The Relationship Between Sources of Mathematics Self-Efficacy and Mathematics Test and Course Achievement in High School Seniors

Bahadır Özcan¹ and Yusuf Ziya Kültür²

Abstract
In school settings, sources of self-efficacy have the potential to directly and indirectly influence performance. The problem of this study is the direct relationship between sources of self-efficacy and achievement. In connection with this problem, the impact of sources of mathematics self-efficacy on high school senior students’ mathematics test and course achievement was investigated. The study consisted of 257 12th-grade high school students. The findings of the study showed that mathematics course and test performance increased, whereas the scores for mastery experience, social persuasions, vicarious experience, and physiological state increased, too. According to the results of the regression analysis on mathematics course achievement, the mastery experience significantly predicted mathematics course performance. It also explained 56% of the total variance in mathematics achievement. On the contrary, mastery experience, social persuasions, and physiological state significantly predicted mathematics test achievement, as well as explained 27% of the total variance in mathematics test achievement. In conclusion, sources of mathematics self-efficacy have effects on both mathematics test and course achievement.

Keywords
self-efficacy, mathematics, course achievement, test achievement, high school students

Exams are one of the measurement and evaluation techniques used to determine the extent to which educational and teaching objectives have been achieved. For individuals, the academic achievement obtained from exams conducted as a result of educational activities is of great importance. From this point of view, it is vital to research the factors that determine students’ academic achievement. Self-efficacy has emerged as a highly effective predictor of students’ motivation and learning (Zimmerman, 2000). According to Bandura (1986), self-efficacy beliefs are a crucial determinant in both the initiation and the maintenance of behavioral change. In addition, self-efficacy beliefs contribute to the individual’s development and change by determining choices and options in his or her life. Thus, the individual’s preferences determine who he or she would be and his or her life path (Bandura, 2012). This is because unless people believe that they could produce the desired effects with their actions, they would avoid acting or struggle with difficulties (Bandura, 2018). Self-efficacy refers to one’s belief in the planning and execution abilities necessary to overcome certain situations (Bandura, 1995, 1997). It also depends on whether the self-efficacy belief is authentic or exaggerated/inflated.

Self-Efficacy
Self-efficacy beliefs have a crucial effect on social cognitive theory (Bandura, 2001). According to Bandura (1997), self-efficacy has formed the basis of human behavior. While self-efficacy affects the way people think, feel, motivate, and behave, the results of individuals’ behavior depend largely on their beliefs about how well they can perform in certain situations (Bandura, 1995). Self-efficacy is an individual’s judgment about his or her ability to perform the given tasks (Bandura, 1995, 1997; Schunk, 1991). It determines how much effort individuals put into an activity, how long they will endure when they face obstacles, and how durable they will be in negative situations; it also affects individuals’ thinking patterns and emotional responses (Phan, 2012).

¹Adiyaman University, Turkey
²Şehit Serkan Yılmaz Anadolu Lisesi, Kahramanmaraş, Turkey

Corresponding Author:
Bahadır Özcan, Department of Special Education, Education of Gifted and Talented, Faculty of Education, Adiyaman University, Adiyaman 02040, Turkey.
Email: baozcan@adiyaman.edu.tr
Sources of Self-Efficacy

Individuals’ beliefs in their abilities vary across activity domains and situational circumstances rather than manifest uniformly across tasks and contexts as a general characteristic. Self-efficacy beliefs develop from four sources: mastery experience, vicarious experience, social persuasions, and physiological/emotional state (Bandura, 1995, 1997, 2012).

Mastery Experience

One’s experiences of success or failure affect his or her perception of the ability to perform tasks (Lau et al., 2018). Mastery experience is the most influential among the sources of self-efficacy (Bandura, 1995; J. A. Chen & Usher, 2013; Pajares et al., 2007; Usher & Pajares, 2009). Indeed, the primary source of self-efficacy beliefs is one’s success and failure performances (Zimmermann et al., 2011). Mastery experiences are the total experiences that the individual has gained throughout his or her life. If individuals have experienced only easy achievements, they would expect to achieve results quickly and would give up easily when faced with the smallest obstacle (Bandura, 1995). In the learning process, evaluation of the individual’s achievements helps him or her evaluate his or her academic self-efficacy (Phan, 2012). When students achieve the desired results as a consequence of their efforts on a task, their confidence in performing similar tasks increases. However, when their efforts do not achieve the expected results, their belief in their ability to perform related tasks decreases (Usher & Pajares, 2008).

