Cypriot Journal of Educational Sciences

Volume 14, Issue 2, (2019) 190-200

www.cjes.eu

Relationships between self-efficacy beliefs, engagement and academic performance in math lessons

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Suggested Citation:
Ozkal, N. (2019). Relationships between self-efficacy beliefs, engagement and academic performance in math lessons. *Cypriot Journal of Educational Science*. *14*(2), 190–200.

Received from September 30, 2018; revised from March 14, 2019; accepted from May 10, 2019.
Selection and peer review under responsibility of Prof. Dr. Huseyin Uzunboylu, Near East University, Cyprus.

Abstract

This study investigated secondary school sixth, seventh and eighth graders' self-efficacy beliefs, engagement and disaffection in Math lessons and academic achievement in relation to learning Mathematics and Math performance. The study was conducted with the voluntary participation of 651 sixth, seventh and eighth graders attending secondary school. Research data were collected with the help of 'Engagement and Disaffection Scale', 'Self-Efficacy sub dimension' of 'Motivation Scale' related to learning and performance and students' Math first semester grades. It was identified in the study that students' self-efficacy beliefs in learning and performance in Math significantly and positively predicted their Math achievement. Behavioural and affective disaffection in Math lessons were found to predict Math achievement negatively. It was determined in the study that students' self-efficacy beliefs related to learning and performance in Math significantly predicted their behavioural and affective engagement in Math positively while predicting their behavioural and affective disaffection negatively.

Keywords: Math, engagement, self-efficacy, academic achievement.

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1. Introduction

Engagement refers to students' or youth's active participation in activities that are offered. Engagement can be addressed at three levels. The first level refers to engagement of the students and the youth with pro-social establishments, youth groups and social organisations. This engagement increases positive development and protects the youth from risks that can emerge from delinquency, participation in gangs, substance abuse and unsafe sexual practises throughout their youth. The second level refers to engagement of the students and the youth with school student groups and (extracurricular) academic and sportive activities. This type of engagement prevents truancy and dropping out. The third level refers to students' participation in in-class learning activities and academic tasks (Skinner & Pitzer, 2012). This type of engagement is the interaction of students in a specified manner with the signals and instructions prepared for student learning (Bloom, 1979).

Student engagement in in-class activities, hence the lessons, can be examined in three parts as behavioural, affective and cognitive. *Behavioural engagement* refers to attending classes and participating in activities, *affective engagement* refers to willingness and motivation to get involved in activities and *cognitive engagement* refers to making cognitive efforts towards learning in the framework of the presented activities (Skinner & Pitzer, 2012). Students' engagement with learning activities is associated with student motivation. By their nature, motivation and engagement are related to one another and they affect each other mutually. Researchers who study the concept of motivation are more interested in the outputs of the motivational processes, whereas researchers who examine the concept of engagement approach motivation as the source of engagement. Hence, while motivation is the relatively idiosyncratic and subjective cause, engagement is the relatively more open and objectively observed effect. Motivation reflects the sources that underline the energy, purpose and endurance (permanency) while engagement is visible form of these (Reeve, 2012; Skinner, Kindermann, Connell & Wellborn, 2009a; Skinner & Pitzer, 2012).

There are students in the learning process who are engaged in the learning activities whereas there are others who are not (Eryilmaz, 2013). Some students may be physically in the classroom but they may not be interested or willing to take part in learning activities. These students may try to disrupt classes by disturbing their classmates. These students experience disaffection in their behaviours and feelings. Engagement is a multifaceted construct related to two motivational constructs, such as engagement and disaffection and includes behavioural, affective and cognitive elements (Skinner, Furrer, Marchand & Kindermann, 2008; Skinner et al., 2009a; 2009b).

The term 'engagement' is used for students who participate in academic and non-academic activities and who value their learning acquisitions, whereas the term 'disaffection' is used for students who do not feel they belong to the school or classroom environment and who distinctly stay away from activities (Appleton, Christenson & Furlong, 2008). Intensity and quality of effective participation in lessons are determined by engagement and disaffection. Students who are engaged in learning activities try to undertake their tasks by internalizing them via making more efforts and being more careful. While undertaking academic tasks, these students experience elation, interest and enjoyment affectively as well. In cognitive terms, these students also make more driven efforts and use strategies and they do not act like they are busy with tasks. Students who feel disaffection try to undertake tasks in a preoccupied manner. They experience negative feelings affectively, such as boredom, anxiety and weariness, while they are busy with academic tasks. In cognitive terms, these students try to look like they are busy with the tasks while they feel suppressed, purposeless and indifferent (Skinner & Pitzer, 2012).

