The Relationship between Teacher Efficacy, and Students' Trigonometry Self-Efficacy and Achievement

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The purpose of the present study is to investigate the relationship between teacher efficacy to student trigonometry self-efficacy and student trigonometry achievement. The study included 16 high school teachers and their tenth grade students (n=571). Teacher efficacy was studied in terms of general teaching efficacy, mathematics teaching efficacy, and trigonometry teaching efficacy. No significant relationship was found between general teaching efficacy or mathematics teaching efficacy and student-related variables. The t-test results show that students of teachers who had high trigonometry teaching efficacy got higher scores on the trigonometry self-efficacy scale, than students of teachers with low trigonometry teaching efficacy. Between these two groups of students' achievement test scores, on the other hand, no significant difference was found. The results underline the importance of teachers' trigonometry teaching efficacy for students' trigonometry self-efficacy, as well as the importance of measuring self-efficacy in a task-specific way.

Introduction

Motivation plays an important role in mathematics education. Students tend to exert more effort on their studies when they have interest in and enthusiasm for the subject. One of the concepts which is claimed to have a crucial role in the motivation and academic achievement of students is self-efficacy (Pajares, 1996). Self-efficacy can be defined as beliefs about whether one can achieve a specific task or not. Much of the recent research related to self-efficacy is based on the *social cognitive theory* of Bandura (1982), which states that people make their choices according to their self-knowledge (a person's perception of oneself).

The need to understand self-efficacy (one's belief in one's own capabilities) with regard to mathematics has been addressed in the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teaching Mathematics, 2000), which states that one goal for students is to become confident in their ability to do mathematics. Furthermore, self-efficacy is emphasised in the mathematics education curriculum of the Ministry of Education of Turkey, which claims that self-efficacy is an important part of shaping students' lives.

Teachers may successfully help students to develop high self-efficacy through using influential teaching methods. Studies have found that teaching strategies are related to teacher efficacy (Ashton, Webb, & Doda, 1983; Ghait &Yaghi, 1997). Teachers who have confidence in their ability to teach, devote effort to teaching and use diverse techniques in class (Ghaith & Yaghi, 1997). This effective teaching may have a positive influence on the learning of students, as well as on their desire to work (Nelson, 2007). When students learn sufficiently and experience repeated success, they may develop the belief that they can achieve in mathematics. Hence, teachers' efficacy beliefs may be related to students' mathematics achievement and mathematics self-efficacy (Ashton, Webb, & Doda, 1983).

Because self-efficacy is a domain-specific concept, it may change for different tasks and settings. For this reason, Bandura suggested studying self-efficacy with regard to specific tasks. Similarly, because there are various topics in mathematics, it would be beneficial to study self-efficacy for specific mathematics topics. Trigonometry is one of the important subjects in the high school mathematics curriculum (Saglam et al., 2007), and it is also one of the topics students have the most difficulty in understanding (Tatar, Okur, & Tuna, 2008). There is a need to improve the trigonometry learning of students.

Therefore, this study focuses on the topic of trigonometry for student variables (self-efficacy and achievement). For teacher efficacy, three different variables were used: general teaching efficacy, mathematics teaching efficacy, and trigonometry teaching efficacy. Based on the literature, researchers decided that these are the main components of a teacher's efficacy for teaching a topic (Pajares, 1996; Riggs & Enochs, 1990; Tschannen-Moran, Woolfolk, & Hoy, 1998). These variables were taken separately to determine the difference among teacher efficacy from different perspectives. Previously, general teacher efficacy was studied. However, in this study teacher efficacy was examined in depth and in a task-specific way in order to understand the relationship between teacher efficacy and student self-efficacy. Since students' self-efficacy and teacher efficacy are crucial for students' motivation and achievement, it will be beneficial for educators to understand their relationship. This study focuses on the relation between teacher efficacy and student self-efficacy and achievement; however, for further research other variables such as teaching methods and school conditions could also be studied. In this respect, this article should function as a preliminary study for further research.

Self-Efficacy

Self-efficacy was defined as one's personal judgments of one's capabilities to organise and execute courses of action to attain designated goals (Bandura, 1997). Self-efficacy affects people's choices and decisions. If people are content with their ability to achieve the desired outcome, they are more likely to intend to do that action. According to the strength of their self-efficacy beliefs, people arrive at judgments about future accomplishments before they actually perform the task. In addition, self-efficacy influences people's self-regulating behaviour. People who are more confident in their ability see the difficulties as manageable through some effort. Hence, they make necessary changes in their behaviours and regulate their actions in order to achieve the desired outcomes (Bandura, 1997).

