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THE RELATIONSHIP BETWEEN STUDENT AND TEACHER RELATED FACTORS AND STUDENTS' PROBLEM SOLVING SKILL THROUGHOUT TURKEY AND ACROSS SCHOOL TYPES: PISA 2012 ANALYSIS

A MASTER'S THESIS

BY

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I dedicated this thesis to my father Faruk Sertkaya..

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Vildan Sertkaya

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VİLDAN SERTKAYA

September 2016

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

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ABSTRACT

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September 2016

Problem solving, which is one of the 21st century skills, is a targeted skill to gain by students in schools. However, problem solving is not taught as a separate lesson. Teachers should integrate this skill into their lessons and encourage their students to improve this skill. Therefore, teachers and students themselves have a major role in developing students' problem solving competency. In this study, the relationship between teacher and student related factors and students' problem solving skill as perceived by students were analysed both throughout Turkey and across school types. While conducting the study, PISA 2012 data was used and the analysis was done with the multiple linear regression method. According to the results of the study, there are statistically significant relationships between student and teacher related factors and problem solving skill. It was observed that the related factors are differed across the school types.

Key Words: Problem, Problem solving, school types in Turkey, teacher and student related factors, PISA 2012.

ÖZET

TÜRKİYE GENELİNDE VE OKUL TÜRLERİ BAZINDA ÖĞRETMEN VE ÖĞRENCİ İLE İLGİLİ FAKTÖRLERİN ÖĞRENCİLERİN PROBLEM ÇÖZME BECERİSİ İLE İLİŞKİSİ: PISA 2012 ANALİZİ

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21. yüzyıl becerilerinden problem çözme okullarda öğrencilere kazandırılması hedeflenen bir beceridir. Buna rağmen ayrı bir ders olarak okutulmamaktadır. Ancak öğretmenlerin bu beceriyi kendi derslerine bütünleşmiş olarak öğrencilerine kazandırmaları gerekmektedir. Problem çözme becerisinin öğrenciye kazandırılmasında öğretmenin rolü büyüktür. Bu çalışmada, hem öğretmen ile ilgili faktörler hem de öğrencinin kendisi ile ilgili faktörlerin öğrencinin problem çözme becerisine karşı olan algısı arasındaki ilişkisi Türkiye genelinde ve okul türleri bazında araştırılmıştır. Bu çalışma PISA 2012 Türkiye verilerine göre sürdürülmüş ve çoklu regresyon yöntemi kullanılarak analizler yapılmıştır. Çalışmanın sonuçlarına göre, problem çözme becerisi ile öğretmen ve öğrenci ile ilgili faktörler arasında anlamlı ilişkiler bulunmuş ve bu ilişkilerin okul türlerine göre farklılıklar gösterdiği gözlenmiştir.

Anahtar kelimeler: Problem çözme, Türkiye'deki okul türleri, öğretmen ve öğrenci ile ilgili faktörler, PISA 2012.

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CHAPTER 1: INTRODUCTION

Along with the quick improvements on science and technology in the 21st century, knowledge and skill have increased and giving them to students in schools become virtually impossible in formal education systems. Therefore, it is expected from schools to teach students how to reach the information and how to use the knowledge and to gain problem solving skill. Because people who can reach and use required knowledge and use it will compete with improvement in knowledge and technology in today's world (Sonmaz, 2012).

People encounter different situations which can be called as problems every day (Matlin, 2005). For instance, a student needs a book for his homework but he has no money; a boy who is tired and hungry comes home and there is no food at home. To accomplish homework, playing games with friends, visiting a new area, finding a ticket for travel, reading a graph, finding way on a map, or having no idea about what we need to do for any situation incorporate solving a problem. People come across such problems in their life and they try to solve them. People need to solve these problems to conduct their lives effectively, improve themselves, and satisfy the world that they live in (Fidan, 1998).

To define a given situation as problem, it needs to disturb a person or be an obstacle for that person and he or she needs to make an effort to solve it (Kilpatrick, 1985; Glassman & Hadad, 2009; Posamentier & Krulik, 1998). In parallel to this, problem solving is defined as to annihilate the situations that prevent the desired targets

(Greene, 2005; Sternberg, 2000). In another way, problem solving is the process of thinking to find a solution to a problem (Flyn, 1989).

Another definition made by Charles, Lester and O'Daffer (1987) stated that problem solving is an exploration, argumentation or a thinking issue. Problem solving is a skill that can be learned and should be developed gradually (Bingham, 1983; Sungur, 1992). This skill involves the process of transferring their knowledge to their life (Mayer, 2002; Reed, 1999). Due to its importance, problem solving skill is covered in formal educational systems to be gained (International Baccaularate-Diploma Program, 2014; International General Certificate of Secondary Education, 2014; (MoNE, 2013a). In the educational environment, problem solving process is substantial rather than solving the problem **(**Latterell, 2003). Students who enter this process explore their skill, and try to develop their talents. They start to feel they can achieve something by themselves and they gain self-confidence (Bingham, 1983).

Teachers are the main source for learning problem solving since students spend most of their times at school with their teachers (Gander & Gardener, 2001). A teacher's attitude towards students affects students' social, emotional and academic development. Thus, teachers are responsible for guiding students to provide them educational materials and situations (Katz & Chard, 2000).

Teachers must motivate their students on problem solving process because students may not be prospering on problem solving without their teachers' help (National Council of Teachers of Mathematics [NCTM], 2000). Krulik and Rudnick (1989) predicated that student must join in the problem solving continuum and teachers should give different and exiting problems to students to encourage them.

Many countries in the world attend international assessments to evaluate their education system. Turkey is one of these countries and attends these assessments to compare students' literacy levels with other counties and determine deficiencies in education system (YEĞİTEK, 2005).

According to the comparisons at the international level, Turkish students have trouble in transferring what they have learned at school to their everyday life as indicated by the results of Program for International Student Assessment (PISA) cycles. (YEĞİTEK, 2005). Thus, students may have trouble in transferring their problem solving skill from school to their real life. In addition, PISA survey is done across school types. In 2012, twelve school types from Turkey attended the PISA cycle. The results indicated that there are differences on students' achievement levels across school types (Berberoğlu & Kalender, 2005).

Improving students' problem solving skill is one of the aims of the mathematics education (MoNE, 2013a). Therefore, this topic is given a high importance in mathematics curricula around the world (Güven & Karataş, 2004). In this study, relationship between students' problem solving skill and teacher and school-related factors were examined using the dataset for PISA 2012 data across school types.

Background

Problem solving is one of the 21st century skill that students are expected to have. "21st century skill" is a widespread term in education nowadays (DuFour & DuFour, 2010). They include abilities that students need to develop in today's world. Problem solving is one of the most important skill and it often requires working collaboratively (Care & Griffin, 2014). Almost all jobs require collaboratively working skill, high problem solving skill, communication skill, and using technology

effectively in this century (Gore, 2013). Therefore, it is important that students acquire problem solving skill at schools, but it is difficult for teachers to integrate problem solving into classrooms (Gewertz, 2008).

Although problem solving is emphasized in different curricula, it is not thought as a separate lesson. Teachers integrate problem solving into their classes and students gain problem solving skill by attending the lessons such as mathematics, science and other lessons (International Baccaularate-Diploma Program, 2014; International General Certificate of Secondary Education, 2014; MoNE, 2013a).

Teachers can have different ways to integrate problem solving into their classes. While some of the teachers can prefer doing group work, some of them prefer individual working and other teaching methods. Teachers can choose real life situations and integrate them into classes. Moreover, almost all teachers expect their students to solve problems step by step and want their students to attend the problem solving process actively (Kayan, 2007). Students need to participate in problem solving process and teachers need to be guides for students and encourage them to solve the problems (Polya, 1957).

Problem is defined in MoNE 2013 curricula as an obstacle or difficulties which people come across during their life (MoNE, 2013a). The problem solving is a skill which should be learned and should always be improved and this skill is gained through time (Brahier, 2000). According to Polya (1957), for teaching problem solving, teachers should provide students to use problem solving strategies while solving problems. Problem solving strategies were defined as the number of strategies which were used in problem solving process to acsess the solution (Krulik & Rudnick, 1987). Polya (1957) defined four steps for problem solving process. The

first step is understanding the problem. Students should understand what the problem is asking, and determine what the solver knows and what the needs are. The second step is making a plan and students make an appropriate plan about how to solve it. The third step is carrying out the plan and students apply their strategies in this step. The last step is looking back and extend. Students check their solutions and try to extend their thinking.

NCTM defines problem solving as one of the five processes standards of mathematics. Problem solving is about both learning mathematics and doing mathematics. Students think and create their own ways for solving the problems and they can carry their problem solving skill outside the classroom. Thus, there is a direct relationship between solving mathematical problems and solving the problems encountered in real life. This means, students can profit from their mathematical knowledge when they encounter problems in their daily life (NCTM, 2000).

Although the curriculum attempts to integrate problem solving skill in mathematics Turkey's problem solving performance has been low in different assessments for years. For example, the PISA 2003 results showed that Turkey is below the OECD average in problem solving competency (YEĞİTEK, 2005). The current PISA results also showed that Turkey is still below the OECD average in problem solving (MoNE, 2013b).

PISA measures to what extent students can apply their knowledge and abilities at schools or in real life instead of how much students recall what they have learned (OECD, 2012). In addition, PISA measures students' guessing skill, when they may come across a new situation in their daily life (OECD, 2003).

PISA is one of the largest data source by which problem solving can be studied. Students' problem solving skill and both teacher-related and student-related attitudes are examined by the student questionnaires in PISA. Since 2000, every three years fifteen-year-old students participate in PISA. Students are selected randomly from schools and take tests in three main subjects: Reading, mathematics, and science literacy. The focus on the subject differs triennially, and the PISA 2012 focus was on mathematics literacy (YEĞİTEK, 2013). PISA includes student questionnaire, school questionnaire, parent questionnaire, education career questionnaire, and communication technology questionnaire, and PISA questionnaires include items about students' attitudes, learning environments, students' background, motivations, school types, socio-economic status and regions where they live in. Moreover, PISA questionnaires also include mathematics questions which try to measure students' content knowledge, process including real life situations, attitude towards mathematics and mathematics teachers (OECD, 2013).

There are several studies about how students' problem solving skill can be improved (Alter, Brown, & Lingo, 2008; Hwang, Hung, & Chen, 2014; Jitendra, Dupuis, & Rodriguez, 2012). Alter, Brown and Lingo (2008) suggest teachers that they can use different reinforcement in their lessons, because both positive and negative reinforcements can increase students' motivation and provides developing problem solving skill for children. According to Jitendra, Dupuis and Rodriguez (2012) the teachers' teaching method affects students' problem solving performance. For instance, doing the lesson by using schema-based instruction way provides teachers with a way to teach problem solving skill to their students. In addition, Hwang, Hung and Chen (2014) stated that for improving students' problem solving competency

teachers should provide student centred activities for students. Teachers should be aware of the fact that students can learn by doing themselves.