Vicarious Experience

The second source to develop and strengthen self-efficacy beliefs is the vicarious experience provided by social models (Bandura, 1995; Zimmerman, 2000). An individual has vicarious experience through observation and social comparison (Phan, 2012). Social models play a substantial role in self-efficacy development, especially when students are unsure of their abilities or have limited experience in academic duty (Britner & Pajares, 2006; Usher, 2009). In addition to interpreting the results of their actions, students build their beliefs in activities through vicarious experience by observing others (Usher & Pajares, 2008). When determining their academic abilities, students compare themselves with specific individuals such as classmates, peers, and adults (Usher & Pajares, 2009). If individuals see models that are very different from themselves, self-efficacy beliefs are not affected by the behavior of those models (Bandura, 1995). In this regard, students are more affected by models with similar characteristics in terms of age, gender, and social status (Britner & Pajares, 2006; Usher & Pajares, 2008). Observing a successful performance can increase observers’ self-efficacy beliefs, whereas observing failures can decrease performance (Schunk & DiBenedetto, 2020). For example, watching a similar classmate succeed in a challenging math problem can motivate other students to overcome similar problems (Lau et al., 2018; Usher & Pajares, 2009).

Social Persuasions

Social persuasions are the third source for developing self-efficacy beliefs (Bandura, 1995). This has a more limited effect on students’ self-efficacy compared with mastery and vicarious experience (Zimmerman, 2000). Encouragement from parents, teachers, and peers, whom the students trust, can increase students’ beliefs in their academic abilities (Pajares et al., 2007; Usher & Pajares, 2009). If people are persuaded to believe in themselves, they are more insistent on struggling with difficulties (Bandura, 2012). However, when individuals are convinced that they do not have capabilities, they avoid activities that can improve their potential and they give up quickly in the face of difficulties (Bandura, 1995). It is often easier to weaken self-efficacy beliefs through such negative encouragement than to strengthen such beliefs through positive encouragement. Social persuasion alone does not produce a positive self-efficacy belief; it works with other sources to exert a greater influence on self-efficacy (Brittnet & Pajares, 2006).

Physiological State

The fourth way to develop self-efficacy is through the physiological/emotional state. This includes improving the physical condition, reducing stress and negative emotional tendencies, and correcting the misinterpretation of bodily reactions (Bandura, 1995). It is a situation in which individuals base their judgments of self-efficacy on physiological responses to emotions interpreted as signs of fatigue, stress, and physical inadequacy (Zimmerman, 2000). Individuals who experience positive emotional or physical arousal may be more successful in overcoming a particular situation than individuals who experience negative arousal (Britner & Pajares, 2006). Moreover, students who experience a sense of terror when going to a particular class probably interpret their concerns as evidence of a lack of skills in this area (Usher & Pajares, 2008). The impact and power of individuals’ physiological and emotional states on self-efficacy depend on how individuals cognitively evaluate these sources (Phan, 2012).

Self-Efficacy and Mathematics Achievement

Mathematics is a systematic way of thinking that is necessary to overcome many of the problems one encounters in daily life (Ersoy, 2003). One of the emotional factors influencing students’ mathematics achievement is self-efficacy.
(Masithoh & Fitriyani, 2018). Self-efficacy belief has a remarkable impact on achievement in educational settings (Hodges, 2008). Students with higher self-efficacy are more successful in mathematics because they can perform better cognitively, have more motivation to continue in the face of difficulties, have less math anxiety, and are more likely to study mathematics (Watson, 2015).

Hackett and Betz (1989) defined mathematics self-efficacy as a situation-specific assessment for the individual to fulfill or accomplish a specific task or problem. It is also a belief that a person can successfully solve math problems and tasks (Watson, 2015; Zimmermann et al., 2011). Although positive experiences with mathematics increase math self-efficacy, negative experiences decrease math self-efficacy in students (Hall & Ponton, 2005). In this respect, self-efficacy is an essential factor to be observed in students in terms of considering their beliefs about the effectiveness of learning methods (Zimmerman et al., 1996). Although high self-efficacy increases motivation for learning mathematics, individuals with low math self-efficacy may tend to avoid mathematical tasks (Zimmermann et al., 2011). Therefore, Doménech-Betoret et al. (2017) recommended implementing programs in schools to improve students’ academic skills and, in turn, increase their academic self-efficacy.

