

PREDICTING STUDENTS PROBLEM-SOLVING SKILLS THROUGH
HOME AND PARENT RELATED FACTORS, SCHOOL TYPES, AND
AFFECTIVE VARIABLES

A MASTER'S THESIS

BY

ELİF SARIGÖZ

THE PROGRAM OF CURRICULUM AND INSTRUCTION İHSAN
DOĞRAMACI BİLKENT UNIVERSITY
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To my beloved family...

Predicting Students' Problem-Solving Skills through Home and Parent Related
Factors, School Types, and Affective Variables

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Elif Sarıgöz

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Elif Sarıgöz
October 2019

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.

Asst. Prof. Dr. İlker Kalender (Supervisor)

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.

Asst. Prof. Dr. Hilal Peker (Examining Committee Member)

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.

Asst. Prof. Dr. Zerrin Toker, TED University (Examining Committee Member)

Approval of the Graduate School of Education

Prof. Dr. Alipaşa Ayas (Director)

ABSTRACT

Predicting Students' Problem-Solving Skills through Home and Parent Related Factors, School Types, and Affective Variables

Elif Sarıgöz

M.A., Program of Curriculum and Instruction

Supervisor: Asst. Prof. Dr. İlker Kalender

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Problem-solving skill is one of the important qualifications that individuals need to have to cope with challenges in daily life. That's why, developing this skill is one of the purpose of Turkish mathematics curriculum. This study investigates which factors among background related, school types, and affective variables have relationship on problem-solving skill. The study was based on data set from PISA 2012 cycle. The sample was 4,848 Turkish students from twelve different school types. The possible relationship between students' problem-solving skills and the variables were investigated by using hierarchical multiple linear regression analysis. The results showed that school types significantly predicted problem-solving skill. Also, this study revealed that mother education level was important on defining problem-solving skill and self-efficacy more affects the skill than other math-related variables.

Key words: Affective variables, home and parent related factors, problem-solving skill, school types

ÖZET

Öğrencilerin Problem Çözme Becerilerinin Ev ve Aile ile İlişkili Faktörler, Okul Türleri ve Duyuşsal Değişkenler ile Yordanması

Elif Sarıgöz

Yüksek Lisans, Eğitim Programları ve Öğretim

Tez Yöneticisi: Dr. Öğr. Üyesi İlker Kalender

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Problem çözme becerisi günlük yaşamda karşılaşılan zorluklarla başa çıkabilmek için bireylerin sahip olması gereken önemli becerilerden bir tanesidir. Bu nedenle Türkiye’deki matematik müfredatının amaçlarından bir tanesi de öğrencilerin problem çözme becerilerini geliştirmektir. Bu çalışmanın amacı ise ev ve aile ile ilişkili faktörler, okul türleri ve duyuşsal değişkenlerle öğrencilerin problem çözme becerileri arasındaki ilişkiyi yordamaktır. Bu çalışmada PISA 2012 testinden elde edilen veri seti kullanılmıştır. Çalışmanın örneklemini ise Türkiye’deki farklı okul türlerinden seçilmiş 4,848 öğrenci oluşturmaktadır. Bu öğrencilerin problem çözme becerileri ile bu beceriyi etkileyen seçilmiş değişkenler arasındaki ilişki hiyerarşik çoklu doğrusal regresyon yöntemi ile analiz edilmiştir. Sonuçlara göre, okul türü ve problem çözme becerisi arasında anlamlı bir ilişki bulunmuştur. Ayrıca bu çalışma, öğrencilerin problem çözme becerilerini belirlemede annenin eğitim düzeyinin etkili olduğu ve öğrencilerin öz yeterlilik algılarının da matematik bu beceriyi açıklamada daha etkili olduğunu ortaya koymuştur.

Anahtar Kelimeler: Ev ve aile ile ilişkili kaynaklar, duyuşsal değişkenler, okul türleri, problem çözme becerisi

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CHAPTER 1: INTRODUCTION

Introduction

Problem-solving is one of the key qualifications that individuals are expected to have today's world to be able to cope with challenges and difficult situations (Organization for Economic Cooperation and Development [OECD], 2004).

Situations that an individual may face do not necessarily have to be complex.

Individuals face situations that are not so complex in their daily lives. Several questions may be asked to give examples of problems in daily life: For example, when the mobile phone of an individual stops working, how he or she let know a friend that he or she will be late for their appointment; or when a room is so cold, how can an individual control air-conditioning by using control switch; when the connecting flight of an individual will leave from different airport, how can she go there by using map? These are some examples of situations with no clear solutions that individuals have to be handled immediately (OECD, 2014; Schoenfeld, 2013).

In the literature, there are different definitions of the term “problem” some examples of which are given above. For example, Heddens (1997) stated that most of us think of a problem as mathematics problems called as exercises depending on four operations at the end of each unit in a mathematics book which help to practice the unit. As an earlier definition, according to John Dewey (1938), however, a problem can be anything that confuses individuals' brain. For example, in modern society, people every day encounter the above-mentioned unexpected situations, they confuse and they try to solve them to improve their selves and to live effectively in their environment.

Problems can be grouped under two main headings: routine and non-routine problems (Zeitz, 2006). Routine problems are the problems whose solution method is already known. Their solution methods are clear and they are solved by using at least one of the arithmetic operations. The solutions of these type problems do not require higher level of cognitive ability such as creativity. Zeitz (2006) emphasized the differences between a problem and an exercise and he stated that exercises are kind of questions which have certain solution method and do not require higher order thinking skills or creativity. Problem solvers know, or easily find out, how they can solve those type questions. In the definition of Zeitz (2006), exercises can be seen as routine problems. In contrast, non-routine problems constitute a different set than routine problems (Mayer, 1998). They include complex situations that require using some cognitive strategies because the solution methods of such non-routine problems are not obvious to a problem solver for the first time or there may not be unique solution. Students can easily solve routine problems that do not need to be solved by using various strategies, but they are not very successful to solve non-routine problems requiring different types of strategies (Elia, Heuvel- Panhuizen, & Kolovou, 2009; Güven, Aydın, & Özmen, 2016).

After the definition related to the term problem, another question arises that should be answered as well: What is problem-solving? There are many studies defining problem-solving in the literature. Problem-solving is defined as an ability in the Cockcroft report (1982). According to this report, the problem-solving ability is at the center of mathematics and it is the most important ability to be able to apply mathematics to a variety of situations. In a different way, Martinez (1998) defined problem-solving as a process that helps problem solvers reach a goal when there is

an uncertain path to reach that goal. Likewise, Erickson (1999) described problem-solving as a situation where there are no ready patterns, algorithms, or procedures that help to reach solution. Mayer and Wittrock (2006) also defined problem-solving as a form of cognitive processing when facing a problem which does not have an obvious solution. As seen, although there are many different definitions of problem-solving in the literature, the agreement among the studies is that there is no certain solution method to be able to solve a problem which had described as obstacles and difficulties.

Societies give problem-solving skill a special importance since it is one of the most important skills that individuals are expected to have in the 21st century (NCTM, 2000). In parallel to this, problem-solving is an important issue that draw attention in Turkish education system. Although routine and non-routine problems are emphasized in both primary and high school mathematics curriculum, especially non-routine problems in verbal form challenge many students in Turkey (Özcan, 2016). When looking at the history of mathematics education in Turkey, it is seen that the meaning that curriculum developers imposes on the term problem-solving has changed over the years. In 1990 mathematics curriculum problems presented in novelty situation and they were solved by using only four mathematical operations. In the 2015 curriculum, problem-solving was emphasized as a way of making sense. The problems were presented in a situation having no obvious solution method and they were solved by using different reasoning skills. In terms of problem types while routine problems have been in the majority of the mathematics curricula over the years, non-routine problems have also taken place (Özmantar & Öztürk, 2017).

Today, mathematics education is shifting from educating students who can solve routine tasks having obvious solution methods to educating them who can solve non-routine tasks having complex challenges (OECD, 2013a). Students should be given such an education so that they can cope with unexpected and unfamiliar problem situations easily. However, to only have curricular based knowledge is not enough to be prepared for tomorrow's world. It is inevitable that curricular knowledge should be used in the teaching of process of problem-solving, yet for students how to use their knowledge is important. Students should be able to integrate their prior knowledge to the new situation; they should be able to create new knowledge by using their existing knowledge and they are able to think creatively and critically to evaluate different solutions (OECD, 2013c).

In parallel to this, there is an obvious need to indicate students' skills of using their knowledge in situations involving non-routine problems. In 2003, a term called as "mathematical literacy" was defined by the Organization for Economic Co-operation and Development. This term highlights the skill of students to use their mathematics knowledge within OECD context. Thus, the skill includes the capacity of individuals for formulating of various mathematical cases; combining of mathematical facts, concepts, and process; and interpreting of mathematical outcomes. Similarly, in Turkey, The Ministry of National Education (MoNE) (2013) interpreted the term as coping skill of individuals when they encounter any problems in their social, academic, professional, and personal lives.

International benchmarking studies provides opportunities to study on problem-solving on large quality samples. Such studies provide countries with an opportunity

to take a picture of the current situation and compare themselves with the other societies. One of the most comprehensive studies is Program for International Student Assessment (PISA) conducted by OECD. PISA uses sampling methods to reach a high degree coverage and representation of the population. Also, using a student questionnaire, PISA gathers information not only about cognitive domains but also about lots of factors such as family background, attitudes toward school and teacher, etc. Problem-solving took place within each domain in PISA cycles since 2003 (OECD, 2013b).

At this point, a question comes to our minds: What are the relationships between students' problem-solving skills and variables related with mathematics? This is a reasonable question considering that schools have a major role in giving students problem-solving skills and mathematics is one of the courses that routine and non-routine problem-solving approaches are used? This question can also be expanded to control for SES and school types of students. These two variables are among the significant predictors of student achievement (Berberoğlu & Kalender, 2005; Kalender & Berberoğlu, 2009).

Background

Today, problem-solving is of importance in education all around the world (Özmantar & Öztürk, 2017). It is a complex activity and it needs higher order thinking skills. That's why one of the priority goals of education is to raise individuals who easily overcome problems to be met in the future (Charles & Lester, 1982).

In mathematics education, to gain and improve problem-solving skills are also among the main goals of curricula all around the world (International Baccalaureate Diploma Program, 2014; International General Certificate of Secondary Education, 2014; MoNE, 2013). Likewise, in 2000, National Council of Teachers of Mathematics (NCTM) highlighted the importance of problem-solving in mathematics, stating that it should not be seen as a separate component than mathematics programs by teachers because it is an integral part of those programs. The primary reason of learning mathematics is seen as problem-solving according to NCTM.

