THE RELATION OF TEACHER EFFICACY TO STUDENTS' TRIGONOMETRY SELF-EFFICACY AND TRIGONOMETRY ACHIEVEMENT

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Dedicated to my family
for their unconditional love and support

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ABSTRACT

THE RELATION OF TEACHER EFFICACAY TO STUDENTS' TRIGONOMETRY SELF-EFFICACY AND STUDENTS' TRIGONOMETRY ACHIEVMENT

The purpose of the present study is to investigate the relationship between teacher efficacy to student trigonometry self-efficacy and student trigonometry achievement. Teacher efficacy was searched through three different variables: general teaching efficacy, mathematics teaching efficacy and trigonometry teaching efficacy. The sample of this study consisted of 16 mathematics teachers (n_1=16) and their tenth grade students (n_2=571) from seven different schools in Istanbul. The teachers completed Teachers' Sense of Efficacy Scale and Self Efficacy Beliefs toward Teaching Mathematics Scale and students completed Student Trigonometry Self-Efficacy Scale and Students Trigonometry Achievement Test. Also, there were semi-structured short interviews with teachers on their trigonometry teaching experiences, in order to study their trigonometry teaching efficacy. According to the interview findings they were categorized as having high trigonometry teaching efficacy and low trigonometry teaching efficacy. No significant correlation was found between general teaching efficacy and mathematics teaching efficacy with student variables of student trigonometry self-efficacy and student trigonometry achievement. The t-test results showed that students of teachers having high trigonometry teaching efficacy get higher scores on trigonometry self- efficacy scale than the students of teachers having low trigonometry teaching efficacy. Between the students' achievement test scores, on the other hand, no significant difference was found.

ÖZET

ÖĞRETMEN ÖZ-YETERLİLİĞİNİN ÖĞRENCİ TRİGONOMETRİ ÖZ-YETERLİLİĞİ VE ÖĞRENCİ TRİGONOMETRİ BAŞARISI İLE İLİŞKİSİ

Bu çalışmanın amacı, öğretmen öz-yeterliliğinin, öğrenci trigonometri öz-yeterliliği ve öğrenci trigonometri başarısı ile ilişkisini araştırmaktır. Öğretmen öz-yeterliliğine üç ayrı değişken vasıtasıyla bakılmıştır: genel öğretmen öz-yeterliliği, matematik öğretimine yönelik öz-yeterlilik ve trigonometri öğretimine yönelik öz-yeterlilik. Bu araştırmaya yedi ayrı okuldan 16 matematik öğretmeni (n_1=16) ve bu öğretmenlerin 10. sınıf öğrencileri (n_2=571) katılmıştır. Öğretmenler, Öğretmen Öz-Yeterlilik Ölçeği ve Matematik Öğretimine Yönelik Öz-Yeterlilik Ölçeği'ni, öğrenciler ise Öğrenci Trigonometri Öz-Yeterlilik Ölçeği ve Öğrenci Trigonometri Başarı Testi'ni cevaplamıştır. Ayrıca, öğretmenlerin trigonometri öğretimine yönelik öz-yeterliliklerini belirlemek amacıyla, onlarla trigonometri deneyimleri hakkında röportaj yapılmıştır. Bu röportaj bulgularına göre öğretmenler, trigonometri öğretme öz-yeterliliği yüksek ve trigonometri öğretme öz-yeterliliği düşük olmak üzere iki gruba ayrılmıştır. Yapılan çalışmada, genel öğretmen öz-yeterliliği ve matematik öğretimine yönelik öz-yeterlilik değişkenleri ile öğrenci değişkenleri arasında anlamlı korelasyon bulunmamıştır. Yapılan t-testi sonuçlarında ise, trigonometri öğretme öz-yeterliliği yüksek olan öğretmenlerin öğrencilerinin, düşük olan öğretmenlerin öğrencilerine göre, öğrenci trigonometri öz-yeterlilik ölçeğinden anlamlı düzeyde daha yüksek sonuçlar aldıkları görülmüştür. Buna karşın, iki gruptaki öğrencilerin trigonometri başarı testi sonuçlarında anlamlı bir farklılık bulunmamıştır.

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1. INTRODUCTION

The students' believes about their capability regarded as their self-efficacy has an important role in the motivation and academic achievement of students. Students tend to work and put more effort on their studies when they believe they can do it. Otherwise, they may get easily bored from the subject and lose their desire to work on it. Especially, in later grades such as high school and college they may develop a kind of resistance to the subjects related with mathematics so that they do not want to study.

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 knowledge of self, how a person perceived himself or herself. Self–efficacy beliefs defined as peoples' perception of their abilities to do specific tasks. It can simply be explained as beliefs people hold about if they can achieve or not.

Bandura's research (1997) on self-efficacy has shed light on how humans use their personal confidence related to specific tasks. People with high self-efficacy expect favorable outcomes, while those who doubt themselves expect ordinary or dull performances, which result in negative outcomes (Bandura, 1982). When people have high self-efficacy in certain areas they tend to involve in activities which are related to those areas. They spend more time and devote more effort in those activities which may result in increased achievement. On the other hand, people tend to avoid the task which they have low self-efficacy. They develop negative feelings such as anxiety and stress when they believe they will not be successful. Hence, self-efficacy can be considered as a mediator between ability and action.

According to Bandura (1997) four sources influence the level of self-efficacy: mastery experiences, vicarious experiences, social persuasion, and physiological and affective states. Mastery experiences are the actual successful or unsuccessful outcomes of performing the task. 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 perform the task. Social persuasion refers to having encouragements from someone who is more knowledgeable to perform the task. Physiological and affective states are the physical and mental processes that may interfere with the performance of the task, such as exhaustion or anxiety.

Self-efficacy has important role in mathematics education also. The need for self-efficacy or a person's belief in his or her capabilities, toward mathematics has been addressed in the mathematics education objectives of Ministry of Education (MEB, 2005) in Turkey, which states that self-efficacy is an important part of shaping students' lives so it is essential for educators to foster high self-efficacy in their classrooms. This issue is also mentioned in the Curriculum and Evaluation Standards for School Mathematics (National Council of Teaching Mathematics (NCTM), 2000), which states that one goal for students is that they become confident in their ability to do mathematics. Furthermore, the relationship between self-efficacy and mathematics achievement is studied in several studies and the results depicted positive relation (Lopez *et al.*, 1997; Pietsch *et al.* 2003; Usher, 2009). Also, some of them revealed that high self-efficacy students are more able to control and monitor their learning and use cognitive strategies that help their learning.

Teachers are a key instrument in helping students to develop positive beliefs about their capabilities. Their classroom experiences and social interactions with other students may influence students' mathematics self-efficacy. This self-efficacy formed in school will likely be carried with them for a lifetime. Hence, teachers should create classroom environments that are favorable for learning and experiencing accomplishments for students. Siegle and McCoach (2007) stated that teachers can modify their instructional strategies and this can result in increases in their students' self-efficacy.

One potential way of identifying highly effective teachers seems to be through an individual's level of teacher efficacy. Teacher efficacy has been defined as how competent the teacher feels in his or her ability to affect the performance of all students, no matter how unmotivated the students are or how difficult the teaching topic is (Tschannen-Moran *et al.*, 2001). Studies have shown that highly effective teachers tend to have high levels of teacher efficacy (Ghaith and Yaghi, 1997).

In fact, a number of studies have concluded that teachers with high levels of efficacy differ significantly from teachers with low levels of efficacy. Teachers with a strong sense of efficacy tend to exhibit greater levels of planning, organization, and enthusiasm (Allinder, 1994) and spend more time teaching in subject areas where their sense of efficacy is higher (Riggs and Enochs,1990), whereas teachers tend to avoid subjects when efficacy is lower (Riggs, 1995). Teachers with higher efficacy judgments tend to be more open to new ideas, more willing to experiment with new methods to better meet the needs of their students (Cousins and Walker, 2000), and more committed to teaching (Coladarci, 1992). Specifically, high efficacy teachers demonstrate more effective teacher behaviors that lead to higher student achievement (Ashton *et al*., 1983; Gibson and Dembo, 1984; Guskey, 1988).

Taking everything into consideration, teachers who believe in their role for effective learning and who have confidence in their ability to teach, put more effort in teaching and use more diverse teaching strategies in class. The effective teaching methods may have positive effect on the learning of their students as well as their desire to work on the subject which in turn may influence students' self-efficacy beliefs toward mathematics. When students learn effectively and experience repeated success they may develop beliefs that they can achieve in mathematics. Hence, teachers' efficacy beliefs may be related with students' mathematics achievement and mathematics self-efficacy. For this study trigonometry topic was studied. Trigonometry is one of the important subjects of high school mathematics curriculum (Sağlam *et al.*, 2007). It is one of the topics students have difficulty in understanding, on the other hand (Tatar *et al.*, 2008).

Therefore, 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 trigonometry achievement. Teacher efficacy was investigated through three different variables: general teaching efficacy, mathematics teaching efficacy and trigonometry teaching efficacy. These three variables were main components of a teacher's self-efficacy for teaching a topic namely trigonometry. These variables were taken separately since Bandura (1982) suggests that self-efficacy can change for different subjects and situations. So we would like to investigate the relationship with a particular topic.

2. REVIEW OF LITERATURE

Self-efficacy, one's beliefs about their ability to accomplish, has effects on academic settings. Student self-efficacy and teacher efficacy are the concepts which were the focus of this study. The literature review will begin with the introduction of self-efficacy in relation with the social cognitive theory and the sources that it stems from as well as its effects on people's lives. The student self-efficacy will follow with its relation to academic settings. Moreover, teacher efficacy will be introduced and its effects on instruction and classroom environment will be discussed. In the last part, trigonometry education will be included.

2.1. Self-Efficacy

Self–efficacy was defined as personal judgments of one's capabilities to organize and execute courses of action to attain designated goals (Bandura, 1997). Namely, they are the beliefs people hold about whether they are capable or not to execute specific tasks.

Social cognitive theory is about the human capacity to control over the nature and quality of one's life (Bandura, 2001). According to this theory humans possess a self mechanism which enables them to control their thoughts, feelings, motivation and actions. Self-efficacy is also connected with this mechanism by effecting the 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. Furthermore, according to the strength of the self-efficacy beliefs, people arrive at judgments about future accomplishments before they actually perform the task. On the other hand, self-efficacy influence the people's self regulating behavior. People, who are more confident in their ability, see the difficulties as manageable through some efforts. Hence, they make necessary changes in their behaviors and regulate their actions in order to achieve the desired outcomes.

2.1.1. Sources of Self-Efficacy

As it was discussed self-efficacy affects people's decisions and choices so it is important to understand the formation of these beliefs to study it. According to Bandura

(1997) self- efficacy is derived from four sources which are *mastery experiences, vicarious learning, verbal persuasion* and *affective and emotional states*. *Mastery experiences* are the most influential ones of these factors (Bandura, 1997). People execute several performances. They make judgments about their experiences and they use these judgments while developing their self-efficacy beliefs. Later, they behave according to the formed self-efficacy beliefs. Experiencing success enhances self-efficacy while experiencing failure undermines it. Research studies which explored mastery experiences have shown that performance accomplishment exerts more influence over self-efficacy beliefs than objective assessments (e.g. college mathematics course grades) (Lopez *et al.*, 1997). It should be noted that success is not always influence self-efficacy. In order it to affect self-efficacy positively; the experience should be attributed to self effort and person's ability. If the success attributed to luck or other people's effort then it may not contribute to the self-efficacy (Pintrich and Schunk, 2002).

Besides learning from own experiences, people also learn from observing others which is called *vicarious learning*. People may develop their self-efficacy to evaluating the outcomes of other people's actions. It should be stated that vicarious learning is not as influential as the mastery experiences. People generally use these indirect experience judgments when they have limited experiences with the situation. According to Bandura (1997), the effect of vicarious experiences will be stronger when the observed model and action are more similar to the observer. It can be explained as people who have models that are successful in certain tasks developed thoughts that the task is achievable. Hence their self-efficacy will be affected positively. For example, students who observe similar peers accomplishing a task may form the idea that they too are capable of to accomplishing it (Schunk, 1991). Observing teachers also has influence on the achievement of students (Osterman, 2000). Besides teaching the content and providing necessary learning experience, teachers are vital for students by being a model for them.

Verbal persuasions, the third source of self-efficacy, are the received messages from others about the performance. Positive evaluations from teachers, parents or friends can increase a student's confidence in his ability. On the other hand, negative evaluations from other people have undermining effect on the self-efficacy (Pajares, 1996). In a research study by Klassen (2004), it was suggested that verbal positive or negative evaluations are

important to some students for their achievement (i.g. females and minorities). Bandura (1997) stated that the effect of negative evaluations is more detrimental and resistant to change than the effect of positive evaluations.

Emotional and physiological states are the self reactions people give to the specific tasks that they perform. Strong emotional reactions to a task give clues about whether a person will experience success or failure. For example, experiencing stress, increased heart rate may be received by individuals as a signal of lack of ability to perform a task (Schunk, 1991). On the other hand, Usher and Pajares (2008) suggested that experiencing positive mood together with success has a positive effect on the self-efficacy of students. Students with high self-efficacy experience joy and happiness but the ones with low self-efficacy experience anxiety (Pintrich and De Groot, 1990). It is concluded that to enhance the self-efficacy, it should be also aimed to physiological and emotional well-being of the individual.

Usher (2009) studied the sources of self-efficacy. He worked with eighth grade students. He interviewed with both low and high math self-efficacy students. Findings of the study showed that students' self-efficacy is affected by Bandura's (1997) four sources: Mastery experiences, vicarious learning, social persuasion from others and physiological states. Students who experience success and mastered the subject reported higher efficacy. Also, they said that modeling others such as parents affect their beliefs about mathematics whether they can achieve or not. Furthermore, prompts from teachers during lessons reported to be influential in the formation of high self-efficacy. Lastly, students told that their feelings about the task such as joy and excitement helped them to do better increasing their self-efficacy while distress and anxiety paralyzed them hindering their self-efficacy.

2.1.2. Self-Efficacy and Self-Concept

It may be helpful to discuss differences between self-efficacy and self concept to understand self-efficacy better. Self-concept was defined as individuals' ratings of their abilities in general areas (Pajares and Miller, 1994). Self-concept differs from self-efficacy in that self-efficacy is a context-specific assessment of competence to perform a particular task, a judgment of one's capabilities to execute certain behaviors in specific situations.