Engagement positively affect learning and academic achievement. Skinner et al. (2008) demonstrated that engagement is a strong predictor for student achievement and behaviours. Celik, Toraman and Celik (2018) reported that cognitive engagement and engagement in class activities positively affect academic achievement while disaffection has a negative impact on achievement. There is a meaningful relationship between engagement and asking for support (Guvenc & Koc, 2016).

Engagement positively affects student support received from their teachers (Skinner & Pitzer, 2012) and student motivation (Reeve, 2012; Skinner & Belmont, 1993). Students who feel disaffection refrain from asking for support and ask for help superficially (Guvenc & Koc, 2016). These students are academically unsuccessful as well (Skinner et al, 2008; 2009).

The study conducted by using PISA 2000 data examined academic performance and engagement relationship. The results demonstrated that behavioural engagement and affective engagement significantly predicted reading performance. According to PISA 2000 data, 23% of the students in 43 countries had low level of feelings of belonging and 20% of these students had disengagement (Willms, 2003). Kahraman (2014) who utilised 2011 TIMSS Turkey data determined that behavioural engagement in Science classes had positive impact on achievement, that enjoying Science classes positively affected academic achievement in fourth grades, while commitment to school did not have significant effects on achievement in terms of affective engagement both dimensions had positive impact on eighth grades.

Disengagement at school is an immense problem. Students who are disengaged make less effort in terms of academic achievement and they have a bigger risk for dropping out and displaying problem behaviours (Fredricks, Blumenfeld & Paris, 2004). The long-term effect of disengagement is underachievement or dropping out. Therefore, increasing engagement prevents drop outs and underachievement (Lee, 2014). In addition, study results included in the literature show that engagement serves as a protective factor against risky activities, such as substance abuse and delinquency (Fredricks et al, 2004; Skinner et al., 2008; 2009; Skinner & Pitzer, 2012). However, during the time frame from starting preschool to completing high school, students' motivation, interest and enthusiasm towards learning activities at school diminish and their engagement decreases as a parallel to this (Kilic-Cakmak, Akgun, Karadeniz, Buyukozturk & Demirel, 2008; Ozkal & Erdik, 2015; Skinner et. al., 2008). Guvenc and Koc (2016) determined that sixth graders apply themselves more to lessons, while eighth grades are more disengaged. In their study, Martin, Way, Bobis and Anderson (2015) reported that engagement of in Math classes significantly decreases from sixth grade to eighth. This decrease is underlined by internal and external dynamics which include individual motivational sources. For instance, when students believe in their own capacity, in other words, when they have high self-efficacy beliefs, they will have higher achievement in learning. Students with lower levels of self-efficacy will try to shy away from reasonability or they undertake tasks unwillingly and in turn become unsuccessful (Skinner et al., 2008).

Self-efficacy is the belief of the individual about his/her capacity to do things (Bandura, 1997). Bandura's basic assumption is that individual expectations of competence mediate actions. Self-efficacy is the belief that desired outcomes can be generated and behaviours can be successfully organised. Bandura explains that expectations related to self-efficacy are related to 1) individuals' preferences based on self-efficacy as preferring to stay away from activities that they believe to be over their capacity and preferring the activities that they believe are achievable, 2) the level of effort they can exert and 3) the level of persistence to try when faced with aversive experiences and barriers (Palmer & Goetz, 1988). Self-efficacy perceptions are psychological tools that affect individuals' thought patterns, affective reactions and behaviours (Bandura, 1986).