In Turkey, there are different literatures on how students' problem solving skill can develop (Yıldız & Güven, 2016). These researchers justify that students' metacognitive skill level has significant role on problem solving competency and teachers should provide students to be aware of their cognitive level during the problem solving process. According to their analysis results, students are aware of their cognitive level mostly on plan step of problem solving method. Thus, teachers should give students more time to spend on plan section and they may provide students to share their plans in class. Soylu and Soylu (2006) suggest teachers that students should construct their own problems because constructing own problem requires a person to think all the steps of the problem solving strategies. Additionally, according to Özen (2015), students should experience different activities included problems at class or out of classroom actively, because according to this researcher learning through experiences is the best way for learning. Thus, under favor of this activities students' problem solving skill can improve.

In summary, according to literature teachers' teaching strategies, attitude towards students, students' metacognition levels and their experiences are significant factors on problem solving skill.

Problem

As stated in the literature, teacher equipped with their both content and pedagogical knowledge in Turkey is one of the factors most associated with students' academic outcomes (Berberoglu & Kalender, 2005; Ceylan & Berberoglu, 2007). Teachers demonstrate their practices by utilizing distinctive and compelling strategies to

motivate students, getting ready before lectures for teaching and learning and attempting to transfer all his or her insight to students (NCTM, 2000). Hence, as Duruhan, Akdağ and Güven (1990) noted remarkable number of students expected that their mathematics teachers should encourage them while they were doing mathematics. For example, students expect their teachers to help them when they need help or encourage them to participate in classes actively. In addition, students who attend extracurricular activities, competitions, participate in clubs, or like to attend in mathematics classes their mathematics achievement improve (Anic, & Babic, 2015).

Although the role of teacher in student achievement is well studied in the literacy, the question whether there is a relationship between teacher-student relation and students' problem solving skill remains still unanswered. Thus, an investigation of relationship between student and teacher related factors and problem solving as perceived by students may provide additional information regarding ways to improve students' problem solving skill.

Developing students' problem solving skill is one of the aims stated in MoNE 2013 mathematics curriculum. In this curriculum, mathematical problem solving is defined as a problem which the student has not known the solution yet and requires using the knowledge and reasoning skill (MoNE, 2013). As stated in the curriculum, students are expected to become good problem solvers whose mathematical thinking skill have improved.

Although the importance of problem solving skill is emphasized in all curricula in Turkey, both national and international assessment results showed that students are much good at problem solving (Özenç & Arslanhan, 2010). In PISA 2012

assessment, students' mathematics literacy was examined. The mathematics literacy tests assessed students' different capabilities like problem solving, and their attitudes towards mathematics or their teachers (OECD, 2013). The PISA 2012 results indicated that there were both positive and negative developments in mathematical literacy for Turkey. For example, Turkish mathematics literacy results increased nearly 25 points in last ten years. In consequence, this increase corresponded to a half-semester school year increase. Although Turkey achieved this increase, the place of Turkey in ranking of PISA did not change. Furthermore, Turkey stayed under approximately 40 or 50 points below among OECD and EU countries, and Turkey fell behind one school year from these countries (Zopluoğlu, 2014).

Students' achievement levels are determined with respect to different variables such as regions, school types, socio-economic status, equity, etc (YEĞİTEK, 2013). There are huge achievement ranges between students who are from different school types in Turkey regarding to PISA 2003 results (Alacaci & Erbaş, 2010). Students who attend Science High schools or Anatolian High schools have the highest performance in both national exams and international student assessments, but students from vocational or general high schools have the lower performances acros all school types (Berberoğlu & Kalender, 2005; Demir, Kılıç & Depren, 2009). Therefore, it was seen appropriate to examine the related factors with problem solving skill of students across their school types.

Purpose

In this study it is aimed to investigate the relationship between student and teacher related factors and students' problem solving skill as perceived by students across different school types in Turkey by the use of PISA 2012 data sets.

Research questions

1. What are the opinions of students about themselves and teacher-related factors?

2. Is there a relationship between students' problem solving skill as percieved by student and both student and teacher related factors throughout Turkey as measured by PISA 2012?

    2.a. Is there a relationship between these factors and problem solving skill as percieved by student when whole PISA Turkish sample is used?

    2.b. Is there a relationship between these factors and problem solving skill as percieved by student when the sample is divided among school types?

Significance

The present study is expected to reveal relationships, if any exists, between both teacher and student related factors and problem solving skill perception of students. This study may provide teachers information which factors are related to developing problem solving skill of the students. Additionally, a large number of school types attended PISA 2012 and in this study relationships examined across school types which has not analyzed before by using PISA 2012 data. In that respect, this study also draws a picture of problem solving across a range of schools.

Definitions of key words

Problem: It is an obstacle which a person needs to overcome (Willoughby, 1990). People use their knowledge and skill to cope with the situation (MoNE, 2013a).

Problem Solving: It is a process of overcoming the problem. (Mayer, 1985) This process starts with understanding the problem and ends up with the solution (Schwieger, 1999).

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

The main aims of this study are to examine what students' opinions about their behaviors on lessons and teacher related attitudes of students and the relationship between students' problem solving skill and both teacher and student related factors from the perspective of the PISA 2012. In addition to that, students' problem solving skill is studied regards to the 12 different school types which determined and attended PISA 2012 in Turkey.

In present chapter, it is aimed to give more details about theoretical framework of the study and present research findings related to the research questions of current study. First, a base about problem solving skill and the student and teacher related factors in problem solving was given. The importance of teacher in the classroom and student improvement was presented. Moreover, the effects of attending extracurricular activities, mathematics competitions and such student related activities on students' achievement were examined.

Problem solving skill

Before discussing problem solving as a concept and skill, the question of what is problem should be discussed. There are different definitions on problem in literature. Brahier (2000) defined the problem basically as a task which has not an instantaneous solution. According to Lester (1994), if a person cannot directly continue for the solution, this situation is a problem for him.

Willoughby (1990) describes the problem as an obstacle which requires making an effort to land up the aim. If the person determines the situation as a hassle and he does not know what he needs to do to negotiate the situation this situation can be defined as a problem. Differently, Schwieger (1999) defined the problem as "a situation or statement which calls for the use of mathematical content, application, and process to resolve a blockage or reach a conclusion" (p. 113).

In many different lesson books, most of the problems are not problems for most of the students. Because students know how to solve them and the main purpose of such problems are to provide students to do some applications on what they have learned at previous lessons (Moschkovich, 2002). According to MoNE mathematics curriculum (2013a) problems should be related to students' real life, challenging and interesting. In the circumstances students' skill on doing mathematics will be more meaningful and they will start to apply their knowledge in different situations more easily.

When the conducted definitions are examined it was observed that there are some conditions for a situation to call as a problem. If the situation is an obstacle for the person, the person has not encountered with the situation before and he needs to solve it (American Educational Research Association, 1996).

When people come across a difficult and unknown situation they generally call this situation as a problem and they need to solve that problem. As concerns to the definition of problem solving, there are different definitions in literature. Cooper (1986) defined the problem solving as a process of analyzing the problem and solving it. Schoenfeld (1992) also defined problem solving as attracting with the problem which the person has not known the solution. According to Mayer (1985)

problem solving is “the process of moving from the given state to the goal state of a problem” (p. 124). In accordance with Heppner (1988), problem solving is synonymous with the concept of coping. Brahier (2000) defined the problem solving as a process started by a person’s initiative to solve the non-routine mathematical question. National Council of Teachers of Mathematics (NCTM; 2000) determines the problem solving as one of the ten main areas of mathematics. Problem solving is determined as tasks that require thinking mentally and challenging tasks to increase students’ mathematical conception and improvement. In NCTM it is also emphasized that students’ mathematical problem solving skill is directly related to their skill to solve problems that they encountered in their real life. While students are solving the problems came across in their social life, they benefit from their mathematical knowledge.

As the importance of problem solving skill is emphasized by NCTM, in Turkish mathematics curriculum problem solving skill is the first aim which needs to be gained by students. In the curriculum it is emphasized that people who valued mathematics, improved mathematical thinking competency, used mathematics in modelling and problem solving are so valuable and companies need these people in 21st century (MONE, 2013a). Therefore, one of the initial aims of the education is to help people to overcome the problems which people come across in their daily life (Güven & Karataş, 2004).

As stated in the mathematics curriculum, students are expected to become good problem solvers and it is aimed that students’ problem solving skill should be developed (MONE, 2013a). People, from child to adult, have different characteristics in problem solving and these characteristics can be developed within cognitive

duration and their mental improvement both during their education years and lifelong (Chi, & Glaser, 1985).

For providing improvement on problem solving skill there are different suggestions in the literature. The problem solving process is significant in problem solving. If the students solve the problem systematically, it is expected that their problem solving skill may improve (Passmore, 2007). In the same vein, students' problem solving skill and creativity of the students, logical thinking, conceptual understanding, and attitude towards mathematics have a positive relation (Mc Leod, 1989; Pimta, Tayruakham & Nuangchalerm, 2009). Hence, students' self-esteem, motivation, behaviour, teachers' teaching strategy and teachers' motivation and behavior in the classroom are really important on improvement of problem solving skill (Akınoğlu, & Tandoğan, 2007; Yaman, & Yalçın, 2005). Similarly, quality of the problems, coherence of the problems and meaningful problems effect students' problem solving skill positively (Lavonen, Meisalo & Lattu, 2001). In the same fashion, using metacognitive strategy on problem solving also effects students' problem solving skill positively (Özsoy, & Ataman, 2009).

Teacher-related factors associated with problem solving skill

Mathematical problem is an issue needed to find the solution but it has not known how to solve it with available knowledge (Brahier, 2000). For a teacher, the problem is a challenging question which student has not seen the solution way before but the student has prior knowledge to solve the question (Shoenfeld, 1989). Therefore, problem solving is not about only finding the solution of a mathematical problem it is also about coming across a new situation and finding effective solution ways.

In Turkey, students' problem solving performances are not at the desired level which is over than the average marks getting from international assessments by students (Güven & Karataş, 2004). However, problem solving strategies can be gained by students if teachers use the appropriate teaching strategies (Kabadayı, 1992). According to Aksoy (2003), in problem solving process used as a teaching method, strategies dealing with a problem should give with in-class activities related to lesson topics. In fact, the process of solving the problems we face in everyday life is similar to the problem-solving process in education. If teacher attitude towards behavioral problems at school is near problem solving methods, students may learn these strategies in practice. According to NCTM (2000), students should be able to learn different strategies for solving problems and teachers should provide students to use these strategies by themselves. Thus, it is significant to create an environment for students to solve many problems by themselves.

Students need a secure environment where there are no provisions dealing with success and failure for the development of personal skills and perceptions. They expect to be listened and taken serious by others in the classroom. In this classroom climate students are eager listening to each other and they can share their emotions and thoughts to solve problems arised in the classroom (Nelsen, Lott & Glenn, 2000). Hence, teacher should provide such kind of classroom environment and should present problems can be encountered in real life and ensure students to solve these problems. While providing students to solve problems teacher should not forget that students need their teacher's help (NCTM, 2000).

