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FACTORS AFFECTING MATHEMATICS LITERACY OF STUDENTS BASED ON PISA 2012: A CROSS-CULTURAL EXAMINATION

A MASTER'S THESIS

BY

GAMZE SEZGIN

THE PROGRAM OF CURRICULUM AND INSTRUCTION

İHSAN DOĞRAMACI BILKENT UNIVERSITY

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To my grandmother

FACTORS AFFECTING MATHEMATICS LITERACY OF STUDENTS BASED ON PISA 2012: A CROSS-CULTURAL EXAMINATION

The Graduate School of Education

of

İhsan Doğramacı Bilkent University

by

Gamze Sezgin

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İHSAN DOĞRAMACI BILKENT UNIVERSITY
GRADUATE SCHOOL OF EDUCATION

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Gamze Sezgin
May 2017

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. Jennie F. Lane (Examining Committee Member)

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Approval of the Graduate School of Education

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ABSTRACT

FACTORS AFFECTING MATHEMATICS LITERACY OF STUDENTS BASED ON PISA 2012: A CROSS-CULTURAL EXAMINATION

Gamze SEZGIN

M.A., Program of Curriculum and Instruction
Supervisor: Asst. Prof. Dr. İlker KALENDER

May 2017

The main purpose of this study is to determine factors affecting mathematics literacy level of participating countries based on the framework of Programme for International Student Assessment (PISA) 2012. In this study, the dependent variable was the mathematics literacy scores whereas the independent variables were index scores of factors i.e. *mathematics self-efficacy, mathematics self-concept, teacher-student relations, index of economic, social and cultural status, mathematics teacher's classroom management, mathematics anxiety, attitude towards school: learning outcomes, attitude towards school: learning activities, sense of belonging to school,* and *mathematics interest*. The data were first analysed using multiple linear regression for three different achievement strata of countries (high-, normal- and low-achieving). Then using the standardized regression coefficients, three separate cluster analyses were conducted to group the countries within each group. At the end of the study, a general framework of the relationship between factors of index scores and mathematics literacy scores were obtained. The results of this framework showed that *mathematics self-efficacy, index of economic, social and cultural status, mathematics interest* and *mathematics anxiety* did not indicate distinguishing properties among countries' groups. In general, variable of *sense of belonging to school* had negative relationship with mathematic achievement in high-achieving countries as *teacher-students relations* indicate negative relationship with mathematics achievement in low-achieving countries' groups.

Key words: Mathematics literacy, factors associated with achievement, PISA 2012, cross countries comparison.

ÖZET

ÖĞRENCİLERİN MATEMATİK OKURYAZARLIĞINI ETKİLEYEN FAKTÖRLERİN PISA 2012 VERİLERİNE GÖRE KÜLTÜRLER ARASI İNCELENMESİ

Gamze Sezgin

Yüksek Lisans, Eğitim Programları ve Öğretim
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Mayıs 2017

Bu çalışmanın amacı 2012 PISA (Uluslararası Öğrenci Değerlendirme Programı) uygulamasına dayalı olarak, katılan ülkelerin matematik okuryazarlık seviyelerine etki eden faktörleri belirlemektir. Bu çalışmada, bağımlı değişken matematik okuryazarlığı skorlarıyken, bağımsız değişkenler *matematik öz-yeterlilik*, *matematik öz-kavram, öğretmen-öğrenci ilişkileri, ekonomik, sosyal ve kültürel statü indeksi, matmatik öğretmeninin sınıf yönetimi, matematik kaygısı, öğrenme kazanımlarındaki okula karşı tutum, öğrenme aktivitelerindeki okula karşı tutum, okula aitlik hissi* ve *matematik ilgisi*dir. Data ilk olarak ülkelerim üç farklı başarı tabakaları (yüksek-, normal- ve düşük-başarılı) için çoklu resrasyon analizi kullanılarak analiz edilmiştir.

Sonrasında standartlaştırılmış regrasyon katsayıları kullanılarak, her ülke grubunun içerdiği ülkeler için birbirinden ayrı üç küme analizi yapılmıştır. Çalışmaının bağımsız değişkenler ve matematik başarısı arasında genel bir ilişki çerçevesi elde edilmiştir. Bu çerçevenin sonucunda *matematik öz-yeterlilik, ekonomik, sosyal ve kültürel statü indeksi, matematik ilgisi* ve *matematik kaygısı* ülkeler arası gruplarda farklılık göstermemiştir. Genel olarak, yüksek başarılı ülkelerde *okula aitlik hissi* değişkeni matematik başarısı ile negatif ilişkiye sahipken, düşük başarılı ülkelerde *öğretmen-öğrenci ilişk*ileri değişkeni matematik başarısı ile negatif bir ilişki göstermiştir.

Anahtar Kelimeler: Matematik okur-yazarlık, başarı ile ilişkili faktörler, PISA 2012, ülkeler arası karşılaştırma.

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CHAPTER 1: INTRODUCTION

Introduction

The determined factors of index scores affecting student achievement have great importance in the educational sciences literature; there is a vast accumulation of knowledge regarding these factors. This study seeks to make a significant contribution the literature by examining relationship between index scores' factors and mathematics literacy scores for each high-, normal- and low-achieving countries which participated in the Programme for International Students Assessment (PISA) 2012 cycle. In this study, the factors of index scores comprise *mathematics self-efficacy, mathematics self-concept*, *teacher-student relations, index of economic, social and cultural status, mathematics teacher's classroom management, mathematics anxiety, attitude towards school: learning outcomes, attitude towards school: learning activities, sense of belonging to school,* and *mathematics interest*.

Background

Factors affecting mathematics achievement

Many factors such as mathematics anxiety, self-esteem, proactive coping and test stress are very important for secondary school students since they are directly or indirectly related to achievement (Hamid, Shahrill, Matzin, Mahalle, & Mundia, 2013). They argued that, among their analyzed factors, the most important variables are mathematics anxiety and test stress, and these two variables were found to have a negative effect on students' mathematics achievement. As other factors such as self-esteem and proactive coping have diverse effects on the students' academic achievement. Buelow and Barnhart (2015) found that mathematics anxiety, worrying about being successful, social concerns, test anxiety and physiological anxiety affected the students' mathematics achievement. Mathematics anxiety also associated with changes in attitudes towards school and mathematics (Núñez-Peña, Suárez-Pellicioni, & Bono, 2013). According to results from different studies (Buelow & Barnhart, 2015; Hamid et al., 2013; Núñez-Peña et al., 2013), a number of affective factors have relationships with the mathematics achievement; these factors include mathematics anxiety, test stress, worry about being successful, psychological anxiety, among several others.

According to data from Trends in International Mathematics and Science Study (TIMSS) 1999, PISA 2003 and PISA 2006 studies, students' mathematics achievement depends not only on affective factors such as student/family-related variables, but also on reading and problem-solving skills. An analysis of PISA results across countries conducted by Kiray, Gok and Bozkir (2015) shows that problem-solving skills and reading skills have influenced not only mathematics achievement and but also science achievement, implying that mathematics and science achievement may be related. They also examined affective factors such as mathematics interest, self-esteem, self-efficacy, mathematics anxiety and similar factors. The result of this research shows that all analyzed factors have an important effect on both mathematics and science achievement.

Moller, Mickelson, Stearns, Banerjee and Bottia (2016) reported that mathematics achievement of students are related to school culture, race, socio-economic status (SES), and teacher's pedagogical culture and their mutual relationships. They focus on these factors with help of the data from the Early Childhood Longitudinal Study.

Considering the factors mentioned above they were classified as strong community orientation, teacher calibration and community adaptation. The first one of these categories is strong community orientation; the second one is teacher collaboration and the last one is community adaptation. The first two were reported to be influential on student achievement directly; on the one hand, community adaptation only affects students' achievement as long as it was combined with community orientation and teacher collaboration. At the end of this study, the researchers arrived at the conclusion that there is a huge gap in SES factors and race among students. To reduce such a gap the organizational culture of schools need to be modified. For instance, they observed that if the teachers sense a professional community, the higher- and lower-SES black students feel less disadvantaged by their classmates.

The study by Firmender, Gavin and McCoach (2014) focused on teacher-student relationship and teachers' instructional practice. According to the result of this study, these factors have a positive effect on elementary schools of students' mathematics achievement and then there is a relationship achievement of students and specific instructional practices. In addition, verbal communication and instructional practice are very important for the mathematics achievement of students.

When studies by other researches are examined, many other factors such as attitude towards school, classroom management, gender, inequality, math self-efficacy, school climate, socio-economic status, sense of belonging, student- family and student-teacher relationship can be identified clearly (Mohamed & Waheed, 2011). According to the results of a study, students' mathematics achievement differs between student's genders. If students are not discriminated against because of genders, their mathematics achievement increase and their attitude towards mathematics change positively. Another study which was conducted by Maloney, Ramirez, Gunderson, Levine and Beilock (2015) focused on why some students cannot be successful mathematics courses. The researchers concluded that parent-student relationship influenced in the mathematics achievement positively; however, the further study showed that if the parents have math anxiety, students' mathematics achievement was affected negatively.

Comparison of achievement levels between the countries

Compared to mathematics achievement across countries, it shows that some factors are the most effective on students' mathematics achievement for a group of countries or they have the same level effect on their achievement for countries. The factors of effects on students' mathematics achievement vary according to a number of group countries. Levels of mathematics achievement countries, which are high, normal and low achieving, have occurred due to this variety. To determine the specific effective factors on mathematics achievement among these groups , the best way is to make a comparison. In addition, the comparison will be useful for seeing general framework if it contains every level achieving countries. Moreover, high-high achieving countries comparison, high-low achieving countries comparison, or low-low achieving countries comparison show the factors of differences among groups of these countries. Because of this reason, some researchers focus on just the factors of affecting students' mathematics achievement in a single country, while others focus on comparisons among some countries to see which factors have an effect on mathematics achievement from an internationally comparative perspective. For example, a study that was conducted by Ghagar, Othman, and Mohammadpour (2011) focused on the comparison of Singapore and Malaysia to determine factors affecting students' mathematics achievement. According to results of this study, there are differences between these two countries in terms of factors related to mathematics achievement. For example, Malaysian students' mathematics achievement is mainly influenced by school-level differences while Singaporean students' achievement is more affected by classroom-level differences. Both countries have several common factors related to achievement such as student level, mathematics self-concept, also school level. However, school climate has the most important influence on students' mathematics achievement for both countries.