In order to understand self-efficacy, it is necessary to know its sources. According to Bandura (1997), four sources influence the level of self-efficacy: *mastery experiences, vicarious learning, social persuasion,* and *physiological and affective states. Mastery experiences* are the outcomes of the performance, successful or unsuccessful. These experiences are considered the most powerful influence on a person's level of self-efficacy. *Vicarious experiences* occur when a person sees someone with perceived similar ability performing the task. *Social persuasion* is when the task is performed with encouragement from someone who is more knowledgeable. Lastly, *physiological and affective states* are the physical and mental processes that may interfere with the performance of the task, such as exhaustion or anxiety. These sources determine the level of self-efficacy one has; in turn, self-efficacy affects people's lives in several areas. Hence, self-efficacy has been studied in fields as diverse as life-course development, education, health, psychopathology, athletics, business, and international affairs (Bandura, 1997). In academic settings, it has been investigated through studies of student self-efficacy and teacher efficacy.

Student Self-Efficacy

Self-efficacy plays a crucial role because of its effect on motivation and achievement of students in academic settings (Pajares, 1996; Zimmerman, 2000). Furthermore, it is related to students' choices, thought patterns and emotions, and the level of effort they put into the learning task. Self-efficacy also influences students' educational and career decisions (Betz & Hackett, 1981; Lent, Brown, & Larkin 1984; O'Brien, Martinez-Pons, & Kopala, 1999). Highly efficacious students made effective career decisions, perceived extensive career options, and persisted in pursuing their educational aspirations. On the other hand, students with low self-efficacy were less decisive and perceived more career option limitations (Taylor & Betz, 1983).

Self-efficacy is also related to students' emotions. In general, students who have high levels of self-efficacy are more likely to experience positive emotions such as pride or happiness in academic contexts, whereas those with lower levels of self-efficacy generally experience negative emotions such as anxiety or depression (Bandura, Barbanelli, Caprara, & Pastorelli, 1996; Pintrich & De Groot, 1990). Negative emotions such as anxiety are more likely to occur in those with low self-efficacy because they tend not to believe they will achieve their goals (Bandura, 1997; Pajares & Kranzler, 1995).

Furthermore, self-efficacy influences academic performance, the way students deal with their studies, and the way they cope with or accomplish different tasks related to the academic domain. Students who have low mathematics self-efficacy cannot maintain study routines, do not have organisational skills, and have difficulty in following the covered material in class (Usher, 2009). On the other hand, students with high self-efficacy participate more willingly in lessons. They work harder, persist longer on tasks, and use more effective learning strategies (Bong, 1997; Pintrich& De Groot, 1990). The enhanced performance resulting from these strategies may lead to increased academic achievement (Bandura, 1997).

Existing studies of the relationship between self-efficacy and mathematics achievement have found positive relationships (Erdogan, Baloglu, & Kesici, 2009; Lopez, Lent, Brown, & Gores, 1997; Pajares & Miller, 1994; Pietsch, Walker, & Chapman, 2003; Usher, 2009). These studies have established self-efficacy beliefs as a "powerful motivation construct that works well to predict academic self-beliefs and performances at varying levels" (Pajares, 1996, p.557). Therefore, educators should take the importance of self-efficacy into consideration and try to enhance student self-efficacy. Teachers can increase students' self-efficacy by creating effective learning environments that let them experience success and develop the belief that they "can do it" (Siegle & McCoach, 2007). Bandura (1997) claims that, a necessary component for creating these learning environments is the teacher's belief in their personal and professional efficacy, referred to as teacher efficacy.

Teacher Efficacy

Teacher efficacy has been defined as teachers' perception of their ability to affect the performance of their students (Tschannen-Moran, Woolfolk, & Hoy 1998). Tschannen-Moran and colleagues (1998) developed a model for the teacher efficacy concept using Bandura's (1997) self-efficacy theory. According to this model, teachers cognitively process their self-efficacy sources (mastery experiences, vicarious learning, social persuasion, and physiological and emotional states), analyse the teaching task and assess personal teaching competence. Through these processes, teachers evaluate their teacher efficacy level. The consequences of teacher efficacy, such as goal setting, and persistence and effort, contribute to teaching performance, which becomes a new source of efficacy for the teacher. Therefore this model proposes a cyclic relationship among teacher-efficacy and teaching outcomes. As seen in Figure 1, accomplishment creates a new mastery experience which provides a new source for future efficacy beliefs. The consequences of greater efficacy include greater effort and persistence, which lead to better performance, which in turn leads to greater efficacy. On the other hand, lower efficacy leads to less effort and faster resignation, which leads to unsatisfactory teaching outcomes, which in turn leads to decreased efficacy beliefs.