What are the reasons that make problem-solving in mathematics education so important? The first reason is that problem-solving is one of the skills of 21st century (MoNE, 2015; OECD, 2013a; Yalçın, 2018). Technology, complex social lives, society structure and economic crisis increase the number of problems individuals face. People should deal with these problems to be able to survive in their environments. Mathematics is one of the subject areas that is suitable to apply problem-solving. The second one is that problem-solving can be seen as a way of effective learning for students (Yalçın, 2018). Students may not have enough knowledge to solve a problem beforehand. When face with a problem, they can ask questions, try to find a solution method, and try to explain the problem from different perspectives. If they find an answer, they also attempt to find better solutions by asking noteworthy questions. The third reason is that problem-solving skill makes individuals active, free, and self-learning. When students meet a problem, they cannot use memorized information. They need to search, create new ways and solution methods. So, they should be active rather than being passive. Problem-

solving enables students to develop new attitudes and new skills to get information (Yalçın, 2018).

Problem-solving is one of the significant parts of mathematics curricula in many countries because of the reasons above, although there may be another reason.

Problem-solving process has some common stages even though they may differ from a problem to another and from person to person. Polya (1957) listed the solving process of a problem into four stages. According to him, a problem solver firstly has to understand the problem. Secondly, a plan for the problem should be devised and the steps which help the problem solver reach a result are defined. Thirdly, the problem solver should check whether the steps are correct or not. As a last step, the result obtained should be examined. Bingham (1983/1998) and Stevens (1998) and also listed similar stages to follow to get a solution of a problem. The steps are to understand a problem, to collect information related to the problem, to choose necessary information about the problem, to organize the chosen information, to define different solution methods by using the organized information and to decide which solution method is convenient for the problem, to solve the problem by using the deciding solution method. Although people need to follow some stages to be able to solve a problem, many studies explain that people once should improve their problem-solving skills, then they can easily solve a problem by using the above problem-solving steps.

However, there are some factors directly or indirectly affect problem-solving skills of individuals. Socio-economic status (SES) is one of these factors. Sirin (2005) found that the SES status of students are one of the strongest indicators of academic

achievement and problem-solving skill which directly affect academic achievement of students. OECD (2011) states that students who come from high SES perform better in problem-solving than the students from low SES. In the studies by Neitzel and Stright (2004) and Sungur and Bal (2016), maternal education level classified as SES variable were found as strong predictor of problem-solving performance of students. Also, the study by Kalender and Berberoğlu (2009) found a strong relationship between SES and the science achievement of students in 6th, 7th, and 8th grade levels.

Other studies have shown that math-related factors such as mathematics anxiety and mathematics self-efficacy are also related to academic achievement and problem-solving performance of students as well as SES (Bakan Kalaycıoğlu, 2015).

Understanding and using mathematics in solving real life problems depend on not only cognitive structures of students but also math-related factors such as belief towards mathematics, attitudes, and anxiety. Pajares and Miller (1994) found that math self-efficiency is the main predictor of problem-solving. The researchers said that other factors such as gender, math self-concept, perceived usefulness of mathematics, prior experience of mathematics have no important effect on being good problem solvers.

Problem

Daily life problems and situations are always around in today's globalizing world. So, being a good problem solver is of importance for individuals to survive in the world. In this sense, growing up individuals who are equipped to easily cope with

such situations encountered in social, academic, professional and personal lives gain importance (MoNE, 2015).

To be able to solve any problems in daily life, individuals certainly need to be equipped with curricular knowledge in schools. OECD states that students should have some degree of mathematical understanding before they try to fully understand, address the problems and situations (OECD, 2013a). They should have an ability to formulate various mathematical cases; combine mathematical facts, concepts, and process; and interpret mathematical outcomes. However, the relationship between problem-solving skills and curricular knowledge may not be so direct. Especially, in countries like Turkey, several background variables are involved in relationships among educational variables. Several studies showed the relationship between SES and student achievement in Turkey (Bakan Kalaycıoğlu, 2015; Kalender & Berberoğlu, 2009). Similarly, between-school differences were also shown in the literature (Berberoglu & Kalender, 2005; Cansız, Özbaylanlı, & Çolakoğlu, 2019; Sammons et al., 1997; Savaş, Taş, & Duru, 2010). SES and school types have a contaminating effect on student achievement. These same variables may have a similar effect on problem-solving skills of students.

In the literature, there are many researches that highlighted the importance of problem-solving skills of students. However, the relationship between problem-solving ability and mathematics-related factors has not given a great deal of attention in Turkey. Thus, a clear picture of the relationships between problem-solving skills and mathematics skills should be depicted by considering some SES and school types in Turkey.

Purpose

The purpose of the present study is to investigate the relationships between problem-solving skills of students and several selected math-related factors (mathematics interest, cognitive activation in mathematics lessons, perseverance, mathematics self-efficacy, mathematics self-concept) while controlling for SES and school types.

Research questions

The present study will address the following questions;

1. Is there any relationship between problem-solving skills of students and the factors related to SES status?
2. Is there any relationship between problem-solving skills of students and the school types in Turkey?
3. Is there any relationship between problem-solving skills of students and affective variables (mathematics interest, cognitive activation in mathematics lessons, perseverance, mathematics self-efficacy, mathematics self-concept)?

Significance

In the literature, there are many studies explaining mathematics achievement/literacy of students using math-related factors and problem-solving skills of students.

However, there is almost no study explaining problem-solving skills of students while controlling for SES and school types. These two variables are especially important that they affect students' achievement in Turkey. It is important to define relationships between problem-solving and math-related variables after effects of these variables are removed. Therefore, the results of this study are expected to make a significant contribution in the literature.

Also, the results of this study can be used by teachers, school principals, and curriculum developers. Particularly, mathematics teachers can prepare lesson plans to foster problem-solving skills of students. School principals can provide opportunities to the students in order to increase their achievements if the students come from low socio-economical background based on the results of this study. Curriculum developers can prepare math curriculum that help students to improve their problem-solving skills.



CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

In this chapter, a review of the related literature is provided. First, the research about problem-solving skill which is an important component of this thesis will be given in detail. Then, the research which are related the variables used in this study will be given to better understand the possible relationship between problem-solving skills and the variables.

Problem-solving skills

It is a fact that a country should be advanced in mathematics to develop and be in a strong position in the world (Aydoğdu & Ayaz, 2008). To provide a good quality of mathematics education give an opportunity to make individuals analyze, communicate, generalize, and think creatively and independently in their daily and professional lives (NCTM, 1989). According to Principles and Standards for School Mathematics published by NCTM in 2000, mathematics is one of the ways to develop students' problem-solving skills. Problem-solving cannot be seen isolated part of mathematics programs because it teaches ways of thinking, provides persistence, curiosity and to feel well in any unexpected situations (NCTM, 2000). That's why, countries include developing problem-solving skills in their mathematics curricula as a goal.

Mathematics curricula in Turkey recently focus on the importance of problem-solving because continuous developments in science and technology, the needs of society, and the developments in learning and teaching have directly affected the

expected roles of individuals and the roles have increased the need of problem-solving skill of individuals (MEB, 2018a). The guidance for MoNE Secondary Education Programs clearly explains that there is always a need for people who are advanced in mathematics; use mathematics and mathematical modelling to solve problems in their lives; have strong mathematical thinking ability in order to solve problems who are caused by the changes in society. Likewise, in the report called as Creative Problem-Solving by OECD, it is emphasized that problem-solving skill is important to meet the needs of today's economies and to actively participate in society (OECD, 2014). Also, the study by NCTM on the importance of problem-solving indicated that a student can actively learn a subject or a concept better by solving different problem situations and the student can easily integrate the methods of problem-solving into her life and new situations (NCTM, 2000).

As explained above, problem-solving skill is considered one of the tools that individuals are expected to have in today's world. Accordingly, countries adjust their educational system to include problem-solving as a component. However, the literature also shows that several background characteristics have influential on students' outcome variables (Berberoğlu & Kalender, 2005; Bakan Kalaycıoğlu, 2015; Tümkaya & İflazoğlu, 1999). In parallel to this, the literature reveals that problem-solving skill which affects many skills of individuals throughout their life is also influenced by different factors. Age, gender, past experiences, family socio economic status such as family income, education level of father and mother and parents' occupations are some of them.

Background characteristics related to problem-solving skills

The literature shows that a parental educational level is one of the important factors in predicting problem-solving skills of students (Sungur & Bal, 2016). These researchers have examined the problem-solving level of primary school students in terms of gender and educational level of parents by a survey. In the study, maternal educational level has made a significant statistical difference in the study while gender is not a significant predictor on children's problem-solving level.

According to Neitzel and Stright (2004), mother education is important for mothers' cognitive, emotional and autonomy to support their children in the process of problem-solving because it is probable that the education provides mothers with more metacognitive knowledge about problem-solving tasks and problem-solving strategies. They have metacognitive information to share their knowledge and strategies with their children to simplify difficult tasks; they know the needs of learners and how to encourage their children to be active in the problem-solving process. However, even if mothers have higher level of education, they may not have effective communication skills. Altıntaş and Bıçakçı (2018) said that if parents do not have communication skills; if they are protective, authoritarian and dismissiveness towards their children; if they do not spend enough time with their children; if they are critical and judgmental and compare their children with others, the level of mother education may not have an impact on developing problem-solving skills of children. The study by Altıntaş and Bıçakçı (2018) also focused on the importance of educational level of father on developing problem-solving skills of students. They explained the reasons of why the education level of father is not important effect on developing problem-solving skill of children. According to the

study, fathers do not have enough time to interest with their children because they usually work. It is especially important for a child to identify any problem on the process of developing problem-solving skills. After defining any problem, s/he needs an adult to produce appropriate solutions. Therefore, father's employment, being tired or late at home may not be an effective in the development of the problem-solving skills of a child, no matter how the father has high or low education level.

The study by Yıldırım, Hacıhasanoğlu, Karakurt, and Türkeş (2011) also examined the relationship between problem-solving skill and some variables related to family such as parental educational level, parents' profession, and family income. Even though the majority of the literature about mother education level pertain positive influence on problem-solving skills, in this study there was no significant relationship between mother's educational level and profession on problem-solving skills. In this study, it was reported that the problem-solving perceptions of the students whose fathers are graduated from university are higher than others and there was significant difference between problem-solving skill and father educational level. However, the study held by Tümkaya and İflazoğlu (1999) reported that the problem-solving skills of the students do not increase as the education levels of parents' increase. Düşek and Ayhan (2014) examined the relationship between problem-solving skill and parents' education from a different perspective. They focused how the relationship between the problem-solving skills and parents' education level differed for children from broken families and full parent families. They found that mother and father education level has statistically significant relationship on children' problem-solving skills from full parent families but there

was no significant relationship between the education level of parents and the problem-solving skills of children who are from broken families.