Unlike the above-mentioned studies, others have focused on only high achieving countries. One of them made an international comparison between the three high-achieving countries of Korea, Japan and Finland using the PISA data (Shin, Lee, & Kim, 2006). The researchers focused on some factors such as school level variables, school level predictors, and examined how the level of achievement can be changed with respect to these factors. Another study focused on low-achieving countries, Botswana, Kenya, and South Africa based on the PISA data (Carnoy, Ngware, & Oketch, 2015). In this study, factors that explain differences among low-achieving countries include school resources, teacher skills and quality, and classroom conditions. At the end of this study, the researcher concluded that school resources are the most important variables for students learning in these African countries. In addition, results illustrated that there is a direct relationship between teacher skills, teacher quality and students' achievement.

On the other hand, some studies involve comparison of countries in different regions. One of these studies was conducted by Wu (2009). The researcher examined differences in student achievement Western, Asian and European region using data from PISA 2003 and TIMSS 2003. These countries showed different levels of achievement. According to the result of this study, Western countries have a good achievement in mathematics in PISA while Eastern European and Asian countries have a good achievement in mathematics in TIMSS. These results highlight two important factors, content balance in course and students' grade, influencing mathematics achievement in order to identify achievement.

Problem

As shown above, although there are many studies in the literature examining factors affecting mathematic achievement from an international perspective, these studies mostly involve a small number of countries. Thus, information that can be extracted from these studies in comparative perspective is limited. Furthermore, those studies focused a limited range of ability. For example, studies contain only high achieving countries (Shin, Lee & Kim, 2009) while some others contain only low achieving countries (Carnoy, Ngware, & Oketch, 2015). There are some other studies that contain specific regions instead of countries and it compares regions according to changing some factors (Wu, 2009). However, studies which use different criteria such as regions, SES, and language may prevent several patterns of achievement from revealing themselves. This can be overcome by including many countries in a study to examine the relationship between several factors and mathematics achievement. There may be significant information that can be obtained from a large-scale comparison study. Thus, covering a larger set of countries to investigate the relationship between selected factors and mathematics achievement may provide information of significant importance.

Purpose

The main objective of this study was to compare 68 countries participating to PISA-2012 cycle. Countries were categorized as high-, normal-, and low- achieving countries. Next, the relationship between determined factors and mathematics achievement was determined. After that, countries were clustered with respect to these relationships to reveal grouping patterns among countries. In this way, a large comparison opportunity was expected to be obtained with a broad range of socio-economic status, regional, language, etc. The high-, normal-, and low- achieving countries were the main concern of this comparative analysis in terms of selected factors such as, mathematics teacher's classroom management (the attitude of mathematics teachers), mathematics self-efficacy (limiting external support for doing math), mathematics self-concept, mathematics anxiety, mathematics interest, socio-economic status (background of the family's income and families' social status), sense of belonging to school (feeling as being a member of the school and the class), attitude towards school; learning outcomes and activities (whether student like the school or not in terms of two variables), and the student-teacher relationship. The main concern of this study was to determine factors affecting mathematics literacy levels of students from a large comparison.

Research questions

The research questions for the present study are given below:

1. What are mathematics-related factors explaining 15-year-old students' mathematics literacy levels in high-, normal- and low-achieving countries based on PISA 2012 data?

2. What are the different clusters of countries across high-, normal- and low-achieving countries based on PISA 2012 data?
3. What are the relationship in different clusters of countries across high-, normal- and low-achieving countries based on PISA 2012 data?

Significance

Findings of this study are expected to be of importance due to the range and number of countries included. Finding common patterns may be especially helpful to identify problems with low mathematics achievement. This study represents a general relationship framework among high-, average- and low- achieving countries in mathematics achievement and its effective factors. Furthermore, thanks to this study, those countries which were included in this study might benefit in accordance with their least developed variables. This study may also provide significant information for Turkey. Examination of countries in the same clusters may give clues as to mathematics-related improvement actions. Identification a common pattern for the relationship across countries may help obtain a better understanding of the mechanism affecting mathematics achievement.

Definition of key terms

Mathematics literacy is able to apply knowledge and skills in mathematics. Students may analyze reason and find a solution in a variety of situation. Mathematics literacy includes identifying solving problems and interpreting the situations (OECD, 2014).

Affective variables are such as motivation, anxiety, attitudes and sense of belonging. The meaning of 'affective' word is related to person emotions, attitudes, feelings and beliefs. In other words, it is related to feelings.

Mathematics self-efficacy is referred that student' belief themselves in mathematics (OECD, 2013b). It is an affective variable for mathematics achievement and its scale can be assessed with the help of students' perform in related mathematics task and their attitude towards mathematics.

Mathematics self-concept shows students belief about their abilities (OECD, 2013b). In addition, self-awareness and self-knowledge are comprised of mathematics self-concept. It is also an affective variable.

Attitude towards school is related to students' parents teachers peers and environment at school (OECD, 2013b).

Sense of belonging to school is a students' reflection about their peers, involving and feeling part of social group and ease at school (OECD, 2013b).

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

In this chapter, the first two subsections are related to the importance of mathematics performance and its assessment. The subsection of assessment of mathematics performance includes two assessment types: One is achievement assessment exams like TIMSS, GMAT, GRE, LYS and similar exams; the other is literacy assessment exams such as PISA and PIRLS. Then, literature related to the following variables will be reviewed in the subsection of factors associated with mathematics performance: affective, school related, and cultural. Regarding affective variables, mathematics self-efficacy and self-concept, mathematics anxiety and interest are covered. For school-related variables, classroom management, instructional resources, strategies and quality, attitude towards school and sense of belonging to school are explained in details. Lastly, cultural variables, such as socio-economic status (SES), will be provided. At the end, some international comparisons and clustering among countries which have high or low mathematics achievement will be covered. Then, according to this clustering, analyzing aforementioned variables, which can show differences in mathematic achievements from the perspective of low achievement and high achievement countries, are explained. To the best knowledge of the author, there is no large-scale international comparison between countries that have taken PISA exams in the literature.

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Importance of mathematics performance

Although mathematics is an important subject of the education of students, some students find it difficult-to-learn (Onwumere & Reid, 1993). Some researchers think that the mathematics language is as important as mathematics performance because the latter cannot be improved unless the former is used effectively (Abdul Gafoor & Sarabi, 2015; Riccomini, Smith, Hughes, & Fries, 2015). According to Abdul Gafoor and Sarabi (2015), mathematics language has a strong effect not only on the mathematics performance, but also on the other language learning processes like foreign and science languages. In other words, while mathematics performance has a direct relationship with mathematics language, it is indirectly related to other subject areas thanks to its language. Simultaneous using of mathematics performance and languages, such as mathematics and science ones, assures the success of students in their educational career/life. Studying mathematics language and its influence on the mathematics performance, Riccomini, Smith, Hughes, and Fries (2015) concluded the same output with the previous study which is the relationship between mathematics performance and mathematics language. Hence, mathematics language, teaching, and learning, is associated with both mathematics and educational performance. Overall, mathematics performance has an undeniable effect on science and technology.

Assessment of mathematics performance

Mathematics achievement

Nowadays, there are many exams to assess students' mathematics achievement. While some are being applied internationally, some others are nation-wide/locally. The international exams include Trends in Mathematics and Science Study (TIMSS), Graduate Management Admission Test (GMAT), and Graduate Record Examinations (GRE). The examples of nation-wide exams include Entrance Examination for Academic Personnel and Postgraduate Education (ALES/ Akademik Personel ve Lisansüstü Eğitim Giriş Sınavı), Higher Education Entrance Examination (YGS/ Yükseköğretime Geçiş Sınavı), and Undergraduate Placement Examination (LYS/ Lisans Yerleştirme Sınavı) are taken in Turkey.

The common characteristics of such exams are that they apply a standardized test to grade students' mathematics problem-solving skills and knowledge. In such exams, students are ordered in mathematics achievement by a score. In the case of a not-high-enough grade in an achievement exam, students should either develop their mathematical knowledge or repeat the same level.

Mathematics literacy

Unlike the achievement exams, literacy exams assess reading, writing, science, and mathematics skills. In addition, these exams are being applied internationally, some examples of which are Progress in International Reading Literacy (PIRLS) and Programme for International Students Assessment (PISA).

PIRLS exam, conducted by International Association for the Evaluation of Educational Achievement (IEA), assess the reading and writing skills in fourth grade. Starting from 2001, this exam is being offered internationally once in five years; the last exam was offered in 2011 (Mullis, Martin, Foy, & Drucker, 2012).

PISA exam assesses not only mathematics literacy, but also reading and science literacy of 15-year-old students. This exam is conducted by The Organization for Economic Co-operation and Development (OECD). Starting from 2000, PISA was applied once in every 3 years; students from Turkey did not participate in the first exam. While assessing mathematics, reading, and science literacy at the same time, it focuses on one of the areas, respectively. The most recent exam focused on mathematics literacy was in 2012. Thanks to results of PISA 2012, mathematics literacy level of each country can be obtained and effective factors, such as affective variables, school-related variables, and cultural (income) variables, on mathematics performance can be determined (OECD, 2014).

Factors associated with mathematics performance

Affective variables

Mathematics self-efficacy and self-concept

Kung (2009) conducted a research on the relationship between self-efficacy and self-concepts effect on mathematics achievement of Taiwanese high school students. He used data from the Third International Mathematics and Science Study of the International Association for the Evaluation of Educational Achievement study. He analyzed the connection between mathematics self-concept, mathematics self-efficacy and mathematics achievement by using a longitudinal study. To examine this relationship, he used some specific questionnaires like Self-Description Questionnaire II (SDQ II) for mathematics self-concept variable and mathematics self-efficacy questionnaire was used in this study. The researcher concluded that mathematics self-efficacy and self-concept have an important relationship with mathematics achievement. Furthermore, mathematics self-concept can develop thanks to skill-development model and promoting students' mathematics problem-solving skills (Kung, 2009). The result of this study shows that Taiwanese high school students have improved skill-development model and the self-enhancement model within the perspective of mathematics self-efficacy, self-concept; and the skill-enhancement has less effect than the skill-development model on mathematics self-concept and mathematics achievement, likewise mathematics self-efficacy and mathematics achievement.