While there are opinions that self-efficacy beliefs can be generalised to different behaviours, studies present evidence that self-efficacy is domain dependent (Schunk, 2011). Therefore, self-efficacy is defined as belief in self to successfully accomplish a task in a given context (Bandura, 1994). Hence, students' self-efficacy beliefs differ according to subject matter. A student with high levels of self-efficacy beliefs in foreign language classes may have low self-efficacy beliefs for Physics or Math classes (Tschannen-Moron & Woolfolk Hoy, 2001; Zimmerman, 2000). This study addressed self-efficacy in the context of Math classes. Bandura (1994) reported that faced with a difficult task, individuals who doubt their capacity displays a tendency to quit. On the contrary, individuals with high self-efficacy beliefs exert more efforts when they are faced with challenging situations. Therefore, self-efficacy has significant contributions to the continuance of motivation (Tschannen-Moron & Woolfolk

Hoy, 2001; Zimmerman, 2000). Examination of studies in the field of Math demonstrates that self-efficacy significantly and positively affects achievement (Aksu & Guzeller, 2016; Cagirgan-Gulten & Soyturk, 2013; Delioglu, 2017; Duran & Bekdemir, 2013; Erkek & Isiksal-Bostan, 2015; Tasdemir, 2016; Zimmerman, 2000), that self-efficacy has a mediating role on Math achievement (Pajares, 1996, Yildirim & Yildirim, 2019) and that self-efficacy was the most significant variable to predict Turkish students' Math achievement in TIMSS 1999, 2007, 2011 and 2015 (Dogan & Baris, 2010; Sari, Arikan & Yildizli, 2017; Yavuz, Demirtasli, Yalcin & Ilgun Dibek, 2017).

Based on these studies, it can be argued that engagement and self-efficacy beliefs have positive relationships with positive affective and cognitive outputs led by academic achievement. Math is among the subject matters in which lowest means are achieved in national exams conducted in Turkey (Ministry of National Education [MoNE], 2016; Student Selection and Placement Centre [SSPC], 2016). Similarly, math achievement in Turkey is below the general average in international exams such as PISA and TIMSS (Yildirim, Ozgurluk, Parlak, Gonen & Polat, 2016). In their study, Sever, Ulusoy, Toraman and Ture (2014) identified that high school students in Turkey had a tendency of disengagement in Math classes. However, Borman and Overman found that students who display more engagement in academic activities that require more perseverance in academic terms have also Math scores that are higher than estimated (Borman & Overman 2014 cited in: Lee, 2014). In this context, identifying the interactions among Math self-efficacy perceptions, Math engagement and Math achievement is significant. In this framework, answers were sought to the following questions:

1) Do secondary school sixth, seventh and eighth graders' Math engagement and their self-efficacy beliefs in learning Math and Math performance predict academic achievement in Math?
2) Do secondary school sixth, seventh and eighth graders' self-efficacy beliefs in learning Math and Math performance predict their engagement in Math?

2. Method

The study utilised relational screening model, one of the general screening models that examine the existence and/or mutual change or its level between two or more variables (Buyukozturk, Kilic-Cakmak, Akgun, Karadeniz & Demirel, 2014).

2.1. Study group

The study was conducted with the voluntary participation of 651 sixth, seventh and eighth graders attending nine separate secondary schools in Alanya district of Antalya Province. Required permit was obtained for this study. 55.1% of the students (*n* = 359) who participated in the study were females and 44.9% (*n* = 292) were males. 28.3% of the participants (*n* = 184) attended sixth grade, 41.2% (*n* = 268) seventh grade and 30.6% (*n* = 199) attended eighth grade.

2.2. Data collection tools

Research data were collected with the help of 'Engagement and Disaffection Scale' and 'Self-Efficacy sub dimension' of 'Motivation Scale' related to learning and performance that were implemented on secondary school sixth, seventh and eighth graders and students' Math first semester grades.

2.2.1. Engagement and disaffection scale

Engagement and Disaffection Scale was developed to identify students' engagement and disaffection in a specific class. The four-point Likert type scale developed by Guvenc (2015) has 4 sun scales and 16 items. Reliability and validity studies of the scale were done on both secondary school and high school students. Examples for the scale items are as follows: 'I try to take the floor at every opportunity' for behavioural engagement sub scale; 'I listen very carefully' for affective engagement

sub scale; 'I pay enough attention to save the day' for behavioural disaffection sub scale and 'I feel nervous when my teacher asks something' for affective disaffection sub scale.