The literature contains many studies on mathematics learning. In some studies, mathematics self-efficacy and mathematics achievement are positively correlated (Britner & Pajares, 2006; Green, 2004; Kung, 2009; Lane et al., 2004; Phan, 2012; Schöber et al., 2018; Talsma et al., 2018). In research on sources of self-efficacy, mastery experience was the most powerful predictor of mathematics self-efficacy (Ahn et al., 2017; Britner & Pajares, 2006; Usher & Pajares, 2006, 2009; Zimmerman, 2000). In elementary school, the most powerful predictor of mathematics self-efficacy belief was social persuasions (Lau et al., 2018). On the contrary, recent studies have examined the possibility of the interplay between self-efficacy and academic achievement. It was pointed out that the positive effect of past academic achievement on self-efficacy is higher than the effect of self-efficacy on academic achievement (Hwang et al., 2016; Talsma et al., 2018).

The literature contains a limited amount of research examining the relationship between sources of self-efficacy and academic performance. Some studies have shown positive relationships between sources of mathematics self-efficacy and academic performance (Arslan, 2013; Kaya & Bozdağ, 2016; Keşan & Kaya, 2018; Loo & Choy, 2013; Özcan & Kontaş, 2020). In addition, mastery experience was the most powerful predictor of academic performance (Arslan, 2013; Kaya & Bozdağ, 2016; Keşan & Kaya, 2018; Loo & Choy, 2013; Özcan & Kontaş, 2020). Moreover, Özcan and Kontaş (2017) specifically investigated the relationship between sources of mathematics self-efficacy and mathematics test achievement. In these studies, different sources of mathematics self-efficacy predicted academic achievement and standardized test performances. In this study, it was proposed that the sources of mathematics self-efficacy would have an impact on mathematics test and course achievement.

**Purpose of the Present Study**

Researchers generally emphasized a positive relationship between mathematics self-efficacy belief and mathematics achievement or sources of self-efficacy and self-efficacy beliefs. Students experience sources of self-efficacy to develop self-efficacy for different academic fields. Specifically, they experience sources of mathematics self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—to development of mathematics self-efficacy beliefs. The mathematics self-efficacy belief affects mathematics performances. On the contrary, mastery experience, vicarious experience, social persuasions, and physiological state may also directly facilitate the mathematics performance, not through self-efficacy beliefs. As a result, students may experience sources of mathematics self-efficacy not only to develop self-efficacy beliefs but also to facilitate mathematics performance. For that reason, it is necessary to reveal the relationship between sources of mathematics self-efficacy and mathematics performance. This study examined the relationship between sources of mathematical self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—and mathematics test performance on the University Entrance Exam (UEE) and mathematics course achievement in high school senior (12th grade) students. Specifically, this study addressed the following questions:

**Research Question 1 (RQ1):** What is the relationship between sources of mathematics self-efficacy and mathematics course achievement?

**Research Question 2 (RQ2):** What is the relationship between sources of mathematics self-efficacy and mathematics test achievement?

**Research Question 3 (RQ3):** What are the differences when comparing the relationship between sources of mathematic self-efficacy with mathematics test achievement and mathematics course achievement?

Based on the research questions, we hypothesized the following:

**Hypothesis 1 (H1):** The sources of mathematics self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—would have a significant relationship with mathematics test performance on the UEE and mathematics course achievement.

**Hypothesis 2 (H2):** The sources of mathematics self-efficacy would have a different level significant relationship...
with mathematics test performance on the UEE and mathematics course achievement.

Hypothesis 3 (H3): Finally, when examining dimensions of sources of mathematics self-efficacy, mastery experience would have the strongest relationship with mathematics test performance on the UEE and mathematics course achievement in comparison with vicarious experience, social persuasions, and physiological state.

Method

This research was designed as a correlational study. A correlational study is a type of research design in which the researcher attempts to understand the kinds of naturally occurring variables that relate to each other (Fraenkel et al., 2012). The criterion variables of the study were the mathematics course and test achievement. Sources of mathematics self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—were the predictor variables. Mastery experience, vicarious experience, social persuasions, and physiological state’s content contained the structure measured on Sources of Mathematics Self-efficacy Scale.