Another study by Uysal (2015) analyzed factors which have an effect on mathematics achievement of Turkish students using PISA 2012 data set. These factors included mathematics interest, mathematics self-concept, mathematics anxiety, teacher-student relations, classroom management and sense of belonging to the school. At the end of the analysis, the researcher found that each factor has a negative or positive effect on mathematic achievement. The result of this study shows that self-concept and mathematics achievement have a positive weak relationship with Turkish students. Moreover, another study conducted by Yoshino (2012). In this study, he used TIMSS data set to analyze the relationship between mathematics achievement and mathematics self-concept among eight-grade students from U.S.A and Japan. Unlike Uysal's (2015) study, Yoshino (2012) did not examine many factors of mathematics achievement: she analyzed the effects of mathematics self-concept on mathematics achievement of both countries' students by comparing some selected factors like students' parents education, and the number of books in their houses. In general, the results of this study demonstrated that mathematics self-concept is positively correlated with students' mathematics achievement, their parents' education and the number of books in their houses. Also, while Japanese students had higher achievement, they did not have mathematics self-concept as high as American students.

When the mathematics self-concept is analyzed across large-scale countries, it is shown that it has positive effects on students' mathematics achievement. For example, Chiu and Klassen (2010) investigated mathematics self-concept effect on students' mathematics achievement with the help of PISA data sets and questionnaires. They applied multilevel analyses for 34 countries with the perspective of cultural differences. Even though mathematics self-concept has a positive relationship with mathematics achievement in almost all participating countries, this study indicated that the developed countries students' have a more positive relationship between mathematics self-concept and mathematics achievement than undeveloped and developing countries. The other study conducted by Lee (2009) analyzed mathematics achievement and effective factors across 41countries which participated PISA 2003. The researcher focused on some similar factors like mathematics self-concept, self-efficacy and anxiety and she constructed two dominant region groups: one of them is Asian countries such as Korea, Japan, andThailand. The other one is Western European countries like Austria, Germany, Liechtenstein, Sweden, and Switzerland. According to the result of this study, there are some differences between Asian countries and Western European countries. For instance, Asian countries have a low level of mathematics self-concept and self-efficacy while they have a high level of mathematics achievement. However, Western European Countries have a balance between high mathematics achievement and mathematics self-efficacy and self-concept factors.

Mathematics anxiety, interest and motivation

Some studies investigate the effects of mathematics anxiety on students' mathematics achievement. One of them is conducted by Buelow and Barnhart (2015) by using Gambling Task (IGT) and Balloon Analogue Risk Task (BART). The researchers applied these tasks on undergraduate students. This study includes not only mathematics anxiety, but also test anxiety, test worry, psychological anxiety and social concerns. Thanks to IGT and BART, researchers tried to find out a correlation among them. According to the result of this study, mathematics anxiety has a strong negative effect on students' mathematics achievement. In addition, their mathematics anxiety depends on their IGT and BART performance while mathematics worry does not depend on students' BART performance. Another study conducted by Wang, Lukowski, Hart, Lyons, Thompson, Kovas, Mazzocco, Plomin and Petrill (2015) analyzed the relationship between mathematics anxiety on two samples. One of them is young adolescent twins and the other one is adult college students. The purpose of this study is to examine whether there is a relationship between emotion and cognition in comprehended mathematics literacy by analyzing not only mathematics anxiety but also mathematics motivation and cognition. The result of this study indicates that students who have a high level of mathematics motivation have inverted-U correlation between mathematics anxiety and mathematics achievement while the students who have a low level of mathematics motivation have a negative relationship between mathematics anxiety and mathematics achievement.

Furthermore, mathematics achievement has associated with mathematics anxiety and mathematics motivation.

Some other studies examined the effects of mathematics anxiety on high school students' mathematics achievement by using more than two or three variables (Hamid et al., 2013; Uysal, 2015a).In this study, factors of mathematics anxiety, self-esteem, proactive coping and test stress are very important for students' mathematics achievement. The most important conclusion is that the student's mathematics achievement is affected by mathematics anxiety and test stress in a negative way. (Hamid, et al., 2013). When evaluated these factors it can be clearly seen that there is a relationship between them. Additionally, when the research analyzed the Brunei Secondary School students, it was observed that the above-mentioned conclusion about mathematics achievement occurred because of favorable understanding of mathematics language and misinterpretation of mathematics concepts. On the other hand, that research has both advantages and disadvantages because findings may not show the correct result or relationship between factors and achievement. Moreover, similar to aforementioned study findings by Hamid et al. (2013), the result of study conducted by Uysal (2015) indicates that mathematics anxiety has a negative effect on students' mathematics achievement unlike mathematics interest. The results of Uysal (2015) showed that there is a positive relationship between mathematics achievement and mathematics interest like mathematics self-concept for Turkish students.

Family-student-teacher relationship factors

Student-teacher relationship

When identified factors which have an effect on students' mathematics achievement, researchers found that student-teacher relationship has also an effect on their mathematics achievement (Adams, 2012; Bottoms & Carpenter, 2000; Hughes, 2011; Petty, Wang, & Harbaugh, 2013; Uysal, 2015). The study conducted by Uysal (2015) investigated that factors and their effects on Turkish students' mathematics achievement with the help of PISA 2012 data set and she found that student-teacher relationship, mathematics interest, mathematics self-concept, mathematics anxiety, and classroom management have an effect on students' mathematics achievement. The result of this study shows that there is no strong correlation between student-teacher relationship and Turkish students' mathematics achievement. The study conducted by Adams (2012) was related to rural teachers' behavior in northwest China. This research investigated whether teacher behaviors have an effect on elementary students' mathematics achievement or not. In this study, the researcher observed teacher-student relationship and teacher attitude in the lesson to get the results. The result of this study indicates that teacher-student factors have a strong effect on students' mathematics achievement, especially teacher attitude towards the students. In addition, teacher's attitude towards students can affect their mathematics achievement in three years. Therefore, researcher's interpretation was teacher's attitude towards students and their relationship with students have a significant role in students' achievement.

Unlike affective factors, student-teacher relationship, student behavior, and school type do not show any limitations on mathematics achievement (Bottoms &

Carpenter, 2000). Based on the previous opinion, the study conducted by Petty, Wang and Harbaugh (2013) analyzed factors of the student-teacher relationship, student behavior, and school type. They concluded that these factors have a stronger effect on college students than other factors. They also investigate socio-economic status (SES), family educational level and gender differences. According to the result of this study, SES, family educational level, gender differences, students' behavior, and schools' type have no strong effect on college students' mathematics achievement. However, teacher- student relations has an important effect on their mathematics achievement.

Student-family relationship

Some studies show that student-family relationship has an effect on students' mathematics achievement (Chiu & Xihua, 2008; Goforth, Noltemeyer, Patton, Bush, & Bergen, 2014; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Nonoyama-Tarumi, Hughes, & Willms, 2015). The study conducted by Chiu and Xihua (2008) is a large-scale comparison between 41 countries from PISA 2012 to examine the effects of student-family relationship on students' mathematics achievement. The result of this study revealed that if students in developed countries live only with their father, mother and siblings (especially older ones) or if their family (excluding grandparents) is in a good socio-economic status, their mathematics achievement level is higher. That is, students who live in developed countries have a higher level of family cultural communication than other countries so they have higher mathematics achievement. The researchers, in addition, explained the mentioned effective factors in five different categories of fewer family members, students' mathematics interest, living single parents, the relationship between mathematics achievement and family’s facilities, and having common family characteristics. All the detailed ways have an effect on mathematics achievement in richer countries. In other words, family-students relations and their variables have a strong positive correlation with achievement in richer countries On the other hand, Maloney, Ramirez, Gunderson, Levine and Beilock (2015) investigate whether there is an effect of parents’ mathematics anxiety on their children mathematics anxiety and achievement or not. The result of their study showed that if the family members have mathematics anxiety, their children would have more mathematics anxiety; this badly affects their mathematics achievement. The finding of these study shows that family-students relationship, not only is related to parents background, culture or socio-economic status, but also to parents mathematics anxiety.

Another study conducted by Nonoyam-Tarumi, Hughes and Willms (2015) examines the association between family background and students’ mathematics achievement with the help of TIMM 2011 data set. This study includes effects of a number of school school resources on mathematics achievement by making a connection with the gross domestic product (GDP). According to the result of this study, family background is very significant for students’ mathematics achievement in developed, developing or underdeveloped countries, while school facilities do not have that much strong effect on mathematics achievement because the amount of school facilities depend on income and GDP. Unlike the previous study, the study conducted by Gofort, Noltemeyer, Patton, Bush and Bergen (2014) analyzed the effects of students-family factors on only Ohio students’ mathematics achievement. The result of this study demonstrates that students’ self-assurance in mathematics has a stronger effect than family background. In other words, the family background does not have a direct effect on students' mathematics achievement. Moreover, the analysis of this study shows that there is a strong correlation between student-family relationship and students' mathematics achievement.

School related variables

Classroom management

Some studies show that classroom management has an effect on students' mathematics achievement (Akyüz & Berberoğlu, 2010; Kim, 2015; Uysal, 2015). As one of them investigated this factor's effect with the help of TIMSS-R data set for Turkey and European Union (EU) students (Akyüz & Berberoğlu, 2010), another research studied its effects with the help of PISA 2012 data set to find effects of this factor on Turkish students' achievement (Uysal, 2015). The result of the study by Akyüz and Berberoğlu (2010) indicated that classroom management depends on class climate and size. These influenced teacher's classroom management as a limiting factor. If conditions like class size and climate are good for students and teacher, students' from Turkey and the European Union achievement will increase. In other words, there is a direct relationship between classroom management and students' mathematics achievement. Unlike Akyüz and Berberoğlu (2010), the result of Uysal (2015) study finds out classroom management does not have any effects on Turkish students' mathematics achievement.