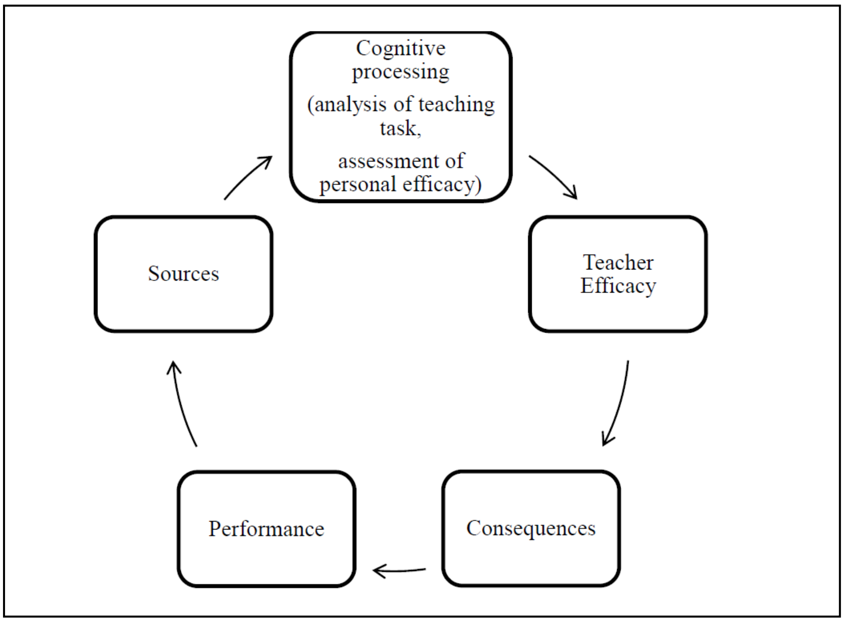


Figure 1. The cyclical nature of teacher efficacy (Tschannen-Moran et al., 1998).

In this model, the sources affect the formation of teaching efficacy. Several studies have been conducted to examine the relationship between Bandura's four sources of efficacy (mastery experiences, vicarious learning, social persuasion, and physiological and emotional states) and teacher efficacy. Strong relationships were found between teacher efficacy and mastery experiences (Charalambus, Philippou, & Kyriakides, 2008; Swars, 2005) as well as social persuasion and teacher efficacy (Mulholland & Wallace 2001; Philippou & Charalambos, 2005; Poulou, 2007).

The model also proposes that teacher efficacy directly affects the teaching processes and classroom environment. High efficacy teachers create more supportive, student-centred classroom environments (Gordon, 2001; Witcher, Onwuegbuzie, Collings, Witcher, Minor, & James, 2002; Woolfolk, Rosoff, & Hoy, 1990). Teachers with high levels of efficacy are likely to use new teaching methods (Ghaith & Yaghi, 1997) and have positive expectations for student achievement (Tournaki & Podell, 2005).

On the other hand, teachers with low teacher efficacy tend to perceive student problems as being more stable and resistant to change than high efficacy teachers. Low efficacy teachers are more likely than high efficacy teachers to use negative consequences and severe punishments (Gordon, 2001). Furthermore, low efficacy teachers prefer to use a lecture-driven, teacher-dominant method of teaching while high efficacy teachers prefer to use more student-centred methods of teaching (Witcher et al., 2002).

Because teacher efficacy is related to teaching methods, it is also related to student motivation and achievement (Ross, 1992). Teacher efficacy predicts students' levels of interest and enjoyment in academic subjects, which in turn predicts motivation (Nelson, 2007). Rose and Medway (1981) found that teachers with high levels of teacher efficacy did have higher achieving students. Furthermore, Ashton and colleagues (1983) conducted a study with high school teachers to explore the relationship. Their results indicated that levels of teaching efficacy were significantly positively correlated to student achievement in mathematics ($r= .78$ and $p<.003$) and language arts ($r= .83$ and $p<.02$).

On the other hand, Winters (2000) investigated the relationship between teacher efficacy and student achievement in a rural school area with high poverty rates among students who were also mostly coming from minority backgrounds. In that study, no significant relationship was found between the results of teacher efficacy and student achievement. The researchers concluded that school regions and student profile might have led to results that were inconsistent with the previous studies. Hence, more research is needed to explore the effect of teacher efficacy on student achievement for different settings.

In addition to studying it in different settings, Bandura (1997) suggested self-efficacy should be studied as specifically as possible for the intended task. He proposed that "Teachers' sense of instructional efficacy is not necessarily uniform across different subjects. Therefore, teacher efficacy scales should be linked to the various knowledge domains." (p. 243). For this reason, for the current study, we chose to examine self-efficacy for a specific topic, trigonometry.

Trigonometry Education

Trigonometry is an important topic in the secondary school curriculum because it helps students develop cognitive strategies. Trigonometry provides rich problem solving opportunities and involves reasoning and proof capabilities. It combines algebra and geometry, and contains visual representations. Also, trigonometric equations are used in later topics, such as complex numbers, limits, derivatives, and integrals. Hence, it is crucial for students to master it in order to advance in mathematics.

Although trigonometry is a fundamental topic and has a very large area of application, some studies have revealed that it is a hard topic for students (Akkoc, 2008; Fi, 2003; Steckroth, 2007; Topcu, Kertil, Akkoc, Yilmaz, & Onder 2006). Durmus (2004) stated that the difficulty of trigonometry stems from its abstract nature, including algebraic equations and formulas such as addition and sum-to-product formulas. When students cannot understand the basic trigonometry concepts, they have difficulty understanding successive topics (Steckroth, 2007).