The research specifically focusing on the relationship between home educational resource and problem-solving skill into consideration are limited. The study *Home resources and children's achievement* by Murnane, Maynard, and Ohls (1981) examined this relationship. In this study, nutritious food, comfortable housing, and reading materials which provide intellectual interest were classified as good inputs while time spent with children was taken as time input. The results revealed that the variables related good inputs such as food, housing quality, and reading materials are not continually related to students' achievement. However, according to researchers, the results do not mean that good inputs are not necessary since the variables had not directly impact on students' achievements; just there was not distinguishable good input affects achievement of children. In 1977, Leibowitz asserted that the availability of reading materials in home positively affects students' achievement. Likewise, Yayan and Berberoğlu (2004) also found that home educational background variables like the number of books at home have strong effect on students' academic achievement. In 2004, Brecko emphasized the importance of quality of books at home on students' achievement. According to him, only the number of book at home is not good predictor of students' performance on school.

School types

Improving problem-solving skills help to increase mathematical achievement (Hooda & Devi, 2018). When looking for PISA results over years, it is seen that the countries getting highest score are also successful in problem-solving domain as well.

Especially, the reasons behind the success of Finnish students in PISA have been gotten the curiosity of many educators. According to study by Ahtee, Lavonen, and Pehkonen (2008), one of the explanation of Finnish students' success can be related school and curriculum although the success is a combination of many factors such as teacher, teacher education, and national developmental projects. According to Kupari, Reinikainen, and Törnross (2007), the successful results of Finnish students in PISA are a reflection of high quality schools. Modelling everyday life situations, activity tasks containing novelty situations, interpreting table and graphs, games are essential parts of comprehensive curriculum in Finland schools (Ahtee, Lavonen, & Pehkonen, 2008).

Compulsory Turkish national education system is 12 years including primary education and secondary education. As of 2019, 6 years old children are accepted to primary education and graduate from primary education by receiving primary education diploma when they are at 14 years old. The performance shown at the end of the primary education (at 6-7-8 grades and the results of national exams) is so important for which type of school students will be accepted for secondary education (MoNE, 2017). Berberoglu and Kalender (2005) found that there are statistically significant differences in Turkish education system. Also MoNE (2015) suggested that school types account for 61% of the variance in Turkish students' mathematics performance and the ratio is 37 among the mathematics performance of OECD countries in PISA 2012 cycle. As Sammons and his friends (1997) stated that schools differed from each other in their effects on students' achievements.

Another study by Sungur (2016) had examined the problem-solving skills of 4th grade Turkish students in private and state schools in terms of some demographic variables like gender, parents' educational levels and school types. To obtain data, problem-solving inventory was given to the students and the results showed that there was significant difference in the problem-solving scores of students from different schools; especially the scores of students attending state schools are higher than the scores of students from private schools.

Other studies focused on mathematics achievement of students in terms of school types in general, not specifically focus on problem-solving scores or skills. Such studies found statistically significant differences between mathematics achievement of students and school types. For example; in the study carried out by Berberoğlu and Kalender (2005), the level of the learning outcomes in the subjects covered by national university admission examination were analyzed in terms of past years, school types, and regions in Turkey. These results were compared with PISA 2003 results. According to results obtained by the analyses, the students from general high schools and vocational high schools showed lower performance compared to the students from other schools in national exams. In terms of performance in PISA 2003, it was also found that the students from public schools showed lower performance than the students from private schools. Considering the results from both exams, the performance difference among students from different type schools was not negligible. The students from science schools showed high performance while the performances of the schools like vocational high schools were below the international average. The findings are in line with Cansız et al. (2019) aimed to identify the effects of school types on student achievement by considering overall

scores of students involving their grades from courses and the scores getting from nation-wide centralized exams. Although there are lots of school types in Turkey, the school types were limited in this study and public schools and private schools were taken as two main categories. They found that school types had big effect on student achievement in Turkey while there was no significant difference between those two types in other countries, especially the achievement of private school students were higher than other students from public schools. The findings were similar with the results of the study by Savaş, Taş, and Duru in 2010.

According to Dinçer and Kolaşın (2009), the performance of a student on national or international exams could be based on two things: student's academic background obtained in past years and the academic background from the school which the student enrolls. Actually, a student's academic background from experiences directly affects the student performance on national examination which is applied to decide which school type a student enrolls and then, the academic background provided by the schools influence a student achievement on international exams like PISA. The results showed that school types were more influential on students' performances than all other factors used in the study. Other studies also showed that the scores of the students from Anatolian high schools are above the scores of the students from general high schools and the performance of students from vocational high schools is lower than the performance of students from general high schools (Alacaci & Erbas, 2010; Berberoğlu & Kalender, 2005; Dinçer & Kolaşın, 2009; MoNE, 2012). In this context, the results are not surprising because in Turkey, there is a highly competitive exam which is applied after primary education. Students compete against each other and the students are placed to a school based on the result of the exam. Since the

rank of science and Anatolian high schools is higher than others, successful students are accepted to these types of schools. That's why, the students from science or Anatolian schools show best performance in both international and national exams. The study conducted in 2016 by İleritürk and Kıncal revealed the same result: the students were from science high schools performed better on problem-solving than others from different type of schools in PISA 2003.

Math-related factors

In this study, some selected variables related to mathematics included another set of variables. In the literature, there are many studies including the relationship between math-related variables and mathematics achievement. However, there are limited studies including the relationship between math-related variables and mathematics literacy or problem-solving skill. In this section, literature about math-related variables used in this study and their relationship with problem-solving skill and mathematics achievement was given in order of cognitive activation, perseverance, mathematics interest, self-efficacy, and self-concept.

Cognitive activation is about teaching strategies that lead students to think, question, inquire, predict, and summarize when they try to solve mathematics problems. These types of strategies motivate students to think deeply on the problem and to focus on solution methods instead of just finding answer of the problem (Burge, Lenkeit & Sizmur, 2015).

In the literature, the study by Stigler and Hiebert (2009) revealed two different examples about strategies that teachers had used for cognitive activation in their

classrooms. According to this study, the difference was found in mathematics lessons taught in Japan and United States. While the mathematics lessons in Japan challenge students with mathematical problems requiring higher order thinking skills, the mathematics lessons in United States focused on practicing lower level skills. In the lesson observations, it was seen that Japanese teachers asked many higher order questions than the teachers in U.S and the questions were related students' own solution methods instead of asking questions about teachers' their own methods like U. S teachers did. The result of the study showed that the strategies of Japanese teachers were differentiated from others in terms of fostering cognitive activation.

Baumer et. al (2010) stated that the type of problems selected by teachers and the way of their implementation in classroom determines the level of cognitive activation. The mathematics tasks that reinforce cognitive activation help students to activate their prior knowledge by challenging their negative beliefs against the subject in the task. However, in any mathematics task, for teachers to use such problems that trivialize cognitive challenge causes to turn the task into routine tasks (Stigler & Hiebert, 2004). Like the Stigler and Hiebert (2009) and Klieme et. al (2009) had pointed out that cognitive activation through challenging content is one of the basic dimensions of qualified teaching. The report by Burge, Lenkeit, and Sizmur (2015) took aim at cognitive activation and the link between cognitive activation and mathematics achievement in England by using PISA 2012 data. The study especially explored how often teachers uses cognitive activation strategies to help students solve mathematics problems. By considering English students' answers, teachers in England use cognitive activation strategies by asking them to use their own strategies, presenting problems without obvious solution methods, asking students

how they had solved the problems, giving problems with different solution methods more than other teachers of students participating PISA 2012 from other countries. According to the report about English students, their teachers often use the strategy of asking the students to explain their own solution method in order to solve given problem, also teachers generally asks students to apply their learning into new and different context. In this study, it was also found that students who were challenged by their teachers and were prompted to think deeply, question, and clarify had high mathematics score than the students who had not been applied cognitive activation strategies in mathematics lessons.

The other strategy for effective mathematics teaching is also to foster students' sustaining engagement. Although there is a misbelief that quick responses against a mathematics problem shows proficiency in mathematics, students know that the solution of a challenging mathematics problem takes some time. That's why; perseverance plays an important role to keep engagement in any problem-solving process and to reach problem solution successfully (NCTM, 2000).

Problem-solving is seen as a base of mathematics learning (English & Gainsburg, 2016; Polya, 1981; Sengupta-Irving & Agarwal, 2017) and one of the aim of problem-solving program of mathematics curriculum in Turkey is to improve students' intentness to problem-solving and their perseverance in the problem-solving process (Aydoğdu & Ayaz, 2008). Other countries also give importance to this issue, for example, according to Human Resource Working Group (HRWG) (2009), problem-solving in mathematics framework is seen as a way of developing attitude of perseverance in Singapore. In 2008, Muir, Beswick, and Williamson

explored common problem-solving behaviors of students by analyzing the strategies used by 6th grade students in six non-routine mathematics problem and they indicated that the feelings of individuals such as motivation, interest, confidence, and perseverance affects problem-solving performance of students. Then, they categorized the students as novice and expert by considering the behaviors of the students. In this study, it was seen that the students who read problem situations quickly without pay attention problem situation itself; the students who did not check whether the answer was reasonable or not; and the students who had no perseverance to find an answer were poor problem solvers called as novice problem solvers.

In the literature, there are more research on the relationship between perseverance and mathematics achievement than the performance on problem-solving. Especially, many studies focused on the topic of how to foster students' perseverance in mathematics. In 2017, Bettinger, Ludvigsen, Rege, F. Solli, and Yeager wondered how schools can motivate students to increase their perseverance in mathematics courses and they used a treatment consisting of three sessions in mathematics lesson. To take the treatment, students used their own computers by logging a website. In the first session, they were firstly given a survey to measure their mindset. Then, they were randomly assigned treatment or controlled group. The students in treatment group took three cognitive exercises. The first one was related reading a neuroscience article about brain grow and change and it used a metaphor that brain is like a muscle growing and expanding thanks to challenging experiences. Secondly, students were asked to write the relationship between the reading passage and their own lives. After that, students were asked to give a growth mindset advise to a friend having difficulty in school. Although the controlled group took the same exercises,

differently their reading passage was just about basic brain functions. In the second session, students were asked to design their own worksheet including math questions. In the third session, students answered two questions from their worksheet and they were assigned a task consisting 34 algebra multiple choice questions. At the end of the treatment, the researchers observed that the students from treatment group showed more interest to solve the algebra questions than the other group. So, they found that the manipulated academic mindset caused to increase academic perseverance and academic performance.