Self-concept is not measured at that level of specificity and includes beliefs of self-worth associated with one's perceived competence. It is clear that beliefs regarding confidence are part of an individual's self-concept, but Bandura (1982) argued that self-concept and self-efficacy represent different phenomena and must not be confused with each other. For example, an individual may feel confident about his ability to cooking deserts but she may not feel so confident to cook meals. In this situation her self-efficacy cannot be generalized to cooking all kind of food. Beside task-specificity, the context of the action is also important for self-efficacy. For example the same person may feel confident cooking in her own kitchen alone, and may not feel so confident to cook another persons' home. When academic settings considered, a student may feel confident to solve problems related with quadratic equations whereas he may not feel so confident to solve problems related with trigonometric equations. For instance, a teacher's level of efficacy for teaching multiplication may be high in a classroom of high ability students and low in a classroom of special education students. Also, a teacher's efficacy may be high in teaching algebra whereas it can be low for teaching probability. Self efficacy may change for different tasks and situations so we need content specific self-efficacy studies.

Lopez and his colleagues (1997) studied the effect of self-efficacy and self-concept on the career choice. Research participants were 205 introductory psychology students (54 men, 151 women) at a university in US. Students completed measures of demographic characteristics, academic self-concept, self-efficacy, and occupational aspirations in group testing sessions. They examined the utility of the self-efficacy and self-concept factors in predicting three dependent variables: (i) the mathematics-relatedness of students' occupational aspirations, (ii) grades earned in mathematics and science-based courses, and (iii) grades earned across all courses in the subsequent academic term. Findings suggested that mathematics self-efficacy beliefs are related with students' occupational aspirations and grades that are received from mathematics and science related courses. Self- concept on the other hand, is a good predictor of the grades earned across all courses in the following term. These results emphasize that self-efficacy and academic self-concept are not interchangeable terms. Self- efficacy is a good predictor when the specific domain is analyzed. However, self-concept is for more general areas and domains, which is parallel to other studies (Pajares and Miller, 1994; Bandura, 1997). It is concluded that self-

efficacy predicts math-related choice and performance criteria and that academic self-concept relates to overall grade performance.

2.1.3. Role of Self-Efficacy

Self-efficacy has influence on the lives of individuals through four means which are goal setting, motivation, perceived ability, and interest (Bandura, 1997). If a person believes he or she is fully capable of completing a task and achieving the desired result, she will set appropriate goals, be fully motivated, perceive her ability level to be adequate to the task, and will be interested in the outcome. A person with a low level of self-efficacy for the task will set incomplete goals, lose motivation, perceive his ability as incompetent, and lose interest in completing the task. Two people may have the same skills and knowledge to complete a task but may perform in entirely dissimilar manners if their level of efficacy differs significantly (Bandura, 1997).

Self-efficacy has great impact on academic outcomes. Self-efficacy influence behaviors of students in three ways: choices, effort level, thought patterns and emotional reactions. A student's choice of behavior is the first way student behavior is influenced. Students are more likely to engage in a task in which they feel competent and confident and will avoid those in which they do not feel that way. The second way that self-efficacy beliefs influence student behavior is that they help determine how much effort one will put into an activity and how long they will persist in it. The higher the level of self-efficacy, the more effort a student will give and the longer will be his perseverance in a given task (Pajares, 1996). Finally, self-efficacy beliefs influence an individual's thought patterns and emotional reactions. Students with high self-efficacy are comfortable when approaching difficult tasks. Conversely, students with low self-efficacy beliefs may believe that things are harder than they really are. This belief brings them stress and a narrow vision of how best to solve a problem (Pajares, 1996).

In conclusion, self-efficacy is derived from four sources defined as mastery experiences, vicarious learning, verbal persuasions, and emotional and physiological states. Self-efficacy determines choices people make, effort level they put on a job, their thought

patterns and emotional reactions. Those means affect the peoples' decision making and the outcome.

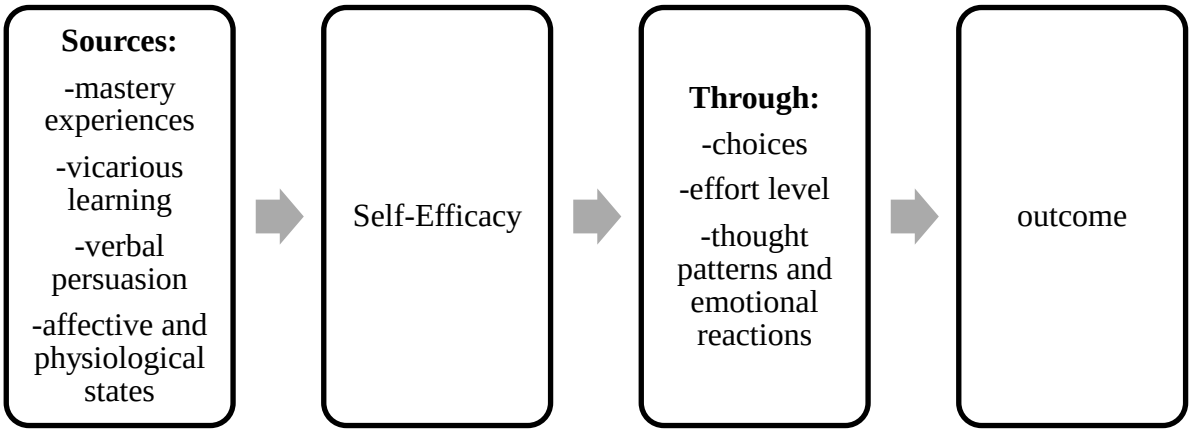


Figure 2.1. Self-efficacy, Its Sources and Consequences.

Self-efficacy plays crucial roles by affecting motivation and achievement of students in academic settings (Pajares, 1996; Zimmerman, 2000). It is essential to examine the relationship between student self-efficacy and teacher efficacy in order to understand self-efficacy in academic settings.

2.2. Student Self-Efficacy

Self-efficacy affects students' choices, effort level they put on the learning task and their thought patterns and emotions. Students with high self-efficacy willingly choose to participate to the activity. Also, they put more effort and study harder. They are less anxious during the activity. All these contribute to the academic performance and achievement of students (Pajares, 1997).

Self-efficacy has an influential role when students make decisions on choices in academic settings. There have been several studies that have focused on the influence of self-efficacy beliefs on the college major choice and career decisions. For instance, Betz and Hackett (1983) suggested that self-efficacy perception plays a major role in influencing educational and career decisions. In another study of Taylor and Betz (1983), it

is reported that there is a direct relationship between the levels of self-efficacy belief and the levels of career decisions. There are factors that are considered to be essential to successfully deciding the desired vocation. These factors are perception of career options and persistence in the chosen educational program. There has been found evidence linking self-efficacy beliefs to both of these factors (Betz and Hackett, 1981; Lent *et al.*, 1984). In these career related studies, it is said that highly efficacious students made more effective career decisions, perceived more extensive career options and persisted toward their educational aspirations. Students with low self-efficacy were less decisive, perceived more career option limitations and were less persistent in their educational aspirations.

Similar to the above studies, Özyürek (2005) studied the relationship between sources of mathematics self-efficacy, mathematics self-efficacy, interest, and mathematics related major preferences. The sample of the study consists of 5590 high school students in Turkey. Students completed instruments of sources of self-efficacy, self-efficacy, interest, and mathematics related major choices. Mathematics self-efficacy and mathematics interest were found to be related. On the other hand, contrary to the findings of previous studies (Betz and Hackett, 1981; Lent *et al*., 1984; Lopez *et al*., 1997), mathematics related major preferences were not found to be significantly related with mathematics self-efficacy and interest. It is mentioned that this could be due to the constrained and complex system of the university placement in Turkey. Students tend to make their choices according to their scores from university exam rather than their interest. It is recommended researchers to do further studies about the self-efficacy theory in Turkey.

Another study related with self-efficacy and career choice has been carried out by O'Brien and his colleagues (1999). In their study, they aimed to examine gender, ethnicity, career choice, mathematics self-efficacy. Results of the study showed that there is a significant association of self-efficacy with interest in a career in science and engineering. Also, it is stated that self-efficacy was predicted by prior academic performance. In addition, gender predicted students' career interests in science and engineering and ethnic identity significantly predicted mathematics self-efficacy.

These studies suggest that mathematics self-efficacy determines the careers that students will pursue by directly affecting their choices. Not only their choices but the way they assess the opportunities also is influenced by self-efficacy.

Self-efficacy influence the quality of effort students put on the task. By quality of effort it is meant that the cognitive engagement of students to the lesson and their deep processing the knowledge in their mind. During the lessons, students should involve cognitively in the learning process. They need to build their own thinking patterns and they need to question the learning material. Rather than just receiving the given information they should reason and build connections to the existing knowledge. These factors are also linked to self-efficacy. For example, Pintrich and De Groot (1990) found that junior high school students with high self-efficacy were more likely to report using various cognitive strategies that help learning. It is a correlational study examined relationships between motivational orientation, self-regulated learning, and classroom academic performance for 173 seventh graders from eight science and seven English classes. A self-report measure of student self-efficacy, intrinsic value, test anxiety, self-regulation, and use of learning strategies was administered, and performance data were obtained from work on classroom assignments. Self-efficacy and intrinsic value were positively related to cognitive engagement and performance. Also, self-regulation, self-efficacy, and test anxiety emerged as the best predictors of performance. Intrinsic value did not have a direct influence on performance but was strongly related to self-regulation and cognitive strategy use, regardless of prior achievement level.

Similarly, Usher (2009) investigated that there is strong relation between the self-efficacy and the self regulated learning behaviors of students. Students who cannot maintain habitual study time and place, who do not have organizational skills and who had difficulty in following the covered material in class are also those who have low mathematic self-efficacy. On the other hand, the ones who have strong self regulatory study skills have more confidence on their ability to success. These findings are also parallel with the Bandura's (1997) proposal. He claims that students are rarely implementing self regulatory strategies unless they believe that they can achieve. He states that students with high self-efficacy believe they do well and put more effort while

students with a low self-efficacy "recounted their poor performance and struggles (Bandura, 1997, p. 307)."

Besides having impact on the cognitive side of the students such as using better learning strategies, self-regulated behaviors and putting more effort, self-efficacy is also related with emotions and values of the students. As emotional beliefs influence self-efficacy (Bandura, 1997), efficacy also influence emotional beliefs (Wright and Mischel, 1992). 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 *et al*., 1996; Pintrich and De Groot, 1990). The negative emotions are more likely to occur in those with low self-efficacy, since they won't believe they will achieve their goals and therefore they become desperate and hopeless of the situation.

Students' confidence about their ability to overcome certain academic tasks can influence them by decreasing their stress, anxiety and depression (Bandura, 1997). For example, Pajares and Kranzler (1995) studied the relationship between self- efficacy and students' anxiety reactions regarding mathematics. Although the two measures were negatively correlated, only self-efficacy was predictor of mathematics achievement. It is also possible that students' performance in academically threatening situations depends more on efficacy beliefs than on anxiety arousal. This study provides evidence of the importance of self-efficacy measures and they suggest educators to focus on fostering a positive sense of personal efficacy rather than diminishing anxiety.

2.2.1. Self-Efficacy and Academic Achievement

The outcomes of students' self-efficacy can be studied by student achievement. Bandura (1997) claims that students' academic achievement is directly tied to self motivational factors such as will to execute certain tasks and interest in that task. If one has a confidence in his ability to execute a task, he will be more motivated to do that task. Therefore, self-efficacy is one of the powerful concepts to predict the performance of students in academic settings (Pajares, 1996).

Self-efficacy affects academic performance which refers to how students deal with their studies and how they cope with or accomplish different tasks related with the academic domain. It influences academic performance through some crucial elements of motivation; as choice of activities, level of effort, persistence and emotional reactions. Students with high self-efficacy participate more willingly to the lessons. They work harder and persist longer on the job. They, also, use more effective learning strategies and self-regulate better than others (Bong, 1997). All these factors may contribute to their achievement (Bandura, 1997).

Wolters and Pintrich (1998) aimed to investigate the differences in the students' level of motivation and self-regulated learning for the subject areas of mathematics, social studies, and English. Motivation is defined in terms of self-efficacy, task value, and anxiety, whereas self-regulated learning is defined in terms of students' cognitive and regulatory strategy use. Results of mathematics, English, and social studies showed that students who reported greater self-efficacy were more likely to report using cognitive strategies than students who reported less self-efficacy. While greater levels of self-efficacy were associated with greater reported use of regulatory strategies, students who reported higher levels of anxiety were less likely to report engaging in regulatory strategy use across all three subject areas. In all three subject areas, students with greater self-efficacy, on average, received higher classroom grades than students with lower self-efficacy.

These studies are providing evidence that students with high self-efficacy show more effective self regulatory behaviors. They set higher goals to achieve. They monitor their academic work more effectively and they persist on the task when they face challenges. All these factors serve as a tenet to improve academic achievement (Zimmerman, 2000).

Lopez *et al*., (1997) have studied mathematics self-efficacy, mathematics ability and academic performance. They argue that both self-efficacy and ability effect task performance and self-efficacy determines how effectively students' use their abilities. Mathematics self-efficacy was assessed with scales that were linked to the specific content such as geometry and advanced algebra courses. The results suggest that objective ability affects self-efficacy largely via its relation to perceived past performance. It is supported

that ability affects grades both directly (via cognitive skills) and indirectly (through self-efficacy). Objective ability and self-efficacy each significantly related with the course grades. It can be concluded that ability affects both grades and future academic performance through cognitive skills and self-efficacy.

Erdoğan and his colleagues (2009) conducted a study of the relationship between self-efficacy toward geometry and geometry achievement of tenth grade students. Also they looked if there is a significant gender difference in students' self-efficacy toward geometry. The results show that there is a significant relation between the self-efficacy beliefs and geometry achievement of students. On the other hand, no significant difference was found in terms of gender. This study suggests that geometry self-efficacy and geometry achievement are interrelated.

Self-efficacy was also studied together with self-concept in some studies. These studies are crucial in providing evidence that those two concepts are different from each other. For example Pietsch and his colleagues (2003) studied the relationship among self-concept, self-efficacy, and performance in mathematics by examining 416 high school students. Students completed a questionnaire assessing mathematics self-concept and mathematics self-efficacy. Performance was assessed using exam results in mathematics. The results of the study suggest that self-efficacy measures are more suitable measures for predicting future performance in mathematics than self-concept. Hence it is suggested that when evaluating the specific subjects it is better to utilize from self-efficacy measures.

Pajares and Miller (1994) also studied the self-concept and self-efficacy on a more specific domain namely, problem solving skills. They reported that math self-efficacy had stronger direct effects on math problem solving than did self concept, perceived usefulness, or prior experience. In addition, they tested whether self-efficacy mediated the effect of gender and prior experience on both the common mechanisms and problem-solving performance. It was found that self-efficacy had stronger direct effects on performance than did any of the variables in the study. Math self-concept and high school level each had modest direct effects. Moreover, prior experience and gender affected performance largely through their influence on self-efficacy. The indirect effects of these variables on performance were, in fact, also largely a result of self-efficacy. The authors also stated that

‘Students who lack confidence in skill they possess are not likely to engage in tasks in which those skills are required, and they will exert less effort and persistence in the face of difficulty’ (p. 201).

