


Middle School Students' Engagement in Mathematics and Learning Approaches: Structural Equation Modelling

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ABSTRACT

This study aims to investigate the effects of middle school students' learning approaches and their attitudes towards mathematics on their engagement in mathematics course. The research cross-sectional survey design was used in the quantitative research model. The research was conducted with the participation of 5th-8th graders who attended schools located in a city in the Central Anatolian region of Turkey. Thus, 383 students in total, 209 of whom were female and 174 of whom were male, were included in the research. Three different data collection instruments were used in the study: student engagement in mathematics scale, approaches to learning mathematics scale, and scale for assessing attitudes towards mathematics in secondary education. The data were analyzed on structural equation modelling. As a result, significant correlations were found between participants' engagement in mathematics course and their learning approaches while no significant differences were found between their engagement in mathematics and their attitudes towards the course.

Keywords: engagement, learning approaches, attitudes, mathematics

INTRODUCTION

Learning mathematics is a complex process (Moenikia & Zahed-Babelan, 2010). Both cognitive and emotional factors are influential in achievement in mathematics and in retention (Singh et al., 2002). Therefore, how students learn mathematics is an issue as remarkable learning the course content (Cano & Berbén, 2009; Goktepe-Yildiz & Ozdemir, 2018; Segers et al., 2008). Mathematics curricula were given prominence with this feature when emotional factors such as interest, attitudes and perception which influenced learning in particular were noticed (NCTM, 2014). In addition to those components, several socioeconomic factors, and factors such as the influence of families, peers, and schools which affect learning mathematics are also available. Research on engagement, attitudes and learning approaches- which are influential in achievement in mathematics have received interest in recent years due to the fact that it is difficult to change variables related to home and family (Cagirgan & Soyurk, 2021; Singh et al., 2002). Besides, the above-mentioned influences are greatly important for students in learning mathematical concepts (Liston & O'Donoghue, 2010). Hence, this paper sets out to investigate the correlations between learning approaches and attitudes towards mathematics course, which affect students' engagement in mathematics.

Engagement

Engagement is defined as a function of the factors for example participation, need, emotions, intention, interest, and so on (Azevedo et al., 2012). Krause and Coates (2008) argue that engagement is a large phenomenon which is both academic and non-academic and which also has social aspects. It involves a multi-dimensional structure. Accordingly, Willms (2003) considers it as two-dimensional labelled as behavioral and psychological engagement while Fredricks et al. (2004) consider it as three-dimensional labelled as behavioral, emotional, and cognitive engagement and some others consider it as four-dimensional labelled as behavioral, cognitive, social, and academic engagement (Christenson et al., 2008) or labelled as behavioral, emotional, cognitive, and agentic engagement (Reeve, 2012), or labelled as cognitive, emotional, behavioral, and social engagement (Wang et al., 2016). For mathematics course, engagement is classified as emotional, social and cognitive engagement by Rimm-Kaufman (2010). Emotional engagement involves interest, emotions, curiosity, enthusiasm, values, attitudes (Fredricks et al., 2004; Reeve, 2012), desire to participate in classes, motivation (Skinner & Pitzer, 2012), attitudes towards teacher and peer relations, and emotions (Bingham & Okagaki, 2012). Besides, belongingness-that is to say, the fact that school is a significant part of life-involves elements important for achievement outside school (Finn & Zimmer, 2012). Besides, social engagement represents students' potential to obey in-class written or unwritten rules. It contains, for instance, behavioral of whether or not they attend classes in time or not, their communication with their teachers and classmates or hindering their friends' studies. The degree of social

engagement affects students' learning. Thus, students with higher social engagement learn easier whereas the opposite has reverse effects (Finn & Zimmer, 2012).