Additionally, to make students familiar with the problem solving process teachers should give enjoyable, interesting and challenging questions to students and present problem solving methods to students (NCTM, 2000). They should ensure students to

attend problem solving process actively because if students do not attend the process actively this phase might not be a problem solving study (Krulik & Rudnick, 1989).

Teachers are in communication with student throughout the day and their interactions and relationship affect students' social, academic and emotional developments. Positive relationships between student and teacher identifies with students' motivation, academic achievement, positive attitude towards school and increase in attending school (Brazelton & Greenspan, 2000; Jennings & Greenberg, 2009). Students have some expectations on regarding behaviors of their teachers. For example, students expect their teachers to show extra care to them and eagerly establish a good relationship with them. These expectations also affect students' social, emotional and educational growing positively (Hawk & Lyons, 2008; Yiu, 2013).

As it is seen in other countries, students have a tendency not to like mathematics in Turkey (Işık, Çiltaş & Bekdemir, 2008). This situation initiates in primary school and proceeds by getting worse. Thus, students start to think that they are not intelligent enough to learn mathematics and mathematics is not favourable course for them. In this impasse, teachers' attitude and behaviors are so significant (Baykul, 1999). Supportive relationships in schools encourage students to feel confident, affect students' performance and these students have positive attitudes towards schooling (Hill & Rowe, 1998; Murray & Greenberg, 2000).

Teachers who respect students, help them, care their progress, prosperous in an occupational sense, and encourage both academic and social developments of students provide the increase of students' academic achievement (Ma, 2003; Ozalper, 2006). Meanwhile, teachers' attitude towards students such as being sincere, open-

hearted, promoter and valuing to students' social progress motivate students' academic achievement (Solomon, Battistichi, Kim & Watson, 1997). Hence, teachers' communication with their students plays an important role in classroom climate and school culture. In this sense, teacher and student relationship in school and classroom is one of the most significant factors which affect their learning and behavior (Goh & Fraser, 1998; Li & Meng, 1997; O'Connor, Dearing, & Collins, 2011; Song & Liu, 2007).

Nevertheless, student teacher relationship can be poor. Children who have negative association with their teachers, they frequently get to be withdrawn or uninvolved classroom activities and they may advance negative state of mind towards school (O'Connor, 2010). In addition, because of negative relationships students may develop misbehavior in the classroom and they may dislike schooling (Croninger & Lee, 2001; Hamre, & Pianta, 2001; Murray & Murray, 2004).

Student-related factors associated with problem solving skill

Problem solving activities done at schools provides students to gain the skill of overcoming the problems encountered in daily life (MONE, 2009). This means problem solving is not an exercise done in class it is a skill used in both work and daily life (NCTM, 2000). Problem solving skill does not gain by heredity; it can be learned and improved (Dale & Balloti, 1997). Students need to formulize the problems; they should find an opportunity to solve complex problems which require extra performance and they should be encouraged expressing their own thoughts (NCTM, 2000).

A person's problem solving achievement is related to some different personal factors. Intelligence, motivation, prior knowledge and habits are some of these

personal factors related to problem solving competency (Morgan 1999). According to Bransford and Stein (1984) a person who is more intelligent than others is more capable on problem solving. However, some people have learned the problem solving strategies perfectly, so they can solve any problem more easily than others can. Morgan (1999) noted that people should be motivated for solving the problems and they should be provided to use their prior knowledge in problem solving process. According to Rips (1994) teachers encourage is important for students to do problem solving. Teachers' behaviors, students' self-competence and perseverance affect students' problem solving skill (Pimta, Tayruakham, & Nuangchalerm, 2009).

In mathematics lessons students come across different problems related to real life and they should attend problem solving activities directly. For solving such kind of problems students apply different problem solving strategies. Hatfield and Bitter (2004) noted that using problem solving strategies give a chance to students not only solving hard and challenging problems but also solving the problems that they come across daily life.

In the literature there is some evidence about attitude towards mathematics and problem solving skill. According to Kandemir (2006), there is a strong positive relationship between problem solving competency and attitude towards problem solving. Similarly, there is a strong positive relationship between mathematics achievement and attitude towards mathematics (Kandemir, 2006; Mayo, 1994; Özkaya 2002). Attitude is defined as a summary of experiences which determine a person's behaviors. Specially, mathematical attitude is defined as a person's like or dislikes mathematics, attending mathematical activities or escaping such activities, and the beliefs to be successful or failed on mathematics (Maqsud, 1998; Neale, 1969).

Program for international student assessment (PISA)

PISA is an internationally reputable assessment whose results are used to evaluate young generation knowledge, abilities and it is a reliable and comparable survey. OECD evaluates the education systems by comparing the nations, provides each country to be aware of their educational performance (Grek, 2009; Rizvi & Lingard, 2006; Rochex, 2006).

PISA is unique assessment. It is administered to students who have achieved the compulsory education. As OECD (2003) noted that students who are nearly 15 have just finished the compulsory education in almost all countries. Therefore, all 15-year-old students, who have finished the compulsory education period, may participate in PISA.

The first survey of the PISA was conducted in 2000 among the members of OECD countries (OECD, 2003). First three PISA survey were also done among OECD countries and after the third application, it was administered every three years among both the OECD countries and other countries in 2003, 2006, 2009 and 2012 (OECD, 2014).

PISA tries to determine students' reading literacy, mathematics literacy and science literacy levels. The focus of the test changes in each application among mathematics, science and reading. For instance, while the focus on PISA 2003 and PISA 2012 was mathematics literacy, students' reading literacy was measured in PISA 2000 and 2009 (OECD, 2014a).

For measuring students' literacy levels in PISA, pencil-paper has been used. However, at first in 2012 test mathematics covered computer-based test which is

optional for student. There are both multiple-choice questions and open-ended questions which students need to devise their own thinking. In addition, there are different questionnaires in PISA. By means of these questionnaires, information about students, their families, their socio-economic status, school types, nations, literacy levels and other information about students, schools, parents, and principles can be gathered (OECD, n.d.).

PISA also assesses students' problem solving competency. In PISA, problem is defined as a challenging and non-routine situation that a person encountered in daily life. Workplaces demand a person who is a good problem solvers and open to learn mistakes. Therefore, todays' world problem solving skill and learning throughout life and turning knowledge into action are needed skill. Therefore, PISA measures also students' problem solving skill and their perceptions of problem solving (OECD, 2012). In summary, PISA expects from students to reflect what they learned in mathematics lesson on real life and solve problems that they encountered in their routine life (Ilbagi & Akgun, 2013).

PISA in Turkey

For analyzing the effects of the shortcomings of the education system on the competitiveness of Turkey, production structure, and how Turkey's performance converges to the developed countries, it is required to compare the abilities of the students from different countries and students who have not begun to work. Thus, by analyzing the results of the PISA lunched in 2000 within the OECD countries, it is possible to make such a comparison (Acar, 2008). Moreover, one of the aims of Turkey to participate in PISA survey is that the deficiencies that need to be corrected

in Turkish national education system can be ascertained with regard to the PISA results (Özoğlu, Yıldız & Canbolat, 2013).

Turkey has been one of the OECD countries and has participated in PISA since 2003. The focus in 2003 was mathematics literacy and Turkey took part in the second survey of PISA (YEĞİTEK, 2005). PISA 2003 results apparently indicated that Turkey was below the OECD average. It was realized that Turkey has considerable problems in education (Cinoğlu, 2009). After PISA 2003, some imporement was done in Turkish education system. For example, primary school curriculum was renovated and it was applied in 2005-2006 education period and in this curriculum, instead of behavioral approach, cognitive approach was applied in curriculum development and the usage of technology, problem solving skill and such student-centered activities gain importance (MoNE, 2005). Additionally, PISA 2003 results showed that Turkey is below the OECD average in reading literacy in both private schools and public schools (Akşit, 2007).

In PISA 2006 Turkey showed quite low performance (Özer & Anıl, 2011). However, in PISA 2009 Turkey's performance increased a little in mathematics, science and reading literacy (Aydın, Sarıer & Uysal, 2014). The last PISA results showed most of the students in Turkey are in the first and second proficiency levels of mathematics literacy. In this sense students have only basic mathematics abilities. Thus, it is expected from these students that they can answer questions when the whole necessary information is given and the question is defined clearly. Moreover, students can interpret the situations or the results very basically. They can reason and make more inferences on mathematical results and they can use the basic algorithms, formulas and operations (YEĞİTEK, 2010b).

Considering the results of PISA cycles, there are differences among school types. Especially in state school students' proficiency levels are below the OECD average (YEĞİTEK, 2005; YEĞİTEK, 2010a; & YEĞİTEK, 2010b). In general high school and vocational high schools, achievement levels of the students are substantially low. However, particularly in some schools such as science high school students show superior performance. These students' literacy levels are above OECD average and most of them are on sixth proficiency level in all domains. Consequently, when PISA results examined according to the school types, differences among schools can be observed (Berberoğlu & Kalender, 2005).

It is asked to the school administers that teachers' attitude towards their students, behaviors in the classroom, and student-teacher relation directly affect students' learning (OECD, 2004). PISA 2003 results also indicated that teachers' expectations on students' success level is fairly low in Turkey. The other evidence from PISA survey is that teachers do not motivate students to use their full capacity, and teacher-student communication is really poor in Turkey (YEĞİTEK, 2010b).

School types in Turkey

In Turkey, there are six school types for high school students: science high school, Anatolian high school, social sciences high school, Anatolian vocational and technical high school, multiprogram high school and Anatolian religious high school. Students enter high school entrance exam at the last year of middle school and according to their exam results they choose one of these school types (MoNE, 2015b). Students who get high score in high school entrance exam they prefer science high school or Anatolian high school, but if they have low score they can

select vocational and technical high school, multi program high school or religious high school (MoNE, 2015a).

However, in PISA 2012 school types were determined according to previous specified school types in Turkey. In 2012, education was varied in two types in Turkey: Formal Education and Mass Education. Formal education is given in schools in regular time. The aim of the formal education was to provide students to gain both vocational and working abilities by means of prepared education programs. There were 23 school types in formal education such as general high schools, vocational high schools, and science high schools and so on. On the other hand, the main aim of the mass education was to provide people to gain basic information and abilities and prepare opportunities for them to earn their life (MoNE, 2009).

In general high schools, it was aimed that students gain all needed information in high school curriculum and they learned the abilities which necessary in higher education. A student who wanted to continue high school could enter general high school. Science high schools were established to train scientists. These students' mathematical and science intelligences were high in science high schools. While it was important to have mathematical and scientical intelligence was crucial for science high school, social and literature intelligence was significal in social science high school. In anatolian high schools, it was aimed to give intensive language training. In other words, in anatolian teacher training high schools, students were given to teacher training and it was tried to give attitudes and behaviors required of the teaching profession.