These studies related to student self-efficacy and achievement 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). Findings from academic achievement research have recognized that students’ self-efficacy beliefs are an important factor in determining their academic motivation, learning and achievement. This depicts the importance and necessity of researching this variable to understand the factors that affect achievement of students.

Furthermore, educators should be aware of this and try to enhance the student self-efficacy. Teachers can modify their instructional strategies and create effective learning environments so that their students experience more success and develop the belief that ‘I can do it’. This may increase the self-efficacy of students (Siegle and McCoach, 2007). Bandura (1997) advocates that an important component necessary for creating these learning environments is the teacher’s belief in their personal and professional instructional efficacy which is referred as the teacher efficacy.

2.3. Teacher Efficacy

Teacher efficacy has been explored along two different perspectives. First one is the locus of control which developed by Rotter (1966). Locus of control emphasizes the idea of attributing the consequences of an action to an internal force or to an outside force. In this view the teacher efficacy defined as the level of control a teacher believed they had over students’ achievement and motivation (Tschannen-Moran *et al.*, 2001). In this perspective, teacher efficacy evaluated through: (i) a teachers’ view about his or her power over outside influences which is referred as the general teaching efficacy and (ii) his or her confidence in teaching by using different strategies to help student learning which personal teaching efficacy is. For example, according to this view a teacher who has high general self-efficacy believes that she or he can teach well whatever the situation. On the other

hand teachers with low self-efficacy tend to attribute the teaching well to the outside influences such as educational system or the inappropriate classroom environment.

Second view about teacher efficacy is based on the Bandura's (1997) social cognitive theory and specifically the concept of self-efficacy as described before. According to this theory teacher efficacy is defined as the level of belief a teacher has in his or her ability to affect student achievement. While the locus of control focuses on the actions and their affect on outcomes, the self-efficacy focuses on the internal belief of someone whether she or he can reach the desired outcome.

Over the last decades, researchers have explored the concept of teacher efficacy and have made suggestions toward expending the construct. Gibson and Dembo in 1984 defined two sub constructs for teacher efficacy: Personal teaching efficacy (PTE) and general teaching efficacy (GTE). PTE has been defined as a teacher's belief in his or her skills and abilities to positively impact student achievement, while GTE has been defined as a teacher's belief that the educational system can work for all students, regardless of outside influences such as socio-economic status and parental influence. Soodak and Podell (1996) argued that teacher efficacy was actually a three dimensional construct consisting of personal efficacy, outcome efficacy, and teaching efficacy. They defined *personal efficacy* as a teacher's belief that he or she has the necessary teaching skills. *Outcome efficacy* was defined as the belief that when the teaching skills are used they produce a desired student outcome. *Teaching efficacy* was defined as the belief that teachers can overcome the effects of all outside influences on their students. These definitions are not fully capture the Bandura's self-efficacy theory therefore researchers continue to work of redefining the term teacher efficacy.

Tschannen-Moran and her colleagues (1998) developed a model for teacher efficacy concept using the Bandura's (1997) self-efficacy theory. Their model starts with the four sources of Bandura's self-efficacy (mastery experiences, vicarious learning, social persuasion and, physiological and emotional states). These sources are cognitively processed by the individual and he analyzes the teaching task and assesses personal teaching competence. Through this processes the teacher reaches a conclusion about his or her teaching efficacy whether he or she will carry out the teaching performance

successfully. This level of efficacy determines the teaching performance and this experience becomes a new source of efficacy for the individual. Therefore this model proposes a cyclic relationship among teacher-efficacy and teaching performances. This model seems to more fully embrace the Bandura's model of self-efficacy.

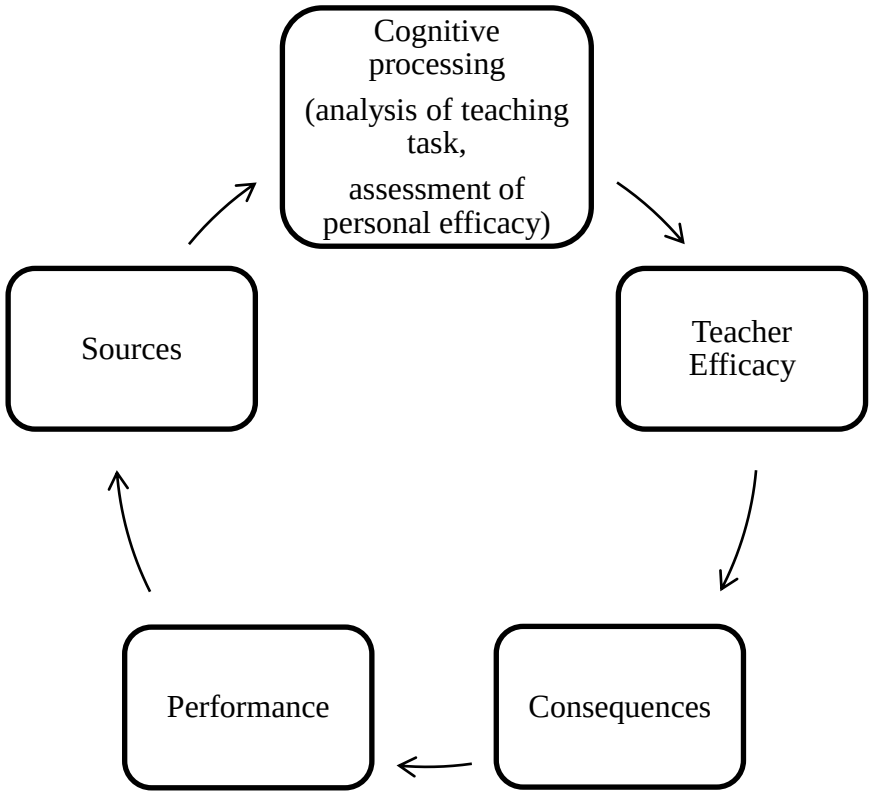


Figure. 2.2. The cyclical nature of teacher efficacy (Tschannen-Moran *et al*., 1998).

Teacher efficacy affects teaching performances and students achievements. Therefore it can be stated that it has an important role in academic settings and classroom environment. So it is important to understand the factors that teacher efficacy stems from.

2.3.1. Factors that Affect Teacher Efficacy

There are several factors that affect teacher efficacy. These factors can be can be categorized into two main headings: (i) Bandura's four efficacy sources, (ii) school related variables.

2.3.1.1. Bandura's Sources of 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 (Swars, 2005; Charalambus *et al.*, 2008) as well as social persuasion and teacher efficacy (Poulou, 2007; Mulholland and Wallace, 2001; Philippou and Charalambous, 2005).

Studies (Poulou, 2007; Mulholland and Wallace, 2001) determined that mastery experiences and social persuasion were the strongest of Bandura's influences. The results revealed that motivation, personality characteristics, and mastery experiences with social persuasion all received high mean scores. Vicarious experiences and physical/affective states received the lowest mean scores. Motivation was also a significant predictor for efficacy for student engagement. Computing multiple regression using only Bandura's sources revealed that mastery experiences with social persuasion significantly predicted all three factors of the TSES (efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement).

Mulholland and Wallace (2001) conducted a case study of one Australian elementary teacher as she transitioned from a pre-service teacher role into an in-service teacher role in order to explore possible influences on her level of science teaching efficacy. Through interviews and observations, the researchers determined that mastery experiences, in the form of successful and unsuccessful lessons, had the greatest impact on her perceived level of science teaching efficacy. Social persuasion from other teachers and from her students also impacted teacher efficacy levels. Vicarious experiences appeared to have a slightly negative impact on her level of science teaching efficacy due to the low status of science and the inexperience in teaching science of her fellow teachers. No evidence of an impact from affective states was found.

Charalambous and his colleagues (2008) adapted the TSES to reflect mathematics teacher efficacy in a study of 89 pre-service teachers in Cyprus. Results indicated that levels of mathematics teaching efficacy increased over the period of student teaching. The researchers then selected four students scoring highest and lowest on levels of efficacy

(n=8) for a series of three interviews. These interviews revealed that efficacy for mathematics instruction was influenced highly by prior experiences with mathematics and by mastery experiences during student teaching. Levels of efficacy were also impacted by mentor support and by the feedback provided by the mentors. These two studies supported that for mathematics teaching efficacy, past experiences with mathematics may have the strongest impact of any of the influences.

In another study by Swars (2005) these sources were studied. From the qualitative analysis past experiences with mathematics appeared to have a direct influence on the student's perceptions of mathematics teaching effectiveness. The past experiences influenced their perceptions of mathematics teaching effectiveness the low efficacy students addressing that they would have to work longer and harder to be effective mathematics instructors and the high efficacy students stressing their strong mathematics content knowledge as an asset to becoming an effective mathematics instructor. In another study by Şahin- Taşkın and Hacıömeroğlu (2010), findings indicated that experiences that pre-service teachers' gain during their teaching practice form their thoughts about teaching and influence their self-efficacy. These studies show the importance of mastery experiences with mathematics and teaching on the development of mathematics teaching efficacy beliefs.

In addition to these studies, Philippou and Charalambous (2005) explored the influence of social persuasion on teaching efficacy in the form of mentor relationships with pre-service teachers. The researchers determined through a qualitative analysis of interview data that mentors have a strong impact on efficacy levels through three ways: teaching style, feedback, and latent messages. Mentors who provided a good model of organization and execution of the teaching task helped the student teachers develop higher levels of teaching efficacy. Feedback that was supportive and constructive also seemed to contribute to higher levels of efficacy. Finally, the mentor teachers also influenced efficacy levels through latent messages. A sometimes subtle disapproval of the student teacher's decision making led to feelings of doubt regarding teaching ability. This study reveals the need for appropriate mentor training in order to provide these experienced teachers with the necessary skills to help support efficacy building in novice teachers. Also these studies

give valuable information for teacher education programs to provide opportunities to pre-service teachers for teaching experiences.

The above mentioned studies revealed that among the four sources of Bandura, mastery experiences are the most influential one. Also, social persuasions and vicarious learning has impacts. Specifically, for mathematics, it is evident that mathematics teaching efficacy is strongly influenced by prior experiences with mathematics.

Also, the effect of several variables gender, experience, and job satisfaction was studied. Gür (2008) examined the predictors of teachers' sense of efficacy including gender, teaching field, years of teaching experience, satisfaction with performance, support from colleagues, support from parents, and support from administration, and teaching resources. The study included a total of 383 science, mathematics, and classroom teachers from 62 elementary schools in Turkey. Data were collected through Teachers' Sense of Efficacy Scale (Tschannen-Moran and Hoy, 2001). Results showed that gender, teaching field, and years of teaching experience variables were not significant predictors for overall teacher efficacy, efficacy in instructional strategies, efficacy in classroom management, and efficacy in student engagement, whereas satisfaction with performance variable made significant contribution to all dependent variables. It is also parallel with the teacher efficacy model (Tschannen-Moran *et al*., 1998) that the perceived performance is a source for the efficacy beliefs.

Saraçaloğlu and Yenice, 2009 carried out a similar study with primary school (grade 1-5) and elementary school (grade 6-8) science teachers. They aimed to examine whether self-efficacy beliefs change in terms of grade level, gender, seniority, weekly lesson hours, in-service training, job satisfaction, socio-economic level of the school, and satisfaction with the working environment. According to the findings, teachers' perception of self-efficacy does not differentiate in respect to gender, seniority, number of the lessons, having in-service training and being satisfied with the working conditions. On the other hand it is related with the grade level and the job satisfaction.

2.3.1.2. School Related Variables. School setting influences the teaching experience so in turn it affects teacher efficacy. Studies that explored the influence of school related

variables on levels of teacher efficacy determined that decision making; collaboration, teacher support, and teacher resources all had significant influences on teacher efficacy. Moore and Esselman (1992) conducted a study of 1,802 teachers to explore the influence of teacher empowerment and school climate on teacher efficacy. They also examined student achievement data in mathematics and reading for the students of the participating teachers. Results of the correlational analysis indicated that a positive school atmosphere was related to lack of impediments to effective instruction and teacher collaboration. High teaching efficacy was correlated with higher levels of classroom decision making. Teachers with higher levels of teaching efficacy had higher achieving students than teachers with low levels of efficacy.

This study demonstrates that a variety of school conditions can influence levels of teacher efficacy and student achievement. Having more influence in school base decision making and classroom based decision making have a direct effect on personal and teaching efficacy. Schools with a positive atmosphere also influence teacher efficacy levels.

Tschannen-Moran and Hoy (2002) examined the impact of teacher resources and support on levels of teacher efficacy. Using the same pool of 255 in-service teachers with varying degrees of experience, the researchers looked at different support variables, job satisfaction, and teacher setting. The 2002 study explored the differences between novice teachers (less than 5 years teaching experience) and career teachers (more than 5 years teaching experience) on these different variables. The results demonstrated that career teachers rated teaching resources, support from administration, and job satisfaction significantly higher than novice teachers. Elementary teachers also had significantly higher levels of teacher efficacy than middle school or high school teachers. The results of the regression analysis revealed that teaching resources significantly contributed to the variance in teacher efficacy.

In a study by Üstüner and his colleagues (2009) high school teachers' efficacy beliefs were investigated. There were 1529 teachers in the study. It was also intended to determine whether the teachers' views differ significantly in terms of; gender, branch, seniority, school type, last graduated school, and pedagogical formation variables. In order to measure the teachers' self-efficacy beliefs, a self administered questionnaire which was

developed by Tschannen-Moran and Hoy (2001) , and then adapted to the Turkish culture by Çapa and her colleagues (2005). Research results revealed that even though the teachers' efficacy did not differ significantly in terms of gender, branch, seniority, or graduated school type; their teacher efficacy did differ in terms of the type of school work performed. Results also showed that in comparison to other school types; teachers from Anatolian High Schools *and* Science High Schools have higher efficacy level.

Taking everything into consideration, teacher efficacy is a multidimensional concept. It is related to several variables in academic settings. Some of these variables related with students and classroom environment while some of them closely related with the personal variables of teachers. Moreover, schools also have impact on the teacher efficacy. The relation of teacher efficacy to several variables will be the topic of the next section.

2.3.2. Relationship of Teacher Efficacy to Other Variables

Teacher efficacy and its impact on several variables can be categorized in two main heading which are classroom instruction and student achievement. Teacher efficacy directly affects the teaching processes, the way teachers teach the lesson and classroom environment (Ghaith and Yaghi, 1997; Woolfolk *et al.*, 1990; Witcher *et al.*, 2002; Gordon, 2001). These influences may also be related with the students' achievement.

2.3.2.1. Teacher Efficacy and Classroom Instruction. There are several research studies which aimed to investigate the relationship between teacher efficacy and the teacher behavior in the classroom. The studies focused on classroom management, the teaching strategies teachers used and their expectations.