Cognitive engagement involves internal motivation for learning, strategies (Bingham & Okagaki, 2012; Fredricks et al., 2004), making efforts to learn within the framework of activities offered and participation in classes and activities (Skinner & Pitzer, 2012). Students who have engagement in the course tend to give prominence to conceptual understanding and have tendency to use self-regulation strategies instead of detailing such as adopting deep learning approaches or using individualized strategies (Bingham & Okagaki, 2012; Reeve, 2012). Behaviors of cognitive engagement include asking greater number of questions, performing challenging tasks, revising the learnt knowledge, searching for sources of knowledge and using strategies. Individuals with higher cognitive engagement make more efforts to learn complicated subjects (Finn & Zimmer, 2012). Engagement means students' awareness of their capabilities and thus setting up emotional ties with a course and taking on active roles in activities (Nayir, 2015). Engagement in mathematics course expresses students' motivation for learning mathematics, achievement, confidence and their emotional states about mathematics. Their engagement in mathematics play critical roles in their acquisition of mathematical knowledge and skills. Besides, the more engagement a student has in learning, the more he will be open to learning (Moenikia & Zahed-Babelan, 2010). As a result, the student's commitment to the mathematics lesson affects both affective and cognitive status towards the mathematics lesson.

Learning Approaches

Learning approaches represent the strategies used depending on desires and motivation which stem from individual differences (Diseth & Martinsen, 2003) and learners' preferences for the point of learning (Biggs, 1979). Several studies investigating students' learning approaches were conducted especially in the late 1970s (Chan, 2003; Darlington, 2011; Diseth & Martinsen, 2003; Ekinci, 2009). Learning approaches were suggested in a study conducted by Marton and Säljö (1976) which investigated Swiss university students' levels of information processing. The researchers analyzed how students' comprehended a reading passage and how they started to learn. While a group of the students considered the reading text as a separate unit of grammar that might be asked in an exam and that needed memorizing, the other group considered the text as a whole and tried to comprehend it and therefore the researchers described two different approaches called deep and surface. Later, they also described strategic approach in addition to the two types they had described (Biggs, 1979; Entwistle & Waterston, 1988; Ramsden, 1979).

Deep approach was defined as the approach in which students aim to understand a subject and to search for meanings. Students have internal interest in subjects in this approach and they enjoy studying. Thus, students who adopt the approach can, for instance, easily communicate with others (Darlington, 2011; Lucas, 2001). Students with surface approach, however, consider learning tasks as elements imposed on them and they adopt memorization-based strategies. They handle the parts of a subject separately and fail to see the whole (Lucas, 2001). It is not likely to gain experience and skills consistent with high quality learning outcomes through surface approach only (Hall et al., 2004). Generally, students who believe that knowledge is precise and unchangeable can be said to adopt surface approach (Chan, 2003).

Strategic approach was recommended by Ramsden (1979) to describe test and achievement-oriented students' learning approaches because deep and surface approaches are suitable to more free environments. Competition—in other words, achievement, is prominent in strategic approach. Students can use any strategy (procedures, comprehension, and memorization) serving to their purpose to achieve success in this approach unlike in the other approaches. Students who adopt strategic approach can reunite deep approach with surface approach (Diseth & Martinsen, 2003). Generally, students who would like to get higher marks and who work in an organized way adopt this approach (Chirikure et al., 2019). Actually, learning approaches are interaction between the student and the learning situation. Therefore, learning approaches can be shaped depending on the student's reaction to the learning environment (Fry et al., 2003; Ramsden, 1981).

Attitudes Towards Mathematics

Studies which investigate students' attitudes towards mathematics in education date back to a long time (Di Martino & Zan, 2011; Yang, 2015). Attitude is an important concept in learning mathematics. Attitudes towards mathematics are regarded as bias to give positive or negative response to the course (Moenikia & Zahed-Babelan, 2010). Attitudes towards mathematics is defined as emotional inclinations (Di Martino & Zan, 2011), and the attitudes represent emotional responses, beliefs and behaviours (Primi et al., 2020). According to Tapia and Marsh (2004), valuing mathematics, self-confidence, enjoying mathematics, and motivation form the essence of attitudes towards mathematics. Students with positive attitudes towards mathematics, for example, will display positive features such as gaining new experience and enjoying mathematics (Yenilmez et al., 2007).

In fact, Taylor (1992) stresses that the process of students' developing an attitude towards mathematics is complicated because attitudes are influenced by individuals' feelings, thoughts and actions. Besides, several factors such as families, social environments, school experience and role models and experiences at earlier ages also play roles in the development of attitudes (Hemmings et al., 2010; Taylor, 1992). Soni and Kumari (2017), on the other hand, point out that students' attitudes towards mathematics affect their perceptions of efficacy in mathematics. In addition to that, several studies also demonstrated that there were positive correlations between students' positive attitudes towards mathematics and their academic achievement (Aiken, 1970; Chen et al., 2018; Lipnevich et al., 2016; Ma, 1997; Mohd et al., 2011; Tuncer & Yilmaz, 2020; Yang, 2015). Attitudes towards mathematics have an important role in students' learning of mathematics. It can be said that students with positive attitudes towards mathematics have higher academic achievement.