Another study conducted by Kim (2015) includes only American high school students who come from a different culture to analyze parents and classroom management effects on students' mathematics achievement. According to the results of this study, classroom management has a strong effect on students' mathematics achievement coming from different cultures.

Instructional resources, strategies and quality

Some studies showed that instructional strategies, instructional quality (teacher quality), and resources can affect students' mathematics achievement. Take Akyüz and Berberoğlu (2010) for instance, the researchers mention the effect of some instructor factors such as mathematics conceptions and instructional practice on mathematics achievement; besides, they investigate the effects of class size and classroom climate on mathematics achievement. In this study, they use TIMSS-R 13-year-old data from 10 countries as the sample. According to this study, they found that those variables, except home educational resources, were not effective on mathematics achievement in all countries. However, class size and climate, limitation to teaching, and re-teaching did not show any effect on student's mathematics achievement in participant countries. Specifically, gender of teacher was the most important factor for mathematics achievement as teachers' qualification or graduate level had no importance as much as their gender for all samples. Moreover, teachers' teaching style or course practices had no significant effect on mathematics achievement.

On the other hand, the study conducted by Firmender, Gavin and McCoach (2014) demonstrated that there is an important relationship between instructional practice and mathematics achievement. Different from Akyüz and Berberoğlu (2010), the researchers investigated these relations for kindergarten curriculum in grade 1 and 2 while using open-response questions. Apart from instructional practice, they found that verbal communication in mathematics and geometry lesson is quite important for mathematics achievement (Firmender, Gavin, & McCoach, 2014).

Besides, another study analyzed family background and school related factors in four grade students and their relations with mathematics achievement (Nonoyama-Tarumi et al., 2015). The researchers analyzed the data from TIMSS 2011 with help of GDP information. The results of this analysis demonstrated that family background factors had a stronger effect on mathematics achievement than school resources factors in low and high socio-economics status countries. The one of the studies conducted by Montt (2011), the researcher used PISA data within more than 50 school systems and models to analyze the effects of educational and instructional inequality, and school systems. Similar to above-mentioned studies, this study demonstrated same results.

Attitude towards school and sense of belonging to school

As mentioned above, school related factors such as classroom management and instructional quality, attitude towards to school and sense of belonging to school have an importance effect on mathematics achievement. one analysis tried to identify the effective variables for students' attitudes on the high-school student (Musheer & Gupta, 2016). The researcher also analyzed school climate factors by comparing students' gender and their family education background. Finding showed that gender can affect attitude towards school. Furthermore, family education background has an important effect on students' attitude towards school. In the results of this study, a number of variables were considered to identify factors that can effect students' attitudes, namely students' family, teacher and friend relations. In addition, the results indicated that there is a relationship between students' achievement and their attitudes. On the other hand, another study focused on the relationship between the factor of attitude towards school and students' achievement (Verešová & Malá, 2016). The result of study had the same results with Musheer and Gupta (2016).

Furthermore, Demir (2016) examined students' science achievement in Turkey by using data from PISA 2012 result. according to the results of this study, there are some significant factors affect the students' academic achievement including socio-economic status, teachers' view on students, and attitude towards school. In particular, there is a weak positive relationship between attitude towards school variables (learning activities and outcomes) and students' academic achievement compared to other factors. Factor of attitude towards school and sense of belonging to school has a weak relationship with students' mathematics achievement. Considering the factor of sense of belonging to school, Cohen and Garcia (2008) investigated its effect on students' academic achievement. For identity engagement, a model is presented to describe how psychological threat and belonging concerns can be triggered by a salient social identity. In another study, the effect of sense of belonging to school on students' mathematics achievement is also (Uysal, 2015). The result of this study revealed that the factor of sense of belonging to school has an important effect on Turkish students' mathematics achievement according to PISA 2012 data. Walton and Cohen (2007a) indicated the same result with Uysal (2015).

Cultural variables

Socio-economic status (SES)

According to the researchers, socio-economic status has an undeniable effect on students' mathematics achievement. In a study conducted by Chiu (2010) a sample was chosen from 15-year-old students of 41 countries and the researcher mainly analyzed socio-economic status (SES). In addition to SES, the researcher also investigated family and school related factors on mathematics achievement. The result of this study showed that SES has a relation with students' mathematics achievement, since SES can support the family and school resources. Correspondingly, physical resources in a country illustrated the same effect on mathematics achievement. In general, the researcher concluded that countries with a high level of SES, have higher mathematics score than those with a low level of SES. Similarly, Sastry and Pebley (2010) investigated the effect of SES on students' reading and mathematics achievement. Researchers compared socio-economic status of families and its neighbor by collecting data from families in Los Angeles and its vicinity. Thanks to this study, they described inequality in SES and education. The results showed that, contrary to the previous study, there is no inequality between students' achievement and families' SES if other variables hold as a constant in Los Angeles families. However, families in a near region had an important relationship between students' achievement and their income. Unlike Sastry and Pebley (2010), K. Demir and Kalender (2014) used SES factors as a constant variable in order to identify the effect of other variables on students' achievement. The researchers analyzed important factors of student-teacher relations, attitude towards school, and sense of belonging within low socio-economic status. The results of the study illustrated that students can be successful even though they are in a low socio-economic status. This result implied that there might be an inverse relationship between students' achievement and socio-economic status.

Some studies analyzed the effect of SES on mathematics achievement in elementary school age group (Cueto, Guerrero, Leon, Zapata, & Freire, 2014; Moller, Mickelson, Stearns, Banerjee, & Bottia, 2013). For instance, a study conducted by Moller, Mickeson, Stearns, Banerjee, and Bottia (2013) focused on the pedagogical teacher culture and their role in the school, and socio-economic status, as well as race and ethnicity with the help of Early Childhood Longitudinal Study data. In terms of the SES results, they found that mathematics achievement has a direct relationship with race and family socio-economic status; that is, students' achievement can reduce, provided that there is a big gap in socioeconomic status. Moreover, they implied the effect of teachers, such as their collaboration, on students' mathematic achievement in a positive way. In another study conducted by Cueto, Guerrero, Leon, Zapata and Freire (2014) the focus was on the relationship between mathematics achievement and the factor of SES in the Peru fourth grade students. Firstly, the researchers started to examine relations with 1-year-old children, then they examined same children after ten years. They used 1-year-old children to see their facilities for learning. Their multivariate analysis showed that SES is a quite important factor to have learning facilities in 1-year-old group. Furthermore, results implied that the factor of SES was associated with students' mathematics achievement up to the age of ten. Lastly, Alacaci and Erbas (2010) studied factor of school characteristics and its relationship with mathematics achievement in Turkey by using the result of PISA 2006. The result of this study implied importance effect of socio-economic status on students' academic achievement. In terms of relationship in socio-economic status, the findings of this study demonstrated that students have socio-economic status groups in their school according to their family SES and their school characteristic. It means that school characteristic and SES are related factors between each other. In addition, results indicated background of their SES associated with mathematic achievement directly.

International comparisons

Many studies compared countries according to their mathematics achievement level to identify which countries students' affect which factors. Generally, these studies analyzed mathematics achievement factors among high, low or high and low achieving countries. The first study conducted by Shin, Lee and Kim (2006). The researchers compared countries of Korea, Japan, and Finland by using data from PISA 2003. These three high achievement countries dealt in terms of students related factors, teacher factors and school related factors. At the end of this comparison, these three countries showed differences among each other. For example, school differences have an important effect on mathematics achievement in Japan and Korea, while Finland does not have an effect of school differences as much as other. Besides, teacher-student relations has no effect on students' mathematic achievement in Korea and Japan, in contrast, Finland has a negative relationship with it (Shin, Lee, & Kim, 2006). For example, for high-low achieving countries comparison, Shin, Lee and Kim (2009) focused on countries of Japan, Korea and the USA. They chose the USA as a low achievement country. In another example of high-low achieving countries comparison, Akyüz (2014) examined Turkey, Singapore, the USA and Finland in terms of school and student related factors by using TIMSS 2011 data in eight grade students. Finding of this study illustrated that all countries were affected by mathematics self-confidence, educational resources in their home and students' socioeconomic in their school according to the TIMSS 2011 data. In another similar study which is conducted by Ker (2013) was used the same year data from TIMSS. The researcher compared mathematic achievement in Chinese Taipei, Singapore, and the USA to see international benchmarks in mathematics. He found that all countries demonstrated differences in mathematics achievement among each other. For example, Chinese Taipei students showed top achievement in the study while achievement of Singapore remained stable. However, the USA had low performance in mathematics.

Moreover, Ghagar, Othman, and Mohammadpour (2011) examined mathematics achievement level and its effective factors in Malaysian and Singaporean students by using data from TIMSS (2003) in eight grade students. The researcher used taking TIMSS students from those countries. At the end of this study, researcher obtained that achievement of Malaysia students are depending on differences in schools' level, and classroom related factors such as level of class are influenced on students' mathematics achievement, similar to Singapore students. Moreover, both countries have a strong relationship with mathematics self-concept and school climate factors. Furthermore, some studies included comparing mathematics achievement with some effective factors between the USA and the Far East countries of Hong-Kong and Japan (Liu, 2009; Yoshino, 2012). As a first one, Liu (2009) examined the effect of gender difference in affective factors on students' mathematics achievement with the help of PISA 2003 data of the USA and Hong Kong. The result of this comparing showed that both countries were influenced by mathematics self-efficacy factor in positive ways. In addition, the USA students showed low achievement in high self-concept factors positively while they had inverse relations between mathematics achievement and mathematics interest. The last results of the study mentioned that the effect of memorizing on students success is more evident in Asian countries than the USA. However, Yoshino (2012) compared American students with Japanese students in mathematics self-concept factor by using data from TIMSS 2007. In this research, he used the students' family education background and students' home resources to compare mathematics self-concept. At the end of the analysis, both countries showed positive relations with mathematics self-concept in mathematics achievement although American students had higher mathematics self-concept than Japanese students. Those results implied cultural differences between them.