Cronbach Alpha Reliability Coefficients for the sub scales are: 0.81, 0.71, 0.75 and 0.71 for behavioural engagement, affective engagement, behavioural disaffection and affective disaffection, respectively. The eighth-item engagement section of the scale has a Cronbach Alpha Reliability Coefficient of 0.82 and eighth-item disaffection section of the scale has a Cronbach Alpha Reliability Coefficient of 0.83. Confirmatory factor analysis of the scale is as follows: Chi Square (χ^2 = 265.24), degree of freedom (df = 98, p = 0.00) rate χ^2/df = 2.71; RMSEA = 0.069; SRMR = 0.053, AGFI = 0.88; CFI = 0.91; GFI = 0.92 and NNFI = 0.89.

2.2.2. Self-efficacy scale related to learning and performance

Motivated Strategies for Learning Questionnaire was developed by Pintrich, Smith, Garcia and McKeachie (1991) to determine university students' motivational sources and learning strategies. The scale was adapted by Karadeniz, Buyukozturk, Akgun, Ozkahveci and Demirel (2004) for students in the age range of 12–18. It was identified in the adaptation study that the scale is composed of seven sub factors. The seven-point type Likert scale includes 'Motivation' and 'Learning Strategies' scales. Adaptation of the Motivation Scale also pointed to seven sub factors and Cronbach Alpha Reliability Coefficients for the sub factors were found as follows: Internal Goal Management0.75, External Goal Management 0.56, Task Value 0.83 and Control of Learning Beliefs 0.63, Self-Efficacy for Learning and Performance 0.86, Test Anxiety 0.56 whole scale 0.90. This measurement tool developed to determine students' motivational sources and learning strategies in a specific lesson or subject matter was used in this study as a sub scale in self-efficacy for learning and performance in relation to Math lessons.

2.3. Data analysis

Data from 651 secondary school students were analysed in the study. SPSS 22 statistical program was utilised in data analysis and relationships among variables were evaluated with the help of simple correlation (Pearson correlation coefficient) analysis. A simple linear regression analysis in which self-efficacy beliefs related to learning and performance in Math was assigned as the predictor variable and math engagement was assigned as the predicted variable in order to identify the predictive value of self-efficacy beliefs related to Math learning and performance on Math engagement. Before the analysis, the normality of data related to variables was examined. In this context, arithmetic means, mode and media were found to be close to one another, skewness and kurtosis coefficients were close to 0 in ±1 limit and relative change coefficient that expressed the rate of standard deviation and means was found to be between 20 and 25 (Tabannick & Fidell, 2015) accordingly, the study was accepted to show normal distribution and simple linear regression analyses were conducted.

The study utilised multiple linear regression analysis to determine the predictive value of learning and performance self-efficacy beliefs and Math engagement on Math achievement. Learning and performance self-efficacy beliefs and Math engagement were assigned as predictor variables, while academic achievement was assigned as the predicted variable. Before the analyses were conducted, the assumptions of multiple linear regression analysis were examined. For this purpose, level of relationship between predictor variables, Durbin–Watson, Tolerance and VIF values were examined. A relationship between predictor variables over r > 0.90, VIF values equal to or higher than 0.10 and tolerance value higher than 0.10 point to multicolinearity (Cokluk, Sekerciogulu & Buyukozturk, 2010). The investigation in the framework of this study found the level of relationship between predictor variables as 0.66 and identified the Durbin Watson coefficient as 1,70. The tolerance value was found to vary between 0.55 and 0.63 and VIF values varied between 1.58 and 1.80. These results show that data met the assumptions of multiple linear regression analysis.

3. Findings

Table 1 presents the means, standard deviation values and Pearson correlation coefficients for math achievement, self-efficacy beliefs for learning and performance and the subscales for Math engagement.

Table 1. Variables in arithmetic means, standard deviation and simple correlation analysis results

Variables	Mean	SD	1	2	3	4	5
1. Self-efficacy	4.91	1.49	1				
2.Behavioural Engagement	2.91	0.74	0.55*	1			
3.Affective Engagement	3.05	0.75	0.58*	0.66*	1		
4.Behavioural Disaffection	2.02	0.68	-0.28*	-0.24*	-0.26*	1	
5.Affective Disaffection	1.80	0.79	-0.31*	-0.32*	−0.31 *	0.58*	1
6. Academic Achievement	3.38	1.26	0.45*	0.33*	0.35*	−0.32	-0.32

*$p < 0.01$.