In addition to the difficulty of trigonometry as a subject, students are often not motivated to learn it. For example, Dogan (2001) investigated the opinions of students ($n=1316$) about trigonometry. The results showed that 22 % of the students liked trigonometry, 46 % did not like it, and 31 % of students said that they did not even want to talk about trigonometry; 46 % of them said that they did not want to study trigonometry. These results demonstrate that many of the students did not like learning trigonometry.

For these reasons, trigonometry self-efficacy should be studied to inform educators about the importance of improving students' confidence and interest for it in relation to the teachers' role. But there is limited research on trigonometry self-efficacy of both students and teachers.

The purpose of the present study is to investigate the relationship between teacher efficacy and student trigonometry self-efficacy, as well as the relationship between teacher efficacy and student achievement in trigonometry. Therefore, our research questions are as follows:

1. Is there any relationship between general teaching efficacy on the one hand, with student trigonometry self-efficacy and student trigonometry achievement, on the other?
2. Is there any relationship between mathematics teaching efficacy, on the one hand, with student trigonometry self-efficacy and student trigonometry achievement, on the other?
3. Are there any significant differences between the students of teachers with high trigonometry teaching efficacy and the students of teachers with low trigonometry teaching efficacy in terms of student trigonometry self-efficacy and student trigonometry achievement?

Method

Structures of the Secondary School System in the Turkey

The education system is comprised of kindergarten, primary, middle, secondary, and higher education levels. A 4-year secondary education is provided in two different types of schools, non-vocational and vocational. Non-vocational secondary education institutions are comprised of five types of institutions: General High School, Anatolian High School, Science High School, Social Sciences High School, Fine Arts, and Sports High School. These institutions demonstrate some differences, for example, with respect to the number of students in classes, selection of teachers, conditions for admission, and predominance of foreign language. While general high schools and all vocational schools admit students by means of direct application, the other institutions admit students by means of a multiple-choice entrance examination. All students have to take this exam, and they are placed according to their scores.

All schools are required to apply the curriculum determined by the Ministry of Education. The curriculum is comprised of common courses and elective courses in compliance with interests, skills, and the characteristics of the area to be selected. Starting from eleventh grade, students in all secondary education institutions are required to choose an area of study, and predominantly enrol in courses related to that area.

At the time of the study, students were asked to choose their area of study at 10^{th} grade and the topic of this study, trigonometry, was included in the tenth grade curriculum of science-mathematics and literature-mathematics areas. The teachers had the flexibility to decide on their own teaching methods and educational activities as long as they were aligned with the objectives of the curriculum and the textbooks determined by the Ministry of Education. The objectives and duration for each topic were determined by the curriculum. In the schools in which the study was conducted, the trigonometry unit was taught at the end of the spring semester.

Sample and Procedure

For this study seven high schools were chosen from Istanbul's three districts. Istanbul is a large metropolitan city with 39 districts. Some districts have more challenging schools which have high service points. For this study, schools from three districts

(Gaziosmanpasa, Bayrampasa, and Sultangazi) were chosen. These districts are neighbours to each other which also add convenience in data collection. Even though three districts were chosen, the purpose was to sample schools from similar geographic region. In order to choose similar schools, the researchers considered two more factors, school type (public, non-vocational general secondary school) and service point. The service points for a school, assigned by the Ministry of Education of Turkey, was determined according to a couple of factors: the number of teachers needed, geographic position, economic and social development level of the school area, transportation conditions, and satisfaction rates for the services needed. In other words, service points indicate the general condition of a school. When the service point of a school is high it reflects the difficult conditions of the school. All the schools in our study had same high service points.

The sample schools were chosen similarly in order to control the effect of school variable on teacher efficacy, student self-efficacy, and student achievement, because different schools are also related to teacher efficacy (Ustuner, Demirtas, Comert, & Ozer 2009).

The sample for this study consisted of sixteen mathematics teachers (n_1=16) and their tenth grade students (n_2=571) from seven high service point general high schools. In these schools, all teachers who teach tenth grade math were included because that is when trigonometry is taught. The number of female students was 301 (52.7%) and the number of male students was 232 (40.6 %). The remaining 38 (6.7%) of students did not report their gender. Among the teachers, four were male and 12 female. The majority of them graduated with degrees in mathematics and received their teaching certificates later. There were also teachers who majored in the sciences. They averaged nine years of experience, with the majority having taught for more than 10years.

First, the teacher instruments were administered to the sample; then student data was collected after their teachers finished teaching the trigonometry unit. In a given school, students answered in the same class hour to prevent interaction between classes. The students first completed the self-efficacy questions, and later in another class hour they completed the achievement test. In addition to the instruments mentioned above, interviews were conducted with teachers to categorise them according to their trigonometry teaching efficacy. The interviews were semi-structured and aimed at getting information about the teaching trigonometry experiences of teachers.