The Purpose of the Study

Students' engagement in mathematics course is influenced by several factors and leads to different learning outcomes. Some of the students try to understand concepts while some memories the mathematical concepts and rules since cognitive engagement is closely associated with learning approaches. In other words, students can show their engagement in mathematics by using deep or surface approach (Kong et al., 2003). Wang et al. (2017) state that students may have more than one learning approach at the same time instead of using a dominant concept while learning. They claim that it would be useful to exhibit the mathematics learning profiles of students by characterizing them according to various critical concepts.

Being informed of factors which contribute to engagement in mathematics can be influential in raising mathematical achievement (Martin & Rimm-Kaufman, 2015). Therefore, Kong et al. (2003) recommend that the correlations between engagement and deep approaches should be investigated in detail. Floyd et al. (2009), on the other hand, suggest that engagement affects deep learning strategies in positive ways and therefore the variables probable to affect them should be investigated in studies to be conducted. This current study aims to analyze the effects of middle school students' approaches to learning mathematics and their attitudes towards mathematics on their engagement in the course by using structural equation modelling. In this context, the hypotheses listed below are tested in this study:

1. **H₀**: Middle school students' learning approaches in mathematics affect their engagement in mathematics in positive ways.
2. **H₁**: Middle school students' attitudes towards mathematics affect their engagement in mathematics in positive ways.

LITERATURE REVIEW

Students' engagement in mathematics is of great importance in raising the effectiveness of mathematics learning and teaching (Nayir, 2015). Trenholm et al. (2018) state that studies concerning students' engagement in mathematics are limited in number despite the increase in the number of studies on engagement. The majority of them focus on academic achievement. The results obtained indicate that engagement in mathematics is influential in academic performance (Lijie et al., 2020; Reyes et al., 2012; Singh et al., 2002; Wang et al., 2017).

Apart from the above-mentioned studies, there are also studies which investigate the correlations between self-efficacy (Liu et al., 2018; Martin & Rimm-Kaufman, 2015; Sagkal & Sonmez, 2021), positive feelings about mathematics (Liu et al., 2018; Sagkal & Sonmez, 2021), classroom emotional climate (Reyes et al., 2012), and teacher support (Liu et al., 2018; Martin & Rimm-Kaufman, 2015) by using structural equation modelling. One of them regarding the correlations between engagement in mathematics course and attitudes was conducted by Lijie et al. (2020) with the participation of middle school students. As a result, the researchers found that engagement in mathematics played a mediatory role between attitudes towards mathematics and academic achievement. Nayir (2015) also contends that students with higher engagement can develop positive attitudes towards the course and that it will raise academic achievement. Besides, Gopal et al. (2018), in a study conducted at university level, found that students' positive attitudes towards statistics course encouraged their engagement in the course.

Students' learning approaches have significant effects on their learning outcome (Chirikure et al., 2019). Studies concerning learning approaches can generally be said to focus on the classification of the approaches and on academic achievement (Chirikure et al., 2019). The availability of positive correlations between deep approach and academic achievement in particular was found in many studies (Cano, 2007; Davidson, 2002; Heikkilä & Lonka, 2006; Maciejewski & Merchant, 2016; Murphy, 2017). Additionally, there are also studies which demonstrate that surface and strategic approaches are influential in academic achievement (Diseth & Kobbeltvedt, 2010; Diseth & Martinsen, 2003). Moreover, students' learning approaches were also analyzed from various perspectives in mathematics education. Goh (2016), for instance, argued that deep approach was closely correlated to skills such as critical thinking and problem solving.