Cross-cultural speaking, some researchers analyzed a variety of countries to identify their effective factors on students mathematics achievement (Chiu & Klassen, 2010; Lee, 2009; Williams, 2005; Grisay, De Jong, Gebhardt, Berezner, & Halleux-Monseur, 2007; Wu, 2009; Skirbekk, Bordone, & Weber, 2014). To start with, the factor of mathematics self-concept was analyzed in cross-cultural comparing with 34 countries which are particıpated OECD for PISA (Chiu & Klassen, 2010). At the end of the result of this study, researchers obtained that chosen factor had a significant effect on students' mathematics achievement in all countries and results implied that mathematics self-concept is more effective providing the low socioeconomic family. Secondly, the one study which is conducted by Lee (2009) handled comparing 41 PISA 2003 countries in terms of mathematics self-efficacy, mathematic self-concept and mathematics anxiety. The result of this study indicated that those countries had differences among each other. To illustrate, mathematics self-concept and mathematics self-efficacy had a weak relationship with mathematics achievement in Asian countries such as Thailand, Korea and Japan, while those countries were affected by mathematics anxiety strongly. On contrary, mathematics self-concept and mathematics self-efficacy had a strong effect on mathematics achievement in Western countries such as Austria, Germany, Liechtenstein, Sweden, and Switzerland. Also, they had weak relationship with mathematics anxiety. Furthermore, comparison of PISA 2003 and TIMSS 2003 in eight grade students was done for 22 participated countries in terms of mathematics and science level (Wu, 2009). Generally, findings implied that Eastern European and Asian countries were not successful in PISA as much as Western countries while they were good at in TIMSS. Last cross-cultural comparing was done by William (2005). The esearcher analyzed 24 countries by using PISA 2000 data in terms of their rural mathematics achievement variations. As a result, he concluded a general overview for each country and their rural mathematics achievement variation like only 14 countries has lower achievement in rural mathematics. Particularly, he focused on the result only the U.S.A, Belgium and United Kingdom and Japan. In generally, rural region of U. K and Belgium showed high achievement in mathematics, unlike U.S.A. Besides, the results showed that mathematics achievement and the population had a strong relationship in Australia. For Japan, students' achievement did not depend on the size of population. The achievement level of Japan followed firstly medium size population, which is between urban and rural areas, then urban areas, and rural areas. On the other hand, in terms of the effect of SES on rural mathematics achievement, he found a positive relationship between mathematics achievement and rural areas in Sweden, Germany, and New Zealand. These results implied that there is a relationship between student's mathematics achievement and their living place's size.

General view of aforementioned literatures, they show that there are a number of effective factors in mathematics performance. They can differ among countries, students' age, gender and culture. In addition, international comparisons imply that countries have common related factors to mathematics performance among each other. Considered mathematics-related factors, the most effective factors on mathematics achievement is observed in this literature. On the other hand, examining the comparisons, they covered same level of achievement some countries, low and high level of achievement countries or comparing some region countries. They did not show any international framework about related factors and their relationship with mathematics achievement. Therefore, this study will analyze mathematics-related factors to explain achievement level of countries as an international framework. In addition,the study will show the distinct patters in each level of achievement countries and effective factors in these distinct patterns.

CHAPTER 3: METHOD

This chapter identifies the methodology of the study, including research design, context, sample/participants, instrumentation, data collection, and data analysis.

Research design

This is a correlational research based on a quantitative data set. Correlation research design is used to find the relationship between two or more variables based on a non-experimental approach. The basic form of the correlation research examines possibility of relationship between two variables; however, the advance level of correlation research investigates the relationship among more than two variables as an independent and dependent variables (Simon & Goes, 2011).

Causal-comparative research, which is based on quantitative data, was also used in this research. It is used to determine cause and effect among already exists categorical independent and dependent groups. The major difference between causal-comparative research and correlation research method is that the former helps to compare results in terms of cause and effect among two or more groups while the latter helps to analyze the existence of causation which has more possible than other variables (Gay & Airasian, 2012). Unlike an experimental study, the researcher can determine differences among groups and compare dependent and independent variables performance to find the effects of differences in causal-comparative research (Fraenkel & Wallen, 2009).

Context

PISA is an international benchmarking study administered by OECD. It includes not only OECD member countries, but also OECD non-members countries. The PISA 2012 was arranged in 68 countries including 34 OECD member countries and 34 OECD non-member countries.

PISA measures three literacy of mathematics, reading, and science among countries' 15-year-old students. According to OECD (2013), the process of mathematics literacy measurements were related to three content. They are "Formulating situations mathematically, Employing mathematical concepts, facts, procedures and reasoning, and Interpreting, applying and evaluating mathematical outcomes". To assess students' mathematics literacy, PISA builds PISA-D which means that PISA for Development. It assess mathematics literacy of middle-income countries. In addition, PISA-D extends in three ways in order to measure mathematics literacy's score of middle- and low- income countries. These three ways are proficiencies, processes and skills (OECD, 2016).

According to result of PISA-D, the high number of participating countries represents a diverse spectrum of socio-economic status, backgrounds, cultures, and languages. PISA defined an index to indicate this diversity called the index of Economic, Social and Cultural Status (ESCS). This index is constructed using three indices of highest occupational status of parents (HISEI), highest educational level of parents (PARED) (OECD, 2013b). The histogram of ESCS across participating PISA 2012 countries is given in Figure 1. When the range of ESCS index is considered, it can be seen how the countries are diverse.

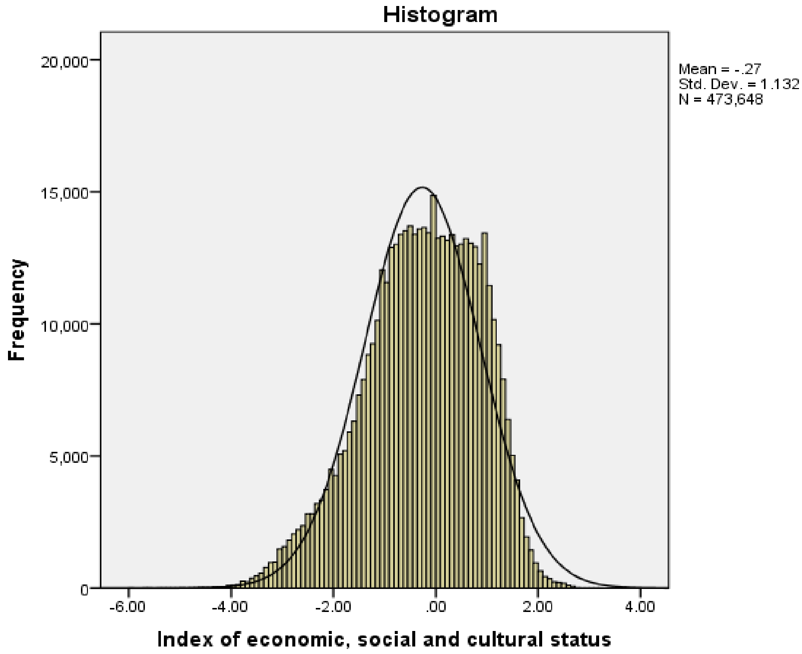

Figure 1. Histogram of participating PISA 2012 countries in ESCS

Sampling

PISA participants include students who are between 15 years 3 months and 16 years 2 months. The average age of participants was 15 years and 8 months across countries. To participate PISA, students should be registered in full-time or part-time education. The reason for targeting the students of that age is that they have reached the level of understanding reading literacy, mathematics literacy and science literacy. In addition, those students do not have linguistic problems at that age (OECD, 2014a). The number of PISA 2012 participants were 485,490, representing about 28 million 15-year-olds in the schools of the 68 participating countries and economies. The participating countries are given Table 1.

Table 1
Participating countries in PISA 2012

OECD member countries participating in PISA 2012	OECD non-member countries participating in PISA 2012
Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States of Amerika.	Albania, Argentina, Brazil, Bulgaria, Colombia, Connecticut (USA), Costa Rica, Croatia, Florida (USA), Hong Kong-China, Indonesia, Jordan, Kazakhstan, Latvia, Liechtenstein, Lithuania, Macao-China, Malaysia, Massachusetts (USA), Montenegro, Perm(Russian Federation), Peru, Qatar, Romania, Russian Federation, Serbia, Shanghai-China, Singapore, Chinese Taipei, Thailand, Tunisia, United Arab Emirates, Uruguay, Viet Nam.

Note: Adapted from http://www.oecd.org/pisa/aboutpisa/pisa-2012-participants.htm. Copyright 2012 by OECD. Reprinted with permission.

The PISA participants were selected by a two-stage stratified sampling. Firstly, individual schools where 15-year-old students were enrolled in were selected (OECD, 2014a; OECD, 2014c). The selection of the schools was made systematically in the consideration of the probabilities proportional to size to include the estimated number of students. The stage sampling units in countries using *the two-stage design* were students within sampled schools. Once schools were selected to be in the sample, a complete list of each sampled school’s 15-year-old students was prepared. For each country a typical *Target Cluster Size (TCS)* of 35 students was set although countries could use alternative values upon agreement. From each list of students that contained more than *TCS*, a sample of typically 35 students was selected with equal probability and for lists containing fewer students than *TCS*, all students on the list were selected. Although larger samples were required in national analyses, minimum of 150 schools were selected in each country. After the schools were selected, replacement schools were identified simultaneously (OECD, 2014c).

In this study, all participating countries are included except Albania because it did not answer index of economic social status questions. In Table 2, countries and the number of participating students are given.