Participants

In this study, the nonrandom purposive sampling method was used while selecting participants. Participants of the study were students studying in 12th-grade high schools located in the center of a province in the Mediterranean region of Turkey. There were 95 academic high schools in the city center, and they were providing academic education. These schools have different achievement levels. One of the criteria that determined high school achievement is UEE results. Schools can be grouped into three groups, taking into account their achievement in this exam: high achievers, medium achievers, and low achievers. One of the schools in each achievement group was selected to ensure each achievement group’s representation in this study. These three schools’ mathematic achievement from UEE out of 40 questions were low achievers \( (M = 2.49, SD = 2.50) \), middle achievers \( (M = 8.18, SD = 5.44) \), and high achievers \( (M = 24.09, SD = 8.27) \). When considering \( M \) and \( SD \) of UEE math achievement of these three achievement groups, it could be concluded that selected three schools for this study represented three achievement groups.

In the study, mathematics teachers applied the instrument to 269 high school senior students attending these three schools. After seven incomplete and five outlier data were excluded from the data set, the total participants of the study were 257. The participants of the study consisted of 104 (40.5%) students in the high achiever school, 74 (28.8%) students in the middle achiever school, and 79 (30.7%) students in the low achiever school. The distribution of participants by gender was 152 (59.1%) boys and 105 (40.9%) girls.

Instruments

The Sources of Mathematics Self-efficacy Scale. The scale was developed by Usher and Pajares (2009) to measure sources of the mathematics self-efficacy beliefs of middle school students. The scale contained 24 items of 7-point Likert-type scale. There were seven reverse items among the scale. The scale had four subscales (mastery experience, vicarious experience, social persuasions, and physiological state), each of which consisted of six items. The total score obtained for each dimension of the sources of mathematics self-efficacy scale was between 7 and 42. Some example items were “I do well on math assignments,” “Seeing kids do better than me in math pushes me to do better,” “People have told me that I have a talent for math,” and “My whole body becomes tense when I have to do math.” Students responded using a 7-point Likert-type scale from 1 (completely disagree) to 7 (completely agree).

The scale was adapted to Turkish by Kontaş and Özcan (2017). The Turkish version of the scale was administered to 282 middle school students in the sixth, seventh, and eighth grades. The results of the Confirmatory Factor Analysis (CFA) indicated good fit indexes \( (\chi^2/df = 2.25, \text{root mean square error of approximation} \ [\text{RMSEA}] = .06, \text{comparative fit index} \ [\text{CFI}] = .98, \text{non-normed fit index} \ [\text{NNFI}] = .97, \text{and standardized root mean square residual} \ [\text{SRMR}] = .05) \). The reliability coefficient estimated by Cronbach’s alpha .86 for mastery experience, .75 for vicarious experience, .94 for social persuasions, and .91 for the physiological state. The scale was applied to 36 students at 16-day intervals to calculate test–retest reliability. The results indicated \( r = .67 \) for mastery experience, \( r = .48 \) for vicarious experience, \( r = .63 \) for social persuasions, and \( r = .41 \) for the physiological state (Kontaş & Özcan, 2017).

Özcan and Kontaş (2020) conducted reliability and validity studies of the Sources of Mathematics Self-efficacy Scale on 281 Turkish high school students. The results of CFA had fit indexed values of \( \chi^2/df = 2.25, \text{RMSEA} = .06, \text{CFI} = .98, \text{NNFI} = .97, \text{and SRMR} = .05 \). The Cronbach’s alpha reliability coefficient was estimated for mastery experience \( (\alpha = .87) \), vicarious experience \( (\alpha = .85) \), social persuasions \( (\alpha = .95) \), and physiological state \( (\alpha = .94) \) (Özcan & Kontaş, 2020). The Cronbach’s alpha reliability coefficient was estimated for this study group of 257 participants. The Cronbach’s alpha for mastery experience \( (\alpha = .86) \), vicarious experience \( (\alpha = .82) \), social persuasions \( (\alpha = .94) \), and physiological state \( (\alpha = .92) \) was obtained. These results suggested that the Sources of Mathematics Self-efficacy Scale is a valid and reliable scale for Turkish high school students.

