mathematics', *Journal of Educational Research*, Vol. 105, No. 5, pp. 319–328. https://doi.org/10.1080/00220671.2011.629694

Bandura, A. (1997) *Self-Efficacy: The exercise of control*, New York:W. H. Freeman and Company.

Bandura, A. (2001) 'Social cognitive theory: An agentic perspective', *Annual Reviews Psychology*, Vol. 52, pp. 1–26. https://doi.org/10.1146/annurev.psych.52.1.1

Chang, C.-S., Liu, E. Z.-F., Sung, H.-Y., Lin, C.-H., Chen, N.-S. and Cheng, S.-S. (2014) 'Effects of online college student's Internet self-efficacy on learning motivation and performance', *Innovations in Education and Teaching International*, Vol. 51, No. 4, pp. 366–377. https://doi.org/10.1080/14703297.2013.771429

Chao, C. N. G., McInerney, D. M. and Bai, B. (2019) 'Self-efficacy and self-concept as predictors of language learning achievements in an Asian bilingual context', *Asia-Pacific Education Researcher*, Vol. 28, No. 2, pp. 139–147. https://doi.org/10.1007/s40299-018-0420-3

Chen, L.-K., Dorn, E., Krawitz, M., SH Lim, Ch. and Mourshed, M. (2018) *Drivers of Student Performance: Insights from Asia*. McKinsey & Company. Available: https://www.mckinsey.com/~/media/McKinsey/Industries/Social Sector/Our Insights/What drives student performance in latin america/Drivers-of-Student-Performance.ashx

Chiu, T. K. F. (2022) 'Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic', *Journal of Research on Technology in Education*, Vol. 54 No.1, pp. 14–30. https://doi.org/10.1080/15391523.2021.1891998

Cho, Y. J. and Perry, J. L. (2012) 'Intrinsic motivation and employee attitudes: Role of managerial trustworthiness, goal-directedness, and extrinsic reward expectancy', *Review of Public Personnel Administration*, Vol. 32, No. 4, pp. 382–406. https://doi.org/10.1177/0734371X 11421495

Chong, W. H., Liem, G. A. D., Huan, V. S., Kit, P. L. and Ang, R. P. (2018) 'Student perceptions of self-efficacy and teacher support for learning in fostering youth competencies: Roles of affective and cognitive engagement', *Journal of Adolescence*, Vol. 68, No. 1, pp. 1–11. https://doi.org/10.1016/j.adolescence.2018.07.002

Damrongpanit, S. (2019) 'From modern teaching to mathematics achievement: The mediating role of mathematics attitude, achievement motivation, and self-efficacy', *European Journal of Educational Research*, Vol. 8, No. 3, pp. 713–727. https://doi.org/10.12973/eu-jer.8.3.713

Deci, E. L., & Ryan, R. M. (2008). *Self-determination theory: A macrotheory of human motivation, development, and health*. Canadian Psychology, 49(3), pp. 182–185. https://doi.org/10.1037/a0012801

Dorman, J. and Adams, J. (2004) 'Associations between students' perceptions of classroom environment and academic efficacy in Australian and British secondary schools', *Westminster Studies in Education*, Vol. 27, No. 1, pp. 69–85. https://doi.org/10.1080/0140672040270106

Durksen, T. L., Chu, M.-W., Ahmad, Z. F., Radil, A. I. and Daniels, L. M. (2016) 'Motivation in a MOOC: a probabilistic analysis of online learners' basic psychological needs', *Social Psychology of Education*, Vol. 19, No. 2, pp. 241–260. https://doi.org/ 10.1007/s11218-015-9331-9

Durksen, T. L., Way, J., Bobis, J., Anderson, J., Skilling, K. and Martin, A. J. (2017) 'Motivation and engagement in mathematics: a qualitative framework for teacher-student interactions', *Mathematics Education Research Journal*, Vol. 29, No. 2, pp. 163–181. https://doi.org/10.1007/s13394-017-0199-1