Table 2
The number of countries' participating

OEDC Countries	Sample Size	Partner Countries	Sample Size
Australia	14481	Albania	4743
Austria	4755	Argentina	5908
Belgium	8597	Brazil	19204
Canada	21544	Bulgaria	5282
Chile	6856	Colombia	9073
Czech Republic	5327	Costa Rica	4602
Denmark	7481	Croatia	5008
Estonia	4779	Hong Kong-China	4670
Finland	8829	Indonesia	5622
France	4613	Jordan	7038
Germany	5001	Kazakhstan	5808
Greece	5125	Latvia	4306
Hungary	4810	Liechtenstein	293
Iceland	3508	Lithuania	4618
Ireland	5016	Macao-China	5335
Israel	5055	Malaysia	5197
Italy	31073	Montenegro	4744
Japan	6351	Peru	6035
Korea	5033	Qatar	10966
Luxemburg	5258	Romania	5074
Mexico	33806	Russian Federation	6992
Netherlands	4460	Serbia	4684
New Zealand	4291	Shanghai-China	5177
Norway	4686	Singapore	5546
Poland	4607	Chinese Taipei	6046
Portugal	5722	Thailand	6606
Slovak Republic	4678	Tunisia	4407
Slovenia	5911	United Arab Emirates	11500
Spain	25313	Uruguay	5315
Sweden	4736	Viet Nam	4959
Switzerland	11229		
Turkey	4848		
United Kingdom	12659		
United States	10294		

Note: Adapted from https://www.oecd.org/pisa/pisaproducts/PISA12_stu_codebook.pdf. Copyright 2015 by OECD. Reprinted with permission

The number of countries listed in Tables 1 and 2 are different from each other. The reason is that the data of Connecticut (USA), Florida (USA), Massachusetts (USA) in Table 1 are combined together and reported as United States in Table 2. The same thing applies for Perm (Russian Federation) and Russian Federation in Table 1 which are reported as Russian Federation in Table 2.

Instrumentation

PISA is administered every three years, focusing one of the subject areas of reading, science or mathematics. The main purpose of PISA is to assess 15-year-old students' performance with perspective of mathematics literacy, science literacy and reading literacy (OECD, 2014).

To assess the students' performance, PISA mainly uses two types of instruments. One is PISA literacy tests of reading, mathematics, and science. They are used to assess students' performance and how students can use their knowledge and skills to solve various kinds of numerical and spatial challenges and problems they might encounter during their daily life (OECD, 2013; OECD 2014b; OECD, 2014c).

The other group of instruments is questionnaires that are used to collect information from the students on various aspects of their home, family and school background, and to collect information from the schools about their various aspects of organizational and educational provisions (OECD, 2014a). The questionnaires included open-ended questions, multiple choice questions, short answer questions, and Likert scale questions. Some of the Likert scale contained a scale from 1 to 4 while some others had a scale from 1 to 5. In Likert scale questions, 1 represents negative opinion or disagreeing idea and 5 shows positive opinions like strong agreement.

Method of data collection

International network of leading institutions and experts took place in the design of PISA 2012. The PISA 2012 assessments were in printed and electronic form. All participants, 15-year-old students, completed both types of assessment. The students were asked to answer the questions in the consideration of the written passages and diagrams. Its aim was to find out whether the students could think actively or not (OECD, 2014c).

To complete these tests, each student has same amount of time. The tests included there parts: first part, which must have been completed in 30 minutes is related with students' background, family structures, approaching the school and courses like mathematics, science or literature. Following these questionnaires, a 40-minute part consists of mathematics, problem solving and reading questions which are based on computer. For the last part, which is the longest one, participants had 390 minute. In this part, there are test items that constituted from text or graphic related real life questions. These items assess students' mathematics, reading and science literacy. The important point is that each student takes different combination of test items (OECD, 2013;OECD, 2013b; OECD 2014c).

PISA 2012 data set provides index scores for some variables. This index values are calculated based on students' responses to a group of items under the same factor (OECD, 2013). Higher index scores are stronger indication of the factor. In this study, indices for *mathematics self-efficacy* (MATHEFF), *mathematics self-concept*

(SCMAT), *teacher-student relations* (STUDREL), *index of economic, social and cultural status* (ESCS), *mathematics teacher's classroom management* (CLSMAN), *mathematics anxiety* (ANXMAT*), attitude towards school: learning outcomes* (ATSCHL*), attitude towards school: learning activities* (ATTLNACT), *sense of belonging to school* (BELONG), *and mathematics interest* (INTMAT) are used.

Method of data analysis

First, countries were classified into one of the three groups of high, normal and low achieving. Figure 1.2.13 which is from PISA 2012 technical report programme for international student assessment volume I was used for this classifying (OECD, 2014c, p7).

Performance of the high-achieving countries are statistically significant above the OECD average, the average-achieving group includes countries not statistically different from them OECD average and the low-achieving countries is statistically significantly below the OECD average. The countries in each group's was given in Table 3.

Table 3
Countries in each achievement group

High Achieving Countries	Normal Achieving Countries	Low Achieving Countries
Shanghai-China	Czech Republic	Luxembourg
Singapore	France	Italy
Hong Kong-China	United Kingdom	Spain
Chinese Taipei	Iceland	Russian Federation
Korea	Latvia	Slovak Republic
Macao-China	Norway	United States
Japan	Portugal	Lithuania
Liechtenstein		Sweden
Switzerland		Hungary
Netherlands		Croatia
Estonia		Israel
Finland		Greece
Canada		Serbia
Poland		Turkey
Belgium		Romania
Germany		Cyprus[1]
Viet Nam		Bulgaria
Austria		United Arab Emirates
Australia		Kazakhstan
Ireland		Thailand
Slovenia		Chile
Denmark		Malaysia
New Zealand		Mexico
		Montenegro
		Uruguay
		Costa Rica
		Albania
		Brazil
		Artgentina
		Tunisia
		Jordan
		Colombia
		Qatar
		Indonesia
		Peru

Note: Adapted from https://www.oecd.org/pisa/46643496.pdf Copyright 2014c by OECD. Reprinted with permission.

[1] In this document, 'Cyprus' refers to The Republic of Cyprus which is recognized by all members of the United Nations except Turkey. Its data relates to the area governed by the Government of the Republic of Cyprus (OECD, 2014, p7).

This correlation research design is used to mathematics achievement as a dependent variable and effecting factors on mathematics achievement as independent variables in order to determine the relationship between them with respect to countries achievement level such as high, average and low achievement. The main purpose of this correlation study is to identify the relationship between mathematics achievement and effective factors in terms of countries' achievement level (Simon & Goes, 2011).

First of all, the mean plausible values in mathematics and were analyzed by using descriptive statistic and frequencies for each high- , normal-, low- achieving countries groups, respectively. The results of analysis were given in Figure 2, 3 and 4. Then, frequencies of descriptive statistics analysis was applied for each independent variables to obtain their mean, median, mode, standard deviation, minimum and maximum values. These results were given in Table 4.