In addition, in technical and vocational schools vocational and industrial education was given (MoNE, 2009). After a student graduate from high school, students need

to continue higher education. For continuing higher education, from all school types they need to enter university entrance exams in Turkey. According to these exams' results, it is indicated that there are differences on exam results among different school types (Köse, 1999; YEĞİTEK, 2004). Students who are in science school show nearly 90% achievements on university entrance exam. Unlike science schools, students from anatolian vocational and technical high schools have nearly 10% success in university entrance exams. Similarly, while in anatolian schools the university entrance exam achievement is high, in general schools this achievement decreases. This means there are differences on students' achievement according to school types (Berberoglu, & Kalender, 2005; Fındık & Kavak, 2013).

Thomson at al. (2003) emphasize that school type is one of the most important factors affects students' mathematical achievement greatly. According to Aksu (2012) university students who graduated from general high school, anatolian high school, vocational high school and multi program high school are more capable on mathematics. Thus, students' mathematical achievement levels differ with respect to school types. Additionally, according to Güzeller, Eser and Aksu (2016) students' success levels in mathematics vary consistent with school types and students who graduated from anatolian high school, vocational high school and multi program high school are more successful on mathematics than graduated from other school types.

In conclusion, the literature makes easier to understand problem solving is crucial in 21st century and it is tried to be gained to students. There are both student and teacher related factors which affect students' problem solving competency. Therefore, it is appropriate to explore which factors are more related to students' problem solving skill according to PISA 2012 results. Additionally, as discussed in this chapter school types have significant effect on students' academicals improvement. Students'

mathematical achievement levels differ with respect to school types. Thus, for conducting the research on the authority of school types determined in PISA 2012 is proper for the study.

CHAPTER 3: METHOD

Introduction

In this chapter, first, research design, context, participants and instrumentation are given. Then, information is given about how data was collected and how it was analyzed.

Research design

This study is a quantitative research and the correlational design was used. Correlational design is used to describe substantial relationships between variables. A typical correlational design defines the degree of how two or more variables are related (Frankel & Wallen, 2008).

Context

PISA is an international survey and from more than 65 economies, 15-years old students have participated in this assessment in 2012 (OECD, 2013a). In its 2012 cycle, around 510,000 students were participated from 34 OECD member countries and 31 partner countries and economies (OECD, 2014b).

PISA is a unique assessment because it does not include any questions from any curricula. It assesses students' improvement at the end of compulsory education. PISA does not examine what students know, it examines how students use their knowledge. In addition, the countries and economies can compare their students' achievements over times and evaluate their education systems (OECD, 2013b).

Participants

The participants of this current research are the students who participated in the PISA 2012 cycle in Turkey. The age level is determined as criteria for international comparison since the school levels cannot be considered as an internationally acceptable criterion. Thus, age criterion is determined between 15 years 3 months and 16 years 2 months in PISA cycles (OECD, 2007). Turkish sample in PISA 2012 included 4848 students from 170 schools, 12 regions, and 57 cities.

Students from 12 different school types attended PISA 2012. The types of the schools which took part in PISA 2012 are primary school, general high school, anatolian high school, science high school, social sciences high school, anatolian teacher training high school, vocational high school, anatolian vocational high school, technical high school, anatolian technical high school, multi program high school (OECD, 2012). In Table 1, brief information is given about the school types. Figure 1 shows the number of students in each school.

Table 1
Brief information about schools included PISA 2012

Primary school	These schools aim to grow free and inquirer citizens, respecting differences, religions of people and respect in society equal students. Thus, it is expected students to contribute Turkey's science, art, language and religion areas.
General high school	Any students who accomplished primary and middle school can enter general high school directly. The school aims to develop students' knowledge and citizenship consciousness.
Anatolian high school	After graduation of middle school, students enter a high

Table 1 (cont'd)
Brief information about schools included PISA 2012

	school examination and according to this exam results students can enter these schools. In first year of the school, students get English language education. After that education continues three years more.
Science high school	Only students who get high marks from high school entrance exam can enter these schools. Thus, students take higher level education in natural sciences related topics.
Social Sciences high school	Social sciences related courses are focus of these schools.
Anatolian Teacher Training high school	The focuses of the courses are about teacher training and education.
Vocational high school	Students enter these schools without taking high school entrance exam. The focus is on developing students' vocational skill.
Anatolian Vocational high school	The focus of these cources is about vocational development. Additionally, learning foreign language is one of other important focus in these schools.
Technical high school	The focuses are students' technical learnings like electronics or mechanics.
Anatolian Technical high school	Technical courses are the focus in these schools such as electronics and mecanics. Moreover, these schools mean learning foreign language.
Multi Program high school	In these schools, general, technical and vocational curricula are used.

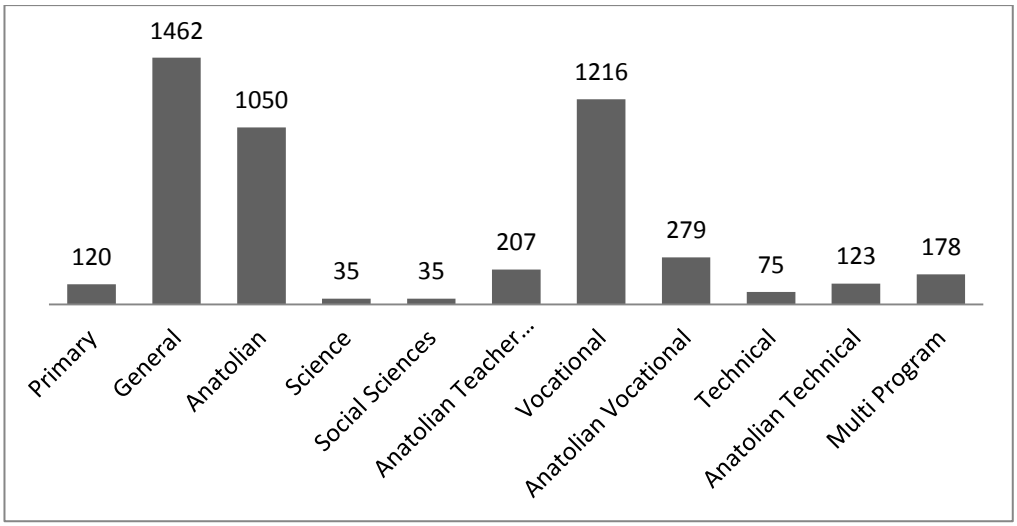


Figure 1. Number of students in each school type in PISA 2012

Instrumentation

There are three literacy tests in PISA: mathematics literacy, science literacy, and reading literacy. The focused subject ares changes from year to year. As in 2003, the focus of PISA 2012 was also mathematics.

In PISA cycles, there are tests that include both multiple-choice and open-ended questions on mathematics, reading and science literacy. These tests are related to real life situations because PISA does not measure students' achademic achievement levels it measures students' skill to use their knowledge (OECD, 2013). Additionally, there are questionnaries about students, their families, homes, schools, teachers and their learning practice. School principles also attend this survey and they answer questionnaries about their school system and learning atmosphere. Furthermore, there are questionnaries for parents and include their child's career expectancy and endorsement for their child's learning. As a result, Turkish students were responsible for only student questionnaire and school principles took part in the test by giving answer their questionnaire.

PISA defines several proficiency levels to describe what a student can do rather than reporting numerical scores only for each domain. For mathematics proficiency levels see Table 2. Detailed descriptions of the proficiency levels are given in OECD (2014b).

Table 2
Summary description for the six proficiency levels in mathematics domain

Level	Lower Score Limit	What students can typically do
6	669	Students can make concepts about complex problem situations and they can make generalizations. Students can make connections between different information source and representatives. They can switch between these two connections. Students have advanced mathematical thinking and reasoning. They can use symbols, mathematical operations, and relations well while reasoning in advanced level. Thus they can improve new approaches when they encounter new situations. Students can show their mathematical works, their findings, and interpretations appropriately and truly, so they can explain how these works are appropriate real life situations.
5	607	Students can develop models in complex situations and they can use or determine the limitedness of these models. Students can make an assumption and they can choose appropriate strategies. Students start to show their mathematical studies or mathematical thinking. They can tell their interpretations and reasoning clearly in writing.
4	545	Students can choose and come together different forms of representations and they can link these representations with real life situations. Their reasoning is limited and they can use their reasoning when situations are clearly stated. If they need to do explanations about their interpretations or reasoning, they can explain.

Table 2 (cont'd)
Summary description for the six proficiency levels in mathematics domain

3	482	They can perform clearly determined procedures which require sequential decisions. Students' interpretations show that they can select or form a model and use on problem solving. They have some abilities to deal with fractions, percentages, decimal numbers, and proportional relationships.
2	420	Students can interpret and recognize the situations which require deducing directly. They can distinguish the information which comes from a single source and use a single representative format.
1	358	Students may have the skill that they can do the simple operations which they are familiar with them. They can solve the questions where the relevant information is clear and given directly.

As it is seen in Table 2, the proficiency levels range from 1 to 6 for mathematics domain. In PISA, students should receive a minimum score of 669 to be placed at level 6, 607 at level 5, 545 points in the level of 4, 482 points at level 3, 420 at level 2 and 358 at the level of 1. Students who are in level 1 have very basic mathematical abilities. These students may only do simple operations and they may solve problem which has very clear and full instructions. On the other hand, students who are in level 6 have abilities to solve complex problems and they can handle complicated and challenging mathematical situations. In addition to that, PISA 2012 mathematics literacy results were showed that 15.5% of the students are below the level 1, 26.5% of students are in level 1, 25.5% of the students are in level 2, 16.5% of students are in level 3, 10.1% of students are in level 4, 4.7% and 1.2% students in level 5 and level 6 in turn.

In Table 3, students' mathematical literacy scores were given with respect to the school types. Moreover, these scores are grouped and the mean scores were examined according to proficiency levels for each school type. The results indicated that there are significant differences among schools' proficiency levels. For example, while students who are in science high school are in highest proficiency level (level 6), students from primary school or general high school have low score (level 1 or less than level 1) in mathematics literacy in PISA 2012.

Table 3
Proficiency levels, frequencies, mean, standard deviation skewness and kurtosis across school types

	Proficiency Levels	N	Mean	Std. Deviation	Skewness	Kurtosis
PRI	1	120	368.43	60.49	-0.03	-0.46
GEN	1	1462	412.61	65.13	0.01	-0.08
ANA	3	1050	531.75	73.89	-0.07	-0.13
SCN	6	35	672.34	34.76	-0.14	0.38
SSCN	3	35	543.10	47.75	0.39	-0.06
ATT	4	207	576.60	45.56	0.20	-0.20
VOC	1	1216	389.52	58.33	-0.04	-0.17
AVOC	2	279	449.96	58.56	0.19	0.02
TEC	2	75	450.00	50.94	-0.19	0.12
ATEC	2	123	475.48	55.54	-0.10	-0.45
MPR	1	178	409.90	67.23	0.03	0.44

Note. PRI: Primary school; GEN: General high school; ANA: Anatolian high school; SCN: Science high school; SSCN: Social sciences high school; ATT: Anatolian teacher training high school; VOC: Vocational high school; AVOC: Anatolian vocational high school; TEC: Technical high school; ATEC: Anatolian technical high school; MPR: Multi program high school.