Flunger, B., Hollmann, L., Hornstra, L. and Murayama, K. (2022) 'It's more about a lesson than a domain: Lesson-specific autonomy support, motivation, and engagement in math and a second language', *Learning and Instruction*, Vol. 77, No. 1, p. 101500. https://doi.org/10.1016/j.learninstruc.2021.101500

Fornell, C. and Larcker, D. F. (1981) 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, Vol. 18, No. 1, p. 39. https://doi.org/10.2307/3151312

Fredricks, J. A., Blumenfeld, P. C. and Paris, A. H. (2004) 'School engagement: Potential of the concept, state of the evidence', *Review of Educational Research*, Vol. 74. No. 1. pp. 59–109. https://doi.org/10.3102/00346543074001059

Gao, J. (2020) 'Sources of mathematics self-efficacy in Chinese students: A mixed-method study with Q-Sorting procedure', *International Journal of Science and Mathematics Education*, Vol. 18, No. 4, pp. 713–732. https://doi.org/10.1007/s10763-019-09984-1

Guay, F., Ratelle, C. F., Roy, A. and Litalien, D. (2010) 'Academic self-concept, autonomous academic motivation, and academic achievement: Mediating and additive effects', *Learning and Individual Differences*, Vol. 20, No. 6, pp. 644–653. https://doi.org/10.1016/j.lindif.2010.08.001

Habók, A., Magyar, A., Németh, M. B. and Csapó, B. (2020) 'Motivation and self-related beliefs as predictors of academic achievement in reading and mathematics: Structural equation models of longitudinal data', *International Journal of Educational Research*, Vol. 103, No. 2, pp. 1–12. https://doi.org/10.1016/j.ijer.2020.101634

Hair, J. F., Babin B., Anderson, R. E. and Black W. (2019a) *Multivariate data analysis, multivariate data analysis*. Cheriton House: UK: Cengage Learning, EMEA.

Hair, J. F., Risher, J. J., Sarstedt M. and Ringle C. M. (2019b) 'When to use and how to report the results of PLS-SEM abstract', *European Business Review*, Vol. 3, No. 1, pp. 3–24. https://doi.org/10.1108/EBR-11-2018-0203

Hidayatullah, A. and Csíkos, C. (2023a) 'Exploring students ' mathematical beliefs : gender, grade, and culture differences', Journal on Efficiency and Responsibility in Education and Science, Vol. 16, No. 3, pp. 186–195. https://doi.org/10.7160/eriesj.2023.160303

Hidayatullah, A. and Csíkos, C. (2023b) 'Students' responses to the realistic word problems and their mathematics-related beliefs in primary education', Pedagogika, Vol. 150, No. 2, pp. 21–37. https://doi.org/10.15823/p.2023.150.2

Hidayatullah, A. and Csíkos, C. (2023c) 'The role of students' beliefs, parents' educational level, and the mediating role of attitude and motivation in students' mathematics achievement', The Asia-Pacific Education Researcher. https://doi.org/10.1007/s40299-023-00724-2

Ho, R. (2006) *Handbook of univariate and multivariate data analysis and interpretation with SPSS*, Abingdon: Taylor & Francis.

Hooper, D., Coughlan, J. and Mullen, M. R. (2008) 'Structural equation modelling: Guidelines for determining model fit', *Electronic Journal of Business Research Methods*, Vol. 6, No. 1, pp. 53–60.

Hu, L. T. and Bentler, P. M. (1999) 'Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives', *Structural Equation Modeling*, Vol. 6, No. 1, pp. 1–55. https://doi.org/10.1080/10705519909540118

Jiang, H., Turnbull, D., Wang, X., Chugh, R., Dou, Y. and Chen, S. (2022) 'How do mathematics interest and self-efficacy influence coding interest and self-efficacy? A structural equation modeling analysis', *International Journal of Educational Research*, Vol. 115, No. 5, pp. 1–10. https://doi.org/10.1016/j.ijer.2022.102058