There are studies that explored the relationship between teacher efficacy and classroom management and they determined that high efficacy teachers tend to have student-centered, supportive classrooms. Several studies have been conducted relating teacher efficacy with student control ideology. Student control ideology is rated along a continuum from custodial to humanistic, or from highly controlled to student-centered and supportive (Woolfolk *et al.*, 1990; Witcher *et al*., 2002). These studies have shown that highly efficacious teachers fall into the humanistic part of the student control ideology

continuum. Woolfolk and her colleagues (1990) conducted a study of 55 Hebrew language school teachers in order to examine the relationship between teacher efficacy and teacher belief regarding classroom control, management, and motivation. The researchers discovered that teacher efficacy levels were negatively correlated with attitudes about student control, which indicated that high efficacy teachers were less likely to maintain a highly controlled teaching environment. This study is important for teacher efficacy by suggesting that teachers with high levels of teaching efficacy are tended to be confident enough in their classroom management approaches to allow more student autonomy.

Gordon (2001) analyzed data from 301 in-service elementary teachers in order to identify a pool of high (N= 96) and low (N = 93) efficacy teachers. They included the variables of student behaviors, teacher attribution and affect, intervention strategies, and the student control ideology. The researcher determined that low efficacy teachers tended to perceive student problems as being more stable and resistant to change than the high efficacy teachers. High efficacy teachers were also less likely to become angry with or embarrassed by their problem students. The study reveals that high efficacy teachers creates more supportive, student-centered classroom environment. Finally, the results indicated that low efficacy teachers were more likely to use negative consequences and severe punishments than high efficacy teachers.

Witcher and his colleagues (2002) explored teacher beliefs regarding classroom control and levels of teacher efficacy. In a study of 70 pre-service teachers, the researchers examine the approaches of teachers either they have a progressive teaching approach or a transmissive teaching approach. The progressive teaching approach refers to a more student-centered, inquiry-based method of teaching, while the transmissive approach refers to a lecture-driven, teacher-dominant method of teaching. The results indicated that teachers with lower levels of teaching efficacy preferred a transmissive view of teaching, while teachers with higher levels of teaching efficacy preferred the progressive method of teaching. This study shows that teaching efficacy has a role in the teaching preferences.

Ghaith and Yaghi (1997) conducted a study of 25 middle and high school Lebanese teachers for the relationship between teacher efficacy and using cooperative learning which allows students to work in small groups. The results indicated that levels of teacher

efficacy were positively correlated with positive attitudes toward using cooperative groups. The t-test comparisons between high and low efficacy groups depicts high efficacy teachers rated cooperative learning as being more important than the low efficacy teachers. This study shows that teachers with high levels of efficacy are more likely to welcome new teaching methods and techniques.

These studies supports the idea that high efficacy teachers are more likely to maintain a less structured classroom that meet the needs of the students which leads to better instruction in the classroom. Also, it may be expected that this will affect student achievement by creating more effective learning environments.

Teacher efficacy beliefs also have a role in the teachers' expectations of students' achievement. Tournaki and Podell (2005) examined the relationship between teacher efficacy and teacher predictions of student achievement. Using a sample of 384 teachers, each participant was presented with one of 32 case studies that described various student situations. The cases varied by gender, reading achievement, attentiveness, and behavior. After reading the case, the participant was given a 9 item survey that measured the teacher's perception of academic and social achievement for the student in the case study. The results of the quantitative analysis revealed that teachers with high teacher efficacy made more positive predictions for student academic achievement than low efficacy teachers. This study also supported the idea that high self-efficacy teachers believe more in their students' ability to achieve.

These studies described above provide clues about that high efficacy teachers have characteristics that are important to create more supportive environment for student learning. They use more student-centered teaching techniques and they believe that they have a role in the performance of students. Hence all these factors may contribute to the students' achievement.

2.3.2.2. Teacher Efficacy and Students' Achievement. Teachers regulate the classroom for student learning by using several teaching techniques. Therefore, they have a vital role in the learning process and the students' performance. Since teacher efficacy is related to teaching methods, it is also related to the student motivation and achievement (Ross, 1992).

Nelson (2007) studied the relationship between teacher efficacy and student motivation. In the study there were 240 fifth grade mathematics students and 11 5th grade mathematics teachers. It is found that teacher efficacy predicts student levels of interest and enjoyment in academic subjects and that level of interest and enjoyment predict motivation.

Several studies explored the relationship between teacher efficacy and student achievement. These studies support the conclusion that teachers with high teacher efficacy seem to have higher achieving students. One of these studies was conducted by Rose and Medway (1981) with a sample of 17 teachers and their students. They determined the teacher efficacy levels as internal versus external orientation. Internal teachers were defined as the ones who attribute consequences to their own actions, whereas external teachers defined as the ones who attribute consequences to factors outside their control. Internal teachers perceive classroom events and student performance as being the consequence of their own actions whereas external teachers perceived the performances as related to school system or students' ability which are out of their control. Using results, teacher observations, and student achievement data, the researchers determined that teachers with high levels of internal attribution did have higher achieving students.

Ashton and his colleagues (1983) also conducted a study to investigate the relationship between teacher efficacy levels and student achievement. Using a sample of 48 high school teachers, the researchers explored the relationship using student achievement data, teacher efficacy scores and classroom observations. The results of the study indicated that levels of teaching efficacy were significantly positively correlated to student achievement in mathematics and language arts.

In a study, Winters (2000) also investigated the relationship between teacher efficacy and student achievement. The study is conducted in a rural school system with a high minority and poverty ratio. The teachers from kindergarten to high school participated to the study. Contrary to the findings of the above studies, no significant relationship was found between the results of teacher efficacy and student achievement. The researcher concluded that school regions and student profile can be an element that leads inconsistent

results with the previous studies. Hence, more research is needed to explore the effect of teacher efficacy on student achievement for different settings.

These studies which are related with the relationship between differing variables and teacher efficacy provide valuable information on teacher characteristics and student achievement. These studies reveal that high efficacy teachers create more effective environment for learning. Some of these studies also revealed a strong positive relationship between student achievement and teacher efficacy. However, teacher efficacy is a complex concept and further research is necessary to understand the relationship of it with student achievement. The focus of the present study will be on teacher efficacy and its relation with student achievement and students self- efficacy specifically on trigonometry.

2.4. Trigonometry Education

Trigonometry is an important topic in secondary school curriculum since it helps students to develop some cognitive strategies and it has implications in everyday situations. It is used in several areas such as geometry, physics, optic, electric, topology and marine (Sağlam *et al.*, 2007). It has a nature of including both algebra and geometry. So students have to make connections between algebra and geometry while learning it. Also, in later topics such as complex numbers, limit, derivative and integral, trigonometric equations are used. Hence, it is important to master trigonometry topics in order to learn further topics conceptually.

Although it is a fundamental topic and has a very large area of application, it is one of the subjects that students have difficulty in understanding (Dumuş, 2004). Durmuş states that students are not motivated to learn trigonometry. They believe that they cannot do it. Also, he said that the difficulty of trigonometry stems from its abstract nature. There are algebraic equations and formulas such as addition, sum-to-product formulas. In addition to these when students cannot understand the basic concepts of the topic, they have difficulty in understanding the other parts (Steckroth, 2007). For example, angle concept and the units of the measure of an angle are some of the basic concepts. Especially, the radian is the most important measuring unit for angles that is necessary to be apprehended by the students (Akkoç, 2008). Some studies revealed that students and pre-service teachers have

difficulty in understanding the fundamental concepts related with trigonometry (Fi, 2003; Orhun, 2004; Topçu *et al.*, 2006; Steckroth, 2007; Akkoç, 2008)

Kültür and Kaplan (2008) searched about the trigonometry education in a school situated in Istanbul. They found that students have difficulty in understanding the basic concepts of trigonometry such as unit circle and angles. They stated that students generally used rote memorization techniques to solve problems rather than using unit circle. They also could not interpret the graphs of trigonometric functions. These results demonstrate that students cannot apprehend the fundamental concepts and they try to learn the topic by memorizing the formulas.

In another study Tatar and his colleagues (2008) investigated the mathematics subjects that students have difficulty in learning. Their sample consisted of 506 college of education students in a university. They investigated that trigonometry is one of the subjects students ranked as most difficult after the graphs of second and third order functions, integral, and derivative. This study pointed out that not only high school students but also pre-service teachers thought trigonometry as a hard subject to learn.

In addition to difficulty of the trigonometry subject, students are not motivated for the subject. For example, Doğan (2001) searched for the opinions of students (n=1316) about trigonometry. The results showed that 21.89 % of the students liked trigonometry, 45.52 % did not like it, and 30.93 % of students said that they did not want to hear about trigonometry, while 46.43 % of them said that they did not want to study trigonometry. These results demonstrate that most of the students did not like to study and learn trigonometry.

To conclude, trigonometry is a very crucial topic for students to understand other subjects such as complex numbers, derivative and integral. On the other hand it is one of the subjects that students and pre-service teachers have difficulty in understanding. Also, students are not motivated to study it, and most of them think it is a hard subject. For this reason, trigonometry self-efficacy should be studied. But there is limited research related with trigonometry self-efficacy of both students and teachers. Hence, the purpose of this

study is to investigate the relationship between teacher efficacy, and students' trigonometry self-efficacy and students' trigonometry achievement.

3. SIGNIFICANCE OF THE STUDY

Educators have long realized the relationship of students' beliefs about their academic capabilities, self-efficacy, and their motivation to achieve (Zimmerman, 2000). Student self-efficacy has shown to be affected by their experiences in class (Lopez *et al.*, 1997). Hence, providing students' effective learning environments and helping them to experience success repeatedly may contribute to their self-efficacy beliefs. In this aspect, teachers play crucial roles. Teachers' beliefs about their effectiveness in increasing the students learning referred as teacher efficacy has shown to be related with their teaching performances (Johnson, 2008).

Although, teacher efficacy and its relation with teaching strategies and teacher characteristics are investigated in several studies (Ghaith and Yaghi ,1997; Witcher *et al.*, 2002; Gordon , 2001; Henson, 2001), the studies which investigate its relation to students' trigonometry achievement and self-efficacy are limited in literature. Also, the research studies that investigated trigonometry teaching efficacy were rare in literature. As Bandura suggested teaching efficacy should be investigated for more specific domains of instruction.

This study aims to investigate the relationship between teacher efficacy and tenth grade students' trigonometry self-efficacy as well as their trigonometry achievement. It is expected that the results of the study will give valuable information to the educators and teacher education programs in order to understand the role of teachers in students' trigonometry achievement and trigonometry self-efficacy.

4. STATEMENT OF THE PROBLEM

The present study questioned the relationship of teaching efficacy with tenth grade students' trigonometry self-efficacy and students' trigonometry achievement. The teacher efficacy was studied through three variables: general teaching efficacy, mathematics teaching efficacy and teacher trigonometry teaching efficacy. The relationships of these components with the student related variables were investigated separately.

4.1. Variables

The variables of this study were general teacher efficacy, mathematic teaching efficacy, teacher trigonometry teaching efficacy, student trigonometry self-efficacy and student trigonometry achievement. The definitions of these variables are as follows:

- *General teaching efficacy* is defined as how competent a teacher believes in his ability to affect the performance of all students as it was defined by Tschannen-Moran and her colleagues (1998). It was measured by the Teachers' Sense of Efficacy Scale.
- *Mathematics teaching efficacy* is defined as a person's perception of his ability to teach others mathematics as it was defined by Kahle (2008). It was measured by Self-Efficacy Beliefs toward Mathematics Teaching Scale.
- *Teacher trigonometry teaching efficacy* is defined as a teacher's perception of their own ability to teach trigonometry to others. This definition is based on the self-efficacy theory of Bandura (1982). It was measured by Teacher Trigonometry Teaching Efficacy Scale.
- *Student trigonometry self-efficacy* is defined as a student's perception about their mathematics ability on trigonometry. This definition is based on the self-efficacy theory of Bandura (1982). It was measured by Student Trigonometry Self-Efficacy Scale.

- *Student trigonometry achievement* is defined as students' attainment in trigonometry skills determined with objectives by the Turkish Ministry of Education. It was measured by Student Trigonometry Achievement Test.

4.2. Research Questions

This study focused on the following research questions:

(i) Is there any significant relationship between general teaching efficacy and student trigonometry self-efficacy?

(ii) Is there any significant relationship between mathematics teaching efficacy and student trigonometry self-efficacy?

(iii) Is there a significant difference between the students of high trigonometry teaching efficacy teachers and the students of low trigonometry teaching efficacy teachers in terms of students' trigonometry self-efficacy?

(iv) Is there any significant relationship between general teaching efficacy and student trigonometry achievement?

(v) Is there any significant relationship between mathematics teaching efficacy and student trigonometry achievement?

(vi) Is there a significant difference between the students of high trigonometry teaching efficacy teachers and the students of low trigonometry teaching efficacy teachers in terms of students' trigonometry achievement?

4.3. Statement of the Research Hypotheses

In the present study it is hypothesized that:

- H.1. There is significant relationship between general teaching efficacy and student trigonometry self-efficacy.
- H_o.1. There is not any significant relationship between general teaching efficacy and student trigonometry self-efficacy.
- H.2. There is significant relationship between mathematics teaching efficacy and student trigonometry self-efficacy.

- H_o.2. There is not any significant relationship between mathematics teaching efficacy and student trigonometry self-efficacy.
- H.3. There is significant difference between the students of high trigonometry teaching efficacy teachers and the students of low trigonometry teaching efficacy teachers in terms of their trigonometry self-efficacy.
- H_o.3. There is no significant difference between the students of high trigonometry teaching efficacy teachers and the students of low trigonometry teaching efficacy teachers in terms of their trigonometry self-efficacy.
- H.4. There is significant relationship between general teaching efficacy and student trigonometry achievement.
- H_o.4. There is not any significant relationship between general teaching efficacy and student trigonometry achievement.
- H.5. There is significant relationship between mathematics teaching efficacy and student trigonometry achievement.
- H_o.5. There is not any significant relationship between mathematics teaching efficacy and student trigonometry achievement.
- H.6. There is significant difference between the students of high trigonometry teaching efficacy teachers and the students of low trigonometry teaching efficacy teachers in terms of their trigonometry achievement.
- H_o.6. There is no significant difference between the students of high trigonometry teaching efficacy teachers and the students of low trigonometry teaching efficacy teachers in terms of students' trigonometry achievement.

5. METHOD

In the study, the aim was to investigate the relationship between teacher efficacy and students' trigonometry self-efficacy, and their trigonometry achievement. Teacher efficacy was studied through three different variables: general teaching efficacy (measured by Teachers' Sense of Efficacy Scale, TSES), mathematics teaching efficacy (measured by Self-Efficacy Beliefs toward Mathematics Teaching Scale, SEBMTS) and trigonometry teaching self-efficacy (measured by Teacher Trigonometry Teaching Efficacy Scale (TTTES) and studied with individual teacher interviews). For the student variables, Student Trigonometry Self-Efficacy Scale (STSES) and Student Trigonometry Achievement Test (STAT) were administered. The data collection took place at the end of the second semester of the school year, after the trigonometry instruction.