Liston and O'Donoghue (2010), from a different perspective, found that students' ways of learning mathematical concepts might not be consistent with the learning approaches that they had adopted. In a similar vein, Maciejewski and Merchant (2016) pointed out that studying mathematics required deep approach because the discipline had theorems, proof and logical system. They found in their four-year study with undergraduate students in which they investigated the correlations between students' marks they had received in mathematics classes and their learning approaches that deep approach was correlated to the marks they had received in earlier years but that surface approach was negatively correlated to the marks they had received in later years. The researchers concluded that deep approach will not result in higher marks and that surface approach will not result in lower marks. Murphy (2017) found that surface approach had negative correlations with modelling and abstract concepts whereas deep approach had consistent correlations with good mathematical performance and with organized learning approaches. Ekinici (2009) found that university students mostly used surface and strategic approaches but that they used deep approach at higher levels when they considered a learning point.

In a similar way, Darlington (2011) found that undergraduate students who received mathematics education adopted strategic approach while studying on their own. Cano and Berbén (2009) found negative correlations between undergraduate students' surface learning of calculus and algebra courses and their academic achievement. Chan (2003), however, found that prospective teachers tended to achieve success through deep approach. The correlations between learning approaches and engagement were investigated by Floyd et al. (2009). Accordingly, it was found that the students with higher engagement in a course were more likely to use deep strategies.

METHODOLOGY

In this study, cross-sectional survey design was used as one of the quantitative research methods. Survey research aims to describe the characteristics of certain audiences. The survey models the relationships between the measured variables (Buyukozturk et al., 2018).

The Study Group

383 students in total were included in this study. The research was conducted in a city located in the Central Anatolian region of Turkey. The research data were collected from five different middle schools (schools in the city center, school with low and medium socio-economic level). 55% (n=209) of the participants were female while 45% (n=174) were male students. Of them, 27% (n=103) were the 5th graders, 28% (n=106) were the 6th graders, 26% (n=100) were the 7th graders, and 19% (n=74) were the 8th graders.

Data Collection Instruments

This study employs three different data collection instruments. One of them is the “*student engagement in mathematics scale*”. It was developed by Rimm-Kaufman (2010) and was adapted into Turkish by Mazman-Akar et al. (2017). The scale aims to determine the factors which influence middle school students’ engagement in mathematics. The validation and reliability test of the scale was done with middle school students. It consisted of 13 items and three factors. The factor of emotional engagement contained five items whereas the factor of social engagement contained four items and the factor of cognitive engagement contained four items. The Cronbach’s alpha internal consistency coefficients for the sub-factors were found as .776, .722, and .752, respectively while the Cronbach’s alpha internal consistency coefficient for the overall scale was found as .872. This study found the Cronbach’s alpha internal consistency coefficient for the scale as .865. In addition to that, confirmatory factor analysis (CFA) was also done in this study. The CFI values were calculated as $\chi^2/df=3,745$; RMSA=.085; GFI=.914; AGFI=.874; NFI=.874; CFI=.903. Some of the samples for the items in the scale are as in the following:

1. I enjoyed solving problems in classes (emotional),
2. We had a conversation about mathematics in the classroom (social), and
3. I tried to learn as much as I could in classes (cognitive).

Another scale used in the study was “*approaches to learning mathematics scale*”. It was developed by Goktepe-Yildiz and Ozdemir (2018) and aimed to determine middle school students’ approaches to learning mathematics. The validation and reliability study for the scale was done with the participation of middle school students. The scale consisted of 33 items and three factors. The factors of deep, surface, and strategic approaches each contained 11 items. The Cronbach’s alpha internal consistency coefficient for the sub-factors were .838, .789, and .837, respectively; whereas the value for the whole scale was .789. The value calculated in this study for the scale was .875. The CFI values found in this study were $\chi^2/df=4,023$; RMSA=.072; GFI=.854; AGFI=.832; NFI=.910; CFI=.912. Some of the samples for the items in the scale are as in the following:

1. I think about each section of a subject of mathematics in detail while learning them and I try to understand them (deep),
2. It seems meaningless to me because I cannot associate the subjects of mathematics with each other (surface), and
3. I plan my study of mathematics in my mind beforehand (strategic).