Jiang, Y., Song, J., Lee, M. and Bong, M. (2014) 'Self-efficacy and achievement goals as motivational links between perceived contexts and achievement', *Educational Psychology*, Vol. 34, No. 1, pp. 92–117. https://doi.org/10.1080/01443410.2013.863831

Jiang, Y. and Zhang, L. (2023) 'High school students' expectancy, value, and cost profiles and their relations with engagement and achievement in Math and English', *Learning and Individual Differences*, Vol. 101, No. 1, pp. 1–14. https://doi.org/10.1016/j.lindif.2022.102252

Józsa, G., Oo, T. Z., Amukune, S. and Józsa, K. (2022) 'Predictors of the intention of learning in higher education: Motivation, self-handicapping, executive function, parents' education, and school achievement', *Education Sciences*, Vol. 12, No. 12, p. 906. https://doi.org/10.3390/educsci12120906

Kareem, J., Thomas, R. S. and Nandini, V. S. (2022) 'A conceptual model of teaching efficacy and beliefs, teaching outcome expectancy, student technology use, student engagement, and 21st-century learning attitudes: A STEM education study', *Interdisciplinary Journal of Environmental and Science Education*, Vol. 18, No. 4, pp. 1–11. https://doi.org/10.21601/ijese/ 12025

Kline, R. B. (2005) *Principles and practice of structural equation modeling*. New York and London: The Guilford Press : New York and London.

Kong, Q. P., Wong, N. Y. and Lam, C. C. (2003) 'Student engagement in mathematics: Development of instrument and validation of construct', *Mathematics Education Research Journal*, Vol. 15, No. 1, pp. 4–21. https://doi.org/10.1007/BF03217366

Kwong-Kay Wong, K. (2013) 'Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS', *Marketing Bulletin*, Vol. 24, No. 1, pp. 1–32.

Latorre-Cosculluela, C., Sierra-Sánchez, V., Rivera-Torres, P. and Liesa-Orús, M. (2022) 'Emotional well-being and social reinforcement as predictors of motivation and academic expectations', *International Journal of Educational Research*, Vol. 115, No. 5, pp. 1–12. https://doi.org/10.1016/j.ijer.2022.102043

Li, K. (2019) 'MOOC learners' demographics, self-regulated learning strategy, perceived learning and satisfaction: A structural equation modeling approach', *Computers and Education*, Vol. 132, No. 5, pp. 16–30. https://doi.org/10.1016/j.compedu.2019.01.003

MacCallum, R. C., Browne, M. W. and Sugawara, H. M. (1996) 'Power analysis and determination of sample size for covariance structure modeling', *Psychological Methods*, Vol. 1, No. 2, pp. 130–149. https://doi.org/10.1037/1082-989X.1.2.130

Metallidou, P. and Vlachou, A. (2007) 'Motivational beliefs, cognitive engagement, and achievement in language and mathematics in elementary school children', *International Journal of Psychology*, Vol. 42, No. 1, pp. 2–15. https://doi.org/10.1080/00207590500411179

Oppermann, E., Brunner, M. and Anders, Y. (2019) 'The interplay between preschool teachers' science self-efficacy beliefs, their teaching practices, and girls' and boys' early science motivation', *Learning and Individual Differences*, Vol. 70, No.1, pp. 86–99. https://doi.org/10.1016/j.lindif.2019.01.006

Orji, C. T. and Ogbuanya, T. C. (2022) 'Mediating roles of ability beliefs and intrinsic motivation in PBL and engagement in practical skills relations among electrical/electronic education undergraduate', *Innovations in Education and Teaching International*, Vol. 59, No. 3, pp. 326–336. https://doi.org/10.1080/14703297.2020.1813188

Pajares, F. (2003) 'Self-efficacy, motivation, and achievement in writing: A review of the literature', *Reading and Writing Quarterly*, Vol. 19, No. 2, pp. 139–158. https://doi.org/10.1080/10573560308222