Differently, Panaoura (2017) mentioned the importance of parental involvement to enhance students' perseverance in problem-solving. In her study, Facebook was used as a social media tool to be able to reach parents immediately and the parents were firstly informed about their role on students' homework throughout Facebook. Their role was just to remind their students to study on mathematics problem and they just guide in the steps that the student should follow to be able to solve the problem. Then, two problems were presented by the researchers in each week on closed Facebook group consisting of the parents. Some sections were opened to share the parents' experiences, criticisms, or questions online whenever they want. They were also responsible to upload the solutions of their students. By arranging some meetings, the parents were informed about the importance of problem-solving in today's world, the contribution of parents on students' cognitive development and the perseverance on problem-solving. Then, the developments of students were observed with some pre and posttests. At the end of the study, the researcher showed that parental involvement played significant role to increase students' perseverance and academic success.

Mohd, Mahmood, and Ismail in 2011 investigated the possible relationship between perseverance on problem-solving and mathematics achievement by implementing a survey to 153 student studying at University of Kuala Lumpur bachelor program. After analyzing the gathered data, the researchers found that the students had showed higher perseverance on problem-solving had higher results in mathematics than others.

The book written by McLeod and Adams (1989) brings some information about the factors affecting problem-solving performance of students by giving some examples from math-classes. Students' interest in mathematics was given as one of these factors. In the given example related mathematical interest, a student showed no interest to solve a math problem in the exam. The result of the student's score in the exam is that the reason for his unsuccessfulness is different than his lack of knowledge. According to writers, for students to write any answer in order to immediately finish an exam is common among students and it is probable that lacked motivation caused the student failure in the exam; this is because the student has no interest in mathematics. The study by Heinze, Reiss, and Augsburg (2005) presented students' interest level and consequently their success in mathematics are related to their classrooms' achievement level and given mathematics instruction. However, according to them, if a classroom tend to show low interest to mathematics, it does not mean that the classroom achievement in mathematics are negatively affected by this situation. Although students show high interest to mathematics when the instruction focusing on algorithm and basic calculation are given to them, the researcher says that probably their results in mathematics will not be good enough. The instruction should be go beyond simple calculation.

Self-efficacy and self-concept are among other factors. Social cognitive theorists defined self-efficacy as judgments of people about their capabilities to complete any academic tasks and they suggested that self-efficacy plays important role on the choices of people, perseverance against challenging situations, performance on specific academic tasks (Bandura, 1999; Pajares & Miller, 1994). It is shown that that self-efficacy better predicts mathematical problem-solving ability than other math-related variables such as mathematical anxiety, previous experiences with mathematics, or self-concept (Zimmerman, Bandura, & Martinez-Pons, 1992). On the other hand, self-concept means the perception of people about their capabilities to do a task, the behaviors against a situation, or their characteristics.

The study by Pajares and Miller (1994) investigated whether self-efficacy beliefs of students are more effective on problem-solving performance than math self-concept, math anxiety, past experiences, and comprehensibility of utility of mathematics.

They found that students had strong self-efficacy in terms of their ability to solve mathematics problems. Pajares and Kranzler (1995) were concerned about whether self-efficacy beliefs of African American students predict their mathematics problem-solving performance when their general mental abilities are taken under control by conducted path analysis including the variables such as math anxiety and gender. The results were parallel with the results of the analysis by Pajares in 1994; when students' general mental abilities get under control, students' self-efficacy beliefs about their capabilities to solve mathematical problems plays important role in terms of predicting students' mathematical problem-solving performance.

Pajares and Miller (1997) also assessed self-efficacy and mathematical problem-solving performance of 327 eight grade students who enrolled pre-algebra and

algebra classes. First of all, they randomly grouped the students into 4 groups. First day, group 1 and group 3 took open-ended mathematics problems while other two groups were administrated multiple-choice mathematics problems and students were asked not to solve them and just fill their confident level when they first came across the questions; did they see themselves capable of solving those questions? Second day, the types of problems were changed for the groups; group 1 and group 3 took multiple choice problems whereas other two took open-ended problems and then they answered what they felt when they saw the questions. At the end, the groups were expected to solve the same problems to assess their problem-solving performances. According to the result of this study, although there were no differences in the self-efficacy judgments of students who took problems in different formats, in the relation between self-efficacy and problem-solving performance there seen differences depending on different problem format; the problem-solving scores of students who were administrated multiple choice problems had higher than others.

As a consequence, the literature emphasized that students' problem-solving skills are affected some factors related students' backgrounds, school type, instruction type, and student behavior towards mathematics such as cognitive activation, perseverance, interest, self-efficacy, and self- concept. The literature showed that all these factors affect problem-solving skill in different degree. For example, the school type that student enroll was the most important factor predicting students' problem-solving performance when compared to the abovementioned background and math-related factor. Particularly, some studies found that the students from private schools are more successful than the students from state schools in terms of mathematics achievement and problem-solving performance. Also, many studies showed that

mother education level better explain students' problem-solving skill than father education level and some studies asserted that the number of books students have at their home positively affects students' problem-solving skills. In terms of math related factors, the literature generally found that self-efficacy and self-concept better predict students' problem-solving skills than other math-related factors.

This chapter provides an overview of the literature on the variables used in the present study. The findings reported in the literature supports the use of some variables such as school type and home background as covariates while the relationships are examined between problem-solving skills of students.

CHAPTER 3: METHOD

Introduction

The purpose of the present study is to seek out the relationships between problem-solving skills of students and parents and home related factors, school types, and some selected variables related to mathematics. This chapter presents the methodology of this study. Firstly, the research design and the context of the study are described. Then, the participation and the instrumentation of PISA 2012 survey are explained in detail. Lastly, the data analysis of the present study is given.

Research design

This study uses quantitative approach. The correlational research design seemed the most appropriate quantitative research method for this study and for the research questions of the present study (Simon & Goes, 2011). As Fraenkel and Wallen (2011) pointed out, the correlational research design explains the possible relationships among two or more variables. Since the study have many variables that can be related to problem-solving skills of the students, correlational research design helps make accurate findings about the possible relationship, if exist any. Since there will more than one variable which can be classified as dependent and independent, regression approach was preferred.

Context

In the Turkish education system, there is a huge diversity in terms of school types and socio-economic background. For example, there are many different kinds of high schools. As defined in PISA 2012 data set, the schools covered in this study are

General High Schools, Anatolian High Schools, Science High Schools, Social High Schools, Vocational High Schools, Anatolian Vocational High Schools, Technical High Schools, Anatolian Technical High Schools, Multi Program High Schools, and Police College (MoNE, 2013).

Anatolian High Schools, the main high school type in the Turkish education system, educate students to higher education by considering their abilities and interests. Also, these type schools in Turkey provide students with various facilities to learn foreign language well and to follow the developments in different fields. Science High schools can be seen as the source of future qualified scientists in the fields of mathematics and science. These type schools educate students who can use new technologies, produce new information and design projects. The schools provide students with necessary knowledge to make scientific research, to follow scientific and technologic developments. Private High schools are also work like Anatolian and Science High schools. The main aim of Social Science High Schools is to educate future qualified scientists who are needed in the field of social science and literature (MoNE, 2018).

On the other hand, vocational and technical high schools aim to educate students to have a profession before the higher education as well as general knowledge. The students who graduated these type schools are given “business license” with the authority and responsibilities of the mastership certificate. General culture courses are given to students besides professional formation courses in industrial technical fields. Graduated students from these schools can enter vocational and technical higher educational programs in higher education institutions. Anatolian Religious

High Schools has curricular components related religion like Qur'an course more than other school types. Graduates of such school can pursue their educations in higher education programs (MoNE, 2018).

Berberoglu and Kalender (2005) provided statistical evidence about the huge achievement difference between different school types in Turkey both on national and international outcomes. Similarly, Savaş, Taş, and Duru (2010) found achievement difference among students in terms of school types. Another source of contamination in student achievement is SES in Turkey. Also SES is an important predictor of students' achievement (Berberoğlu & Kalender, 2009; McConney & Perry, 2010; OECD, 2013d; Sirin, 2005).

Sampling

Two stage stratified sampling method was used to determine the students who participated in PISA 2012. In the first stage, the schools which have 15-year-old students are chosen by the National Center of PISA from eligible school list. In the second stage, for each country, a Target Cluster Size (TCS) was determined and nearly 35 students from each chosen school are selected with equal probability. However; for the countries who take Financial Literacy as an optional, TCS was increased for each selected schools in order to have the required student sample size (OECD, 2013b).

Around 510000 students were randomly selected to participate in PISA 2012 from 34 OECD member countries and 31 partner countries and economies. The students represented nearly 28 million 15 year-old students from 65 countries. The students' ages range from 15 years 3 months and 16 years 2 months (OECD, 2013b).

In PISA 2012, the number of 15 year-old students in Turkey was 1.266.638. Four thousand eight hundred forty-eight of them participated PISA 2012 exam. The students were randomly chosen from 170 different schools representing 12 different geographical regions from Turkey which were defined by OECD (MoNE, 2015).

The region with the highest number of students and schools was Istanbul while the region with the least number of participating students was Northeast Anatolian Region. With respect to school type, the Table 2 shows that 2.48 % of the students were from primary education, 57.5 % of the students were from secondary education, 38.6 % of them from vocational and technical education, and 1.4 % of them were from Police College (As of 2015, these schools were closed). The schools representing 12 different regions in Turkey were included to the sample proportionally to the number of schools in the regions. In terms of gender, approximately 49% of 4848 students participating PISA 2012 were female students and 51% of them were male students.

In this study, all students in the Turkish sample of PISA 2012 ($n = 4,848$) data were included. In the following tables (Table 1 and 2), the number of students who participated in PISA 2012 from different type of high schools in Turkey and their distributions are given.

Table 1
The number of students in terms of school types

School Types	Frequency	Percent
Anatolian	1,050	21.66
Anatolian Teacher	207	4.27
Anatolian Technical	123	2.54
Anatolian Vocational	279	5.75
General High School	1,462	30.16
Multi Program	178	3.67
Police College	68	1.40
Primary School	120	2.48
Science	35	0.72
Social Science	35	0.72
Technical	75	1.55
Vocational	1,216	25.08

Table 2
The distribution of students in terms of school types

School Types	Girls		Boys		Total	
	n	%	n	%	n	%
Anatolian	593	12.23	457	9.43	1050	21.66
Anatolian Teacher	117	2.41	90	1.86	207	4.27
Anatolian Technical	21	0.43	102	2.10	123	2.54
Anatolian Vocational	175	3.61	104	2.15	279	5.75
General	712	14.69	750	15.47	1,462	30.16
Multi Program	81	1.67	97	2.00	178	3.67

Table 2 (cont'd)

The distribution of students in terms of school types

School Types	Girls		Boys		Total	
	n	%	n	%	n	%
Police College	0	0	68	1.4	68	1.4
Primary School	56	1.16	64	1.32	120	2.48
Science	22	0.45	13	0.27	35	0.72
Social Science	20	0.41	15	0.31	35	0.72
Technical	9	0.19	66	1.36	75	1.55
Vocational	564	11.63	652	13.45	1216	25.08
Total	2,370	48.89	2,478	51.11	4,848	100

Instrumentation

In PISA, literacy tests based on mathematics, reading, science and questionnaires are used as measuring instruments and the instrumentation can be grouped into two main categories as paper-based assessment and computer-based assessment. The data related problem-solving is obtained by computer-based assessment.