Mathematics achievement test. A national two-stage placement system determines access to tertiary education and places students into different programs. The first stage is the Basic Proficiency Test—Temel Yetenlik Testi (TYT)—previously
known as the Transition to Tertiary Education Examination—
Yükseköğretim Geçiş Sınavı (YGS). It is a multiple-choice
assessment of core subjects such as Turkish, social sciences,
mathematics, and science. Passing the TYT is sufficient to
access the short-cycle tertiary programs in which most stu-
dents are enrolled. To access bachelor’s programs, students
must take an additional test, called the Field Qualification
Test—Alan Yeterlilik Testleri (AYT)—previously known as
the Undergraduate Placement Exam—Lisans Terleştirmesi
Sınavı (LYS), in subjects relevant to their desired field of
study. Students’ preferences and results in the TYT and AYT,
and their average classroom marks during high school, are
used to determine their placement in short-cycle tertiary
and bachelor’s programs through a centralized system that
automatically assigns applicants to study programs (Kitchen et al.,
2019; Student Selection and Placement Center [SSPC], 2018).

Higher Education Institutions Exam—yükseköğretim
Kurumlar Sınavı (YKS)—is a three-session exam: Session
1 TYT, Session 2 AYT, and Session 3 Foreign Language
Test (YDT). All applicants applying to YKS must take the
TYT. Other sessions are optional (SSPC, 2018). TYT on
the first day, AYT on the second day, and third session
YDT on the second day afternoon apply to candidates
(SSPC, 2018). TYT consists of four parts and 120 ques-
tions, including 40 questions in Turkish, 40 questions in
basic mathematics, 20 questions in social sciences, and 20
questions in science. The multiple-choice questions have
five choices for each question. Only one of them is the cor-
correct answer. The total time is 135 min.

In the basic mathematics test, candidates are asked ques-
tions about using basic math concepts and creating opera-
tions using these concepts, creating abstract operations using
basic mathematical relationships, and measuring basic math-
ematics principles and operations in daily life (SSPC, 2018).
From the correct answers that students provided to 40 math-
ematics questions, the mathematical total answer numbers
were calculated by subtracting 0.25 lines of one wrong
answer. In this study, this calculated number of true answers
of the students over 40 questions taken into consideration.
The mathematics test questions included the following sub-
jects: sets, linear equations and inequalities, real numbers,
functions and relationships, exponential expressions and
equations, problem-solving, statistics and probability, trian-
gles, quadrilaterals and polygons, analytic geometry, circles,
and surface area and volume (Ministry of National Education
[MoNE], 2018a, 2018b).

Mathematics course achievement. In this study, mathematics
course achievement was the students’ one-semester math-
ematics mean scores. Students’ mathematics course achieve-
ment is determined by taking the arithmetic average of the
scores obtained from written exams and performance studies
in line with the curriculum and learning outcomes. There are
two written exams each semester. There are also two perfor-
manace points other than the written exam scores. One of
them consists of the individual or group work done under the
supervision of the lesson teacher, whereas the other is given
according to the student’s course preparation, attendance,
active participation, and exemplary behavior. Written exams
and performance studies are evaluated through 100 points.
To be considered successful in mathematics at the end of the
semester, the student must have a mean score of at least 50
out of 100 (MoNE, 2017).

Results
This study investigated whether the sources of mathematics
self-efficacy—mastery experience, vicarious experience,
social persuasions, and physiological state—significantly
predict mathematics course achievement and mathematics
test achievement. Mean, standard deviation, and correlations
related to the variables of the regression were in Table 1.

As seen in Table 1, there were significant strong positive
correlation between mathematics course achievement
(dependent variable) and the independent variables of mas-
tery experience (r = .75, p < .01), significant moderate posi-
tive correlation between mathematics course achievement
and social persuasions (r = .59, p < .01) and vicarious expe-
rience (r = .43, p < .01), and significant positive but weak
correlation between mathematics course achievement and
physiological state (r = .38, p < .01). These findings suggest
that as the mathematics achievement score of the high school
students increased, their scores for mastery experience,
social persuasions, vicarious experience, and physiological
state increased as well. In addition, standardized mathemat-
ics test achievement had significant moderate positive cor-
relation with mastery experience (r = .49, p < .01), and
social persuasions (r = .43, p < .01), significant positive but
weak correlation with vicarious experience (r = .21, p < .01),
and physiological state (r = .20, p < .01). These find-
ings suggested that as the mathematics test achievement
score of the high school students increased, their scores for
mastery experience, social persuasions, vicarious experi-
ence, and physiological state increased as well.