In Table 4, summary description of students' problem solving scores were given with respect to the school types. Moreover, these scores were grouped and the mean scores were examined according to Trace Steps dimension for each school type. The mean scores did not differ much across school types. The skewness results indicated that students' answers mostly skewed right. Thus, most of the students' answers changed between 1 to 3 out of 5. However, in Social Sciences high school, students' answers skewed negatively. Therefore, most of the students' answers on problem solving literacy in such schools changed from 3 to 5 out of 5.

Table 4
Summary description of students' problem solving skill across school types.

	N	Mean	Std. Deviation	Skewness	Kurtosis
Primary School	76	1.63	0.80	1.10	0.50
General High School	948	1.50	0.71	1.47	2.01
Anatolian High School	692	1.37	0.54	1.24	1.19
Science High School	23	1.22	0.42	1.47	0.16
Social Sciences High School	24	1.54	0.51	-0.18	-2.16
Anatolian Teacher Training High School	141	1.36	0.55	1.22	0.52
Vocational High School	798	1.52	0.68	1.26	1.48
Anatolian Vocational High School	186	1.31	0.50	1.21	0.33
Technical High School	52	1.60	0.75	1.12	0.27
Anatolian Technical High School	77	1.47	0.58	0.77	0.23
Multi Program High School	116	1.47	0.67	1.27	1.15

In student questionnaires, there are five different sections which include questions about students' personal issues, their family and home, how they learned mathematics, their mathematics experiences, their problem solving experiences.

Method of data collection

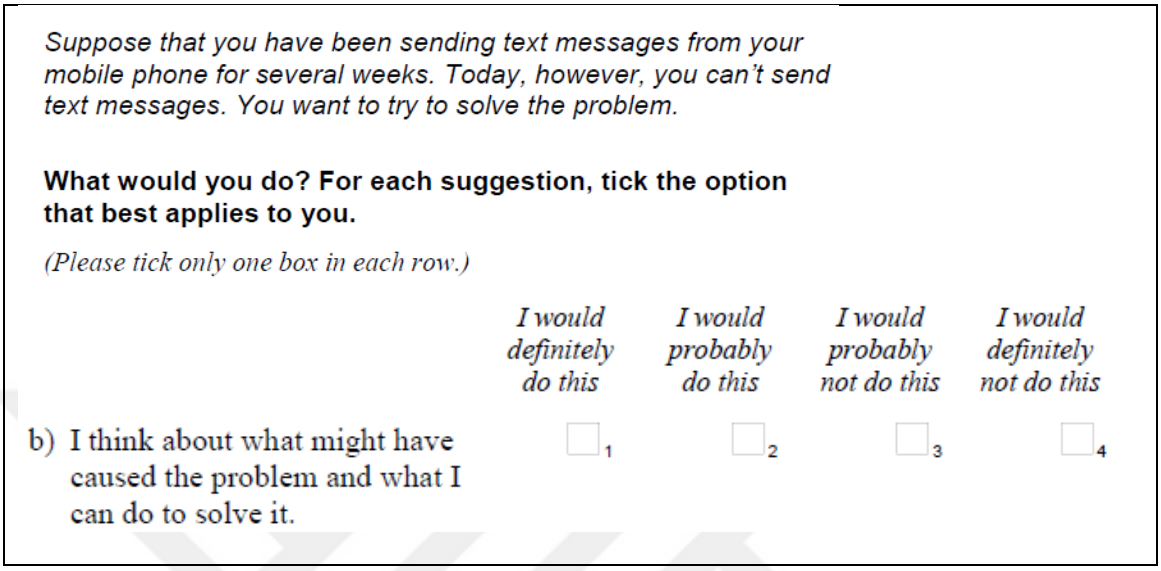
Responses to PISA 2012 student questionaires were used as data source in this study. Anyone who wants to study on the data of PISA 2012 can easily acsess since the data sets are publicly available.

Data collection in PISA cycles is conducted as follows: For providing the communication between the schools and the PISA National Center, school coordinators undertake this task. In this process, it is crutial to determine the students and getting permission to their parents. School coordinators determine all the names of students who are the age of fifteen and send the list to the PISA National Center in the country. PISA National Center chooses 35 students randomly and gives informations to the school coordinators. Coordinators get the permission to parents and if they let their child attends the test.

The date/time of the test implementation is determined by both school coordinators and test administers. The test administers are also responsible for sending different booklets to different students and they are charge with sending back the booklets to the PISA National Center. In Turkey, Ministery of National Education conducts all the PISA procedures (Yıldırım, Yıldırım, Yetişir, & Ceylan, 2013).

With regard to the research questions, as dependent variable the item of *Trace Steps* from the *Problem Text Message* scale was chosen as representative of problem solving score. There are four observed values students need to answer and for all observed values there are four items that students should rank. For instance, for the dimension of *Trace Steps* students should decide whether definitely do, probably do, probably not do or definitely not do this. These items rank from 1 to 4. Students who

definitely agree the situation selected 1 and student who definitely disagree the situation selected 4 item. In Figure 2, the the item was given.



Suppose that you have been sending text messages from your mobile phone for several weeks. Today, however, you can't send text messages. You want to try to solve the problem.

What would you do? For each suggestion, tick the option that best applies to you.

(Please tick only one box in each row.)

	I would definitely do this	*I would probably do this*	*I would probably not do this*	*I would definitely not do this*
b) I think about what might have caused the problem and what I can do to solve it.	☐ 1	☐ 2	☐ 3	☐ 4

Figure 2. Problem text message-trace steps

As independent variables seven dimensions from student questionnaire were selected: *Perseverance, Openness for Problem Solving, Maths Behavior, Maths Teaching, Teacher-Directed Instruction, Cognitive Activation, Student-Teacher Relations.* From all these dimensions, 42 observed values were used. In Table 5, there is some information about selected dimensions and observed values. Parantheses in the table indicate the code of the item in the Student Questionnaire.

The PISA student questionnaire have different scales. While the scales of *Perseverance* and *Openness for Problem Solving* rank from 1 to 4, the other scales of Teacher-Directed Instraction, Cognitive Activation, Student-Teacher Relation, Maths Teaching and Maths Behavior rank from 1 to 5. In the Perseverance and Openness for Problem Solving dimensions the scales consisted of *not at all like me, not much like me, somewhat like me, mostly like me* and v*ery much like me* scales. The scales

in *Teacher-Directed Instraction*, *Cognitive Activation*, *Maths Teaching* and *Maths Behavior* ranked *never or hardly ever, sometimes, often and always or almost always* scales. While the scales of Student-Teacher Relation consisted of strongly disagree-disagree, agree and strongly agree scales, Problem Text Message observed value ranked *I would definetly do this, I would probably do this, I would probably not do this* and *I would definetly not do this.*

Additionally, in the items, while the value of 1 corresponds "I agree", the value of 4 or 5 corresponds "I definitely disagree". This means, while students agree the situation they select 1, if they disagree the situation they select 4 or 5. Therefore, it was appropriate to do recoding for prevent any trouble. For only Give Up and Put Off dimensions the recoding did not apply, because these two observed values were ranged appropriately in the questionnaire. Before conducting the analysis 40 variables from 42 independent variables and dependent variable recoded. The data analyzed across school types.

Table 5
Selected dimensions and observed values as dependent and independent variables

Abbreviation	Variable
	Problem Text Message
Trace Steps	I think about what might have caused the problem and what I can do to solve it. (ST96Q02)
	Perseverance
*Give up	When confronted with a problem, I give up easily. (ST93Q01)
*Put off	I put off difficult problems. (ST93Q03)
Remain	I remain interested in the tasks that I start. (ST93Q04)
Perfection	I continue working on tasks until everything is perfect. (ST93Q06)
Expectations	When confronted with a problem, I do more than what is expected of me. (ST93Q07).

Table 5 (cont'd)
Selected dimensions and observed values as dependent and independent variables

	Openness for Problem Solving
Handle	I can handle a lot of information. (ST94Q05)
Understand	I am quick to understand things. (ST94Q06)
Seek	I seek explanations for things. (ST94Q09)
Link facts	I can easily link facts together. (ST94Q10)
Like	I like to solve complex problems. (ST94Q14)
	Teacher-Directed Instruction
Sets goals	The teacher sets clear goals for our learning. (ST79Q01)
Reasoning	The teacher asks me or my classmates to present our thinking or reasoning at some length. (ST79Q02)
Check	The teacher asks questions to check whether we have understood what was taught. (ST79Q06)
Summarize	At a beginning of a lesson, the teacher presents a short summary of the previous lesson. (ST79Q08)
Inform	The teacher tells us what we have to learn. (ST79Q15)
	Cognitive Activation
Encourage	The teacher asks questions that make use of reflect on the problem. (ST80Q01)
Think	The teacher gives problems that require us to think for an extended time. (ST80Q04)
Procedures	The teacher asks us to decide on our own procedures for solving complex problems. (ST80Q05)
No obvious	The teacher presents problems for which there is no immediately obvious method of solution. (ST80Q06)
Context	The teacher presents problems in different context so that students know whether they have understood the concepts. (ST80Q07)
Mistakes	The teacher helps us to learn from mistakes we have learned. (ST80Q08)
Explanations	The teacher asks us to explain how we have solved a problem. (ST80Q09)
Apply	The teacher presents problems that require students to apply what they have learned to new contexts. (ST80Q10)
Multiple	The teacher gives problems that can be solved in several different ways. (ST80Q11)
	Student-Teacher Relation
Get along well	Students get along well with teachers. (ST86Q01)
Interested in	Most teachers are interested in students' well-being. (ST86Q02)
Listen	Most of my teachers really listen to what I have to say. (ST86Q03)
Help	If I need extra help, I will receive it from my teachers. (ST86Q04)
Treat fair	Most of my teachers treat me fairly. (ST86Q05)

Table 5 (cont'd)
Selected dimensions and observed values as dependent and independent variables

	Maths Teaching
Shows interests	The teacher shows an interest in every student's learning. (ST77Q01)
Extra help	The teacher gives extra help when students need it. (ST77Q02)
Teacher helps	The teacher helps students with their learning. (ST77Q04)
Teacher Continuous	The teacher continues teaching until the students understand. (ST77Q05)
Express Opinions	The teacher gives students an opportunity to express opinions. (ST77Q06)
	Maths Behavior
Talk About Maths	I talk about mathematics problems with my friends. (ST49Q01)
Help Friends	I help my friends with mathematics. (ST49Q02)
Extracurricular	I do mathematics as an extracurricular activity. (ST49Q03)
Competitions	I take part in mathematics competitions. (ST49Q04)
Study More	I do mathematics more than 2 hours a day outside of school. (ST49Q05)
Play Chess	I play chess. (ST49Q06)
Computer	I program computers. (ST49Q07)
Maths Club	I participate in a mathematics club. (ST49Q09)

Note: * recoding did not apply.