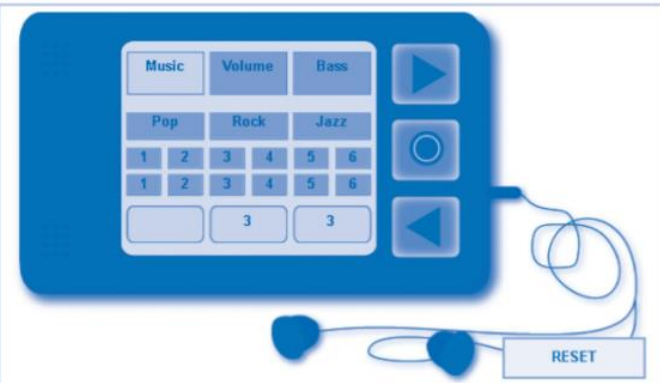
PISA 2012 paper-based assessment includes reading, mathematics, and science literacy test and it takes two hours to complete. The paper-based assessment also includes student questionnaire measuring the attitudes of students towards learning, learning attitudes, and learning environment at home. To complete the questionnaire, students are given 30 minutes. In the present study, only student questionnaire and problem-solving scores was used as data source. In terms of organizing scheme, the paper-based assessment is organized into nine clusters. Six of the clusters are new

prepared while three of them contain common items from previous PISA assessments. However, each country should use seven of the clusters for each domain. The seven clusters and the clusters related other domains are compiled in thirteen standard text booklets by rotating test design. As of 2003, problem-solving assessment is developed in addition to paper-based assessments. However, in 2012, the most important difference of problem-solving assessment was that it was applied on computer and students had to actively participate problem situation.

The computer-based problem-solving assessment can be considered as an opportunity because it provides broad scenario possibilities even in case of the paper-based problem situations are sufficient. Each student meets with approximately twenty item on the computer screen and they are given 40 minutes to complete it. While students are answering the items, they may need to choose a specific option by using mouse, drag a shape to a specific position, use menus, or illuminate a shape by clicking on it like Figure 1 and Figure 2. So, they need to have some basic computer skills. Also, students are sometimes asked to explain their answers by filling a text box. Three-quarters of the items are scored automatically while one-quarter consisting open-ended items are scored online by experts. In the following (Figure 1 and 2), there are two examples from PISA 2012 computer based problem-solving questions.

Question 1:

MP3 PLAYER
A friend gives you an MP3 player that you can use for playing and storing music. You can change the type of music, and increase or decrease the volume and the bass level by clicking the three buttons on the player.
(▶, ●, ◀)
Click RESET to return the player to its original state.



Question 1: MP3 PLAYER CP043Q03

The bottom row of the MP3 player shows the settings that you have chosen. Decide whether each of the following statements about the MP3 player is true or false. Select "True" or "False" for each statement to show your answer.

Statement	True	False
You need to use the middle button (●) to change the type of music.	☐	☐
You have to set the volume before you can set the bass level.	☐	☐
Once you have increased the volume, you can only decrease it if you change the type of music you are listening to.	☐	☐

? ➔

Figure 1. MP3 player example from PISA 2012 problem-solving item (OECD, 2013c, p.128)

Question 2:

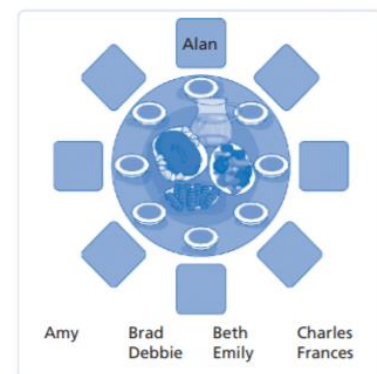
BIRTHDAY PARTY

It is Alan's birthday and he is having a party.

Seven other people will attend. Everyone will sit around the dining table.

The seating arrangement must meet the following conditions:

- Amy and Alan sit together
- Brad and Beth sit together
- Charles sits next to either Debbie or Emily
- Frances sits next to Debbie
- Amy and Alan do not sit next to either Brad or Beth
- Brad does not sit next to Charles or Frances
- Debbie and Emily do not sit next to each other
- Alan does not sit next to either Debbie or Emily
- Amy does not sit next to Charles



Arrange the guests around the table to meet all of the conditions listed above. Use drag and drop to position the guests around the table.

Figure 2. Birthday party example from PISA 2012 problem-solving item (OECD, 2013c, p.134)

In PISA 2012, the scale of the problem-solving scores was designed to have the mean score of 500 ($SD = 100$) for OECD countries and two thirds of the students from the countries got between 400 and 600 points (OECD, 2019). Turkey's mean is 454 points ($SD = 79$). In order to interpret what the numerical scores of students mean, basically six proficiency levels were defined based for problem-solving scores (OECD, 2014). The proficiency levels are seen in the following Table 3.

In this study, the dependent variables are the five problem-solving scores of 15 year-old students (PV1CPRO, PV2CPRO, PV3CPRO, PV4CPRO, PV5CPRO, as defined in PISA 2012 data set).

Table 3
Proficiency levels for problem-solving skill

Level	Score Range	What students can do
Level 1	358 to less than 423 points	Students can explore similar problem situations they are encountered before. Also, the students at Level 1 partially describe the behavior of a basic device by considering their previous observations.
Level 2	423 to less than 488 points	Students can explore a problem situation they have not encountered before and can understand small part of it. The students at Level 2 may have the capacity to generalize solutions.
Level 3	488 to less than 553 points	Students can use the information given in different formats, discover a problem situation, and establish simple relationships between their components. The students at Level 3 have problem with complex digital devices whereas they can control simple one.

Table 3 (cont'd)
Proficiency levels for problem-solving skill

Level	Score Range	What students can do
Level 4	553 to less than 618 points	The students will be able to analyze a complex problem situation in a good way and can understand the connection among the components which are important to solve problems. The students at Level 4 can control unfamiliar home devices or vending machines called as moderately complex devices, yet they cannot always do it efficiently.
Level 5	618 to less than 683 points	Students can explore a complex problem situation in a systematic way in order to understand its structure. The students at Level 5 respond very quick to control moderately complex devices. If they face with an unexpected situation, they can change their solution methods.
Level 6	Equal to or higher than 683 points	Students can solve complex problem situations in an efficient way. They can explore very complex and strategic manner to fully understand the problem situation. The students at Level 6 can quickly learn how to control very complex devices which are unfamiliar to them. They are highly proficient at problem-solving and they can use strategic plans to solve a problem. If it is needed, they can change their strategies to be able to solve the problem situation.

Note. Adapted from *PISA 2012 Results: Creative Problem Solving: Students' skills in Tackling Real Life Problems* (Volume V, p. 57), by OECD, 2014, Paris: OECD Publishing

The independent variables used in this study are as follows (abbreviations in the parentheses indicate item code in PISA 2012 data set): educational level of father (FISCED) and mother (MISCED), home educational resources (HEDRES), school types and math-related factors such as cognitive activation in mathematics lessons (COGACT), perseverance (PERSEV) mathematics interest (INTMAT), mathematical self-efficiency (MATHEFF), and mathematical self-concept (SCMAT). Their descriptive statistics can be seen in the Table 4 and the information about the variables is given detail in the following.

Parental education is used as a variable related family background to analysis educational outcomes. In PISA, students are asked their parents education by choosing ISCED (International Standard Classification of Education) levels which are categorized as ISCED 1 (primary education), ISCED 2 (lower secondary), ISCED 3B-3C (vocational/pre-vocational upper secondary), ISCED 3A (general upper secondary) or ISCED 4 (non-tertiary post-secondary), ISCED 5B (vocational tertiary), ISCED 5A (theoretically oriented tertiary and post-graduate). Then, students' responses to these categories are coded as MISCED and FISCED. (OECD, 2013b). In Turkey, 12.3% of students' parents graduated from higher education whereas the father and mother of 54.5% of students graduated from primary and secondary education. It means that the graduation of majority of mothers and fathers are more likely to accumulate on primary and secondary education (MoNE, 2015).

Since home possessions are seen as an indicator of stable source of wealth, it is believed that it more reflects wealth than the income of family (OECD, 2013d). In PISA 2012 student questionnaire, students answered 14 different items related to

households at their own home. The items were related to home educational resources (HEDRES). They were asked whether they have a desk and a quiet place to study, a computer and educational software for school works, technical reference books, and dictionary (OECD, 2013d, p.316).

Five items which measured students' perseverance in mathematics lessons (PERSEV) were added student questionnaire. The items were about different statements describing students well such as "I give up easily when confronting with a problem", "I put off difficult problems", "I remain interested in the tasks that I start", "I continue working on tasks until everything is perfect", and "I do more than what is expected from me when I confronted with a problem" (OECD, 2013d, p. 337).

In PISA 2012 student questionnaire, there were nine items which measure cognitive activation in mathematics lesson (COGACT). Students were asked how often their math teachers want their reflections on problems and their procedures to solve complex problem situations. Also, the students were asked whether their math teacher present problems having no immediate solutions and help them to learn something new from their mistakes. Since the related items were reversed, the higher difficulty means the most occurrence event in the classroom. Students responded the items by choosing one of the categories "always or almost always", "often", "sometimes", or "never or rarely" (OECD, 2013d, p. 330).

Four mathematics interest (INTMAT) items were used in student questionnaire. Students were presented some statements to measure their thinking about mathematics such as "I enjoy reading mathematics", "I look forward to my

mathematics lessons”, “since I love mathematics, I do it”, “and I am interested in the things I learned in mathematics”. The response categories to the items were “strongly agree”, “agree”, “disagree”, or “strongly disagree” (OECD, 2013d, p.321).

Eight items were used to measure self-efficacy (MATHEFF) in mathematics. The items presented some mathematics tasks to students and asked the students how do they feel when they had asked the given mathematics tasks. As a response, students chose one of the categories “very confident”, “confident”, “not very confident”, or “not at all very confident” (OECD, 2013d, p. 322).

In PISA 2012 student questionnaire, to measure self-concept (SCMAT) students were asked to what extend they agree “they are not good at mathematics, they get mathematics good grade, they learn mathematics quickly, they always believe that mathematics is their best subject, and they can understand the most difficult mathematical works” and the student responded the items from the categories range from strongly agree or strongly disagree (OECD, 2013d, p. 323).