Instruments

In this study, there were four instruments which were shown in Table 1: for teachers, the Teachers' Sense of Efficacy Scale (TSES) and the Self-Efficacy Beliefs toward Mathematics Teaching Scale (SEBTMTS); and for students, the Student Trigonometry Self- Efficacy Scale (STSES) and the Student Trigonometry Achievement Test (STAT). In addition to these instruments, interviews were conducted with teachers to get further information about their experiences teaching trigonometry to categorise them for their trigonometry teaching efficacy.

Table 1
Variables and Instruments

	Variable	Instrument
Teacher	General Teaching Efficacy(GTE)	Teachers' sense of efficacy scale (TSES)
	Mathematics Teaching Efficacy (MTE)	Self-Efficacy Beliefs toward Mathematics Teaching Scale (SEBTMTS)
Student	Trigonometry Self-Efficacy	Student Trigonometry Self- Efficacy Scale (STSES)
	Trigonometry Achievement	Student Trigonometry Achievement Test (STAT)

The TSES was used to gather information about the teaching efficacy of teachers. The instrument was developed by Tschannen-Moran and Woolfolk-Hoy (2001) and uses a nine-point Likert scale. Capa, Cakiroglu, and Sarikaya (2005) translated the questions into Turkish and conducted a study for the instrument with 628 pre-service teachers from six different universities. They reported that the reliability of the whole scale was .95. Hence, the TSES is a valid and reliable instrument to measure general teacher efficacy. For this study, the reliability of the whole scale was .92, which indicates high internal consistency for the TSES.

The SEBTMTS is used to gather data about the mathematic teaching efficacy of teachers. The instrument was developed by Dede (2008) based on the STEBI (Science Teaching Efficacy Belief Instrument) of Riggs and Enochs (1990). The reliability for the scale was reported to be .80 (Dede, 2008). For the present study the Cronbach α internal consistency coefficient value was calculated and found to be.77, which shows a good internal consistency.

The STSES scale was developed by the authors in order to measure the efficacy level of students in trigonometry. While developing the scale, The Mathematics Self-Efficacy Scale (MSES), developed by Betz and Hackett (1981) for college mathematics topics, algebra, calculus, economics, and statistics, was taken as the primary model. Each item had a rating scale with 5 levels to show the confidence level of subjects in solving the problems. Subjects chose the appropriate number, which shows their confidence level, rather than finding the answer. The structure of the scale was kept the same as MSES to maintain the construct validity. Since the purpose of the present study was to measure self-efficacy in trigonometry, the trigonometry problems were adopted from textbooks according to the objectives determined by the Ministry of Education. Since the instrument was developed for this specific setting, it was necessary to use Ministry of Education curriculum objectives for content validity of the instrument. These objectives were trigonometric functions, graphs of trigonometric functions, inverse trigonometric functions, addition and summation formulas, trigonometric relations in a triangle, and trigonometric equations. There were 18 items in total to cover six objectives. Figure 2 depicts a sample item from the STSES, related to graphs of functions. To assess the reliability of STSES, Cronbach's alpha was computed and found to be .90, which indicates that the items form a scale that has good internal consistency.

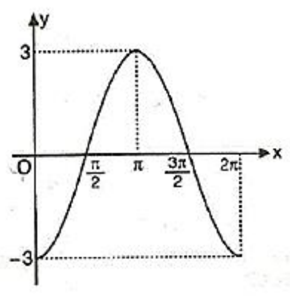
9.Draw the graph of the following function :$h(x) = tanx$

My confidence level to solve above problem:

1 2 3 4 5

*Figure 2.*Sample item from the STSES.

The STAT was used to measure students' trigonometry achievement. The test was developed by the authors using the same procedure as the STSES to choose trigonometry questions based on the curriculum objectives of the Ministry of Education. Using national curriculum objectives also allowed authors to have instruments which were parallel to each other in nature. In total there were 13 questions to cover all the objectives. Since some objectives are basic knowledge objectives and also some achievement test items measured more than one objective, there were less achievement test items compared to STSES (18 items). STSES items were asking students about their perception of being able to solve the question, but students actually solved STAT items. Because of that, the items were not identical but addressing same trigonometry knowledge and skills. The multiple-choice questions were to be completed in 40 minutes. A group of experts was consulted to check the relevance of the questions to the intended objectives. These experts were a mathematics education researcher and three high school mathematics teachers who had at least five years' experience teaching mathematics. Their suggestions were considered. An example question from the STAT is shown in Figure 3. This item is related to the objective of graphs of functions. In a pilot study with 64 tenth grade students, the Cronbach's alpha value for the STAT was computed to be .77, which indicated that the items formed a scale that has good internal consistency.



Which of the functions corresponds to the above graph?

A) $f(x)=cos3x$ B) $f(x)=-3sinx$ C) $f(x)=-3cosx$

D) $f(x)=sin3x$ E) $f(x)=3sinx$

Figure 3. Sample question from the STAT.