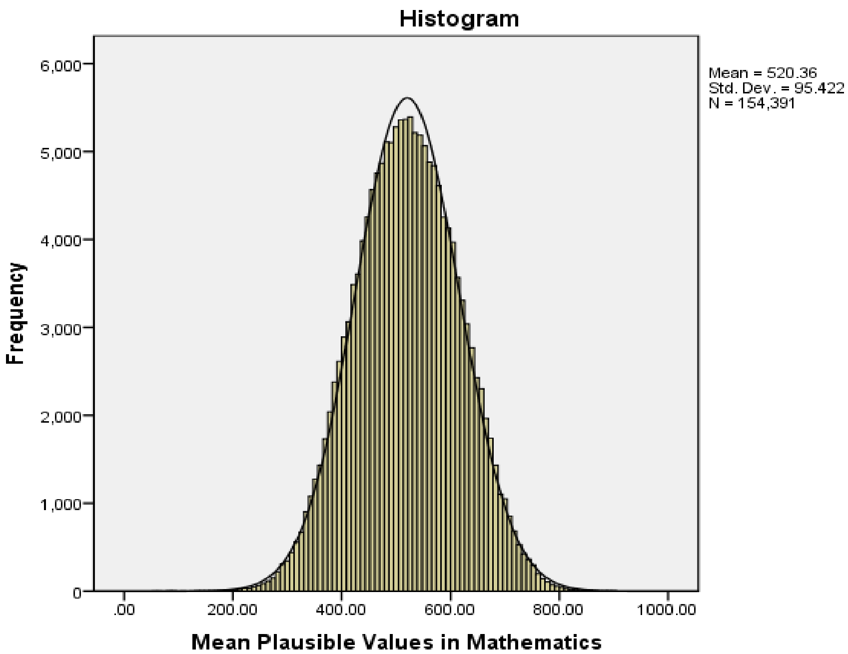

Figure 2. Mathematics achievement histogram for high-achieving countries

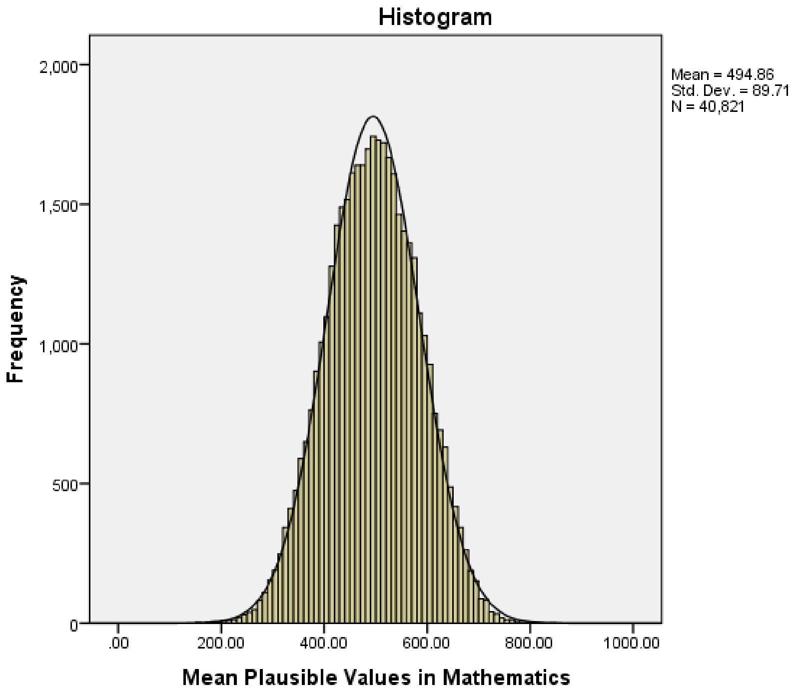

Figure 3. Mathematics achievement histogram for normal-achieving countries

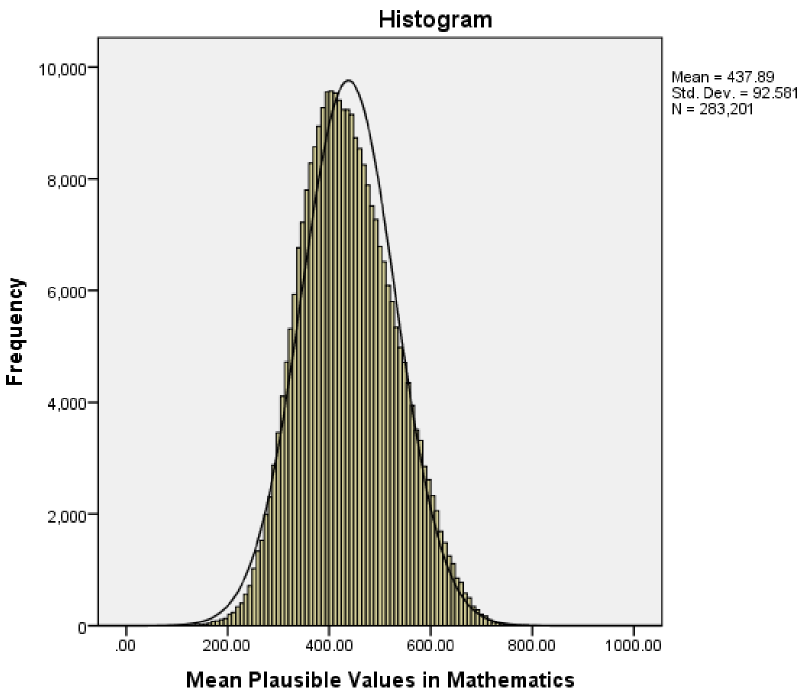

Figure 4. Mathematics achievement histogram for high-achieving countries

Table 4
Descriptive statistics for independent variables

Independent Variables	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
Mathematics Anxiety	0.15	0.06	0.06	0.96	-2.37	2.55
Attitude towards School: Learning Outcomes	0.05	-0.24	-0.24	1.00	-2.99	2.35
Attitude towards School: Learning Activities	0.04	0.09	1.21	1.00	-3.38	1.21
Sense of Belonging to School	-0.02	-0.15	-0.37	0.98	-3.69	2.63
Mathematics Teacher's Classroom Management	0.08	-0.08	-0.08	0.99	-3.25	2.20
Index of economic, social and cultural status	-0.27	-0.19	-0.42	1.13	-5.95	3.69
Mathematics Interest	0.21	0.30	-0.34	1.00	-1.78	2.29
Mathematics Self-Concept	0.04	-0.06	0.41	0.96	-2.18	2.26
Teacher Student Relations	0.12	-0.02	-0.02	1.03	-3.11	2.16
Mathematics Self-Efficacy	-0.05	-0.18	-0.18	0.97	-3.75	2.27

Then, data were analyzed in terms of multiple linear regression assumptions: normality of residuals linearity, homoscedasticity, multicollinearity.

Multiple linear regression analyses were conducted for each high-, normal- and low-achieving countries, separately according to each dependent variable which was mathematics literacy plausible variables (PV1MATH, PV2MATH, PV3MATH, PV4MATH, PV5MATH), while independent variables were mathematics-related index values which were calculated using the scores given the items in the student questionnaire: *mathematics self-efficacy* (MATHEFF), *mathematics self-concept* (SCMAT), *teacher-student relations* (STUDREL), *index of economic, social and cultural* (ESCS), *mathematics teacher classroom management* (CLSMAN), *mathematics anxiety* (ANXMAT), *attitude towards school: learning outcomes*

(ATSCHL), *attitude towards school: learning activities* (ATTLNACT), *sense of belonging to school* (BELONG), and *mathematics interest* (INTMAT).

OECD (2013b) defines "*Scale indices* are the variables constructed through the scaling of multiple items. Unless otherwise indicated, the index was scaled using a weighted likelihood estimate (WLE) (Warm, 1989), using a one-parameter item response model (a partial credit model was used in the case of items with more than two categories)". The main reason of choosing these independent variables is that all of them were related with mathematics achievement according to literature review. The input value of Probability of F was 0.05 while the output was 0.10, for all tests. Significance criteria were set to 0.05 for all test in the regression analyses.

After multiple regression analyses for each mathematics literacy plausible variables, standardized regression coefficients tables were constructed in high-, normal-, low-achieving countries for each regression analysis provided that significant value of β smaller than 0.05. Each achieving group countries had five standardized regression coefficients tables for PV1MATH, PV2MATH, PV3MATH, PV4MATH and PV5MATH, respectively. Then, the mean of each five table were calculated to obtain one mean of standardized regression coefficients table for high-, normal- and low-achieving countries.

In next step, standardized (β) regression coefficients of high-, normal, and low-achieving countries were grouped with the help of cluster analysis to see whether there are distinct patterns among high-, average- and low-achieving countries or not. This cluster analysis was completed as fallows steps:

- Analyze of hierarchical cluster analysis was determined for cluster analysis.
- The independent variables were chosen as variables and the dependent variable was chosen as label.
- The method of Word's Method was chosen with the measure of interval: Squared Euclidean distance.
- Dendrogram was also chosen from plots segment.

CHAPTER 4: RESULTS

Introduction

In this chapter, results of the analyses were presented: the research questions of the present study were as follows:

1. What are mathematics-related factors explaining 15-year-old students' mathematics literacy levels in high-, normal- and low-achieving countries based on PISA 2012 data?
2. What are the different clusters of countries across high-, normal- and low-achieving countries based on PISA 2012 data?
3. What are the relationship in different clusters of countries across high-, normal- and low-achieving countries based on PISA 2012 data?

Results are presented in order of ability grouping of the countries, as described in Chapter 4 starting with the high achieving countries and ending with low achieving countries. First, results regarding multiple linear regressions were presented. Then grouping based on the cluster analyses were given.

Regression analyses were conducted for each PV1MATH, PV2MATH, PV3MATH, PV4MATH and PV5MATH as dependent variable. In these regression analyses, *mathematics self-efficacy* (MATHEFF), *mathematics self-concept* (SCMAT), *teacher-student relations* (STUDREL), *index of economic, social and cultural status* (ESCS), *mathematics teacher's classroom mana*gement (CLSMAN), *mathematics anxiety* (ANXMAT), *attitude towards school: learning outcomes* (ATSCHL), *attitude towards school: learning activities* (ATTLNACT), *sense of belonging to school* (BELONG), *and mathematics interest (*INTMAT) as independent variables.

Clusters were formed using standardized regression coefficient to respond fourth research question. Lastly, based on standardized coefficient beta values, graphs were created for each cluster, using the SPSS software.

Factors related to mathematics achievement

Regression analysis for high-achieving countries

Results of the regression analyses for each plausible values in mathematics with respect to high-achieving countries were given in appendices. For all countries, ANOVA results indicated that models were significant at the 0.05 level.

Table 5
Averaged regression analysis results in high-achieving countries

Country	R	R^2	Adjusted R^2
Australia	0.66	0.44	0.44
Austria	0.62	0.38	0.38
Belgium	0.59	0.35	0.35
Canada	0.64	0.41	0.41
Switzerland	0.63	0.40	0.39
Germany	0.63	0.40	0.40
Denmark	0.67	0.44	0.44
Estonia	0.63	0.39	0.39
Finland	0.65	0.43	0.43
Hong Kong-China	0.59	0.34	0.34
Ireland	0.64	0.41	0.40
Japan	0.59	0.35	0.35
Korea	0.66	0.43	0.43
Liechtenstein	0.69	0.48	0.42
Macao-China	0.56	0.31	0.31
Netherlands	0.53	0.28	0.28
New Zealand	0.69	0.47	0.47
Poland	0.75	0.56	0.55
Shanghai-China	0.63	0.39	0.39
Singapore	0.64	0.42	0.41
Slovenia	0.57	0.33	0.32
Chinese Taipei	0.71	0.50	0.50
Viet Nam	0.60	0.36	0.36

In this table, mean of adjusted R^2 was 0.40 and the values of adjusted R^2 varied between 0.28 and 0.55. The highest value of adjusted R^2 belonged to Poland, indicating that mathematics-related factors explain almost half of students' mathematics literacy in this country, whereas the smallest value of adjusted R^2 was seen in Netherlands, where significant value was determined as 0.05.

Average standardized regression coefficients (β) were given in Table 5 for each high-achieving country separately. If β was not statistically significant, this coefficient was not included in this table. Higher means for variables, and beta coefficients, indicate higher positive scores or agreement levels.

Table 6
Averaged standardized regression coefficients for high achieving countries

Countries	Factors									
	Mathematics self-efficacy	Mathematics self-concept	Teacher- student relations	Index of economic, social and cultural status	Mathematics teacher's Classroom management	Mathematics anxiety	Attitude towards school (Learning outcomes)	Attitude towards school (Learning activities)	Sense of Belonging to School	Mathematics interest
Australia	0.41	0.19	0.04	0.23	0.06	-0.11	0.06	-	-0.10	-0.17
Austria	0.36	0.16	-0.11	0.23	-	-0.19	-	-	-	-0.11
Belgium	0.33	-	-	0.34	0.04	-0.15	0.01	-0.06	-0.02	-
Canada	0.37	0.25	0.01	0.19	0.03	-0.14	0.04	-	-0.12	-0.14
Switzerland	0.46	0.10	-	0.22	-	-0.17	0.03	-	-0.01	-0.14
Germany	0.37	0.06	-	0.28	0.02	-0.19	-0.05	0.02	-0.05	-0.10
Denmark	0.25	0.26	0.09	0.27	-	-0.18	-0.01	-	-0.12	-0.15
Estonia	0.33	0.18	-	0.21	0.04	-0.25	0.02	-	-0.07	-0.15
Finland	0.23	0.39	-0.01	0.21	-0.04	-0.16	0.08	-	-0.13	-0.16
Hong Kong-China	0.43	-	-0.05	0.17	0.00	-0.15	-	0.07	-0.04	-
Ireland	0.38	0.14	0.05	0.25	0.03	-0.16	-	0.01	-0.11	-0.13
Japan	0.47	-	-	0.16	0.05	-	-0.02	-	-0.06	0.14
Korea	0.48	0.14	-	0.09	0.03	0.01	-0.07	0.06	-	0.03
Liechtenstein*	0.52	0.42	-	-	0.04	-	-	-	-	-0.32
Macao-China	0.44	-	-	0.09	0.05	-0.23	0.07	-0.06	-0.14	-
Netherlands	0.42	-0.05	-	0.25	0.01	-0.13	0.08	-	-0.08	-0.01
New Zealand	0.38	0.21	-	0.26	0.05	-0.14	0.11	-0.03	-0.13	-0.20
Poland	0.38	0.25	-0.02	0.20	-	-0.20	-0.09	0.03	-0.06	-0.13
Shanghai-China	0.44	0.13	0.07	0.20	0.07	-0.08	-0.05	-0.07	-0.10	-0.08
Singapore	0.43	-	-	0.19	0.06	-0.24	0.10	-0.12	-0.11	-0.15
Slovenia	0.31	0.19	-0.07	0.27	-	-0.16	-	-	-	-0.09
Chinese Taipei	0.50	0.18	-	0.23	-	-0.02	-	0.01	-0.13	-
Viet Nam	0.40	0.07	-0.15	0.24	-0.02	-0.15	-	-	-	-

* In this analysis, Liechtenstein did not indicate relationship between a number of variables and mathematics achievement. Therefore, it did not consider in Cluster Analysis.