Table 4
Descriptive statistics for variables

Variables	Mean	Median	Std. Dev.	Min.	Max.
FISCED	2.59	2	1.88	0	6
MISCED	1.79	1	1.64	0	6
HEDRES	-0.61	-0.69	1.10	-3.93	1.12
COGACT	-0.05	-0.04	1.01	-3.88	3.20
PERSEV	0.45	0.26	1.08	-4.05	3.52
INTMAT	0.44	0.44	1.06	-1.78	2.29
MATHEFF	-0.01	-0.18	0.93	-3.75	2.27

Table 4 (cont'd)

Descriptive statistics for variables

Variables	Mean	Median	Std. Dev.	Min.	Max.
SCMAT	-0.05	-0.06	0.97	-2.18	2.26
PV1CPRO	454.26	451.86	76.91	220.55	714.83
PV2CPRO	454.48	452.67	78.14	171.85	732.69
PV3CPRO	453.99	452.67	76.85	167.80	718.90
PV4CPRO	453.93	451.86	77.52	196.20	735.12
PV5CPRO	454.41	451.05	78.14	235.15	721.33

Method of data collection

Data collection in PISA studies can be summarized as follows: First of all, a school-coordinator is appointed to each school that will participate in PISA. The school coordinator is charge of sending a name list of students who are 15 years old in the school to the National Center of PISA in the country. Then, 35 students are randomly selected by the center to participate in PISA. After the selection, the school coordinator gets necessary permission from the students' parents. Next, a test administrator who is appointed by the National Center communicates with the school coordinator to plan the administration of the assessment. When the assessment is conducted, the main task of the test administrator is to distribute booklets to correct students (OECD, 2013b).

The data used in this study were gathered from computer-based problem-solving assessment and student questionnaire in PISA 2012. Computer based problem-solving assessment is offered to participating countries in PISA 2012 for the first

time. Although questions are presented to students on computer screen, students were given the opportunities to use paper and pencil in organizing their responses. The computer-based assessment takes 40 minutes. Also, the time given to students for answering student questionnaire were 30 minutes. After the assessments are finished, the test administrator sends the collected booklets to the National Center (MoNE, 2015).

Method of data analysis

Hierarchical multiple linear regression was used to investigate the relationships between problem-solving skills of students and several math-related variables while controlling for SES and school type variables. Analyses were conducted by IBM SPSS Statistics 20.

Before the analysis data weighting was applied to the data set in order not to affect the reliability of the analysis. The variable final student weight (W_FSTR80) was used to weight the data. Based on PISA analysis manual for SPSS (OECD, 2009), data weighting should check for the following reasons;

- The probability of the choosing of both a student and a school within a country is not the same for all of them.
- The participation rate can be different for a student based on his/her characteristics.

Hierarchical multiple linear regression was conducted with three blocks. First block included the educational level of mother (MISCED), the educational level of father (FISCED), home educational resources (HEDRES) as SES indicators; the school

type variable coded with dummy-coded by taking general high school as reference school type were categorized into the second block; the third block included math related variables cognitive activation (COGACT), perseverance (PERSEV), mathematics interest (INTMAT), mathematical self-efficacy (MATHEFF), and mathematical self-concept (SCMAT). For each dependent variable, a separate regression analysis was repeated and the results were averaged.

All statistical assumptions were checked prior to the hierarchical multiple linear regression analysis. The first assumption is normality. To check normality of the variables of this study, their histograms, variance coefficients, Skewness and Kurtosis values, their detrended plots, and Kolmogorov-Smirnov tests results were controlled. All factors are not normally distributed based on Kolmogorov-Smirnov test results, George and Mallery (2010) said that the multiple linear regression analysis is resistant for non-normality if their skewness and kurtosis values are between -2 and +2. Since the Skewness and Kurtosis values for all factors were in this range, thus the normality assumption were considered to be satisfied.

The second assumption of multiple linear regression analysis is homoscedasticity, which means equally distributed variance on a scatter plot of a data. According to the results, although we observed the variance of some variables did not look like equally distributed because of some minor outliers, we can say that homoscedasticity was satisfied because it was observed on the scatter plots of most data.

The third and the last assumption was to check whether the independent variables showed multi-collinearity which means the independent variables are not correlated

each other in a high degree. To check multi-collinearity, variance inflation factor (VIF) was controlled. Since the VIF value of the data was under 2, the independent variables did not show multi-collinearity.



CHAPTER 4: RESULTS

Introduction

In this chapter the results of the analysis will be presented. As explained in the previous chapter, home and parent related factors (educational level of father, educational level of mother, home educational resources), school types (dummy-coded), and affective variables (cognitive activation in mathematics lessons, perseverance, mathematics interest, mathematical self-efficacy, and mathematical self-concept) are taken as independent variables while problem-solving skills of students is dependent variable in a hierarchical multiple linear regression with three blocks; home and parent related factors in block 1, the school types in block 2 and affective variables in block 3.

Findings

This section presents evidence about the relationship between problem-solving skills of students and the factors throughout three models. Table 5 presents results regarding the significance of the models.

Table 5
ANOVA results of regression analysis

Model	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>
1 Regression	1562114.31	3	520704.77	106.04*
Residual	7262485.24	1479	4910.40	
Total	8824599.55	1482		

Table 5 (cont'd)
ANOVA results of regression analysis

Model	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>
2 Regression	3234098.99	12	269508.25	70.90*
Residual	5590500.56	1470	3803.06	
Total	8824599.55	1482		
3 Regression	3482841.89	17	204873.05	56.22*
Residual	5341757.66	1465	3646.25	
Total	8824599.55	1482		

* $p < .05$

According to Table 5 given above, all of the three models are statistically significant.

Table 6 provides information about models and changes between the models.

Table 6
Model summary table

Model	<i>R</i>	<i>R</i> ²	Adjusted	<i>SE</i>	Change Statistics			
					<i>R</i> ²	<i>F</i>	<i>df1</i>	<i>df2</i>
			<i>R</i> ²		Change	Change		
1	0.42	0.18	0.18	70.07	0.18	106.04*	3	1479
2	0.61	0.37	0.36	61.67	0.19	48.89*	9	1470
3	0.63	0.39	0.39	60.38	0.03	13.66*	5	1465

* $p < .001$

According to the Table 6, the predictors in the first block (model 1) educational level of mother, educational level of father, and home educational resources explain 18% variance in problem-solving skills of students. As evidenced by statistically

significance, the predictors in this block together as a group is able to predict problem-solving skill significantly ($F(3, 1479) = 106.04, p < .001, R^2 = .18$).

In the second block (model 2), school types which are taken along with educational level of mother, educational level of father, and home educational resources increases R^2 to 0.37 ($p < .001$), adding 0.19 in the explained variance. All the variables are taken as a group, they significantly predict problem-solving skills of students ($F(12, 1470) = 70.90, p < .001, R^2 = .37$). It is said that when school types were added to the model 1, the school types accounts for a significant amount of variance.

In the third block (model 3), the variables taken in model 1 and model 2 and adding affective variables cognitive activation in mathematics lessons, perseverance, mathematics interests, mathematical self-efficacy, and mathematical self-concept overall are significant predictors of problem-solving skill ($F(17, 1465) = 56.22, p < .001$). However, affective variables made the least contribution in the explained variance by increasing 0.03 although it is statistically significant (R^2 change = .03, $p < .001$). In the Table 7, both standardized and unstandardized regression coefficients are given for each block in the regression equation.

Table 7
Regression coefficients of students' mathematics problem-solving skills

Variables	Model 1				Model 2				Model 3			
	<i>B</i>	β	<i>t</i>	<i>p</i>	<i>B</i>	β	<i>t</i>	<i>p</i>	<i>B</i>	β	<i>t</i>	<i>p</i>
Ed. Level of Father	4.86	0.12	4.07	.00	1.60	0.04	1.50	0.14	1.20	0.02	0.88	0.39
Ed. Level of Mother	6.94	0.15	5.13	.00	3.95	0.08	3.28	.00	3.65	0.08	3.10	.00
Home Ed. Resources	18.90	0.27	10.31	.00	15.39	0.22	9.44	.00	13.38	0.19	8.27	.00
Anatolian					65.36	0.36	14.30	.00	60.76	0.33	13.31	.00
Science					152.45	0.18	8.34	.00	135.18	0.16	7.50	.00
Social Science					101.36	0.12	5.62	.00	101.87	0.12	5.76	.00
Anatolian Teacher					89.57	0.25	11.21	.00	84.61	0.23	10.56	.00
Vocational					-9.30	-0.05	-2.18	0.05	-7.25	-0.04	-1.71	0.13
Anatolian Vocational					35.05	0.11	4.83	.00	34.36	0.11	4.86	.00
Technical					34.62	0.06	2.63	0.01	29.86	0.05	2.30	0.03
Anatolian Technical					49.08	0.10	4.72	.00	51.51	0.11	5.04	.00
Multi Program					14.43	0.03	1.61	0.14	16.08	0.04	1.82	0.10

Table 7 (cont'd)
Regression coefficients of students' mathematics problem-solving skills

	Model 1	Model 2	Model 3			
Variables			<i>B</i>	β	<i>t</i>	<i>p</i>
Cognitive Act. in Math			2.53	0.03	1.48	0.17
Perseverance			1.17	0.02	0.72	0.46
Mathematics Interest			-10.40	-0.15	-4.76	.00
Self-Efficacy			9.84	0.12	4.75	.00
Self-Concept			11.80	0.15	4.49	.00

By considering the above Table 7, the block 1 (model 1) in which educational level of mother, educational level of father, and home educational resources were taken into consideration as independent variables presents that all the predictors have positive beta values (β) indicating positive relationship with problem-solving skills of students. When the B values of all the predictors are considered, it is seen that the B value of home educational resources is higher than others ($B = 18.90$). If the effects of all other predictors are held constant, home educational resources affect dependent variable problem-solving with the degree of 18.90. One-unit increase in this variable, more educational resources increase students' problem-solving by 18.90 points. In this model, all variables, educational level of mother, educational level of father, and home educational resources are statistically significant predictors of problem-solving skill of students ($p < .001$). It can be said that home educational resources have slightly more impact on problem-solving skill than the other predictors educational level of mother and educational level of father. Also, standardized beta coefficient for educational level of mother is 0.15, for educational level of father is 0.12, and for home educational resources is 0.27. Thus, the beta values show that home educational resources have relatively higher impact on predicting problem-solving skills of students by comparing other two factors in model 1.