The findings related to the multiple linear regression anal-
ysis were in Table 2. The output included multiple determi-
nation coefficients (R²), adjusted multiple determination
coefficients (adj-R²), regression coefficients related to model
(β), and F values for the model.

A multiple linear regression was calculated to predict
12th-grade high school students’ mathematics course
achievement based on their sources of mathematics self-
efficacy—mastery experience, vicarious experience, social
persuasions, and physiological state. A significant regres-
sion equation was found, $F(4, 252) = 80.12, p < .001,
with an $R^2$ of .56. Participants’ predicted mathematics
course achievement is equal to $34.32 + 1.77 \text{ (mastery}
\text{ experience)} + -0.04 \text{ (vicarious experience)} + 0.06 \text{(social}
\text{ persuasions)} + -0.16 \text{ (physiological state)}$, where each
source of mathematics self-efficacy is measured from 7 to
42 points. Only mastery experience dimension of the sources of mathematics self-efficacy was a significant predictor of mathematics course achievement (see Table 2). These findings indicated that sources of mathematics self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—explained 56% of the total variance related to mathematics course achievement. Mastery experience was a strong predictor, whereas vicarious experience, social persuasions, and physiological state did not significantly predict mathematics course achievement.

The findings related to the multiple linear regression analysis were in Table 3. The output included multiple determination coefficients ($R^2$), adjusted multiple determination coefficients (adj-$R^2$), regression coefficients related to model ($\beta$), and $F$ value for the model. Table 3 showed the multiple linear regression results to predict 12th grade high school students’ mathematics test achievement based on their sources of mathematics self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state. A significant regression equation was found, $F(4, 252) = 23.50, p < .001$, with an $R^2$ of .27. Participants’ predicted mathematics test achievement is equal to $-1.86 + 0.67$ (mastery experience) + $-0.04$ (vicarious experience) + $0.06$ (social persuasions) + $-0.16$ (physiological state), where each source of mathematics self-efficacy is measured from 7 to 42 points. Mastery experience, vicarious experience, and social persuasions dimensions of the sources of mathematics self-efficacy were significant predictors of mathematics course achievement. These findings indicated that sources of mathematics self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—explained 27% of the total variance related to mathematics test achievement.

According to the standardized regression coefficient ($\beta$) in the $t$-test results, the relative order of significance for the predicted variables on mathematics test achievement were mastery experience ($\beta = .50$), social persuasions ($\beta = .20$), and vicarious experience ($\beta = -.17$). While mastery experience and social persuasions positively predicted mathematics test achievement, vicarious experience negatively predicted it. Physiological state negatively, but not significantly, predicted mathematics test achievement.

**Discussion**

This study proposed that sources of mathematics self-efficacy could have a direct predictive effect on mathematics test and course achievement. The finding on mathematics course achievement indicated that mastery experience significantly predicted mathematics course achievement and it was a powerful predictor of math course achievement. Moreover, the findings on test achievement showed that mastery experience, vicarious experience, and social persuasions significantly predicted mathematics test achievement. The predictive power of the predictor variables of mathematics test performance was set as mastery experience, social persuasions, and vicarious experience, respectively. While mastery experience and social persuasions positively predicted mathematics test achievement, vicarious experience
negatively predicted mathematics test achievement. Although physiological state negatively predicted test achievement, it was not a significant predictor. In addition, mastery experience was the strongest predictor of mathematics course and test achievement.

The importance of this research was that it investigated the predictive effect of sources of mathematics self-efficacy on mathematics course achievement and mathematics test achievement on the same sample. Only mastery experience—one of the sources of mathematics self-efficacy—significantly predicted mathematics course achievement. On the one hand, mastery experience, social persuasions, and vicarious experience significantly predicted mathematics test achievement. These findings are supported by studies (Arslan, 2013; Kaya & Bozdağ, 2016; Keşan & Kaya, 2018; Loo & Choy, 2013; Özcan & Kontaş, 2017, 2020). On the other hand, these findings are consistent with findings on the effect of sources of self-efficacy on self-efficacy beliefs (Bonne & Johnston, 2016; Britner & Pajares, 2006; Grigg et al., 2018; Phan, 2012; Stevens et al., 2004; Tossavainen et al., 2021). Sources of self-efficacy not only affect mathematics achievement through self-efficacy belief but also have a direct impact on mathematics achievement. These results also showed that sources of mathematics self-efficacy have an impact on mathematics course and test achievement.