The third scale used was “*scale for assessing attitudes towards mathematics in secondary education*”. The scale which was developed by Yáñez-Marquina and Villardón-Gallego (2016) was adapted into Turkish by Sen (2019). The scale aimed to determine middle school students’ attitudes towards mathematics. The validation and reliability study for the scale was done with the participation of middle school students. It consisted of 18 items and three factors. Seven items were available in the factor of self-concept whereas five items were available in the factor of the perceived usefulness of mathematics and 6 items were available in the factor of interest. The Cronbach’s alpha internal coefficients for the sub-factors were .89, .87, and .89, respectively while the value .91 for the overall scale. The Cronbach’s alpha internal coefficient was calculated as .92 in this study. The values for CFI analysis done in this study for the reliability of the scale were found as $\chi^2/df=5,046$; RMSA=.068; GFI=.921; AGFI=.897; NFI=.941; CFI=.952. Some of the samples for the items in the scale are as in the following:

- a. I was not a born math learner (self-concept),
- b. Mathematics is necessary for life (perceived usefulness of mathematics), and
- c. I like studying mathematics (interest).

All the scales were in 5-pointed Likert type (ranging between 1-totally disagree, ... 5-totally agree).

Data Collection

The necessary permissions were obtained from the provincial directorate of national education prior to data collection. The relevant data were collected under the control of the researcher. Initially, the teacher of the class in which the data would be collected was contacted and parents were sent written information about the research. The data were collected in the class hour that the teacher chose. Before collecting the data, the students were informed of how to complete the questionnaire form and it was explained that they might not complete the form unless they want to. They were allowed a class hour (40 minutes) to complete the questionnaire and they completed it in 25-35 minutes. The forms which were not completed or which contained repeated answers were excluded from the scope of the study. Thus, approximately 4% of the questionnaire forms which were considered invalid were excluded from the study.

Table 1. The results of descriptive statistics

Variables	Min	Max	\bar{X}	SD	Sum	Skewness	Kurtosis
Emotional	1.00	5.00	3.85	0.92	1,478.30	-.886	.383
Social	1.00	5.00	3.36	0.61	1,288.25	-.648	.249
Cognitive	1.00	5.00	3.63	0.88	1,390.33	-.465	-.247
Surface	1.00	5.00	2.95	0.73	1,131.46	.688	-1.564
Deep	1.00	5.00	3.79	0.75	1,454.02	-.669	.361
Strategic	1.27	5.00	3.89	0.73	1,491.89	-.651	.258
Self-concept	1.00	5.00	3.60	1.03	1,382.38	-.648	-.360
Perceived usefulness of math	1.00	5.00	3.71	1.02	1,421.90	-1.758	.920
Interest	1.00	5.00	4.20	0.92	1,610.93	-.514	-.506

Note. SD: Standard deviation

Table 2. Fit indices for the measurement model and the structural equation model

Fit indices	Measurement model	SEM	Perfect fit	Acceptable fit	Resources
X^2/df	2.236	1.419	$0 \leq X^2/df \leq 3$	$3 \leq X^2/df \leq 5$	Byrne (1998)
RMSEA	.057	.053	$.05 \leq RMSEA \leq .08$	$.06 \leq RMSEA \leq .08$	Browne and Cudeck (1993)
GFI	.970	.984	$.95 \leq GFI \leq 1.00$	$.90 \leq GFI \leq .95$	Hooper et al. (2008)
AGFI	.944	.967	$.90 \leq AGFI \leq 1.00$	$.85 \leq AGFI \leq .90$	Hooper et al. (2008)
NFI	.964	.983	$.95 \leq NFI \leq 1.00$	$.90 \leq NFI \leq .95$	Tabachnick and Fidell (2001); Thompson (2004)
CFI	.979	.995	$.95 \leq CFI \leq 1.00$	$.90 \leq CFI \leq .95$	Thompson (2004)

Note. SEM: Structural equation modelling

Data Analysis

The data set was put to MS Excel programme before analyzing the data. The descriptive statistical results and normality and skewness values for the data set were calculated on the IBA SPSS 22 programme. The skewness values of the variables ranged between -1.758 and .688 whereas the kurtosis values ranged between -1.564 and .920. George and Mallery (2010) point out that the values of ± 1.0 are perfectly acceptable but that the values of ± 2.0 are also acceptable. Therefore, the variables can be regarded as having normal distribution.

Confirmatory factor analysis was done so as to test whether or not the data set was suitable for analysis. The Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett sphericity values were also checked. The KMO value should be bigger than .60 and the Bartlett sphericity test should be significant in factor analysis (Pallant, 2013). The KMO value for engagement in mathematics and for learning approaches was found to be .89 at the end of the analysis, and it was found to be .90 for attitudes towards mathematics. The Bartlett test results ($p < .01$) were found significant. Thus, the results indicated that the data were suitable for factor analysis. The research hypotheses were tested with structural equation modelling. **Table 1** shows the results for descriptive analysis of the variables included in the structural equation modelling. The average scores of the variables included in the model are on the mid-point of the range of scores. Accordingly, while the variable with the highest score is interest, the one with the lowest average is surface approach.