Rubach, C. and Bonanati, S. (2021) 'The impact of parents' home- and school-based involvement on adolescents' intrinsic motivation and anxiety in math', *Psychology in the Schools*, Vol. 5, No. 6, pp. 1–21. https://doi.org/10.1002/pits.22577

Ryan, R. M. and Deci, E. L. (2000) 'Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being', *American Psychologist*, Vol. 55, No. 1, pp. 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Skaalvik, E. M., Federici, R. A. and Klassen, R. M. (2015) 'Mathematics achievement and self-efficacy: Relations with motivation for mathematics', *International Journal of Educational Research*, Vol. 72, No. 4, pp. 129–136. https://doi.org/10.1016/j.ijer.2015.06.008

Skaalvik, E. M. and Skaalvik, S. (2013) 'School goal structure: Associations with students' perceptions of their teachers as emotionally supportive, academic self-concept, intrinsic motivation, effort, and help seeking behavioral', *International Journal of Educational Research*, Vol. 61, No, 5, pp. 5–14. https://doi.org/10.1016/j.ijer.2013.03.007

Skilling, K., Bobis, J. and Martin, A. J. (2021) 'The "ins and outs" of student engagement in mathematics: shifts in engagement factors among high and low achievers', *Mathematics Education Research Journal*, Vol. 33, No. 3, pp. 469–493. https://doi.org/10.1007/s13394-020-00313-2

Skinner, E. A., Kindermann, T. A. and Furrer, C. J. (2009) 'A motivational perspective on engagement and disaffection', *Educational and Psychological Measurement*, Vol. 69, No. 3, pp. 493–525. https://doi.org/10.1177/0013164408323233

Suherman, S. and Vidákovich, T. (2024) 'Mathematical Creative Thinking-Ethnomathematics based Test: Role of Attitude toward Mathematics, Creative Style, Ethnic Identity, and Parents' Educational Level', *Revista de Educación a Distancia*, Vol. 24, No.77, pp. 1–22. https://doi.org/10.6018/red.581221

Trautner, M. and Schwinger, M. (2020) 'Integrating the concepts self-efficacy and motivation regulation: How do self-efficacy for motivation regulation influence self-regulatory success?', *Learning and Individual Differences*, Vol. 80, No. 4. https://doi.org/ 10.1016/j.lindif.2020.101890

Usher, E. L. and Pajares, F. (2009) 'Sources of self-efficacy in mathematics: A validation study', *Contemporary Educational Psychology*, Vol. 34, No. 1, pp. 89–101. https://doi.org/ 10.1016/j.cedpsych.2008.09.002

Voica, C., Singer, F. M. and Stan, E. (2020) 'How are motivation and self-efficacy interacting in problem-solving and problem-posing?', *Educational Studies in Mathematics*, Vol. 105, No. 3, pp. 487–517. https://doi.org/10.1007/s10649-020-10005-0

Walker, C. O., Greene, B. A. and Mansell, R. A. (2006) 'Identification with academics, intrinsic/extrinsic motivation, and self-efficacy as predictors of cognitive engagement', *Learning and Individual Differences*, Vol. 16, No. 1, pp. 1–12. https://doi.org/ 10.1016/j.lindif.2005.06.004

Welesilassie, M. W. and Nikolov, M. (2022) 'Relationships between motivation and anxiety in adult EFL learners at an Ethiopian university', *Ampersand*, Vol. 9. No. 1, pp. 1–10. https://doi.org/10.1016/j.amper.2022.100089

Xia, Q., Yin, H., Hu, R., Li, X. and Shang, J. (2022) 'Motivation, engagement, and mathematics achievement: An exploratory study among Chinese primary students', *SAGE Open*, Vol. 12, No. 4, pp. 1–13. https://doi.org/ 10.1177/21582440221134609

Xie, F., Yang, Y. and Xiao, C. (2022) 'Gender-math stereotypes and mathematical performance: the role of attitude toward mathematics and math self-concept', *European Journal of Psychology of Education*, Vol. 39, pp. 695–708. https://doi.org/10.1007/s10212-022-00631-y