Methods of data analysis

Percentage of responses to different response categories for each observed item were calculated to answer the 1st research question. A seris of multiple linear regressions was conducted to answer the subquestions of 2nd research question. For the analysis 1 dependent variable which is *Trace Steps* from *Problem Text Message* dimension and 42 observed variables from 7 dimensions were included (See Table 5). A single regression analysis was conducted on the whole Turkish sample without focusing school types. Then a group of linear regression analyses were also conducted with respect to the school types.

The purpose of the regression can be prediction or explanation. In multiple linear regression, there is a single dependent variable which is predicted by more than one predictor which are called independent variables (Creswell, 2003). Regarding to data

scales, while the scale of independent variables can be nominal, interval or ratio, the scale of dependent variable must be measured at the ratio or interval (Huck, 2011).

While conducting multiple linear regression, the stepwise method was preferred. Stepwise regression is a modification of advanced selection in which at each step the best predictors among independent variables are determined (Courville & Thompson, 2001). Therefore, stepwise method provided to see the best predictor at first step, the second predictor at second step, and so on. Finally, at last step all the predictors which has relation with the dependent variable are included (Montgomery, Peck & Vining, 2012). Stepping model criteria for entry and removal were set to .05 - .10 respectively.

Statistical Package for the Social Sciences was used to analyze data. Data were explored with respect to assumptions of multiple linear regression. The primary assumptions were as follows:

- linearity
- homoscedasticity
- normality of residuals (Huck, 2011).

A significant assumption of multiple linear regression is linearity of dependent and independent variables. This assumption can be test by scatter plot of standardized predicted values against standardized residual values (Huck, 2011). The homoscedasticity is the variance of errors and it was checked by examination of residuals scattergram. Normality assumption can be checked by examining the histogram of the residuals, the normal probability plot and the scatter plot. Skewness estimates can also be used. If the skewness value less than plus or minus one the distribution can be a normal (Tabachnick & Fidell, 2007).

Results showed that assumptions can be considered to be met within the acceptable ranges.

CHAPTER 4: RESULTS

Introduction

This chapter provides the results of the current study which examines the relationship between students' problem solving skill and factors related to both teacher and student with respect to the PISA 2012.

Research question 1. What are the opinions of students about themselves and teacher-related factors?

Table 4 presents percentages of each response categories for the dimension of *Perseverance*. The responses on Table 6 showed that when students confronted with a problem more than fifty percent of the students (26.4% + 26.2%) do not give up the problem easily. Fifty-two point six percent of the students keep their consistency while they are solving the problem.

More than fifty percent of the students (36.3% + 34.5%) think that they remain their interest in the task that they started. Only 9.3% (6.0% + 3.3%) of students think that they lose their interest in the task. Sixty-six point four percent (33.8% + 32.6%) of the students say that they continue working on task until everything is perfect. This means more than fifty percent of the students do not give up the task until it is accomplished perfectly.

Similarly, more than fifty percent of the students (32.2% + 33.9%) think that they do more than what is expected when they confronted with a problem. However, the responses showed that when students encounter with difficult problems, 36.1% (15.7% + 20.4%) of the students put off the problems. This means less than fifty

percent of students do not like to come across difficult problems and they need to postpone them.

Table 6
Distribution of responses for *perseverance* subscale

	Not at all like me	Not much like me	Somewhat like me	Mostly like me	Very much like me
Give Up	26.2	26.4	26.0	10.6	10.9
Put Off	14.9	17.6	31.4	20.4	15.7
Remain	3.3	6.0	19.9	34.5	36.3
Perfection	3.0	7.8	22.8	32.6	33.8
Expectation	3.4	6.7	23.8	33.9	32.2

Table 7 represents rates of responses for the measurement of *Openness for Problem Solving*. Students' responses demonstrated that while 52.9% of the students think they can handle a lot of information only 11.3% (8.7% + 2.6%) of the students think that they cannot cope with the problem if it has lots of information. Similarly, while 66.1% of students believe that they understand the things quickly and 70.8% of the students agree that they seek explanations for things, less than 10% (6.0% + 1.5% and 5.7% + 1.4%) of the students say that they do not understand the things very quickly and they do not seek explanations for things. Furthermore, the responses show that 71.2% of students (highest percentage) think that they can easily link facts together. However, slightly few of the students (5.7% + 1.6%) think they cannot easily link facts. Differently, while 35.9% (18.4% + 18.7%) of students say they do not like to solve complex problems, 37.1% (19.1% + 16.8%) of students believe that they like to solve complex problems. This means number of the students who like to solve complex problems and who do not like to solve complex problems is very close to each other.

Table 7
Percentage of *openness for problem solving* responses

	Not At All Like Me	Not Much Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
Handle	2.6	8.7	35.8	31.7	21.2
Understand	1.5	6.0	26.4	40.3	25.8
Seek	1.4	5.7	22.2	39.0	31.8
Link Facts	1.6	5.7	21.5	38.3	32.9
Like	16.8	19.1	27.1	18.7	18.4

The percentages of students' responses on *Teacher-Directed Instruction* are given in Table 8. Students' responses show that 62.9% (32.9% + 36.3%) of the students think their teachers set clear goals for students' learning in every lesson or most lessons, but only 6.3% of the students believe that their teachers never or hardly ever set clear goals in the lesson. Moreover, more than 75% (42.8% + 34.5% and 46.5% + 29.7%) of the students' responses indicated that their teachers encourage their students to present their thinking reasoning and check their learning by asking questions to them.

Table 8 indicates that while 56.2% (29.8% + 26.4%) of the students that at the beginning of a lesson their teachers summarize the previous lesson, but 13.2% of the students' responses showed that their teachers do not remind the previous lesson. In addition, 78.6% (45.7% + 32.9%) of students' belief is that their teachers inform them about what they have to learn in every lesson or most lessons while only 5.2% of them believe their teachers never or rarely inform them about learning goals.

Table 8
Percentage of *teacher-directed instruction* responses

	Never or Hardly Ever	Some Lessons	Most Lesson	Every Lesson
Set Goals	6.3	24.5	36.3	32.9
Reasoning	4.1	18.6	34.5	42.8
Checks	5.7	18.1	29.7	46.5
Summarizes	13.2	30.6	26.4	29.8
Informs	5.2	16.2	32.9	45.7

In Table 9, the percentages of students' responses on *Cognitive Activation* are given. According to the results, for each observed item except procedures (20.6%) and presents problems with no obvious solution (39.0%), less than 12% of students think their teachers never or hardly ever activate their cognitive levels. For example, only 6.0% of students think their teachers never or rarely ask them to explain their solutions. On the other hand, more than 50% of students' responses indicated that teachers often or sometimes provide them to improve their cognitive skill. Moreover, nearly less than 40% of students believe that their teachers always or almost always help students' cognitive improvement.

Table 9
Percentages of *cognitive activation* responses

	Never Or Rarely	Sometimes	Often	Always Or Almost Always
Encourage	10.1	37.8	31.8	20.4
Think	11.0	47.2	28.2	13.6
Procedures	20.6	37.9	25.8	15.8
No Obvious	39.0	34.0	16.8	10.2
Context	9.8	29.2	34.9	26.1
Mistakes	11.6	26.9	33.8	27.7
Explanations	6.0	19.3	35.6	39.7
Apply	8.1	26.0	36.0	29.8
Multiple	6.7	28.7	34.8	29.9

Students' responses in Table 10 demonstrated that more than seventy percent of students strongly agree or agree all the observed variables. Thus, more than 70% of students strongly agree or agree that they get along well with their teachers, listen their teachers, their teachers are interested in them and help them, and their teachers treat their fair. However, less than 10% of students strongly disagree that they have a good relation with their teachers. This means most of the students in Turkey have a positive relationship with their teachers.

Table 10
Percentage of s*tudent-teacher relation* responses

	Strongly Disagree	Disagree	Agree	Strongly Agree
Get Along Well	2.4	9.2	46.9	41.5
Interested In	5.1	19.5	46.4	29.0
Listen	2.8	13.2	49.1	34.9
Help	5.7	17.3	44.9	32.0
Treat	9.4	18.8	45.5	26.3

In Table 11, the percentages of students' responses on *Maths Teaching* are given. According to the results, more than fifty percent of the students think that their mathematics teacher shows interest to them. When they need their teacher gives extra help, the teacher helps their learning and continues teaching until they understand, and the teacher provides opportunity for the students to share their opinions in mathematics lessons. On the other hand, less than ten percent of the students (6.5%) think their mathematics teacher never or hardly ever helps their learning by giving extra help, opportunities to express their opinions and so on.

Table 11
Percentage of *maths teaching* responses

	Never or Hardly Ever	Some Lessons	Most Lessons	Every Lesson
Shows Interests	6.1	26.1	29.3	38.5
Extra Help	6.0	26.8	28.8	38.4
Teacher Helps	3.0	13.5	27.8	55.8
Teacher Continues	6.5	21.5	28.6	43.4
Express Opinions	5.9	20.7	30.2	43.3

As it is seen on Table 12, percentages of *Maths Behavior* results showed there are some differences from all other selected dimensions results. For instance, with respect to the results only 3.3% of the students say they always or almost always join in mathematics clubs, just 3.8% students participate in competitions, and only 7.4% of them attend extracurricular activities. In contrast to these low percentages, 76.4% of the students think they never or rarely join in mathematics clubs. The same, 68.0% of the students never or scarcely participate in competitions.

Table 121
Percentages of *maths behavior* responses

	Never or Rarely	Sometimes	Often	Always or Almost Always
Talk about Maths	27.8	45.8	17.8	8.6
Help Friends	23.3	44.9	22.0	9.8
Extracurricular	42.1	37.0	13.4	7.4
Competition	68.0	21.0	6.4	3.8
Study More	38.3	42.2	13.0	6.4
Play Chess	29.3	33.6	19.9	17.1
Computer	50.0	22.9	11.8	9.4
Maths Club	76.4	15.1	5.2	3.3

As dependent variable *Problem Text Message* - Trace Steps was chosen in order that it represents students' problem solving skill. Students' responses show that 94.0% (61.3% + 32.7%) of the students would definitely or probably think the why the problem occurred and they think in what ways they can solve the problem. Nevertheless, only 1.3% of students say they would definitely not trace steps and just 4.7% of them believe that they probably would not trace the steps. See Table 13.

Table 13
Percentage of *problem text message* responses

	I would definitely do this	I would probably do this	I would probably not do this	I would definitely not do this
Trace Steps	61.3	32.7	4.7	1.3

Research question 2.a. Is there a relationship between these factors and problem solving skill as percieved by student when whole PISA Turkish sample is used?

Multiple linear regression was conducted to answer the 2nd and 3rd research questions. To this end, students' problem solving skill scores as measured by *Trace Steps* variable were taken as dependent variable and the 42 variables given above as independents.

For the first regression, all students were included without grouping them with respect to school types. As a result of the regression analysis the model was statistically significant, F(12, 1401 = 24.914, p < .001) multiple correlation coefficient was .42 ($R^2 = .18$; $R^2_{adjusted} = .17$) indicated that 17% of the variance in students' problem solving skill was explained by the 12 variables.