In the second block (model 2), all school types except vocational high school which has negative B value ($B = -9.30$) have positive relationship with dependent variable problem-solving, as their B values are positive. Also, educational level of father ($t = 1.50$, $p = .14$) and multi program high school ($t = 1.61$, $p = .14$) have no statistically significant contribution in predicting problem-solving skills of students. However,

Science high school is the best school type which predicts problem-solving skill of students as dependent variable, as its B value is 152.45 which is higher than others ($p < .001$). The result is followed by social science high school and Anatolian teacher high school with the B values 101.36 and 89.57, respectively. In other words, students in Anatolian schools have almost 65 points more in problem-solving as compared to general high schools. Similarly, science school students have around 152 point more in problem-solving.

When mathematics related factors are taken into consideration in the third block (model 3), it is seen that mathematics interest has negative relationship with the dependent variable problem-solving, as it has negative B value ($B = -10.40$) while other predictors have positive relationship with the dependent variable. On the other hand, mathematical self-concept affects the problem-solving skills of students with the increase of 11.80 when other predictors are taken as a constant ($B = 11.80$), while the contribution of cognitive activation in mathematics lessons to the model is 2.53. By considering the results in the model 3, it is also said that cognitive activation in mathematics lessons and perseverance are not significant predictors of problem-solving skill of students because their p -values are higher than 0.05 ($p = 0.17$ for cognitive activation in mathematics lessons; $p = 0.46$ for perseverance). When comparing beta values of all mathematics related predictors, the beta value of mathematical self-concept is higher than the beta value of self-efficacy. This tells that self-concept has slightly more impact on the model.

In this block, home educational resources have still statistically significant relationship between students' problem-solving skills. Similarly, between-school

differences are still statistically significant. Anatolian and science school students have more than 100 points in problem-solving scale as compared to general high schools.

When standardized regression coefficients were investigated in the third block, the highest three coefficients belong the school types (Anatolian, science and Anatolian teacher). Even home educational resources have a higher standardized coefficient than all math-related variables.

To further explain the model and visualize the results, several figures were created. In the Figure 3, changes in beta values of the three variables in the first block (education level of father, education level of mother, and home educational resources) are shown. When the variables in the second block are introduced, beta values decreased significantly. However, introduction of variables in third block did not create significant changes in beta values. Although the beta values related educational level of father and home educational resources continued to decrease, the beta values related educational level of mother stayed steady.

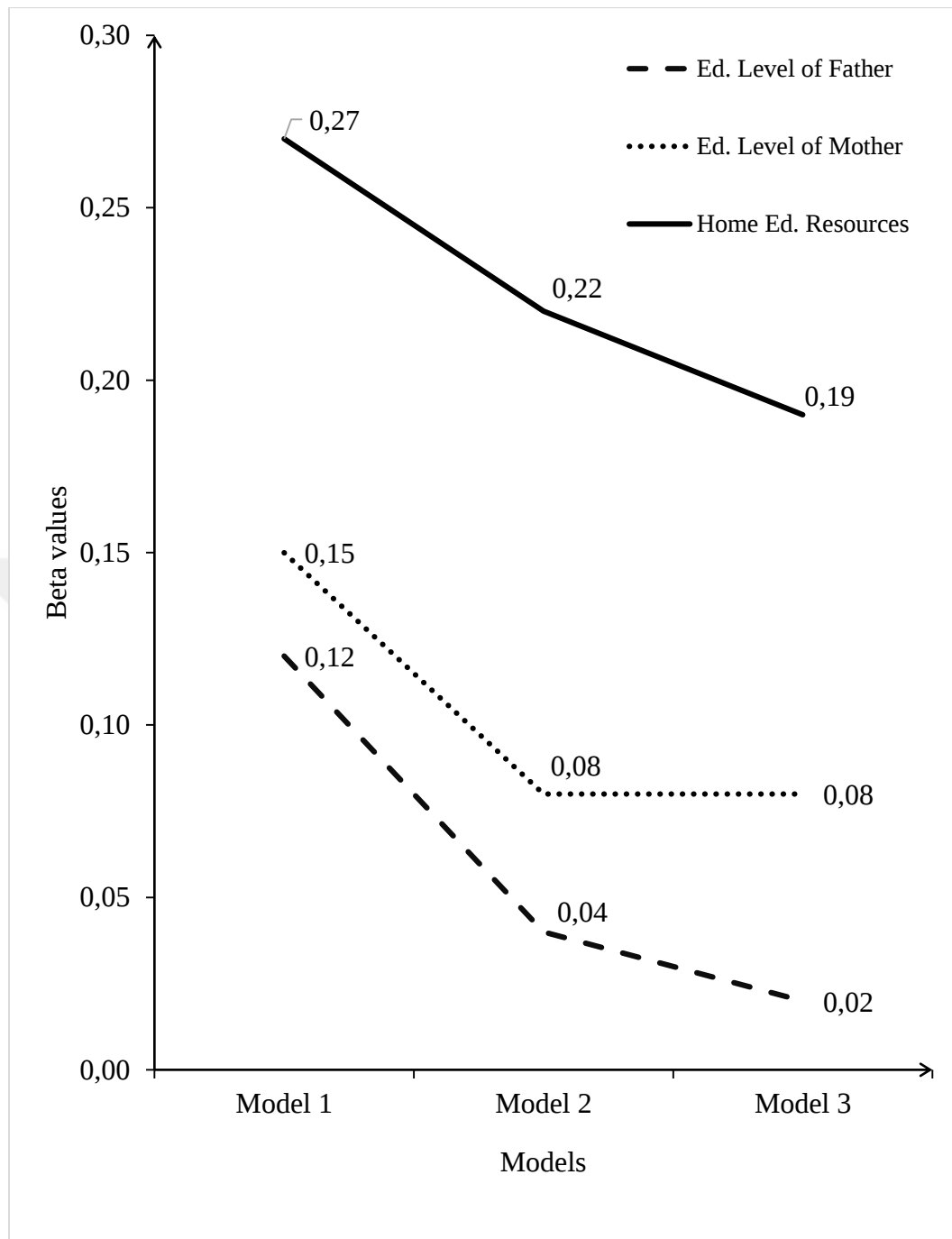


Figure 3. The changes in beta values of three variables in the first block

In the Figure 4, the changes in the beta values of school types are given between the models 2 and 3. In general, there are no significant changes in beta values before and after the variables in the block 3 were introduced. For most of the school, small decreases were observed.

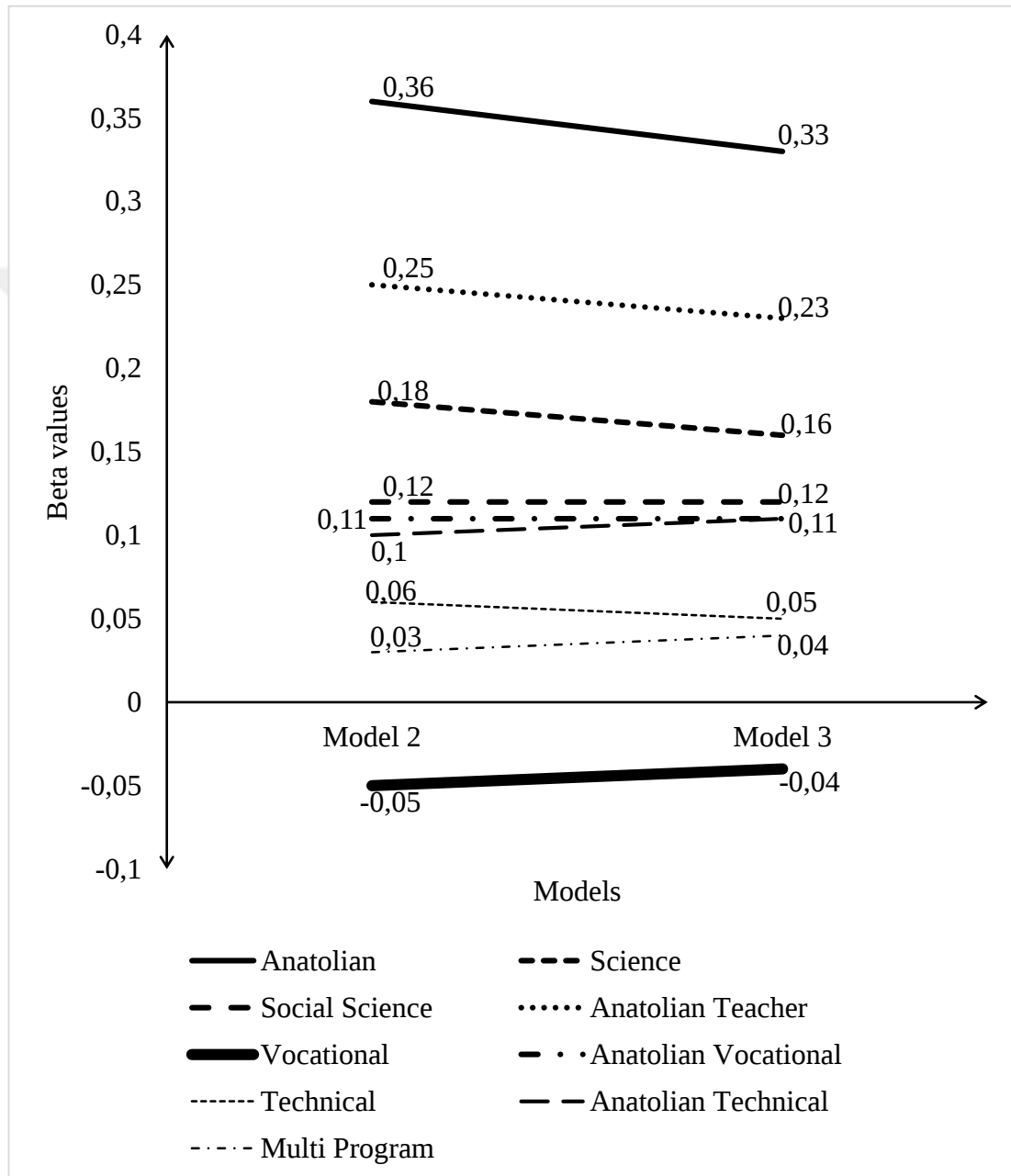


Figure 4. The changes in the beta values of different school types

Summary

As a conclusion, home and parent related factors which are the predictors in the first block of the analysis explained 18% of the variance in students' problem-solving.

When the second block variables related to school types taken along with the predictors in the first block, the variables increased the variance to the 36%. It means that only school types explained 19% of the variance. When affective variables were added to the analysis as third block, the explained variance increased to 39%. These affective variables caused only 3% increase on the students' problem-solving skills.