In addition to the above-mentioned instruments, a short interview was conducted with teachers in order to get information about their teaching efficacy for trigonometry. Teachers were asked to share their classroom experiences and teaching methods related to trigonometry teaching. In this way, we sought to gather information about their teaching trigonometry efficacy. The interview focused on trigonometry teaching moments because one's experiences related to a task are both one of the major sources and the outcome of the self-efficacy (Bandura, 1997; Lopez *et al.*, 1997; Pintrich & Schunck, 2002). So the experiences can provide clues about self-efficacy. Furthermore, as Philippou and Christou (1998) pointed out, "teachers' formative experiences in mathematics emerge as key players in the process of teaching since what they do in the classroom reflects their own thoughts and beliefs" (p. 191).

Previous studies of the features of high and low self-efficacy people (Pajares, 1996) were utilised. First, teachers' answers during the interviews were coded according to the presence of three codes which were derived from Bandura's theory of self-efficacy. These codes were *choices, effort, and thought patterns-emotions*. Detailed information about the development of coding can be found in Sarac and Aslan-Tutak (2013). If the code was present in a teacher's answers, it was marked as 1; if not, it was marked as 0. Teachers' answers were then used to categorise them as low (0-1 points) or high (2-3 points) for self-efficacy in teaching trigonometry. In order to ensure the reliability of using interview data, this coding and categorisation of teachers' interview transcripts was checked by mathematics education experts. Since codes were defined according to Bandura (1997), only one teachers' code about thought patterns-emotions was changed after the discussion. Because the scope of this manuscript is examining the relationship between teacher and student efficacıes interested readers may check authors' previous work (Sarac & Aslan-Tutak,2013) for further information about development of the codes and coding procedure.

Design and Statistical Analysis

The study was a correlation design. The resulting correlation coefficients indicate the degree of relationships between the paired scores. Correlation coefficient matrices were formed with teacher efficacy scores from two different instruments: student trigonometry self-efficacy scores and students' trigonometry achievement scores. The students were divided into three groups according to percentile ranks, so we evaluated students in the high and low ends separately. In this way, we sought to find the relationship between students who are at different achievement levels (low, average, high) and prevent the overgeneralisation of the scores. For each group, the means of the groups' scores were computed. Then the correlation coefficient was calculated between the teachers' scores and the mean of the low, middle and high percentile of students' scores. Hence, for each relationship, three different correlation coefficients were calculated. Therefore, we were able to see the relationship of teacher scores with low achieving (0%-25%), medium (26%-75%), and high achieving students (76%-100%).

In addition, for the comparison of the students of teachers having high trigonometry teaching efficacy and the students of teachers having low trigonometry teaching efficacy, a t-test was used to compare the scores of students from the STSES. The scores of students from the STAT were compared using the Mann Whitney U test, which is the non-parametric version of the t-test (Gay, Mills, & Airasian, 2009).

Results

Descriptive Findings

The mean, standard deviation, maximum, and minimum scores were calculated for the scores obtained from the instruments, as presented in Table 2. The highest scores from the TSES, SEBMTS, STSES, and STAT were 216, 70, 90, and 13, respectively. The mean score for students' trigonometry achievement test was 4.19, which is very low. One can infer that the achievement level of students was not high, although they were taught all of the topics addressed in the test.

Table 2
Descriptive Statistics

	N	Min	Max	Full scores	Mean	Standard Deviation
TSES	16	148	198	216	172.75	14.735
SEBTMTS	16	40	64	70	53.19	7.026
STSES	486	14	70	90	47.49	13.809
STAT	558	0	11	13	4.19	2.810

Correlation Analysis

All correlation analyses were conducted using the Spearman Rho correlation coefficients. Spearman Rho is the non-parametric version of the Pearson R. In this study Spearman Rho was preferred because the teacher related data was not normally distributed.

The aim of the study was to investigate the relationship between the teacher-related and student-related variables. Each teacher's score was compared to the means of the high, medium, and low percentile scores of their students, respectively, to see the relationship of teachers' scores with students from different levels. Please note that $p < .05$ for all correlations shown; non-significant correlations are omitted. Table 3 depicts the correlation coefficient matrices between teacher-related variables and student trigonometry self-efficacy.

Table 3
Correlational Coefficients between Teacher Efficacy Variables and Student Self-Efficacy

		TSES Scores	SEBMTS Scores
Students' Trigonometry Self-Efficacy Scores	Low	- .362	- .242
	Medium	- .297	- .189
	High	- .143	- .189

As seen in Table 3, no significant relationship was found between the two types of teacher efficacy, and the high, medium, and low scores of student trigonometry efficacy.

The same correlation calculations were done for teacher related variables and student trigonometry achievement and no significant relationship was found. The results are depicted in Table 4.