Table 14 shows the standardized coefficients of each predictor variable of students' problem solving skill. The analysis results indicated that Link Facts had most substantial impact (β = .159) on students' problem solving scores, producing a chance of .159 units in students' problem solving scores for each unit change in Link Facts. The analysis results indicated that 12 observed items out of 42 items were included in the regression analysis ($p < .05$). While some of these observed values have a positive relationship with Trace Steps which is the dependent variable some of the values have negative relation. While Link Facts, Multiple, Extra Help, Perfection, Understand, Seek, Expectation, and Remain have positive relationship with problem solving, Procedures, Competitions, Handle and Shows Interests have negative relationship.

Table 14
Standardized coefficients included in the regression equation

	Unstandardized Coefficients		Standardized Coefficients	
	B	Std. Error	Beta	t
(Constant)	2.146	0.102		21.029
Openness for Problem Solving - Link Facts	0.105	0.022	.159	4.853
Cognitive Activation - Multiple	0.072	0.019	.103	3.831
Maths Teaching - Extra help	0.065	0.019	.098	3.451
Perseverance - Perfection	0.058	0.020	.096	2.854
Openness for Problem Solving - Understand	0.065	0.023	.095	2.763
Openness for Problem Solving - Seek	0.055	0.024	.081	2.339
Perseverance - Expectations	0.049	0.020	.080	2.447

Table 14 (cont'd)
Standardized coefficients included in the regression equation

Perseverance - Remain	0.042	0.018	.069	2.283
Cognitive Activation - Procedures	-0.036	0.018	-.055	-2.067
Maths Behavior - Competitions	-0.052	0.020	-.068	-2.647
Openness for Problem Solving - Handle	-0.045	0.020	-.070	-2.287
Maths Teaching - Shows Interest	-0.051	0.019	-.077	-2.704

Research question 2.b. Is there a relationship between these factors and problem solving skill as percieved by student when the sample is divided among school types?

Another set of regression analyses was conducted for each school type separately. Again, while the predictor of Trace Steps was used as dependent variable, 42 observed values from 7 different dimensions took place in analysis as independent variables. Every variable input analysis in the same time.

The results of the regression analysis indicated that the models were statistically significant in primary school, general high school, anatolian high school, science high school, social sciences high school, vocational high school, technical high school and anatolian technical high school ($p < .05$). However, there is not statistically significant results in anatolian teacher training high school, anatolian vocational high school, and multi program high school ($p > .05$). Therefore, while doing the regression these school types were not further examined.

The analysis results were also indicated that 78% of the variance in Anatolian high school, 27% of variance in General high school, 21% of variance in Vocational high school was explained with the 12 independent variables in students' problem solving skill.

Table 15
ANOVA output for problem solving across school type

School Types	Model	df	F
Primary School	Regression	31	1.60*
	Residual	12	
	Total	43	
General	Regression	42	3.67*
	Residual	362	
	Total	404	
Anatolian	Regression	42	1.64*
	Residual	280	
	Total	322	
Science	Regression	11	1.64*
	Residual	5	
	Total	16	
Social Sciences	Regression	11	1.21*
	Residual	5	
	Total	16	
Anatolian Teacher Training	Regression	42	.70
	Residual	25	
	Total	67	
Vocational	Regression	42	3.12
	Residual	302	
	Total	344	
Anatolian Vocational	Regression	42	.98
	Residual	35	

Table 15 (cont'd)
ANOVA output for problem solving across school type

	Total	77	
Technical	Regression	24	1.75*
	Residual	12	
	Total	36	
Anatolian Technical	Regression	31	1.99*
	Residual	10	
	Total	41	
Multi Programme	Regression	42	.56*
	Residual	6	-
	Total	48	-

$p < .05$

As it is seen in Table 16, the significant levels of predictor variables differed across each school type. First, each observed value took part in general high school, anatolian high school and vocational high school in analysis. This means all the variables statistically significant for these school types to predict the relation of students' problem solving skill. On the other hand, any observed value from *Openness for Problem Solving* dimension gave significant value in social sciences high school.

In the meantime, each school type may have both negative and positive relationship for different variables. For example, while there is a positive relationship between students' problem solving skill and *Handle* in general regression, students' problem solving skill and *Link Facts* has negative relationship in primary school.

The analysis results differently revealed that while some of the school types have strong correlation ($\beta > 1.0$), for some of them it is not observed high correlations for any variables ($\beta < .5$). For example, in primary school and anatolian technical high

school some of the observed values have high relations ($\beta > 1.0$), but there is not any variable greater than .5 β value for general high school and anatolian high school. Therefore, for general high school and anatolian high school there is a medium size relationship for the variables.

In Table 16, the results presented that the item of *Put off Difficult Problems* is significant ($p < .05$) for each school type. Conversely, other items did not take part in some school types. For example, *Treats Fairs* is significant ($p < .05$) in only primary school and general high school, but it is not significant for other school types.

On the one hand, the results revealed that there are both positive correlations and negative correlations in different school types. For example, there is a positive relationship between the item of *Give Up* and students' problem solving skill in general high school and anatolian high school, the negative relationship between *Give Up* and students' problem solving skill is observed in vocational high school, and technical high school.

Some of the variables have strong positive relationship in some school types. For example, *Handle* took part in nearly all school types except social sciences high school and technical high school. There is a positive relationship between students' problem solving skill and *Handle* in primary school, science high school and anatolian technical high school. In addition, the results presented that in primary school, there is a strong positive relationship between students' problem solving skill and *Handle* ($\beta = 1.28$), Each unit change in *Handle* provides 1.28 change on students' problem solving score.

Conversely, there is a negative correlation between *Handle* and students' problem solving skill in general high school, anatolian high school and vocational high

school. This means students who are from these schools think that they put off difficult problems and this is negatively related their problem solving scores.

The analysis results showed that students who are in primary school, general high school, Anatolian high school, vocational high school and technical high school think that when they encountered something they seek explanations for that. Thus, the positive correlation occurs for the students from those school types between students' problem solving skill and Seek. Students who are from primary school has strong positive correlation (β = 1.26). Each unit change in *Seek* provides 1.26 changes in students' problem solving score. Conversely, according to the analysis results students who are from anatolian technical high school think that they do not seek explanations for things. Thus, the results indicated that there is a negative relationship between students' problem solving skill and *Seek.*

Table 16
Standardized coefficients with respect to school types

	PR	GE	AN	SC	SSC	VO	TE	ATE
				Perseverance				
Give up	-	.03	.06	-	-	-.02	-.35	-
Put off	.45	-.05	-.02	-.30	.06	-.01	.70	.25
Remain	-.23	.06	.12	-	-	.04	-	-.51
Perfection	-.15	.14	.02	-	-	.07	-.09	.12
Expectations	-	-.02	.12	-	.24	.12	-	-
				Openness For Problem Solving				
Handle	1.28	-.15	-.06	.36	-	-.07	-	.36
Understand	-.91	.20	.06	-	-	.18	-	.22
Seek	1.26	.14	.04	-	-	.06	.77	-
Link facts	-.52	.19	-.04	-	-	.15	.15	-.27
Like	-.68	-.14	.20	1.02	-	-.09	.15	.38
				Teacher-Directed Instruction				
Sets goals	.28	-.09	.05	.24	-	.01	-	.49
Reasoning	-	-.04	.07	-	-.27	.06	.83	-.01
Check	.95	.05	-.02	.30	-	.07	-	.21
Summarize	-.21	.04	-.09	-	-	.00	-.97	.09
Inform	.60	-.01	-.05	-	-.23	.03	.88	-
				Maths Behavior				
Talk about Maths	-	.03	.05	-	-	-.06	-	.29
Help Friends	-	-.02	-.01	-	-	-.05	-.43	-.46
Extracurricular	.09	.05	-.02	-	.83	.02	-	-
Competitions	-	-.02	.01	-	-	-.06	.48	-
Study More	-	-.07	-.13	-	-	.10	-	.35
Play Chess	.01	.03	-.02	-.51	-	-.04	-	-.26
Computer	-.69	.04	.06	-	-	.08	-	.31
Maths Club	1.04	-.09	-.01	-	-	-.05	-.16	-

Table 16 (cont'd)
Standardized coefficients with respect to school types

				Maths Teaching				
Shows interest	-	.01	-.10	-	-	-.08	-	-.88
Extra help	-	.22	.09	-.12	.37	.05	.10	-.29
Teacher helps	-.97	-.08	-.04	-	-	-.11	-1.04	-
Teacher continues	-	.09	.02	-	-	-.01	-	.50
Express opinions	-	.01	-.05	-	-	-.09	-	.22
				Cognitive Activation				
Encourages	.11	.05	.01	-	-	-.10	-	.29
Think	.02	.05	-.03	-	-	.02	-.09	-.41
Procedures	-.77	.04	-.08	-	-.46	-.01	-.15	-
No Obvious	-.70	.04	.04	-.47	-.33	-.09	-.44	-.41
Contexts	-.72	.04	-.08	-	-	.13	.71	-1.05
Mistakes	.88	.04	.11	-	-	-.05	.04	.54
Explanations	.62	.04	.01	-	-	.02	-.41	-.11
Apply	-.71	.05	.00	-.09	-.68	.07	.28	-.23
Multiple	-.59	.04	.14	-	-	.05	-	1.00
				Student-Teacher Relation				
Get Along well	-.74	.09	-.05	.61	-.09	-.01	-.14	-.17
Interested in	.18	-.01	-.05	-	-	.13	-.10	1.14
Listen	.53	-.03	.07	-.41	-.60	.01	-	-.07
Help	.80	-.09	-.07	-	-	.02	-	-
Treat Fair	.19	.06	-.01	-	-	.01	-.87	-
Explained Variance	1.00	.30	.20	1.00	1.00	.30	1.00	1.00

Note. PR: Primary school; GE: General high school; AN: Anatolian high school; SC: Science high school; SSC: Social sciences high school; VO: Vocational high school; TE: Technical high school; ATEC: Anatolian technical high school.

CHAPTER 5: DISCUSSION

Introduction

This chapter includes overview of the major findings of the study, implications for practice, implications for further research and limitations of the study.

Overview of study

As it is stated before, there are two purposes for this study. First, to investigate both teacher and student related factors and students' problem solving skill relationships in Turkey based on PISA 2012. Second, to examine the relationship between students' problem solving competency and teacher- student related factors across school types in Turkey determined PISA 2012. For conducting the research, multiple linear regression method was used and the relationships were determined with respect to regression results.

Discussion of major findings

What are the opinions of students about themselves and teacher-related factors?

When the descriptive results were examined in general, it was seen that more than half of the students think that they are so patient when they encounter with a problem, they are open to problem solving, their relationships with their teachers are strong, their teachers give the instructions directly, and they believe that their mathematics teachers care on them. Nonetheless, students' responses on *Cognitive*

Activation (See Table 5) vary by dimensions. For example, while most of the students think their teachers let them share their own solution in lessons, they sometimes or hardly ever give problems whose solutions are not obvious. Their teachers rarely or sometimes encourage them to share their ideas, teachers hardly ever give chance to students to decide their own procedures by solving any problem. In summary, not many teachers are aware of how to activate their students cognitively or they hardly ever do something for providing students' cognitive activation.