5.1.Sample

The pilot study was conducted to check the validity and reliability of the instruments which were developed by the researcher. The pilot school was in the same area with the schools of actual sample. There were four mathematics teachers in the school. TTTES was applied to these teachers and six other mathematics teachers from various schools in the same area in Istanbul. Also, among the tenth grade students of the pilot school, two classes were chosen for STSES and STAT. In total 80 students were included for the pilot study.

Sample of the actual study consisted of sixteen mathematics teachers (n_1=16) and their tenth grade students (n_2=570) from seven different schools in Istanbul. In each school, all teachers who teach tenth grade students were included. The number of students of each teacher according to the schools is presented in Table 5.1. The number of classes and the number of students in each school vary. For the teachers, pseudonyms were used. In some schools there were more mathematics teachers than the others. Also, some teachers had more than one classroom. So each teacher has different number of students. The schools were chosen from similar and close districts so they are similar in terms of type (public, non-vocational high school) and student profile (social economic status, educational

background etc.) in order to control the effect of school variable which may be related with teacher efficacy (Moore and Esselman, 1992; Üstüner *et al*., 2009).

Table 5.1. Number of students according to the teachers and schools.

School	Teacher	Number of Students
A	Özge	49 (two classes)
	Dilan	20
B	Sevgi	47
	Öykü	43
	Çiğdem	35
C	Hasan	75(two classes)
	Ayça	37
	Fahri	40
D	Gaye	19
E	Suat	47
	Kerem	28
F	Canan	23
	Melisa	19
	Hale	22
G	Nermin	51
	Hülya	15

Demographic data for students included gender. For this study 571 students involved, 37 of them did not report their gender. The number of girls is 301(40.6%) and boys are 232 (52.7%).

Furthermore, demographic data for teachers included gender, the degree (department of graduation) and years of mathematics teaching experience. Among the teachers, four of them were male and 12 of them were female. Majority of them graduated from mathematics department and there are teachers who did not graduated from mathematics related departments. Table 5.2 presents the departments that teachers graduated. Teachers' years of experiences in teaching mathematics was high as majority of

them have been teaching more than ten years. Table 5.3 presents the frequency of teachers according to teaching experience.

Table 5.2. Number of teachers according to the departments.

Department	Number of Teachers
Mathematics Teaching	3
Mathematics	9
Mathematics Engineering	1
Physics	2
Chemistry	1

Table 5. 3. Number of teachers according to the mathematics teaching experience.

More than 15 years	4
10-15	3
5-10	6
Less than 5	3

5.2. Instruments

In this study, there were five instruments: -Teachers' sense of efficacy scale (TSES) (Çapa *et. al.*,2005), Self-Efficacy Beliefs toward Mathematics Teaching Scale (SEBMTS) (Dede,2008), and Teacher Trigonometry Teaching Efficacy Scale (TTSES) for teachers and Student Trigonometry Self- Efficacy Scale (STSES) and Student Trigonometry Achievement Test (STAT) for students. Three of those, TTSES, STSES and STAT was developed by the researcher and were piloted before the study to check validity and reliability. In addition to these instruments, some demographic information collected from teachers. Later, a short interview was conducted with the teachers to categorize them according to their trigonometry teaching efficacy. In this section these instruments will be discussed in detail.

Table 5. 4. Variables and instruments.

	Variable	**Instrument**	**Reliability** (Cronbach alpha)	**Source**
Teacher	General Teaching Efficacy (GTE)	Teachers' Sense of Efficacy Scale (TSES)	0.95	Çapa and her collegues(2005) adapted from Tschannen-Moran and Woolfolk Hoy (2001)
	Mathematics Teaching Efficacy (MTE)	Self-Efficacy Beliefs toward Mathematics Teaching Scale (SEBMTS)	0.80	Dede,2008 adapted from STEBI (Science Teaching Efficacy Belief Instrument) of Riggs and Enochs (1990)
	Trigonometry Teaching Efficacy (TTE)	Teacher Trigonometry Teaching Efficacy Interviews		Researcher Conducted individual interviews to categorize teachers according to their TTE
Student	Trigonometry Self-Efficacy	Student Trigonometry Self-Efficacy Scale (STSES)	0.90	Researcher Revised from Mathematics Self-Efficacy Scale (MSES) of Hackett and Betz (1982)
	Trigonometry Achievement	Student Trigonometry Achievement Test (STAT)	0.77	Researcher developed based on the objectives given by MEB and resources of MEB for classroom instruction

5.2.1. Teachers' Sense of Efficacy Scale (TSES)

In order to gather information about the teaching efficacy from teachers the TSES instrument developed by Tschannen-Moran and Hoy (2001) was used. In this study, the Turkish version of the TSES was used (Appendix A). The TSES adaptation into Turkish was conducted by Çapa and her colleagues (2005). They conducted confirmatory factor analysis and found three factor structures of TSES compatible with the study of Tschannen-Moran and Hoy (2001). Thus, the instrument included three subscales with each including 8 items: efficacy in instructional strategies-IS (items 7, 10, 11, 17, 18, 20, 23, and 24), efficacy in classroom management-CM (items 3, 5, 8, 13, 15, 16, 19, and 21), and efficacy in student engagement-SE (items 1, 2, 4, 6, 9, 12, 14, and 22).The researchers reported that the reliability of whole scale was 0.95, the reliability coefficients of subscales were 0.82 for SE, 0.86 for IS, and 0.84 for CM.

The items were developed to be a 9-point rating scale (1-Nothing, 3-Very little, 5-Some influence, 7-Quite A Bit, and 9-A Great Deal). High score for this test mean higher teaching efficacy. The maximum score to be taken from the scale is 216 whereas the minimum score to be taken is 24. Some examples from TSES subscales:

- Efficacy in instructional strategies
  "How well can you implement alternative strategies in your classroom?"
- Efficacy in classroom management
  "How much can you do to calm a student who is disruptive or noisy?"
- Efficacy in student engagement
  "How much can you do to help your students' value learning?"

5.2.2. Self-Efficacy Beliefs toward Mathematics Teaching Scale (SEBMTS)

SEBMTS is used to gather data about the mathematic teaching efficacy of teachers (Appendix B). The instrument was adopted by Dede (2008) from STEBI (Science Teaching Efficacy Belief Instrument) which was developed by Riggs and Enochs in 1990. To determine the validity of the instrument, explanatory factor analysis was used. The analysis revealed three factors. Thus, the instrument includes three sub scales: efficacy in

teaching (items 2,3,5,14), motivating and taking responsibility (items 4,6,8,10,11,13) and effective teaching (items 1,7,9,12). (For the items, a 5-point rating scale which ranges from 5-Strongly Agree, 4-Agree, 3-Uncertain, 2-Disagree, 1-Strongly Disagree). The high scores point to the higher mathematics teaching efficacy. The maximum score to be taken from this scale is 70 whereas the minimum score to be taken is 14. The instrument also includes some reverse items (items 2, 3, 4, 6, 8, 10, 11, 13, 14). The researcher reported that the reliability coefficient for the scale was 0.80.

Some examples from the scale are as follows:

- I know how to teach mathematics concepts effectively.
- I will not be very effective in monitoring mathematics activities.
- I will typically answer students' questions.

5.2.3. Teacher Trigonometry Teaching Efficacy Scale (TTTES)

This scale was developed by the researcher in order to measure the efficacy level of teachers in teaching trigonometry (Appendix C). While developing the scale, the researcher took the Mathematics Self- Efficacy Scale (MSES) which was developed by Betz and Hackett (1981) as the model. Betz and Hackett (1981) developed the MSES to assess college students' mathematics self-efficacy with greater specificity than had previous instruments. This instrument has been used widely in research (Zimmerman, 2000). The MSES has 52 items and three subscales, each of which represents a different domain of mathematics-related behavior: solution of mathematics problems, completion of mathematics tasks used in everyday life, and satisfactory performance in college courses that require knowledge and mastery of mathematics. Some college mathematics topics which were addressed in this instrument are such as algebra, calculus, economics, and statistics. Each item has a rating scale with 5 levels to show the confidence level of subjects to solve the problems. Subjects chose appropriate number which shows their confidence level to solve these problems, rather than finding the answer. Some example items from MSES are as follows:

- Add two large numbers (e.g., 5739 + 62543) in your head.
- Figure out how long it will take to travel from City A to City B driving 55mph.

- Determine how much interest you will end up paying on a $675 loan over 2 years at 143/4 % interest.

Since purpose of the present study was to measure self-efficacy on trigonometry teaching, MSES could not be used. The content of the items needed to be changed, because it was applied to measure self-efficacy on trigonometry teaching. The format of the scale was kept to be parallel with the MSES but the presented mathematics problems were for trigonometry. This adaptation of the items was supported by the suggestions of Bandura (1997) to assess self-efficacy. According to Bandura, the items should be aligned with the task being assessed and the domain which is analyzed.

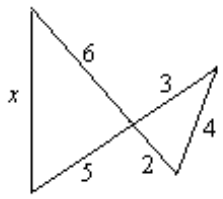
In order to determine the topics to be addressed by the questions, the objectives of subject determined by Ministry of Education (MEB) was used. The trigonometry unit consists of six main objectives which are as follows:

(i) Trigonometric Functions
(ii) Graphs of Trigonometric Functions
(iii) Inverse Trigonometric Functions
(iv) Trigonometric Relations in a Triangle
(v) Addition Formulas
(vi) Trigonometric Equations

Each of these main objectives has several detailed objectives for instruction in the classroom (Appendix D). So, the questions were developed according to cover all the objectives. There were 18 items in the test. There was at least one question related to each objective.

Teachers did not solve the problems but they only rated their perception of confidence level to teach those problems. Each item has a rating scale with 5 levels ranging from 1 (I am not at all confident) to 5 (I am totally confident). For example, if they are totally confident to teach a problem they rated 5 but they rated 1 if they are not confident at

all. The items were adopted from problems in several textbooks (MEB, 2005; Altuntaş, 2007). Some examples from the TTTES are:

- Graph the function $f(x) = 3 \sin(2x)$.
- 

  Find the x value in the above figure.

- $\tan\left(\arctan\ \frac{1}{2} + \operatorname{arccot}\ \frac{2}{3}\right)$ = ?

For this instrument, teachers generally marked the highest confidence level for the items. Some teachers reported that they felt as if they were tested about their teaching qualities and some of them reported that they felt offended by doing this instrument. So it is highly possible that they might not reflect their actual beliefs about their self-efficacy. Looking at those results, the researcher concluded that the instrument did not serve the purpose of the measuring teaching trigonometry efficacy. Instead of the results obtained from this instrument, an interview was conducted and teachers were categorized according to their answers for the interview questions.

5.2.4. Individual Interviews

In order to study teachers' trigonometry teaching efficacy, the author conducted interviews with teachers. Among the sixteen teachers, thirteen of them accepted to participate in an interview. Since teachers were not comfortable talking about their trigonometry teaching efficacy directly, in the interview this issue is asked through other questions (Appendix E). During the interview, they talked about their teaching trigonometry experiences and their teaching methods. Ones' experience related to a task is one of the major sources and the outcome of the self-efficacy (Bandura, 1997; Lopez *et al.*, 1997; Pintrich and Shunck, 2002). So the outcome gives clues of one's self-efficacy. Furthermore, as Philippou and Christou (1998) point 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). Hence, by asking teachers' experiences, it is aimed to get some information about their self-efficacy in teaching trigonometry.

Interviews were conducted and analyzed in Turkish but for the writing purposes, the researcher translated them into English in this thesis. Also, for the teachers pseudonyms were used in this thesis. The interviews were coded which then used to categorize teachers as low and high self-efficacy in teaching trigonometry. They were categorized according to three codes. These codes were based on Bandura's self-efficacy theory. Also, the previous studies related to the features of high and low self-efficacy people (Pajares, 1996) were utilized. These codes are as follows:

- *Choices*: People who have high self-efficacy engage in the activities more willingly and they tend to set higher goals to achieve. On the other hand, people with low self-efficacy tend to set incomplete goals and they feel incompetent (Bandura, 1997). Some teachers reported that they really liked teaching trigonometry while some stated teaching trigonometry to students is more difficult than other subject.

  Teacher A (Hülya): 'I get pleasure most while I teaching trigonometry. It is a wonderful subject, since I teach it by forming connections with analytic geometry. I teach it by helping students to connect it to the triangles and unit circle.' (High self-efficacy: Engage willingly and set high goals.)

  Teacher B (Ayça): 'It is difficult to teach trigonometry because students do not have the necessary pre knowledge. It is so long that students get bored easily and once they get lost, they cannot continue. I am not able to help all of them.' (Low self-efficacy: Do not set high goals and do not wish to involve in teaching trigonometry.)

- *Effort:* People with high self-efficacy put more effort on the job, they work harder. They show more self-regulated behavior and use more effective strategies (Bong, 1997). They believe in themselves whatever the situation is. They attribute the success or failure to themselves while low self-efficacy people blame other factors such as crowded classrooms, intense curriculum (Rotter, 1966). Some teachers in the

interview stated that they try hard to teach trigonometry and to overcome the difficulty of lack of previous knowledge while some stating that they cannot do something to teach the ones who are not good at mathematics and unmotivated to learn.

*Teacher C (Dilan): "*We strived hard to teach trigonometry since it is a very important subject. We tried to teach firstly the necessary pre knowledge. Also, I gave homework to students not let them to get away from the topic and learn all the parts of it well. I talked individually with the students who are not so good at the subject and recommended them some extra works to close the gap.' (High self-efficacy: Put more effort and strive hard to teach.)

Teacher D (Nermin): "It is a difficult subject. Students' levels are low. It is necessary to complete their missing previous knowledge and to teach it at low level. However, it was not possible to give all the previous knowledge because when I go back, the subject is messed up and I cannot build it up.'(Low self-efficacy: Do not strive hard for the students who do not have the previous knowledge.)

- *Thought patterns and Emotions:* People with high self efficacy are more comfortable and they are less anxious (Bandura *et al.*, 1996; Pintrich and De Grrot, 1990). While talking about their experiences they use less negative words (Bandura, 1997) while low self-efficacy people concentrate on difficulties and use more negative words about their experiences. In this study, some teachers talked more on difficulties and blame to students, while some concentrated on their efforts and joy in teaching trigonometry.