CHAPTER 5: DISCUSSION

Introduction

The purpose of the present study is to investigate whether parent and home related factors, school types, and math-related factors predict students' problem-solving skills or performances by using PISA 2012 data set. To this end, a hierarchical multiple linear regression model was constructed. In the model, background variables (educational level of father, educational level of mother, and home educational resources) and school type were entered into the regression equation as the first and the second blocks. The third block included the math-related variables. Results indicated that home/parental background variables and school type have strong relationships with Turkish students' problem-solving skills. This chapter discuss the findings and provides implications.

Overview of the study

To develop problem-solving skills of students is one of the aims of mathematics curricula around the world. When the literature was reviewed, it was seen that students' problem-solving skill is affected by many factors from socio-economic status of them to their own beliefs. In countries like Turkey, home background variables and school type are important predictors of students' outcome variables. Thus examination of factors affecting students' problem-solving skills should take these factors into considered to get a clear picture. In order to explore this issue more, this study proposed a regression model to explore whether problem-solving skills of students are predicted by cognitive activation in mathematics, perseverance, mathematics interest, mathematics self-efficacy, and mathematics self-concept while

parental educational levels, home resources, school types are controlled for using PISA 2012 Turkish data set.

The researcher seeks an answer to the following research questions:

1. Is there any relationship between problem-solving skills of students and the factors related to socio-economic status (home educational resources, educational level of mother, and educational level of father)?
2. Is there any relationship between problem-solving skills of students and the school types in Turkey?
3. Is there any relationship between problem-solving skills of students and affective variables (mathematics interest, cognitive activation in mathematics lessons, perseverance, mathematics self-efficacy, mathematics self-concept)?

Major conclusions

In the present study, the researcher examined whether problem-solving skills of Turkish students are predicted by affective variables when home and parent related factors and school types are controlled for using PISA 2012 data set.

The variables in the first block (educational level of father, educational level of mother, and home educational resources) explained 18% of the variability in problem-solving. Similarly, school types explained 19% of the variable in the same variable. Affective variables (cognitive activation in mathematics, perseverance, mathematics interest, mathematics self-efficacy, mathematics self-concept) made only 3% contribution to this variability. As can be seen, the parent and home related

variables and school types that were added to the model to be controlled for had a stronger relationship with problem-solving than affective variables.

The results obtained in the hierarchical linear regression analysis revealed that education level of mother and father and home educational resources make significant contribution for prediction problem-solving skills of students, yet home educational resources have a stronger relationship with problem-solving skill compared to parental education levels.

On the contrary, the study by Murnane, Maynard, and Ohls (1981) in which home educational resources categorized into two categories such as possessions and time given by parents indicated that educational resources related good inputs did not directly affect students' performance in mathematics although time input like education level of mother strongly affects. The result difference between the present study and the one in 1981 can be explained by the chosen home educational resources. The materials related home educational resources may not be always related students' education. The result in the present study showed that home educational resources taken in PISA such as a desk, a quiet place to study, a computer with educational software for school homework, supplementary resources and dictionaries have an important effect on explaining problem-solving skills of students. It may be due to that the educational resources are always received by students for education purposes and these materials contribute to both students' achievements and problem-solving skills. This result is in the same line with the results by Leibowitz (1977) and Yayan and Berberoğlu (2004). Brecko stated that the number of books at home is an indicator of students' high academic achievement.

Since the number of books students have at home asked in PISA 2012 student questionnaire, like the study by Brecko, our study revealed that the quality of books and their usage purpose are effective on students' academic performance as well as the number. The relationship between home education resources and problem-solving skills can also be explained by income of families, which make access to such resources easier.

When the educational level of parents is considered, this study showed that educational level of mother better predicts problem-solving skills of students than educational level of father. The result is in parallel with the result of the studies by Neitzel and Dopkins (2004), Sungur and Bal (2016), and Altıntaş and Bıçakçı (2018). As explained in the study by Neitzel and Dopkins (2004), the result can be related to mother skills obtained throughout their own education process because education is a good resource for mothers to gain knowledge about how to support children when they encounter with complex situations like daily life problems or the daily life problems in math context. Also, the mothers know different strategies and how to direct their children to simplify a complex problem thanks to their own experiences obtained from education. As indicated in the study by Altıntaş and Bıçakçı (2018), the reason of why fathers have not enough contribution to predict problem-solving skills of students may be correlate with the time spending with children. However, the result is contradictory to the study by Hacıhasanoğlu, Karakurt, Türkeş, and Yıldırım (2011) stating there is no statistical difference between maternal educational level and problem-solving skills of students.

The other result of the study revealed that school types made considerable contribution to predict the Turkish students' problem-solving skills when compared to parent and home related factors and affective variables taken into consideration in this study. As can be seen in the Figure 4, some schools have strong relationships as evidenced by high beta values. For example, Anatolian, Anatolian teacher, and Science high schools have higher beta values than other high school types. Dinçer and Kolaşın (2009) and Sungur (2016) analyzed students' problem-solving performance in terms of school types and different variables, school type was found the strongest predictor like in this study.

Also, it is seen that there are huge differences among the B values of different type schools. It means that there are differences in terms of problem-solving performance of students from different type schools, as seen in the Table 8. The difference between schools which have the highest and the lowest values (science and multi program schools, respectively) is 0.15. In other words, a skill that we want students to gain regardless of school types appears at different levels in different school types. Between-school differences were shown to be related to students' literacy levels (Berberoglu & Kalender, 2005). The results of the present study confirmed the same pattern for problem-solving skills.

Table 8
Problem-solving scores of different school types

School Types	N	Mean	SD
Anatolian	1050	512.92	68.14
Anatolian Teacher	207	535.13	43.09
Anatolian Technical	123	497.76	50.54
Anatolian Vocational	279	472.86	47.24
Multi Program	178	437.58	49.67
Science	35	594.78	32.53
Social Science	35	553.53	44.92
Technical	75	470.15	55.44
Vocational	1216	415.46	52.29

Based on the result of this study, if school types are compared in terms of their effects on problem-solving skill, it is seen that science high schools in Turkey made considerable contribution on students' problem-solving performance. The performance of students from science high schools was followed by the students from social science high schools and Anatolian teacher schools respectively, whereas the students' performance from vocational high schools on problem-solving is lower than others. The result is in line with the study by İleritürk and Kıncal (2016). Also, although the studies by Berberoğlu and Kalender (2005), Dinçer and Kolaşın (2009), Alacacı and Erbaş (2010), and Gümüş (2012) analyzed students' achievements in terms of school types and different variables from this study, the result of the previous study is same with the results of their studies in terms of the order of school types. As said by Gümüş (2012), science schools in Turkey accept the students who got the highest point from the exam taken after primary education. So, it is inevitable

that the achievements and problem-solving performance of students from science high schools are higher than the students from other schools.

According to the results, self-concept and self-efficacy among affective variables are the predictors of problem-solving skills of students. The finding is in accordance with the studies by Burge, Lenkeit, and Sizmur (2015); NCTM (2000); Muir, Beswick, and Williamson (2008), Pajares and Miller (1994), Pajares and Kranzler (1995). When compared to the effects of self-efficacy and self-concept on students' problem-solving skill, although these both factors are the predictors of problem-solving skill the researcher found that self-concept better explain problem-solving skills of students than self-efficacy. However, Pajares and Miller (2005) determined self-efficacy is more efficient to predict problem-solving skills of students than self-concept. So, the result of this study did not parallelism with the finding of Pajares and Miller. Based on the result of this study, we might say that students' beliefs about themselves are more efficient than their confidence in their abilities to predict their problem-solving skills.

Also, mathematical interest had negative relationship with problem-solving skills of students whereas cognitive activation in mathematics class and perseverance positively had positive relationship with students' problem-solving skills, yet their contributions were not significant. This result contradicts with the study by McLeod and Adams (1989) who said that the unsuccessfulness of a student in a problem-solving task is related his interest to the task instead of lack of knowledge.

According the results of this study, background variables and school types are strongest variables explaining students' problem-solving skills. However, math-

related variables do not seem to be as relevant to problem-solving skills as background variables and school types. The result shows the strong relationship between socio-economic status and students' achievement or problem-solving performance. As a result, the performance difference among different school types reveals that the basic skills that students should gain could not be acquired at a minimum level.

Implications for practice

As seen in this study, school type is the significant variable predicting students' problem-solving skills. Especially, certain school types in Turkey such as Science, Anatolian, and Anatolian Teacher High Schools are more successful than others in terms of developing problem-solving skills of students. It means that the students attending the top three school types are good problem solvers; they are able to use their knowledge to solve the problems in daily life without difficulty. So, the gap between different school types should be minimized by taking some actions. The gap can be related teachers, teaching techniques, opportunities, or school environment. If the differences among the schools are decrease, the difference among students in terms of problem-solving skill can be made minimum.

The first action is to determine the needs of each school and then the schools that need specific opportunities should be supported. If the difference is due to teaching techniques used by teachers in those schools, some seminars can be given those teachers. Students based lessons might be good for students so that they can inquire, apply existing information, and solve problems. Also, teachers should teach lessons

in real life context and they present students in a real-life problem based on curriculum to help students develop problem-solving skills.

Furthermore, in Turkey, the above-mentioned top schools are seen as the entrance key for good universities and the good universities is seen as a first step to have a good job in the future. So, they are preferred by most successful students and for the students from the top schools are good at examinations is not surprising. That's why Technical, Vocational, and Multi-program High Schools should be made attractive for successful students. For example, high quality laboratories in terms of technology and futuristic school atmosphere can be provided. Even, the schools can ensure a job for their graduates in specific institutions and organizations.

In this study, it is also found that home educational resources are also good predictor of students' problem-solving. However, in Turkey, all students do not have a chance to have educational resource at home because of low family income. Even if they have, the resources may not be enough for their education. That's why, schools and libraries should provide the resources to students.

Implications for further research

The findings of the present study can be considered by other researchers to analyse the relationship between students' problem-solving skills and parents and home related factors, school types, and math-related factors. In this sense, gender can be also taken into consideration.

Also, SES includes other dimensions except parental education level, especially in Turkey it is known that there are huge differences among geographical regions in terms of mathematics achievement of students from different SES. So, problem-solving performance of students from different SES can be further investigated based on the data from different regions of Turkey, as well. Similarly, teacher related factors can be added to the variables predicting students' problem-solving skills.

PISA is one of the strongest assessments giving us the information about countries' education performances. It is repeated every three years and it focuses one of the domains from math, reading or science in each cycle. The data set from the upcoming mathematics domain can be used to analyse the relationship between students' problem-solving skills and other variables. So, we can see the effects of changing education policies of Turkey on students' problem-solving skills.

Limitations

Since PISA questionnaire and tests are not originally in Turkish, the translation of some items from English to Turkish can cause a comprehension problem. Especially, problem-solving questions need firstly reading comprehension, some items might be clear for some students. Other limitation is that problem-solving questions were presented on computer to students. The students who are not used to use computer can have some problems about this issue.

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