Examination of the correlation coefficients included in Table 1 shows a positive and meaningful relationship between students' Math achievement and self-efficacy beliefs for learning and performance ($r = 0.45$; $p < 0.01$) and students' behavioural ($r = 0.33$; $p < 0.01$) and affective ($r = 0.35$; $p < 0.01$) engagement in Math classes. A negative relationship was detected between students' Math achievement and behavioural ($r = -0.32$; $p < 0.01$) and affective disaffection ($r = -0.32$; $p < 0.01$). There was a positive and significant relationship between students' self-efficacy beliefs for learning and performance in Math and their behavioural ($r = 0.55$; < 0.01) and affective engagement in Math ($r = 0.58$ $p < 0.01$), while a negative and significant relationship existed between self-efficacy beliefs for learning and performance in Math and behavioural ($r = -0.28$; $p < 0.01$) and affective disaffection ($r = -0.31$; $p < 0.01$).

The study implemented multiple linear regression analysis to determine the predictive value of students' self-efficacy beliefs for learning and performance in Math and their Math engagement on Math achievement and its results are presented in Table 2.

Table 2. Results of multiple linear regression analysis

Dimensions	*B*	*SD*	*R*	R^2	*F*	*β*	*t value*	*p*
Self-efficacy	0.26	0.03	0.51	0.26	44.8	0.31	7.16	0.00*
Behavioural Engagement	0.09	0.08				0.05	1.08	0.28
Affective Engagement	0.12	0.08				0.07	1.47	0.14
Behavioural Disaffection	-0.25	0.08				-0.13	−3.17	0.00*
Affective Disaffection	-0.16	0.07				-0.10	−2.40	0.01*

*$p < 0.01$.

Data presented as a result of multiple linear regression analysis in Table 2 show that together, independent variables could successfully predict Math achievement [F (5.645) =44.86, $p < 0.01$]. Together, the independent variables could explain 26% of Math achievement. Results of the *t*-test conducted to study the significance of regression coefficients show that Math achievement could predict self-efficacy beliefs for learning and performance in Math ($\beta = 0.31$, $t = 7.16$, $p < 0.01$), behavioural disaffection ($\beta = -0.13$, $t = -3.17$, $p < 0.01$) and affective disaffection ($\beta = -0.10$, $t = -2.40$, $p < 0.05$). While there was a positive relationship between math achievement and behavioural ($\beta = 0.05$, $t = 1.08$, $p > 0.05$) and affective ($\beta = 0.07$, $t = 1.47$, $p > 0.05$) engagement, the contribution of this independent variable to the model was not found to be significant. Table 2 presents the finding that students' self-efficacy beliefs for Math learning and performance positively and significantly predicted Math achievement while they negatively predicted behavioural and affective disaffection.

Simple linear regression analysis was implemented in the study to determine the predictive value of students' self-efficacy beliefs for Math learning and performance on Math engagement and results are presented in Table 3.

Table 3. Results of simple linear regression analysis

Dimensions	*B*	*SD*	*R*	R^2	*F*	*β*	*t value*
Behavioural Engagement	0.27	0.02	0.55	0.30	279.03	0.55	16.70*
Affective Engagement	0.29	0.02	0.58	0.34	330.74	0.58	18.19*
Behavioural Disaffection	2.65	0.02	0.28	0.08	57.05	-.28	−7.55*
Affective Disaffection	-0.17	0.02	0.31	0.10	70.10	-0.31	−8.37*

*$p < 0.01$.

Examination of the data presented in Table 3 and obtained as a result of simple linear regression analysis demonstrates students' self-efficacy beliefs for Math learning and performance significantly predicted students' behavioural [$F(1,649) = 279.03$, $p < 0.01$] and affective [$F(1,649) = 330.74$, $p < 0.01$] engagement in Math and behavioural [$F(1,649) = 57.05$, $p < 0.01$] and affective [$F(1,649) = 70.10$, $p < 0.01$] disaffection. Students' self-efficacy beliefs for Math learning and performance explained 30% of students' behavioural engagement, 34% of their affective engagement, 8% of their behavioural disaffection and 10% of their affective disaffection. Results of the *t*-test conducted to determine the significance of regression coefficients display that students' self-efficacy beliefs for Math learning and performance were significant predictors of behavioural engagement ($\beta = 0.55$, $t = 16.70$, $p < 0.01$), affective engagement ($\beta = 0.58$, $t = 18.19$, $p < 0.01$) and behavioural ($\beta = -0.28$, $t = -7.55$, $p < 0.01$) and affective ($\beta = -0.31$, $t = 8.37$, $p < 0.01$) disaffection. Table 3 presents that students' self-efficacy beliefs for Math learning and performance positively and significantly predicted behavioural engagement and affective engagement in Math while they negatively predicted behavioural and affective disaffection.