Measurement Model

Data analysis was examined by using IBM AMOS V22 (Chicago, USA). First, the measurement models for the variables were evaluated. Chi-square, p-value, and fit indices should be investigated in evaluating measurement models (Raykov & Marcoulides, 2000). In order to test whether the model is supported, the two-step method most commonly used in the literature was used. First, the measurement model was tested and then the structural equation model was examined (Anderson & Gerbing, 1988). The results of the fit indices found in the first analysis were found to be within the desired limits. Yet, the standardized route coefficient for the sub-factor of surface approach of the approaches to learning scale was below .50 (0.067). Kline (1998) argues that standardized route coefficients below .10 are considered to have small effects, values of .30 and around .30 are considered to have medium effects and values of .50 and above are considered to have large effects. Modification indices were examined in this study because the standardized route coefficient for surface approach had small effects. In consequence, the recommendation for correction in relation to the variable was observed.

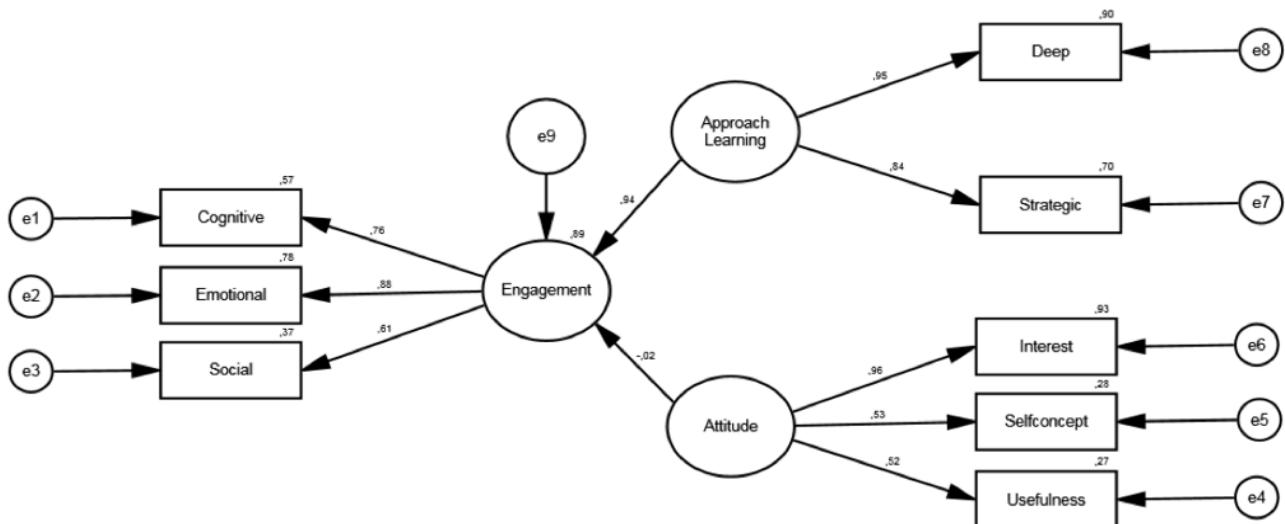
After the observation, the variable of surface approach was removed from the analysis and the analysis was repeated. As a result, the other variables of the approaches to learning scale were found to be significantly correlated to all other variables available in the model. The fit indices for the measurement model were found as Chi-square=53.655; $df=24$; $X^2/df=2.236$; $RMSEA=.057$; $GFI=.970$; $AGFI=.944$; $NFI=.964$; $CFI=.979$. Besides, all the route coefficients were statistically significant and had perfect fit (**Table 2**). **Table 2** presents information on the acceptable and perfect fit indices necessary for structural equation modelling.