Mastery experience was the most powerful predictor of mathematics course and test achievement. These findings fit the results of the studies (Arslan, 2013; Kaya & Bozdağ, 2016; Keşan & Kaya, 2018; Loo & Choy, 2013; Özcan & Kontaş, 2017, 2020). Studies on the effect of sources of mathematics self-efficacy on the development of self-efficacy belief showed that mastery experience was the most powerful predictor of mathematics self-efficacy. These findings are consistent with this study (Britner & Pajares, 2006; Usher & Pajares, 2006, 2009; Zimmerman, 2000). Mastery experience is not only an important source for the development of self-efficacy but also considerably increases achievement performance.

In this study, social persuasions predicted the test achievement of mathematics. This finding can be explained by the fact that the social environment is concerned with the results of the tests rather than with course achievement. In addition, the social environment was attributed to a greater extent to mathematics test achievement than course achievement. In addition, mathematics achievement offers a vital contribution to the determination of which students to place into tertiary education programs. This finding can be explained by the tendency of students’ social environment to give more social incentives to students for standardized achievement tests. As a result, students attributed more value to encouragement given by the social environment in test achievement.

The exciting finding of the study was that although mastery experience and social persuasions positively predicted mathematics standardized test achievement, vicarious experience negatively predicted mathematics test achievement. When students are determining their self-efficacy beliefs, they compare themselves with their classmates. This finding may be explained by the fact that students usually observed peers who fail in mathematics, or see more successful students than themselves in mathematics. Consistent with this finding, vicarious experience negatively predicted test achievement in middle schools (Özcan & Kontaş, 2017). Bandura (1995) suggested that a student’s self-efficacy decreased when peers’ scores were higher and that student’s self-efficacy increased when peers’ scores were lower. As mentioned by Britner and Pajares (2006), a peer model with similar characteristics to those of the student could be the most influential factor in improving a student’s self-efficacy through vicarious experience. These findings were consistent with this study.

**Conclusion**

In conclusion, sources of mathematical self-efficacy—mastery experience, vicarious experience, social persuasions, and physiological state—have relationships with mathematics test and course achievement. Moreover, mastery experience is the most powerful source of mathematics self-efficacy to predict mathematics test and course achievement. Sources of mathematics self-efficacy beliefs not only develop mathematics self-efficacy but also directly promote mathematics achievement. There are reciprocal effects between self-efficacy and achievement (Schöber et al., 2018; Talsma et al., 2018). Besides, there may be reciprocal relationships between sources of self-efficacy and achievement too.
Mathematics curriculum and materials should be arranged so that students have more chances to live mastery experience to develop mathematics self-efficacy and facilitate mathematics achievement. In the classroom, teachers should provide more opportunities for students to have more frequent successful experiences in mathematics. These successful experiences increase students’ mathematics achievement and contribute more to the development of mathematics self-efficacy beliefs. In addition, families, teachers, and friends, social environment of students, may encourage students to increase students’ mathematics test achievements. To transform the negative predictive effect of vicarious experience into a positive experience, students need to observe, in the school environment, more successful peer models that have mathematics achievement levels similar to their own. Not only a small group of students experience success in the schools but also a majority of the students should experience success. In this way, students can observe successful peer models experiencing mathematics success at all levels in the educational environment.

The relationship between sources of self-efficacy and performance can be examined at different educational levels, such as elementary, secondary, high school, and university. In addition, the relationship between sources of self-efficacy and mathematics achievement should be investigated in student groups with different success levels (high achievers, medium achievers, and low achievers). In particular, it may be more informative to test the direct relationship between sources of self-efficacy and achievement, and the mediating effect of self-efficacy belief between them, with structural models.

The results of this study have limited generalizability due to the small sample size of the schools not representing all 12th graders. Therefore, this study’s results can be generalized to students who attend schools with similar characteristics and achievement levels of this study, not to all students in 12th grade. Future research should be made on groups that represent all 12th-grade students to increase the generalizability of such studies.

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ORCID iD
Bahadır Özcan https://orcid.org/0000-0003-4278-8417

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