In addition, as student related factors, most of the students do not talk about maths problems with their friends, they rarely help their friends in mathematics lessons, and they hardly ever attend extracurricular activities on mathematics. Therefore, it may be said that students have problems to behave with mathematics both at school and outside of the school.

Is there a relationship between these factors and problem solving skill as percieved by student when whole sample is used?

The current study results indicated that twelve observed values from five different dimensions are related to the students' problem solving skill. While eight of these observed values have strong positive correlation with problem solving skill, four of them have strong negative correlation.

According to the results of the study, students' problem solving ability is positively related to *Link Facts* (I can link the facts together) observed item of *Openness for Problem Solving* dimension. If the problem solving is considered as element of the intelligence, it may be said that intelligence is used to deal with the real life situations. According to Stenberg's (2000) dealing with real-world context idea,

intelligence consists of the sets of the competencies and problem solving ability is one of these sets (p. 68-70). Moreover, problem solving ability is directly related to logical thinking, to have the ability to link facts together, to open different ideas, to make decision, to examine the reasons of the facts and evaluate the results steps (Nayak & Rao, 2008).

Resent study results revealed that the second most related observed value with problem solving skill is *Multiple* (The teacher gives problems that can be solved in several different ways) of *Cognitive Activation* dimension. If the teacher gives the problem which can be solved by using different solution ways students' problem solving ability can increase. At this point it comes to minds that teachers' problem choices are really important for improving students' problem solving ability. Thus, teachers need to choose a good problem for students.

According to Krulick and Rudnick (1989), the problems which are on students' text books and require practicing the known algorithms should not call as a problem. In the same manner, Polya (1966) expressed that such kind of text book questions does not contribute to students' mental improvement (p. 126). So, for choosing a good problem teachers need to know the characteristics of a good problem. In literature, characteristics of a good problem are determined by researches (Krulik & Rudnick, 1989; Schwieger, 1999).

1.The problem should be related to real life situations.

2.The problem should address the level of the students.

3.The solutions of the problem should require using mathematical knowledge.

4.The problem should be solved in different ways.

5.The problem should be challenging and interesting.

As the researchers defined, good problems could be solved by different ways. Therefore, as the current study results supported, teachers should give good problems for their students to provide development on problem solving skill.

The third most related observed value with students' problem solving ability is *Extra Help* (The teacher gives extra help when students need it) of *Maths Teaching* dimension. In literature, problem solving is defined as a process which the students actively attend and teachers are guides for them (Polya, 1957). According to Sert (2008), students attend problem solving continuoum with collaboration of their friends or with their teachers guidence. Moreover, teachers should remember that their students need their help in problem solving process (NCTM, 2000). Similarly, according to resent research results while teachers' direct help with their students' learning is not statistically significant for students' problem solving ability, teachers' extra help when students need is positively related with problem solving. This situation may be interpreted as students prefer to struggle with a problem by themselves or with their friends, but they ask for help with their teachers when they are in trouble with the problem. Thus, if the students ask for help with their teachers when they need, this help may enhance their problem solving ability.

The next positively correlated observed value is *Perfection* I continue working on tasks until everything is perfect. In literature, researchers defined problem solving as a process which needs to accomplish from given state to the goal state (Schwieger, 1999; Lester, 1980; Mayer, 1985; Grugnetti & Jaquet, 1996). For solving a problem perfectly, students need to accomplish the tasks patiently. In literature, different steps for solving the problem perfectly are determined (Krulik & Rudnick, 1989; Charles, Lester & O'Daffer, 1987; Polya, 1957). For instance, according to Polya's (1957) suggestions students first understand the problem, make a plan, conduct the plan,

look back and check whether the solution is appropriate (p. 16). In the circumstances, students need to do something more than one step to accomplish the task excellently. As it is seen in recent study, students' problem solving ability is positively correlated with students' perseverance of continuing until everything is perfect. This means it is important to solve the problem until being sure that the problem is solved at all points.

The other positively correlated value is *Understand* (I am quick to understand things). As Polya (1957) suggested that the first step of problem solving process is understanding the problem. Thus, for solving a problem it is required to understand the problem correctly. Students need to understand what information is given, what the problem is asking and whether the given information is sufficient or not (Polya, 1957; Krulik & Rudnick, 1989). Hence, student who can understand the problem quickly and easily can accomplish the first step of solution. This study results also support the situation and expressed that there is a positive relation between students' problem solving skill and their quick understanding on tasks.

Seek (I seek explanations for things) observed value is also positively related to students' problem solving competency. When students encounter with a problem in their routine life they first try to understand the problem and then make a plan. To constitute their plan, they search what they know and what they need (Charles, Lester ve O' Daffe, 1987). Thus, students need to seek explanations for the problem and the solving process. As it is seen in this current research that students who seek explanation for things they may increase their problem solving ability more easily.

The observed value of *Expectations* (When confronted with a problem I do more than what is expected of me) is the seventh significant variable positively related to

problem solving skill. This study results assert that students' problem solving ability is related to decisiveness and their patience. They need to accomplish the problem solving steps and they need to do what is expected of them until they solve the problem.

Another positively related value is *Remain* (I remain interested in the tasks that I start). There is a positive correlation between success and motivation. While high motivation can increase the level of success, low motivation can decrease the level of achievement (Jacobsen, Eggen & Kauchak, 2002). The lack of motivation and persistence on problem solving can be evaluated as the preventer of solving problem, and lack of motivation and persistence may cause students to abandon problem solving in a short time (Santrock, 2001). However, being consistend in problem solving process and not to give up solving the problem untill it is solved is important to enhance problem solving ability (Schwieger, 1999; Lester, 1980; Mayer, 1985). Thus, as it is seen in this study results, students who remain their interest in the problem task may improve their problem solving ability.

Differently, four observed value from four dimensions have strong negative correlation with problem solving ability. These observed values are *Procedures*, *Competitions*, *Can Handle*, and *Shows Interest*.

The *Procedures* (The teacher asks us to decide on our own procedures for solving complex problems) is the most significant negatively related observed value for students' problem solving ability. Teachers should ask different problems related to real life in mathematics lesson (MoNE, 2013). Teachers should provide students a good problem which is clear, appropriate students' age level, challenging and can be solved by using different strategies (Schwieger, 1999). To solve such problems,

students need to attend the solving process actively and teachers should provide students to use their own methods (Kayan, 2007). However, the current study results indicated that there is negative relationship between students' problem solving competency and their own ways to solve the problem their teacher asked. According to PISA 2003 in Turkey, students' problem solving level is low (YEĞİTEK, 2005). This means until the age of fifteen students have not the ability to solve problem and they may not know how to decide the ways needed to solve problem.

The second negatively related observed value is *Competitions* I take part in mathematics competitions. Attending mathematics competitions engage students and motivate them to do mathematics (Rudnick, 2014). However, with regard to the recent research there is negative relationship between attending mathematics competitions and problem solving ability.

The third and fourth negatively related observed values are *Handle* (I can handle a lot of information) and *Shows Interest* (The teacher shows an interest in every student's learning). When the teacher shows interest for every student's learning, this situation does not help development on students' problem solving skill. The reason behind this result may students' preference on teacher's guidance instead of teacher's direct help. Students need their teachers while solving problem but they need their teacher when they get in trouble. Therefore, teachers should be guide for them.

Is there a relationship between these factors and problem solving skill as percieved by student when sample is divided among school types?

After the analysis was conducted throughout Turkey, the relationships were examined across school type. When the study was conducted across school types different results were observed.

The results indicated that *Handle* observed value is the strongest positively related variable in problem solving in Primary school. However, when the study was conducted throughout Turkey, the observed value of *Handle* was negatively related to students' problem solving skill. On the other hand, *Contexts* observed value is strongest negatively related value with problem solving in Anatolian Technical high school. Nevertheless, the general regression results showed that there is not significant relation between *Contexts* observed value and students' problem solving ability in Turkey.

As it was observed in the study that the results differ across school types and some factors at schools may cause these differences. Students who get high marks from high school entrance examination start Science and Anatolian high school. Therefore, selective students get education at these schools. Moreover, the curriculum applied at these schools include more mathematics and science lessons (MoNE, 2014). However, students who are at Vocational or Technical high schools the curriculum applied at these schools includes vocational training courses. These students have more chance to do practice and they may encounter more problems while doing these practices. These differences may be related to curricula applied at these schools in terms of weekly course hours and content of courses.

The differences across school types may stem from teacher related factors. School facilities, teacher attitudes, student and teacher positive relationships may cause different relationships on students' problem solving skill as perceived by students (UNICEF, 2000; Thapa, 2015).

School facilities may affect students' problem solving skill development. Improving school facilities have positive effect on students' learning performances (O'Neill &

Oates, 2001). Therefore, the use of technology and accessibility of technology increase students' learning (Ercan, 2014). Having such instructional materials at classes may enhance their problem solving skill and in some school types students may not access these facilities.

Finally, the results of the study showed that there are many different factors both student and teacher related in relation with students' problem solving skill. When the analysis was done across school types, the differences were observed. For eliminating these differences, teachers should be aware of the facilities that they have and try to use them.

Implications of practice

First of all, there are both teacher and student related factors associated with problem solving skill. Although these related factors differ across school types, throughout Turkey both teachers and students try to improve these factors to develop problem solving that students encountered in their daily life. For instance, a school teacher should provide students real life context problems and the teacher should be aware of which conditions can improve each student's problem solving skill. In addition, teachers' attitude towards students is significant on their improvement on problem solving. For example, students do not want their teacher's help. They need their teacher only when they have in trouble. It was thought that this means teacher should be guide for students.

As it was emphasized before, related factors with problem solving changes across school types. Thus, with respect to these school types and their both facilities and curriculum applied at these schools should be used appropriately and the activities should be selected in view of the fact that which related factors are effective for

developing problem solving skill. For example, teacher who teaches at Vocational high school has more chance to give real life context problems with regard to curriculum. However, in Science high school, the teacher tries to focus on students' academic achievement because of Turkish university entrance exam system. If both of the teachers aware of their facilities and behave according to them, students' problem solving skill can improve more easily.

As a result, if teachers are aware of their students' learning style and how they can improve problem solving skill they can enhance their students' improvement on problem solving. For instance, if the student's achievement level on problem solving increases by attending mathematics competitions, the teacher should be aware of this situation and direct the student to attend competitions. As a teacher, it should be known that problem solving skill is a required skill in the 21st century so we should try to develop our students' competency.

Implications for further research

Further studies may focus on how teachers can enhance positively related factors provided improvement on problem solving skill in their classes based on experimental designs. Also in-depth analyses of the reasons of differences this study showed should be made.

Limitations

In this study, students' problem solving scores were limited to the what student responses to a question that involves one observed action realted to problem solving. Thus results of this study should be considered limited since the definition of the problem solving skills may different in other contexts.

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