Teacher E (Öykü) : "This year it was good for me to observe that I can teach students some necessary knowledge in trigonometry. Also, I feel successful in that I can help them to study in 80 per cent. If I can help them to change their negative emotions about trigonometry, the remaining part becomes nice to teach.' (High self-efficacy: Do not concentrate on difficulties and do not use negative words. She says that it is good to observe students learn)

Teacher F (Melisa): ‘Teaching those [low achieving] students was very frustrating for me since I could not get any sign of learning from them.’ (Low self-efficacy: Concentrate on difficulties, use negative words.)

Teachers’ answers to interview questions were evaluated by giving score for each code (0 or 1). The teachers depicted high self-efficacy scored as 1 and the ones who depicted low self-efficacy scored as 0 for each code. In total, the scores were ranging from 0 to 3. Teachers who received 2 or 3 were categorized as having high trigonometry teaching efficacy and teachers who received with 0 or 1 point categorized as having low trigonometry teaching efficacy. These coding and categorization of the teachers according to their interviews was checked by a mathematics education expert.

5.2.5. Student Trigonometry Self-Efficacy Scale (STSES)

The student trigonometry self-efficacy was measured by STSES which was developed by the researcher. The mathematics content of the STSES was similar to the TTTES. In this instrument as well, only trigonometry questions was included as the purpose was to focus on the trigonometry. It is also parallel to the advice of other researchers (Bandura, 1997; Pajares, 1996; Zimmerman, 1995, Zimmerman, 2000). Pajares (1996) proposed that self-efficacy measurements work best when the presented questions corresponds to the aimed task specifically.

In order to determine the topics to be addressed by the questions, the objectives of subject determined by Ministry of Education (MEB) was used as in the case of TTES. The STSES has eighteen items in total (Appendix F).

To assess the reliability of STSES, Cronbach's alpha was computed by using the scores of students in the pilot school. The alpha value for the eighteen items was 0.90 (N=80), which indicates that the items form a scale that has good internal consistency.

5.2.6. Student Trigonometry Achievement Test (STAT)

STAT was applied to students to measure their trigonometry achievement. The test was developed by the researcher. The test included questions arranged to address the Ministry of Education (MEB) objectives of trigonometry. There was at least one question related to each objective. In total there are thirteen questions (Appendix G). The test includes multiple choice questions to be administered in 40 minutes. The experts were 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 which have at least five years experience in teaching mathematics. Their suggestions were considered. The pilot study was done with 65 tenth grade students. The Cronbach alpha value for the STAT was computed to be 0.77, which indicates that the items form a scale that has acceptable internal consistency.

5.3. Design

The present study aimed to investigate the relationship between teacher efficacy and students' trigonometry self-efficacy in addition to their trigonometry achievement. Therefore the study adopted a correlation research design. The resulting correlation coefficients indicated the degree of relationships between the paired scores. A correlation coefficient matrix was formed with teacher efficacy scores from two different instruments (TSES, SEBMTS) and, students' scores from STSES and students' scores obtained from STAT.

Table 5.5. Matrix of correlation coefficients.

	Scores of STSES	Scores of STAT
Scores of TSES	ρ_{11H}, ρ_{11M}, ρ_{11L}	ρ_{12H}, ρ_{12M}, ρ_{12L}
Scores of SEBMTS	ρ_{21H}, ρ_{21M}, ρ_{21L}	ρ_{22H}, ρ_{22M}, ρ_{22L}

While calculating the correlation between teacher scores and student scores Spearman Correlation Coefficient was used. Since the number of teachers who were involved in the study was sixteen, a nonparametric statistical correlation method is

suggested (Gay *et al.*, 2009). The Spearman Correlation Coefficient is a method for quantifying correspondences between lists of ordinal data. Spearman Correlation Coefficient tries to assess the relationship between ranks. In this study, the students divided into three groups according to the percentile ranks (25 % highest, 50% middle, 25 % lowest). For each group, the means of the student scores were computed. Then the correlation coefficient was calculated between the teachers' scores and the mean of low, middle and high percentile of students' scores. Hence, for each relationship three different correlation coefficients were calculated. For example, ρ_{11H} denotes the correlation coefficient between scores of teachers from TSES and the mean STSES scores of students from high percentile rank. ρ_{11M} denotes correlation coefficient between the scores of teachers from TSES and mean STSES scores of students in middle percentile rank. ρ_{11L} denotes the relationship between teachers' sores from TSES and mean STSES scores of students in lowest percentile rank. In this way, it is intended to find the relationship with students who are at different level (low, average, high) in order to prevent the overgeneralization of the class scores. Also, it is aimed to see the relationship of teacher scores with low achieving, average and high achieving students.

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, t-test was used. The scores of students from STSES were compared using t-test. The scores of students from STAT were compared using Mann Whitney U test which is the non-parametric version of the t-test (Gay *et al.*, 2009).

5.4. Procedure and Analysis

Upon the completion of the pilot study, for this study, the data was collected from six different schools. From each school all the teachers who teach tenth grade classes answered the teacher efficacy related instruments and each teacher's students answered STSES and STAT. First, the teacher instruments were administered to the sample; meanwhile the information about completion of trigonometry was asked in order to plan the student data collection schedule.

Student data was collected after their teachers finished the unit. In the same schools, students answer in the same class hour to prevent the student interaction. The students firstly answered the STSES and later in another class hour they answered STAT. First, the STSES was applied otherwise their scores might be affected if they first solved the achievement test. After the data was collected it was coded according to the received scores and the correlation coefficients were calculated.

In addition to the instruments mentioned above, a semi-structured interview was conducted with teachers. The purpose of the interviews was collecting data about teachers' trigonometry teaching experiences. The interviews were structured around three main questions but teachers also talked about their experiences besides the interview questions. The first question was about their way of teaching trigonometry and their recommendations to teach it. The second question was about their experiences while teaching trigonometry for that year with that year students and the last question was about their past experiences. In this way, more detailed information was gathered from teachers to support the findings.

6. RESULTS

In this section, the findings of the research will be presented. Firstly, the descriptive statistics (range, mean and standard deviation) related to the scores from the instruments will be given. Secondly, coefficients between teacher related variables and student related variables will be presented. Thirdly, the interview findings and the categorization of teachers according to the trigonometry teaching efficacy levels will be introduced. The last part consists of the comparison of students of teachers with high and low trigonometry teaching efficacy.

6.1. Descriptive Characteristics of the Data

The mean, standard deviation, maximum and minimum scores were calculated for the scores obtained from the instruments. Each of them is presented in Table 6.1. The mean score for Teachers' Sense of Efficacy Scale (TSES) of teachers found to be 172 and the standard deviation for this data was calculated to be 14.74. The highest score to be taken from this scale is 216. For the Self-Efficacy Beliefs toward Mathematics Teaching Scale (SEBMTS), the mean score is 53.19 and the standard deviation is 7.06. The highest score to be taken from SEBMTS is 70. The mean of the Student Trigonometry Self-Efficacy Scale (STSES) is 59.84 and the standard deviation for the same scale is 17.79. The highest score to be taken from this scale is 90. Finally, for the Students Trigonometry Achievement Test (STAT), the mean was calculated to be 4.31 and the standard deviation was calculated to be 3.03. The highest score to be taken from this scale is 13. The student numbers were different for two scales since the scales were applied in different days. Also, some students did not rank their confidence level for some items of STSES and their data were not taken for the calculations. So the number of students for STSES was less than the number of students for STAT.

Table 6. 1. Descriptive statistics.

	N	Min	Max	Mean	Standard Deviation
TSES	16	148	198	172.75	14.74
SEBMTS	16	40	64	53.19	7.03
STSES	486	18	90	59.84	17.79
STAT	565	0	12	4.31	3.03

6.2. Correlational Analysis

This part of the research focused on the relationships between the variables of general teaching efficacy, mathematics teaching efficacy, student trigonometry efficacy and student trigonometry achievement. This part only describes the correlations, not causal relationships between variables. Correlation is a statistical technique that shows at what degree two variables are related to each other. All correlation analyses were conducted by the use of the Spearman Rho correlation coefficients. Spearman Rho is the special version of the Pearson r. In this study Spearman rho is preferred since the teacher related data were not normally distributed.

The aim of the study was to investigate the relationship between teacher related variables and the student related variables. For this reason, calculations were done three times. Each teacher's score was related with the highest, median and lowest scores of their students respectively to see the relationship of teachers' scores with students from different levels (low, average, high). Table 6.2 depicts the correlation coefficients with teacher related variables and student trigonometry self efficacy.

Table 6. 2. The correlation coefficients between teacher efficacy variables and student efficacy.

		TSES Scores	SEBMTS Scores
Students' Trigonometry Self Efficacy Scores	Mean of Lowest Scores	-0.353 (ρ_{11L})	-0.247 (ρ_{21L})
	Mean of Middle Scores	-0.225 (ρ_{11M})	-0.028 (ρ_{21M})
	Mean of Highest Scores	-0.266 (ρ_{11H})	-0.153 (ρ_{21H})

As from Table 6.2, no significant relation is found between the two types of teacher efficacy and the maximum, median and minimum scores of student trigonometry efficacy. The same correlational calculations were done for teacher related variables and student trigonometry achievement. The results are depicted in Table 6.3.

Table 6. 3. The correlation coefficients between teacher efficacy variables and student achievement.

		TSES	SEBTMTS
Students' Trigonometry Achievement Test Scores	Mean of Lowest Scores	-0.075 (ρ_{12L})	-0.001 (ρ_{22L})
	Mean of Middle Scores	-0.053 (ρ_{12M})	0.095 (ρ_{22M})
	Mean of Highest Scores	-0.199 (ρ_{12H})	0.117 (ρ_{22H})

As from Table 6.3, no significant relation is found between the two types of teacher efficacy and the maximum, median and minimum scores of student trigonometry efficacy.

6.3. Teacher Categorization

Thirteen teachers were interviewed. According to the finding, the teachers were categorized as high trigonometry teaching efficacy or low trigonometry efficacy. The categories were formed by three codes which were derived from the literature. The results of the codes are depicted in Table 6.4.

Table 6. 4. Self-efficacy codes derived from the interviews.

Teacher	Total	Category
Öykü	3	High
Dilan	3	High
Çiğdem	2	High
Hülya	2	High
Fahri	2	High
Kerem	2	High
Özge	2	High
Hasan	1	Low
Gaye	1	Low
Ayça	0	Low
Nermin	0	Low
Hale	0	Low
Melisa	0	Low

As seen from the Table 6.4, six teachers were categorized as having low trigonometry teaching efficacy whereas seven teachers were categorized as having high trigonometry teaching efficacy.

6.4. Trigonometry Teaching Efficacy and Student Variables

According to the teachers' level of teaching efficacy scores from the interview results, the students were grouped. 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). Means of STSES and STAT were calculated for both groups and compared. The descriptive of the students trigonometry self efficacy scores were presented in Table 6.5.

Table 6. 5. Descriptive statistics related to Sh and Sl groups' scores from STSES.

	N	Mean	Std Deviation
Sh	195	66.38	16.43
Sl	213	55.30	18.93

For this data, t test was applied to compare the means of two groups. The results depicted that there was a statistically significant difference between trigonometry self efficacy of students of high and low trigonometry teaching efficacy teachers, t (406) = 6.325, p=0.000, d=0.66. The students of high trigonometry efficacy teachers scored higher (M=66.38, SD =16.43) than the students of low trigonometry teachers (M=55.30, SD=18.93), and the effect size was 0.66 which is of medium value for behavioral sciences (Leech, Barett, Morgan, 2005). This result showed that the students of teachers who have higher trigonometry teaching self-efficacy scores had also higher trigonometry self efficacy than the students of teachers who had lower trigonometry teaching efficacy.

Furthermore, the descriptive data for student trigonometry achievement test scores is presented in Table 6.6.

Table 6. 6. Descriptive statistics of Sh and Sl scores from STAT.

	N	Mean	Standard Deviation
Sh	228	5.83	2.30
Sl	243	4.30	3.39

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

7. CONCLUSION AND DISCUSSION

In this study, teacher trigonometry teaching efficacy investigated more specifically. The purpose of this study was to examine the relationship of teacher efficacy to student trigonometry self-efficacy and trigonometry achievement. The importance of teacher related variables such as general teaching efficacy and mathematics teaching efficacy seems to be important components of student learning and motivation in some studies (Moore and Esselman, 1992, 1994; Muijs and Rejnolds, 2001; Ross, 1992). These teacher variables pointed toward higher student achievement and higher student self-efficacy.

The research questions were investigated by means of correlation analysis for general teaching efficacy and mathematics teaching efficacy. For the comparison between students of teachers having high teacher trigonometry efficacy and students of teachers having low trigonometry teaching efficacy, t- test was used. Their means from student trigonometry achievement test and trigonometry self-efficacy scale were compared.

For the general teaching efficacy and mathematics teaching efficacy to student trigonometry self-efficacy, no significant relationship was found. Also, it is interesting to denote that some correlation coefficients were in negative value which is not expected. The t-test results for teacher trigonometry teaching efficacy, on the other hand, indicated significant difference for student trigonometry self efficacy comparison. Finally, the student achievement test comparisons for trigonometry teaching efficacy did not show significant difference for the present study.

7.1. General Teaching Efficacy, Mathematics Teaching Efficacy

In relation to the research questions about the relation of general teaching efficacy and mathematics teaching efficacy to student trigonometry self-efficacy, no significant relationship was found. In previous studies, teacher's perceived self-efficacy has been found to be associated with enhanced student's motivation (Ashton *et al*., 1983; Roeser, Arbreton, and Anderman, 1993; Nelson, 2007), increased self-esteem (Borton, 1991) and strong self-direction (Rose and Medway, 1981). Teacher's self-efficacy may also contribute

to promote student's sense of efficacy, fostering their involvement in class activities and their efforts in facing difficulties (Ross, 1998). All these studies were related with more general area of students' motivation such as school, mathematics, language. However, there was limited research related with more specific self-efficacy such as trigonometry. In this study, contrary to other studies, student self- efficacy measured on a specific topic which is trigonometry and no significant results found. The reason can be due to the fact that measuring teacher efficacy from a broader perspective than the intended specificity may be insufficient to detect the relation with student trigonometry self-efficacy. This is parallel with Bandura's (1997) suggestion of measuring self-efficacy as specific as possible for the intended task. In his book he proposes 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). 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. Also, Bandura suggested for further investigation with the specificity of measurement.

The findings about the research questions of the relation 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 (Medway, 1981; Ashton *et al*., 1983). These studies were different from this research in that they looked for the students' general achievement in academic areas. In this research, however, only the trigonometry achievement was investigated. These inconsistent results can be attributed to the difference in specificity in variables that is measured. This is an important contribution to the literature in that the importance of specificity is depicted.

7.2. Teacher Trigonometry Teaching Efficacy

The research question about the teacher trigonometry teaching efficacy and student trigonometry self-efficacy was investigated by comparing the scores of the students whose teachers having high trigonometry teaching efficacy and low trigonometry teaching efficacy. T-test results depicted significant results between scores of two groups. The students of higher trigonometry teaching efficacy teachers scored higher 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. Teachers may have an effect on the beliefs of students about their capability to do trigonometry. The previous studies also found that teachers have an effect on the students' motivation, attitudes toward the lessons and school (Nelson, 2007; Caprara, 2006).