Two hypotheses were analyzed in the structural model: "H₀: Middle school students' learning approaches in mathematics affect their engagement in mathematics in positive ways" and "H₁: Middle school students' attitudes towards mathematics affect their engagement in mathematics in positive ways". The results obtained in the structural model indicated that the model had perfect fit. Thus, the values for the model fit index were as in the following: Chi-square=24.125; $df=17$; $X^2/df=1.419$; $RMSEA=.053$; $GFI=.984$; $AGFI=.967$; $NFI=.983$; $CFI=.995$, which were within the desired limits (**Table 2**). It was found that the fit indices for the structural model created had perfect fit and that the standardized route coefficients were above .50. The route coefficient between

Table 3. Measurement model and structural equation modelling

Measurement model		β_1	β_2	SD	CR	p-value
Cognitive	<--- Engagement	.758	1.000			
Social	<--- Engagement	.611	.566	.048	11.876	<.001
Emotional	<--- Engagement	.881	1.218	.069	17.694	<.001
Deep	<--- Learning approach	.949	1.000			<.001
Strategic	<--- Learning approach	.838	.854	.037	23.174	<.001
Interest	<--- Attitudes	.962	1.000			<.001
Self-concept	<--- Attitudes	.531	.542	.087	6.248	<.001
Perception	<--- Attitudes	.516	.476	.077	6.189	<.001
Structural equation modelling						
Engagement	<--- Learning approach	.945	.877	.051	17.302	<.001
Engagement	<--- Attitudes	-.016	-.011	.021	-.511	.609

Note. SD: Standard deviation

**Figure 1.** Standard coefficients of the structural equations model

engagement in mathematics and approaches towards calculated in the model was statistically significant ($\beta=.945$; $p<.001$). Hence, hypothesis H_0 was confirmed. The route coefficient between engagement in mathematics and attitudes towards mathematics was not found statistically significant ($\beta=-.016$; $p=.609$), and thus, hypothesis H_1 was not confirmed. **Table 3** shows both the standardized and non-standardized route coefficient analysis results. **Figure 1** shows standard coefficients of the SEM.

DISCUSSION AND CONCLUSIONS

This study analyzed the correlations between middle school students' engagement in mathematics, their learning approaches and their attitudes towards the mathematics with structural equation modelling. The model created for the purpose was tested in this study. The effects of the students' learning approaches in mathematics and their attitudes towards mathematics on their engagement in mathematics were analyzed through route analysis in the model. First, the descriptive analysis values for the variables were calculated in accordance with the purpose of the study. The highest averages for the variable of engagement in mathematics were found in the sub-factors of emotional engagement, cognitive engagement and social engagement while the highest averages for the variable of approaches to learning mathematics were found in the sub-factors of strategic approach, deep approach and surface approach and the highest averages for the variable of attitudes towards mathematics were found in the sub-factors of interest, the perceived usefulness of mathematics and self-concept, respectively.

According to the findings, the averages for all the sub-factors were above the mid-point. Thus, the students could be said to have positive perceptions of all the variables. Another finding obtained in this study was that the model tested had perfect and acceptable fit indices. The standardized route coefficient for surface approach was found to be below the desired level in the first measurement result. Therefore, the factor was removed from the model and thus, the standardized route coefficients for all the factors were found significant at the end of the analyses. The findings demonstrated that there were correlations between the participants' approaches learning and their engagement in mathematics. Significant correlations were available between the engagement of students who adopt deep and strategic approaches. It may be said that there are no correlations between the engagement of students who adopt surface approach. In fact, while strategic approach is more independent, the deep approach and surface approach isolate each other because focusing and not focusing at the same time is impossible (Diseth & Martinsen, 2003). Therefore, Maciejewski and Merchant (2016) point out that consistent correlations should not be expected between deep and surface approaches and quantitative evaluation.

One of the results obtained in this study was that deep and strategic approaches clearly had positive effects on engagement in mathematics. In a similar vein, Floyd et al. (2009) state that engagement in the course is an important factor in learning but they also say that there are no significant correlations between surface approach and engagement. It is because surface approach is students' technique of survival- that is to say, it is an effort to pass the exams given. In fact, it may not be said that different approaches are a property of students (Lucas, 2001). What is expected of students is to adopt deep and strategic learning strategies when mathematics is concerned. Deep approach contains the properties of surface and strategic approach contains the properties of the other two learning approaches. Operant learning, for instance, may contain the elements of rote learning (Diseth & Martinsen, 2003), a student may adopt deep approach for an issue and surface approach for another issue (Lucas, 2001), or it may be inadequate to adopt only deep approach to solve a complicated problem (Davidson, 2002).