Table 4
Correlation Coefficients between Teacher Efficacy Variables and Student Achievement

		TSES	SEBTMTS
Students' Trigonometry Achievement Test Scores	Low	- .317	- .179
	Medium	.189	.284
	High	-.158	.081

Teachers' Trigonometry Teaching Efficacy

Thirteen teachers agreed to participate in the interview and discuss their trigonometry teaching experiences. The other three teachers declined for unknown reasons. So, for the trigonometry teaching efficacy part the other three teachers' data was not included. According to the interview findings, teachers were categorised as having high trigonometry teaching efficacy or low trigonometry teaching efficacy. The results of the codes are depicted in Table 5.

Table 5
Self-efficacy codes derived from the interviews

Teacher	Total	Category
A	3	High
B	3	High
C	2	High
D	2	High
E	2	High
F	2	High
G	2	High
H	1	Low
I	1	Low
J	0	Low
K	0	Low
L	0	Low
M	0	Low

As Table 5 demonstrates, six teachers were categorised as having low trigonometry teaching efficacy, while seven teachers were categorised as having high trigonometry teaching efficacy.

Trigonometry Teaching Efficacy and Student Variables

The students were grouped according to the teachers' level of teaching efficacy scores from the interview results. The students of the teachers with high trigonometry teaching self-efficacy formed one group (Sh) and the students of the teachers with low trigonometry teaching efficacy formed the other group (Sl). The means of STSES and STAT scores were calculated for both groups and compared. The descriptive statistics of the students' trigonometry self-efficacy scores are presented in Table 6.

Table 6
Descriptive Statistics Related to Sh and Sl Groups' Scores from the STSES

	N	Mean	Std Deviation
Sh	246	51.01	12.44
Sl	173	44.42	13.65

For this data, the t-test was applied to compare the means of two groups. The results demonstrated that there was a statistically significant difference between the trigonometry self-efficacy of students of high and low trigonometry teaching efficacy teachers, $t(417) = 5.04$, $p< 0,001$, $d= .51$. The students of teachers who had high trigonometry teaching efficacy scored higher (M=51.01, SD =12.44) than the students of teachers who had low trigonometry teaching efficacy (M=44.42, SD=13.65), and the effect size (Cohen's d = .51) was of medium value for the behavioural sciences (Leech, Barett, & Morgan, 2005). These results depicted that the students of teachers who had higher trigonometry teaching self-efficacy scores also had higher trigonometry self-efficacy than the students of teachers who had lower trigonometry teaching efficacy. The descriptive data for student trigonometry achievement test scores is presented in Table 7.

Table 7
Descriptive Statistics of Sh and Sl scores from STAT

	N	Mean	Standard Deviation
Sh	244	5.4	1.821
Sl	199	3.9	2.909

For STAT scores the data was not normally distributed, so for comparison of the means the Mann-Whitney U test was used. No significant difference was found between the mean trigonometry achievement scores of students of high trigonometry teaching efficacy teachers and the mean scores of students of low trigonometry teaching efficacy teachers.

Discussion

The purpose of this study was to investigate the relationship between teacher efficacy and student trigonometry self-efficacy and trigonometry achievement. We examined teaching efficacy from three different perspectives: general teaching efficacy, mathematics teaching efficacy, and trigonometry teaching efficacy. Teacher efficacy has been studied by several researchers (Tschannen-Moran, Woolfolk, & Hoy 1998; Tournaki & Podell, 2005; Gordon, 2001; Witcher, Onwuegbuzie, Collings, Witcher, Minor, & James, 2002; Woolfolk, Rosoff, & Hoy, 1990; Ross, 1992). However, the studies that investigate its relationship with student self-efficacy are limited in the literature. Also, teacher efficacy has been studied for more general topics, such as classroom management and teaching general subjects. In this study we investigated teacher trigonometry teaching efficacy alongside general teaching efficacy and mathematics teaching efficacy. The discussion consists of two parts. In the first part we discuss general teaching efficacy and mathematics teaching efficacy, while in the second part we focus on trigonometry teaching efficacy and its relationship with student trigonometry self-efficacy and trigonometry achievement.

General Teaching Efficacy, Mathematics Teaching Efficacy

In this study, contrary to other studies, student self-efficacy was measured on a specific topic, trigonometry, and no significant relationship was found between general teaching efficacy and student trigonometry efficacy, or between mathematics teaching efficacy and student trigonometry efficacy. The reason may be because measuring teacher efficacy from a broader perspective than the intended specificity, may be insufficient to detect the relationship with student trigonometry self-efficacy. This is consistent with Bandura’s (1997) recommendation of measuring self-efficacy as specifically as possible for the intended task. He proposes that teachers’ self-efficacy may differ between subject domains. It is an important contribution to the literature that in this study no relationship was found between a general self-efficacy domain and a specific one.

The findings about the research questions, the relationship of general teaching efficacy and mathematics teaching efficacy to student trigonometry achievement revealed no significant results, as in the case of student trigonometry self-efficacy. The previous studies found significant results between teaching efficacy and student achievement (Ashton et al. 1983; Rose & Medway, 1981). These studies were different from this research in that they looked for the students’ general achievement in academic areas. In this research, however, only trigonometry achievement was investigated. These inconsistent results can reasonably be attributed to the difference in specificity in the variables that were measured.