General teaching efficacy and mathematics teaching efficacy did not found to be related with the students' trigonometry self efficacy. However, when the two variables were compared in similar specific ways significant results were found. This shows the necessity of measuring the self-efficacy according to the indented task and subject. Individuals' self efficacy may change from one task to another task. In this case self-efficacy was evaluated from general to the more specific. The more general ones did not show significant results, however the specific one depict significant results. This can be evidence for the suggestion of Pajares (1996) that's elf-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, the attempt of measuring trigonometry teaching efficacy was not successful since it did not differentiate the teachers. Teachers ranked the highest scale for their trigonometry teaching efficacy for almost all questions. Hence, an interview was used to categorize the teachers. This may be also an evidence for the necessity of utilizing qualitative techniques to get deeper information. In some previous studies, also, to explore the teaching efficacy observations and interviews were used (Mulholland and Walles, 2001; Philipou and Charalambous, 2005).

In relation to the research question about difference between the students of high trigonometry teaching efficacy and low trigonometry teaching efficacy in terms of trigonometry achievement test scores no significant differences were found contrary to the student trigonometry efficacy results. In previous studies it was found that teachers' efficacy beliefs had effects on their classroom management styles, management of

classroom problems (Gordon, 2001) and teaching methods (Gaith and Yaghi, 1997; Cousins and Walker, 2000; Guskey, 1988). Hence, it was expected that teachers' self efficacy may have effect on the students' achievement. Also, in some studies direct relationships were found (Midway, 1981; Ashton *et al*., 1983; Ross, 1992). In this study, it was expected to find differences between two groups of students. However no difference was found.

One reason for this inconsistent result can be the low achievement test scores of the students. Students' trigonometry achievement score means were very low for both groups. In the region of the study, the schools are very crowded and students' mathematics level was not high. So it may be expected that instruction in those schools may not be in the level of the objectives of MEB. However, in the study the instrument was developed according to the objectives of the MEB and questions were prepared to cover all the objectives. This may cause the low scores from students. Hence, for more detailed information about students' achievement some further investigation such as observations, interviews with students might be more enlightening.

The schools in the region of the study were different than the ones in other studies. Generally, classes are crowded and students' mathematics level did not so high. When the school factor is considered the results of this study is consistent with the previous study done by Winters (2000). He searched the relationships between teacher efficacy and student achievement in schools with high poverty ratio which is similar to the present study and he also did not find significant results.

The results of the study also might be an indicator that teacher trigonometry teaching efficacy might be insufficient to explain student trigonometry achievement. Some other factors can have effect such as teacher content knowledge, 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 is found to be an important element for effective instruction. Also, some detailed observations of class instruction may be necessary to get a better picture about the nature of this issue. The previous studies which found relationships between teacher efficacy and student achievement also includes classroom observations and interviews (Ashton *et al*., 1983;

Ross, 1992). This study, on the other hand, was not effective enough to reach the conclusion of trigonometry teaching efficacy is a predictor of student trigonometry achievement.

To sum up, teacher efficacy can be different for general, mathematics and a specific topic such as trigonometry. Since our interest was for trigonometry, and when the researcher compares trigonometry related variables got significant results. This depicts that it is important to study self-efficacy in specific variables. Furthermore, the unsuccessful attempt for measuring trigonometry teaching efficacy displays that teacher efficacy construct is not an easy issue to measure and quantitative investigations can be insufficient at some point and more detailed qualitative approaches are necessary. In high poverty schools, the results for the relationship between teacher trigonometry efficacy and student trigonometry achievement was inconclusive. The achievements of students were not differing and this depicts that other than teacher efficacy there can be other factors that affect students' achievement.

7.3. Limitations of the Study

This study is limited only to the public schools and the schools have student profile that is not high in achievement. Different results may be expected for different type of schools.

Furthermore, the sample was limited to sixteen teachers and their students. Even though, there were enough number of students, for generalizations studying with more teachers might be necessary. Also, the teacher related variables were limited only to teacher efficacy. There can be other factors such as teacher content knowledge and teaching methods for the effect on student trigonometry achievement. In addition, teachers' experiences were ranged from one year to 19 years. This can be an effect to the teacher efficacy.

7.4. Suggestions for Future Research

There are some suggestions of present study for future trigonometry self-efficacy research. In this study, quantitative techniques were used in measuring student and teacher related variables. To enhance the results of this quantitative study, a qualitative investigation might be necessary. The teacher related variables can be collected by utilizing observations and interviews. The classroom norms can be investigated to get information about teacher efficacy. In addition, for student trigonometry achievement, students can be interviewed and they can be observed during class hours. Beside teacher efficacy, the teacher content knowledge and teaching methods can be included for a future research to understand the effect on the student trigonometry achievement.

In addition, cross-sectional studies should be performed to compare efficacy beliefs of teachers at different level of their careers (i.e., pre-service teachers, novice teachers, and experienced teachers). In this way the effect of experience can be compared.

Furthermore, studies for other topics might be enlightening for further information of secondary school mathematics education research. For example, derivative, integral, complex numbers or logarithm can be investigated.

APPENDIX A: TEACHERS' SENSE OF EFFICACY SCALE (TSES)

Turkish version of the Teachers' Sense of Efficacy Scale (TTSES)

	ÖĞRETMEN ÖZYETERLİK ÖLÇEĞİ	yetersiz		çok az yeterli		biraz yeterli		oldukça yeterli		çok yeterli
1.	Çalışması zor öğrencilere ulaşmayı ne kadar başarabilirsiniz?	1	2	3	4	5	6	7	8	9
2.	Öğrencilerin eleştirel düşünmelerini ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
3.	Sınıfta dersi olumsuz yönde etkileyen davranışları kontrol etmeyi ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
4.	Derslere az ilgi gösteren öğrencileri motive etmeyi ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
5.	Öğrenci davranışlarıyla ilgili beklentilerinizi ne kadar açık ortaya koyabilirsiniz?	1	2	3	4	5	6	7	8	9
6.	Öğrencileri okulda başarılı olabileceklerine inandırmayı ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
7.	Öğrencilerin zor sorularına ne kadar iyi cevap verebilirsiniz?	1	2	3	4	5	6	7	8	9
8.	Sınıfta yapılan etkinliklerin düzenli yürümesini ne kadar iyi sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
9.	Öğrencilerin öğrenmeye değer vermelerini ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
10.	Öğrettiklerinizin öğrenciler tarafından kavranıp kavranmadığını ne kadar iyi değerlendirebilirsiniz?	1	2	3	4	5	6	7	8	9
11.	Öğrencilerinizi iyi bir şekilde değerlendirmesine olanak sağlayacak soruları ne ölçüde hazırlayabilirsiniz?	1	2	3	4	5	6	7	8	9
12.	Öğrencilerin yaratıcılığının gelişmesine ne kadar yardımcı olabilirsiniz?	1	2	3	4	5	6	7	8	9
13.	Öğrencilerin sınıf kurallarına uymalarını ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
14.	Başarısız bir öğrencinin dersi daha iyi anlamasını ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
15.	Dersi olumsuz yönde etkileyen ya da derste gürültü yapan öğrencileri ne kadar yatıştırabilirsiniz?	1	2	3	4	5	6	7	8	9
16.	Farklı öğrenci gruplarına uygun sınıf yönetim sistemi ne kadar iyi oluşturabilirsiniz?	1	2	3	4	5	6	7	8	9
17.	Derslerin her bir öğrencinin seviyesine uygun olmasını ne kadar sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
18.	Farklı değerlendirme yöntemlerini ne kadar kullanabilirsiniz?	1	2	3	4	5	6	7	8	9
19.	Birkaç problemli öğrencinin derse zarar vermesini ne kadar iyi engelleyebilirsiniz?	1	2	3	4	5	6	7	8	9
20.	Öğrencilerin kafası karıştığında ne kadar alternatif açıklama ya da örnek sağlayabilirsiniz?	1	2	3	4	5	6	7	8	9
21.	Sizi hiçe sayan davranışlar gösteren öğrencilerle ne kadar iyi baş edebilirsiniz?	1	2	3	4	5	6	7	8	9
22.	Çocuklarının okulda başarılı olmalarına yardımcı olmaları için ailelere ne kadar destek olabilirsiniz?	1	2	3	4	5	6	7	8	9
23.	Sınıfta farklı öğretim yöntemlerini ne kadar iyi uygulayabilirsiniz?	1	2	3	4	5	6	7	8	9
24.	Çok yetenekli öğrencilere uygun öğrenme ortamını ne kadar sağlıyabilirsiniz?	1	2	3	4	5	6	7	8	9

APPENDIX B: SELF-EFFICACY BELIEFS TOWARD MATHEMATICS TEACHING SCALE (SEBMTS)

Sıra No	SEÇENEKLER	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle Katılmıyorum
1	Matematiği öğretmek için sürekli etkili yollar bulurum.					
2	Çok sıkı çalışsam bile matematiği iyi öğretemem.					
3	Matematiği etkili bir şekilde öğretmek için yeterli tecrübeye sahip değilim.					
4	Bazı öğrencilerin matematik dersinde başarısız olmalarının nedeni öğretmenleri değildir.					
5	Matematik kavramlarını çok iyi öğretecek seviyede bulunuyorum.					
6	Matematik öğretiminin iyi olmasına yönelik yapılacak çalışmalar bazı öğrencilerin matematik başarısında çok az değişikliğe neden olur.					
7	Aileler çocuklarının matematiğe yönelik ilgilerinin arttığını gördüklerinde bunun nedenini muhtemelen öğretmenlerinin performansına bağlarlar.					
8	Matematikteki ispatları niçin yaptığımızı bulmakta zorlanırım.					
9	Öğrencilerin matematikle ilgili sorularını cevaplayabilirim.					
10	Öğrencilerin matematiğe yönelik motivasyonları matematik başarıları üzerinde az etkilidir.					
11	Öğrenciler matematiği zor anladıkları zaman, onlara matematiği daha iyi anlamaları için genellikle yardımcı olmam					
12	Matematik öğretirken öğrencilerin sorularını genellikle nazikçe karşılarım.					
13	Öğrencileri matematiği öğrenmeye motive etmek için ne yapacağımı bilmem.					
14	İyi bir matematik öğretme yeteneğine sahipsem bile bazı öğrencilerin matematiği öğrenmelerine yardımcı olamam.					

APPENDIX C: TEACHER TRIGONOMETRY TEACHING EFFICACY SCALE (TTTES)

Aşağıdaki soruları öğretmenizin istendiğini varsayın. Bunları öğrencilere öğretme konusunda kendinize güven derecenizi işaretleyin.

LÜTFEN SORULARI ÇÖZMEDEN İŞARETLEYİN.

BU ANKETİ DOLDURDUKTAN SONRA SORULARI ÇÖZMENİZ İSTENMEYECEKTİR.

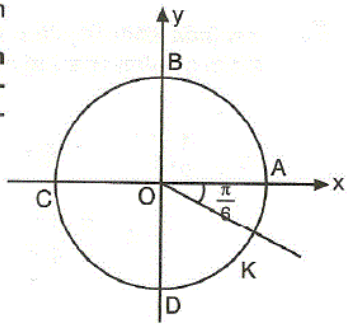
1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

1.

$m(\widehat{AOK}) = \frac{\pi}{6}$ radyan

O merkezli birim çemberde K noktasının ordinatı kaçtır?

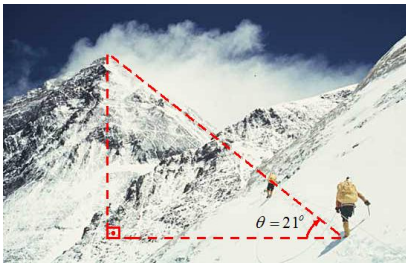


Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

2.



Everest dağı, Nepal ve Tibet ülkelerinin sınırları içindedir. Dağın yüksekliği, ilk kez 1849-1850 yıllarında Hindistan da yapılan bilimsel araştırmalar sonucunda bulunmuştur. Modern tekniklerle yapılan ölçümler, 1850'lerdeki hesaplamaların sonuçlarının hemen hemen doğru olduğunu göstermektedir. Everest dağının zirvesinin biraz aşağısında, 7845 metre yükseklikte ölçme aracı kullanılarak yapılan ölçümler sonucunda bulunulan konumdan zirveye eğim açısının ölçüsünün ve bulunulan konum ile zirve arasındaki mesafenin 2798,8 metre olduğu belirlenmiştir. Buna göre zirvenin yüksekliği, hesap makinesi kullanılarak bulun. $(\sin 21° = 0,3584)$

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

3. $\cos^2\frac{3\pi}{10}+\cos^2\frac{\pi}{5}+\cot\frac{3\pi}{8}\cdot\cot\frac{\pi}{8}$ işleminin sonucu bulun.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

4. $\tan 60°.\tan 45°.\tan 30°$ işleminin sonucu kaçtır?

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

5. $\frac{\pi}{2}<x<\frac{3\pi}{2}$ ve $\sin x=-\frac{2}{5}$ olduğuna göre, $\tan x$ değeri kaçtır?

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

6. $\frac{\sin\left(\frac{3\pi}{2}-\theta\right)}{\cot(\pi+\theta)}$ ifadesini en sade şekilde yazın.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

7. $0° < x < 90°$ olmak üzere $\cos x = 0,9945$ ve $0° < y < 90°$ olmak üzere, $\tan y = 4,0108$ olduğuna göre, *x* ve *y* değerlerini trigonometri cetveli ve hesap makinesi yardımıyla bulunuz.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

8. $f(x) = \sin(5x + 12)$ fonksiyonunun esas periyodu kaçtır?

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

9. Aşağıdaki fonksiyonun grafiğini çizin.

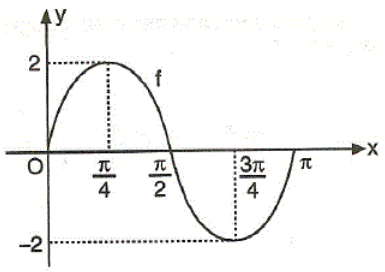
$h(x) = \tan x$

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

10.



[0, π] aralığında grafiği verilen f fonksiyonu aşağıdakilerden hangisi olabilir?

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

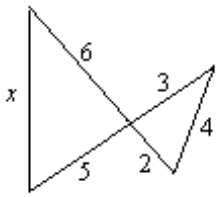
11. $arcsin\left(\frac{\sqrt{3}}{2}\right)$ değerini bulun.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

12.