4. Result and discussion

The study found that secondary school sixth, seventh and eighth graders' self-efficacy beliefs for Math learning and performance were found to predict Math achievement positively and significantly. Accordingly, students with higher self-efficacy beliefs for Math learning and performance can be said to have better Math achievement. This result is parallel to research findings obtained in other subject matter areas in general and Math in particular (Aksu & Guzeller, 2016; Delioglu, 2017; Dogan & Baris, 2010; Duran & Bekdemir; 2013; Erkek & Isıksal-Bostan, 2015; Fomina, 2017; Kaba, 2017; Koca & Dadandi, 2019; Sari et Al., 2017; Tasdemir, 2016; Yavuz et al., 2017, Yildirim & Yildirim, 2019). The study identified a negative and significant relationship between behavioural and affective disaffection in Math and Math achievement. According to this result, students who are bored and anxious in Math classes and who participate in activities unwillingly and students who display negative behaviours such as disturbing their friends and making noise in the class are less successful in Math classes. This is an expected outcome that corresponds to research results in the literature (Skinner et. al., 2008; 2009a; 2009b).

The study also identified a positive and significant relationship between behavioural and affective engagement in Math classes and Math achievement. However, it was found that behavioural and affective engagement did not significantly predict Math achievement. This is an unexpected finding. The literature points to cases where behavioural and affective engagement positively and significantly affect academic achievement (Celik et al., 2018; Kahraman, 2014; Skinner et al., 2008). The study identified that secondary school sixth, seventh and eighth graders' self-efficacy beliefs for Math learning and performance predicted behavioural and affective engagement positively and behavioural and affective engagement negatively. Based on the findings obtained in the study the fact that students experienced self-efficacy enhanced their engagement in class and decreased disaffection. In this context, students with higher self-efficacy beliefs for Math learning and performance can be said to have behavioural and affective engagement in math classes.

According to Bandura (1977), students with high self-efficacy tend to engage in classes more willingly in order to reach their goals. Students with low self-efficacy exert less effort in the face of difficulties and tend to spend more time on and idle around past mistakes. Findings obtained in this study also support this view. The obtained results in the current study are supported by the findings in literature. Grant (2017) found a significant positive correlation between self-efficacy beliefs and engagement. He also found that engagement and self-efficacy beliefs were significantly related to academic achievement. Birgin et al. (2017) reported that secondary school students' Math engagement differed according to their self-efficacy Math achievement perceptions and identified that students with high self-efficacy Math achievement perceptions had higher levels of Math engagement. Kaya (1995) demonstrated a strong relationship between student motivation and self-efficacy and engagement. Guneri and Guvenc (2013) identified a positive and strong relationship between student self-efficacy perceptions in Science and Technology classes and behavioural and affective engagement but a negative and strong relationship between student self-efficacy perceptions in Science and Technology classes and behavioural and affective disaffection.

Wan, Liang, Lin and Tsai (2017) reported that students with high levels of engagement in Math classes had high levels of self-efficacy beliefs for Math learning and performance while students with passive learning profiles had lower levels of self-efficacy beliefs for Math learning and performance. Martin, Rimm-Kaufman and Sara (2015) identified that fifth graders with low levels of self-efficacy had lower social and affective engagement compared to students with higher levels of self-efficacy.

Based on study results, it can be suggested to create learning environments that will support student self-efficacy in Math classes. In order to prevent disaffection in Math classes, teachers and teacher candidates (before and during service) can be taught effective learning methods and techniques that will allow students to experience positive achievement experiences and feelings. In addition, it would be effective to provide teachers and teacher candidates with information on the effects of self-efficacy beliefs on engagement. This study was conducted on a limited number of students. Conducting similar and longitudinal studies on larger groups that include fourth and fifth graders can provide a wider perspective to identify Math achievement, engagement and self-efficacy relationships. This study focused on achievement, engagement and self-efficacy relationships based on Math. The study can be replicated by using other subject matters to determine the relationships among these variables.

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