Teachers’ Trigonometry Teaching Efficacy

The research question about teacher trigonometry teaching efficacy and student trigonometry self-efficacy was investigated by comparing the results of the students of teachers who had high trigonometry teaching efficacy and low trigonometry teaching efficacy. T-test results depicted a significant difference between the scores of two groups. The students of higher trigonometry teaching efficacy teachers had higher trigonometry self-efficacy scores than students of low trigonometry teaching efficacy teachers. These results may point out that teacher trigonometry teaching efficacy can be an important element in predicting students’ trigonometry self-efficacy. Teacher efficacy can be associated with beliefs of students about their capability to do trigonometry. The previous studies also found that teacher efficacy is related to students’ motivation and attitudes toward the lessons (Nelson, 2007).

General teaching efficacy and mathematics teaching efficacy were not found to be related to the students’ trigonometry self-efficacy. However, when teaching efficacy and student trigonometry efficacy were compared in similar specific ways, significant difference was found. This shows the necessity of measuring self-efficacy according to the intended task and subject. Peoples’ self-efficacy may change from one task to another. In this case, self-efficacy was evaluated from general to more specific. The more general instances did not show significant results; however, the specific ones did. This might be evidence for the suggestion of Pajares (1996) that self-efficacy should be measured specifically to the intended content.

Another difference of trigonometry teaching efficacy from general teaching efficacy and mathematics teaching efficacy was the measurement technique. The researcher measured general teaching efficacy and mathematics teaching efficacy quantitatively. However, for the trigonometry teaching efficacy, an interview was used to categorise the teachers. This may also be evidence for the necessity of utilising qualitative techniques to get more in depth information. For instance, in some previous studies, a combination of observations and interviews was used to explore teaching efficacy (Mulholland & Walles, 2001; Philipou & Charalambous, 2005).

In relation to the research question about the difference between the students of teachers with high trigonometry teaching efficacy and low trigonometry teaching efficacy in terms of trigonometry achievement test scores, no significant results were found, contrary to the student trigonometry efficacy results. Previous studies have found that teachers' efficacy beliefs are related to their classroom management styles, management of classroom problems (Gordon2001), and teaching methods (Cousins & Walker, 2000; Gaith & Yaghi, 1997; Guskey, 1988). Hence, it was expected that teachers' self-efficacy maybe associated with the students' achievement. Moreover, in some studies direct relationships were found between teachers' self-efficacy and student achievement (Ashton et al., 1983; Ross, 1992). Though we expected to find differences between two groups of students in this study, no such differences were found.

One reason for this inconsistent result could be the low achievement test scores of the students. Students' trigonometry achievement mean scores were very low for both groups. In the region of the study, the schools are very crowded, and students' mathematics levels were not high. Hence, for more detailed information about students' achievement, further investigation including observations and interviews with students might be more enlightening.

The schools in the region of the study were different from the ones in other studies. Generally, students' achievement levels were low. When the school factor is considered, the results of this study are consistent with the previous study done by Winters (2000). He researched the relationships between teacher efficacy and student achievement in schools with high poverty levels similar to the present study, and he also did not find any significant results.

The insignificant results of the study might also be an indicator that teacher trigonometry teaching efficacy might be insufficient to explain student trigonometry achievement when it is evaluated alone. Some other factors could be related, such as teacher content knowledge and teaching methods. Teacher efficacy might be searched together with these variables to get further information about this topic. For instance, in the study of Swars (2005), teacher content knowledge was found to be an important element for effective instruction. Also, some detailed observations of class instruction may be necessary to get a better picture of the nature of this issue. The previous studies that found relationships between teacher efficacy and student achievement also included classroom observations and interviews (Ashton *et al*., 1983; Ross, 1992). This study, on the other hand, was inconclusive on the question of whether trigonometry teaching efficacy is related to student trigonometry achievement.

Conclusion

The findings for the relation of general teaching efficacy and mathematics teaching efficacy to student trigonometry self-efficacy showed no significant correlation. The t-test results for teacher trigonometry teaching efficacy, on the other hand, indicated a significant correlation with student trigonometry self-efficacy. Finally, the student achievement test comparisons for trigonometry teaching efficacy did not show significant results for the present study.

To sum up, this study supports that teacher efficacy can be different for general, mathematics, and a specific topic such as trigonometry. Our interest was in trigonometry, and when the researchers compared trigonometry related variables, the results were significant. This can be considered as evidence of the importance of studying self-efficacy in specific subjects and contexts. Furthermore in schools where achievement is not high, the results for the relationship between teacher trigonometry efficacy and student trigonometry achievement have been inconclusive. The achievement levels of students did not differ, suggesting that factors other than teacher efficacy can be related to students' achievement. It is also important to note that the sample of this research was limited to certain districts of Istanbul, and these results cannot be generalised to all of Turkey.

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