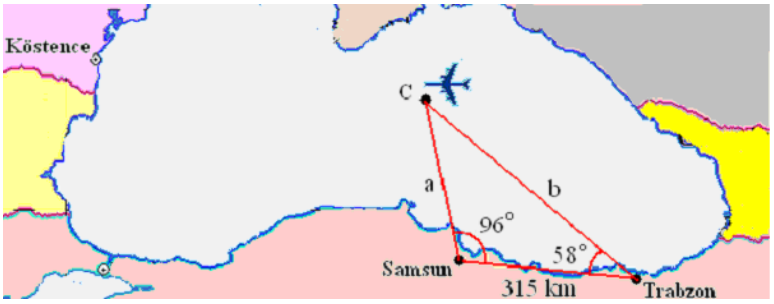
Şekilde verilenlere göre x kaçtır?

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

13.



Şekilde görüldüğü gibi Erzurum'dan havalanan bir uçak Köstence'ye doğru ilerlemektedir. Pilot, şekilde görülen C noktasına ulaştığında uçakta, mekanik bir arıza olduğunun farkına varıyor. Uçağın konumuna göre yakındaki hava alanları Samsun ve Trabzon'da bulunduğuna göre uçağın zorunlu iniş yapabileceği en yakın hava alanına olan uzaklığı hesap makinesi yardımıyla hesaplayın.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

14. $\tan\left(\arctan\frac{1}{2}+\operatorname{arc\,cot}\frac{2}{3}\right)$ değeri kaçtır?

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

15. $\sin 25^\circ = t$ ise $\cos 40^\circ$ nin t türünden değerini bulunuz.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

16. $\frac{\cos 10^\circ + \cos 30^\circ + \cos 50^\circ}{\sin 10^\circ + \sin 30^\circ + \sin 50^\circ}$ ifadesinin değerini bulunuz.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

17. $\sin\left(3x-\frac{\pi}{4}\right) = -\cos x$ denkleminin çözüm kümesini bulun.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

18.2 sin x + 3 cos x = 4 denkleminin çözüm kümesi bulun.

Öğrencilere öğretme konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

APPENDIX D: OBJECTIVES FOR TRIGONOMETRY

10.SINIFLAR TRİGONOMETRİ ÜNİTESİ KAZANIMLAR VE SORULAR

Trigonometri ünitesi altı ana bölüme ayrılmıştır ve her bölüm kendi içinde çeşitli kazanımlar içermektedir.

A. Trigonometrik Fonksiyonlar

A1. Trigonometrik fonksiyonları birim çember yardımıyla ifade eder, tanım ve görüntü kümelerini belirler, trigonometrik özdeşlikleri gösterir.

A2. Dik üçgende dar açıların trigonometrik oranlarını belirtir.

A3. Tümler açıların trigonometrik oranları arasındaki ilişkiyi belirtir.

A4. Dik üçgen yardımıyla $30°$, $45°$ ve $60°$ lik açıların trigonometrik oranlarını hesaplar.

A.5. Trigonometrik fonksiyonları birbirleri cinsinden bulur.

A6. $k \in Z$ olmak üzere, $\frac{k\pi}{2} \mp \theta$ sayılarının trigonometrik oranlarını θ sayısının trigonometrik oranı cinsinden yazar.

A7. Bir açının trigonometrik oranını trigonometrik değerler tablosunda bulur.

B. Trigonometrik Fonksiyonların Grafikleri

B1. Periyodu ve periyodik fonksiyonu açıklar, trigonometrik fonksiyonların periyotlarını bulur.

B2. Trigonometrik fonksiyonların grafiklerini çizer.

C. Ters Trigonometrik Fonksiyonlar

C1. Ters trigonometrik fonksiyonları açıklar.

D. Üçgende Trigonometrik Bağıntılar

D1. Sinüs, kosinüs teoremlerini belirtir, gösterir ve üçgenin alan formüllerini bulur.

E.Toplam ve Fark Formülleri

E1. İki sayının toplam ve farkının trigonometrik oranlarını bulur.

E2. Yarım açı formüllerini bulur.

E3. Dönüşüm ve ters dönüşüm formüllerini bulur.

F. Trigonometrik Denklemler

F1. Trigonometrik denklemi ifade eder ve sin$x=a$, cos$x=a$, tan$x=a$, cot$x=a$ biçimindeki denklemlerin çözüm kümesini bulur.

F2. $a\cos x+\ b\sin x=c$ biçimindeki trigonometrik denklemlerin çözüm kümesini bulur.

Table D. 1. Objectives and corresponding items from the scales.

Objectives	Corresponding items in TTTES	Corresponding items in STSES	Corresponding items in STAT
A	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,12
B	8,9,12	8,9,10	13
C	10	11	6
D	13,16	12,14	7
E	11,14,15	13,15,16	8,9
F	17,18	17,18	10,11

APPENDIX E: INTERVIEW QUESTIONS

1. Trigonometri öğrenimini/öğretimini geliştirmek için neler önerirsiniz?

2. Bu seneki öğrenci grubuna trigonometri öğretirken yaşadığınız deneyimleri paylaşır mısınız?

    a) Olumlu:

    b) Olumsuz:

3. Bütün öğretmenlik mesleği süresince trigonometri öğretirken yaşadığınız deneyimleri paylaşır mısınız?

    a) Olumlu:

    b) Olumsuz:

APPENDIX F: STUDENT TRIGONOMETRY SELF-EFFICACY SCALE (STSES)

ÖĞRENCİ TRİGONOMETRİ ÖZ YETERLİLİK ÖLÇEĞİ

Aşağıdaki soruları cevaplamanız istendiğini varsayın. Soruları doğru cevaplayabileceğiniz konusunda kendinize olan güven derecenizi lütfen işaretleyin.

LÜTFEN SORULARI ÇÖZMEDEN İŞARETLEYİN.

BU ANKETİ DOLDURDUKTAN SONRA SORULARI ÇÖZMENİZ İSTENMEYECEKTİR.

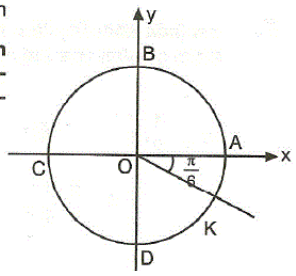
1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

1.

$m(\widehat{AOK}) = \frac{\pi}{6}$ radyan

O merkezli birim çemberde K noktasının ordinatı kaçtır?

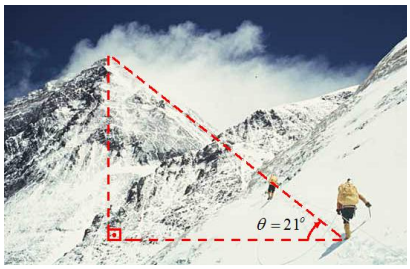


Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

2.



Everest dağı, Nepal ve Tibet ülkelerinin sınırları içindedir. Dağın yüksekliği, ilk kez 1849-1850 yıllarında Hindistan da yapılan bilimsel araştırmalar sonucunda bulunmuştur. Modern tekniklerle yapılan ölçümler, 1850 lerdeki hesaplamaların sonuçlarının hemen hemen doğru olduğunu göstermektedir. Everest dağının zirvesinin biraz aşağısında, 7845 metre yükseklikte ölçme aracı kullanılarak yapılan ölçümler sonucunda bulunulan konumdan zirveye eğim açısının ölçüsünün ve bulunulan konum ile zirve arasındaki mesafenin 2798,8 metre olduğu belirlenmiştir. Buna göre zirvenin yüksekliği, hesap makinesi kullanılarak bulun. $(\sin 21° = 0,3584)$

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

3. $\cos^2\frac{3\pi}{10}+\cos^2\frac{\pi}{5}+\cot\frac{3\pi}{8}\cdot\cot\frac{\pi}{8}$ işleminin sonucu bulun.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

4. $\tan 60°.\tan 45°.\tan 30°$ işleminin sonucu kaçtır?

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

5. $0<x<\frac{\pi}{2}$ ve $\tan x=\frac{1}{3}$ olduğuna göre, $\cos x$ değeri bulun.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

6. $\frac{\sin\left(\frac{3\pi}{2}-\theta\right)}{\cot(\pi+\theta)}$ ifadesini en sade şekilde yazın.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

7. $\sin 37°$ ve $\cot 56°$ değerlerini trigonometri cetveli ve hesap makinesi yardımıyla bulunuz.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

8. $f(x) = \sin(5x + 12)$ fonksiyonunun esas periyodu kaçtır?

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

9. Aşağıdaki fonksiyonun grafiğini çizin.

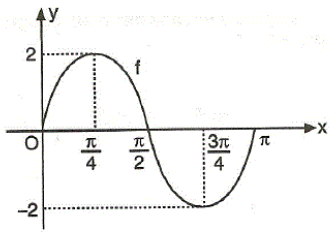
$f(x) = \sin x$

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

10.



$[0, \pi]$ aralığında verilen fonksiyonunun periyodunu belirtin ve denklemini yazın.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

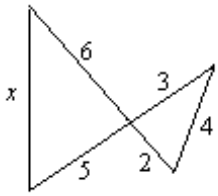
11. $\operatorname{arc}\cot\left(-\sqrt{3}\right)$ değerini bulun.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

12.



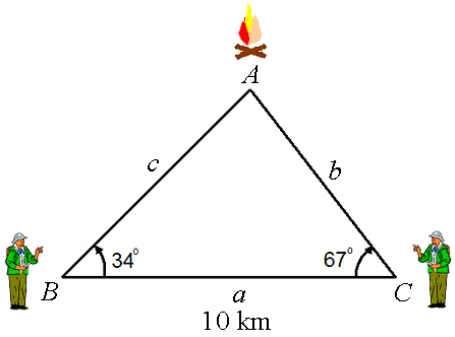
Şekilde verilenlere göre x kaçtır?

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

13.



Şekilde, bir orman yangını ve yangına müdahale etmek isteyen 2 itfaiye eri görülmektedir. Verilenlere göre her bir itfaiye erinin yangına uzaklığını hesap makinesi yardımıyla hesaplayın.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

14. $\tan 75°$ değeri kaçtır?

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

15. $\tan x = 2$ ise $\sin 2x$ ve $\cos 2x$ in değerini bulunuz.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

16. $\frac{\cos 10° + \cos 30° + \cos 50°}{\sin 10° + \sin 30° + \sin 50°}$ ifadesinin değerini bulunuz.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

17. $\cot 3x = -\tan x$ denkleminin çözüm kümesini bulun.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

18. $\sin x + \sqrt{3} \cos x = 0$ denkleminin çözüm kümesi bulun.

Doğru cevaplayabileceğim konusunda kendime olan güvenim:

1 2 3 4 5

Hiç güvenmiyorum Tamamen güveniyorum

APPENDIX G: STUDENT TRIGONOMETRY ACHIEVEMENT TEST (STAT)

TRİGONOMETRİ TESTİ

1. $\left(\frac{\tan x+\cot x}{\sec x.\csc x}\right)$ ifadesinin en sade şekli aşağıdakilerden hangisidir?

a)$\sin x$ b)$\cos x$ c)1 d)$\tan x$ e)$\cot x$

2. $x+y=90°$ olmak üzere, $\left(\tan x+\frac{1}{\tan y}\right).\left(cotx+\frac{1}{\cot y}\right)$ ifadesinin değeri kaçtır?

a) 1 b) 2 c) 3 d) 4 e) 9

3. $(\sin 150°.\cos 30°)$ işleminin sonucu kaçtır?

a) $\frac{\sqrt{3}}{4}$ b) $-\frac{\sqrt{3}}{2}$ c) $\sqrt{3}$ d) $-\frac{1}{2}$ e) $\frac{1}{4}$

4. $\frac{\sin x-\cos x}{\cos x}=\frac{3}{4}$ olduğuna göre, $\cot x$ in değeri kaçtır?

a) $\frac{7}{4}$ b) 1 c) $\frac{6}{7}$ d) $\frac{5}{7}$ e) $\frac{4}{7}$

5. $\cos\left(\frac{3\pi}{2}+x\right)+\cos\left(\frac{\pi}{2}-x\right)$ ifadesi aşağıdakilerden hangisine eşittir?

a) $2\cos x$ b) $2\sin x$ c) 0 d) $-2\cos x$ e) $-2\sin x$

6. $Arccos\left(\frac{1}{2}\right)+Arcsin(-1)$ ifadesinin değeri kaç radyandır?

a)$-\frac{\pi}{6}$ b) $-\frac{5\pi}{6}$ c) $\frac{2\pi}{3}$ d) $\frac{9\pi}{3}$ e) $\frac{11\pi}{6}$

7. Bir ABC üçgeninin kenar uzunlukları a, b ve c arasında,

a^2-b^2-c^2-b.c=0 bağıntısı olduğuna göre, BAC açısı kaç derecedir?

a) 30 b) 45 c) 60 d) 120 e) 135

8. $\frac{sin70°+\sin 20°}{\cos 25°}$ işleminin sonucu kaçtır?

a) $\sin 25°$ b) $\tan 25°$ c) 1 d) $\sqrt{2}$ e) $\sqrt{3}$

9. $\tan 10° = a$ olduğuna göre , $\tan 20°$ nin a cinsinden değeri aşağıdakilerden hangisidir?

a) $\frac{a^2+1}{2}$ b) $\frac{a^2-1}{2}$ c) $\frac{2a}{1-a^2}$ d) $\frac{a^2-1}{2a}$ e) $\frac{2a}{a^2-1}$

10. $\sin x = -\frac{1}{2}$ olduğuna göre, x in alabileceği değerlerden biri aşağıdakilerden hangisidir?

a) 300° b) 210° c) 150° d) 120° e) 30°

11. $\sqrt{3}\sin x + \cos 2x = 1$ denkleminin $[0,2\pi]$ aralığında kaç tane kökü vardır?

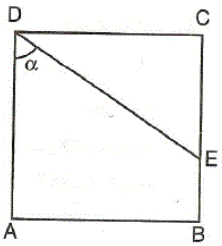
a) 1 b) 2 c) 3 d) 4 e) 5

12.

ABCD bir kare

$3|BE| = 2|CE|$

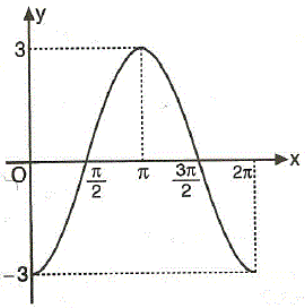
$m(\widehat{ADE}) = \alpha$



olduğuna göre, $\cot\alpha$ kaçtır?

A) $\frac{1}{5}$ B) $\frac{2}{5}$ C) $\frac{3}{5}$ D) $\frac{3}{2}$ E) 2

13.



[0, 2π] aralığında grafiği verilen f fonksiyonu aşağıdakilerden hangisi olabilir?

A) $f(x)=\cos 3x$ B) $f(x)=-3\sin x$ C) $f(x)=-3\cos x$
D) $f(x)=\sin 3x$ E) $f(x)=3\sin x$

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