Students' feeling of cognitive, emotional and social engagement in mathematics is effective when they adopt deep and strategic approaches. As Skinner and Pitzer (2012) also point out, all these elements should be considered together for high quality learning. Changes made in learning environments will affect students learning approaches, as Hall et al. (2004) contend. Moore and Gilmartin (2010) found that using different learning approaches such as blended learning affected students' engagement in a course and their deep approaches in positive ways. Yet, the researchers emphasize that the correlations between the two need further research. Cano and Berbén (2009) argue that the approaches adopted by students to learn mathematics are not related to ways of understanding a subject or personal choice but are related generally to the quality of education. Therefore, it is important to consider the strategies students use in learning the subjects of mathematics. It can be said that the engagement of students who adopt deep and strategic approaches in learning mathematics is influenced positively by their choice.

Skinner and Pitzer (2012) claim that engagement influences students' daily psychological and social experiences. High engagement and the resultant learning and academic achievement contribute positively to students' relations with their environment. Besides, studies available in the literature also demonstrate that there are correlations between students' levels of engagement and their attitudes (Gopal et al., 2018; Lijie et al., 2020; Nayir, 2015). However, no significant correlations were found between middle school students' engagement in mathematics and their attitudes towards mathematics in this study. Singh et al. (2002) point out that it is difficult to measure factors such as attitudes towards and engagement in mathematics with reliability and validity.

It is widely known that attitudes and interest have direct effects on achievement (Singh et al., 2002). Despite the fact that the studies which argue that there are positive correlations between attitudes towards mathematics and academic achievement are in the majority, Yenilmez et al. (2007) claim that there is no much consensus in the literature on the correlations between attitude and achievement in mathematics. Behaviors such as attitudes and motivation are generally influenced by experiences at earlier ages, attitudes change over time and then they tend to be stable—as Hannula (2002) suggests. According to Mayes et al. (2008), students' inadequate preparation for mathematics or their negative attitudes towards it cause deficiencies in their engagement in the course. For this reason, Singh et al. (2002) recommend that in-class activities to promote engagement in the course should be done.

Hemmings et al. (2010) argue that interventions should be made at school to affect students' attitudes towards mathematics positively because attitudes are the factors which influence students' mathematics learning and their engagement in the course. Nayir (2015) found correlations between high school students' engagement in school and their attitudes but stated that the situation may differ according to courses. The middle school students' emotional engagement and interest in mathematics course in this study was higher than the other variables. In fact, interest in mathematics is an indicator of emotional engagement (Martin & Rimm-Kaufman, 2015). Reeve (2012) states that feelings such as interest which facilitates tasks affect emotional engagement. However, high interest cannot be expected everyday while learning difficult and new materials (Martin & Rimm-Kaufman, 2015). Skilling et al. (2016) point out that it is impossible for teachers who have implementations related to short-term interest and behaviors to encourage engagement in mathematics in the long term. It would be beneficial to investigate why there are not any significant correlations between attitudes and engagement despite high levels of student interest.

Recommendations

Fredricks et al. (2004) suggest that the concept of engagement should be researched further. They think that there are gaps in the literature although there is too much information on academic engagement and school engagement. Several studies demonstrated that students' learning approaches, attitudes and their engagement were important in learning mathematics and in academic achievement. Yet, it may be said that the number of studies on the way the three components influence each other is limited. Thus, it will be beneficial if the studies to be conducted investigate how students' engagement in mathematics, their learning approaches and their attitudes toward mathematics affect each other. Fredricks et al. (2004) insist that how the factors which affect engagement should be illuminated with qualitative studies. According to Yang (2015), students' attitudes will be more positive in environments which they will discover and where possibilities to inquire and teacher support are available. Prospective studies could investigate the way classroom environment affects engagement in and attitudes towards mathematics. Engagement is thought to be a substantial factor in learning. The qualitative studies to be conducted could also investigate the effects of attitudes towards mathematics and learning approaches it on engagement in the course. The correlations between them could be investigated in depth and interpreted. This current study was conducted with the participation of middle school students. Further studies are needed to exhibit the correlations between engagement in mathematics, learning approaches and attitudes with the participation of students from differing grade levels.

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