Mathematics literacy factors of β values showed that relationships between dependent variable and independent variables differed significantly across high achieving countries. The sign of β values describe relationship between mathematics literacy and mathematics-related factors. Plus (+) refers to positive relationship while minus (-) refers to negative relationship.

Analysing relationship between mathematics achievement and factors of index scores in high achieving countries, *mathematics self-efficacy* has the most statistically significant relationship in mathematics achievement positively. There is a statistically significant positive relationship among mathematics achievement and *mathematics self-concept, index of social, economic and cultural status, mathematics teacher's classroom management*. However, countries of Belgium, Hong Kong-China, Japan, Macao-China and Singapore have showed no relationship between mathematics achievement and *mathematics self-concept*. In addition, there is statistically significant relationship between mathematics achievement and *index of social, economic and cultural status* in Liechtenstein. The factor of *mathematics teacher's classroom management* is positive associated with mathematics achievement except Finland and Viet Nam, while it has no relationship with Austria, Switzerland, Denmark, Hong Kong-China, Poland, Slovenia and Chinese Taipei in mathematics achievement.

Considering the negative relationships, there is a strong relationship among mathematics achievement and *mathematics anxiety, sense of belonging to school, mathematics interest*. The factor of *sense of belonging to school* illustrates negative relationship with high-achieving countries except Austria, Korea, Liechtenstein, Slovenia and Viet Nam. On contrary many high-achieving countries, Korea shows that mathematics achievement is related to *mathematics anxiety* positively. Besides, mathematics achievement of Korea and Japan have association with *mathematics interest.*

The mathematics-related factors of *teacher-student relations*, *attitude towards school: learning outcomes, and attitude towards school: learning activities* showed positive relationship with some high-achieving countries in mathematics achievement while they had negative relationship in some high-achieving countries. The value of these three factors had weak relationship with mathematics achievement. The weakest relationship with mathematics achievement belonged to *teacher-students relations* in high-achieving countries.

Regression analysis for normal-achieving countries

Results of the regression analyses for each plausible values in mathematics with respect to normal-achieving countries were given in appendices. For all countries, ANOVA results indicated that models were significant at the 0.05 level.

Table 7
Averaged regression analysis results in average-achieving countries

Country	R	R^2	Adjusted R^2
Czech Republic	0.67	0.45	0.44
France	0.68	0.46	0.46
United Kingdom	0.64	0.41	0.41
Iceland	0.63	0.39	0.39
Latvia	0.66	0.44	0.43
Norway	0.70	0.49	0.48
Portugal	0.69	0.48	0.48

In this table, mean of adjusted R^2 was 0.44 and the values of adjusted R^2 varied between 0.39 and 0.48. The highest value of adjusted R^2 belonged to Norway and Portugal, indicating that math-related factors explain almost half of students' mathematics literacy in this country. On the contrary, whereas the smallest value of adjusted R^2 was seen in Iceland. In this regression, significant value was determined as 0.05.

The average value of β coefficient were constructed in Table 6 for each normal-achieving country separately. In this table, some β values which are not statistically significant were not included. Higher means for beta coefficient and variables demonstrate higher positive scores levels. The plus (+) signs of factors show positive relationship and minus (-) signs of factors show negative relationship in mathematics.

Table 8
Averaged standardized regression coefficients for average achieving countries

Countries	Factors									
	Mathematics self-efficacy	Mathematics self-concept	Teacher- student relations	Index of economic, social and cultural	Mathematics teacher's Classroom management	Mathematics anxiety	Attitude towards school (Learning outcomes)	Attitude towards school (Learning activities)	Sense of Belonging to School	Mathematics interest
Czech Republic	0.35	0.18	-0.06	0.27	0.06	-0.14	0.06	-0.09	-0.05	-0.07
France	0.36	0.26	-	0.31	-0.02	-0.09	0.06	-	-	-0.15
United Kingdom	0.42	0.13	0.03	0.22	-	-0.15	0.05	0.05	-0.16	-0.10
Iceland	0.27	0.30	-	0.12	-	-0.13	0.10	0.12	-0.11	-0.11
Latvia	0.30	0.25	-0.02	0.25	-	-0.17	0.15	-0.07	-0.15	-0.13
Norway	0.32	0.34	-	0.14	0.01	-0.14	-	0.01	-0.10	-0.09
Portugal	0.46	0.18	-0.06	0.21	-	-0.12	0.07	-	-0.07	-0.14

In this table, mathematics literacy factors of β values showed that relationships between mathematics literacy and mathematics-related factors differed significant across average achieving countries.

According the Table 6, *mathematics self-efficacy, mathematics self-concept, index of economic, social and cultural status, attitude towards school: learning outcomes* have positive relationship with mathematics achievement in normal-achieving countries. It means that mathematics achievement is apparently associated with mathematics-related these factors. Unlike all normal-achieving countries, only Norway does not illustrate any relationship between mathematic achievement and *attitude towards school: learning outcome*.

On the other hand, *teacher student relationship* except United Kingdom, *mathematics anxiety, sense of belonging to school* and *mathematics interest* are related to mathematics achievement negatively.

Unlike other normal-achieving countries, a positive relationship is observed between mathematics achievement and *mathematics teacher's classroom management* in Czech Republic and Norway. In addition, there is weak relationship between *teacher-student relations* and mathematics achievement. However, France, Iceland and Norway demonstrate no relationship between *teacher-student relations* and mathematics achievement. Also, the factor of *attitude towards school: learning activities* has negative effect on mathematics achievement in Latvia and Czech Republic while it shows positive relationship with mathematics achievement in United Kingdom, Iceland and Norway.

Regression analysis for low-achieving countries

Results of the regression analyses for each plausible values in mathematics with respect to low-achieving countries were given in appendices. For all countries, ANOVA results indicated that models were significant at the 0.05 level.

Table 9
Averaged regression analysis results in low-achieving countries

Country	R	R^2	Adjusted R^2
United Arab Emirates	0.56	0.32	0.31
Argentina	0.59	0.35	0.35
Bulgaria	0.63	0.40	0.39
Brazil	0.58	0.34	0.33
Chile	0.68	0.46	0.46
Colombia	0.57	0.32	0.32
Costa Rica	0.55	0.30	0.30
Spain	0.59	0.35	0.35
Greece	0.60	0.36	0.36
Croatia	0.64	0.40	0.40
Hungary	0.70	0.49	0.48
Indonesia	0.42	0.18	0.17
Israel	0.62	0.38	0.38
Italy	0.58	0.33	0.33
Jordan	0.52	0.27	0.27
Kazakhstan	0.45	0.21	0.20
Lithuania	0.66	0.44	0.44
Luxembourg	0.61	0.37	0.36
Mexico	0.56	0.32	0.32
Montenegro	0.53	0.28	0.27
Malaysia	0.51	0.26	0.26
Peru	0.57	0.33	0.32
Qatar	0.52	0.27	0.27
Romania	0.57	0.33	0.32
Russian Federation	0.60	0.36	0.35
Serbia	0.56	0.32	0.31
Slovak Republic	0.68	0.46	0.46
Sweden	0.64	0.41	0.41
Thailand	0.55	0.31	0.30
Tunisia	0.50	0.25	0.25
Turkey	0.58	0.34	0.33
Uruguay	0.64	0.41	0.41
United States of America	0.66	0.44	0.44

In Table 8, mean of adjusted R^2 was 0.34 while the range of adjusted R^2 differed 0.17 and 0.48. Compared to all low achieving countries, Indonesia had the most lowest value of adjusted R^2 while Hungary had the biggest value of adjusted R^2. This table was obtained under 0.05 significant value condition.

Table 7 was constructed for each low achieving countries separately by using the average value of standardized β. In this table, some β values which are not statistically significant were not included. Higher means for beta coefficient and variables demonstrate higher positive scores levels. In Table 7, positive relationships are shown with plus (+) signs and the negative relationships are shown with minus (-) signs.

Table 10

Averaged standardized regression coefficients for low achieving Countries

Countries	Factors									
	Mathematics self-efficacy	Mathematics self-concept	Teacher- student relations	Index of economic, social and cultural status	Mathematics teacher Clasroom management	Mathematics anxiety	Attitude towards school (Learning outcomes)	Attitude towards school (Learning activites)	Sense of Belonging to School	Mathematics interest
United Arab Emirates	0.28	0.07	-0.06	0.21	-	-0.33	0.09	-	-	-0.24
Argentina	0.20	0.14	-0.13	0.33	-	-0.23	0.14	-	-	-0.16
Bulgaria	0.23	0.13	-0.20	0.31	0.09	-0.26	0.10	-	-	-0.21
Brazil	0.22	0.17	-0.03	0.28	-0.04	-0.26	0.13	0.06	-0.08	-0.30
Chile	0.18	0.26	-0.06	0.45	-	-0.16	0.05	-	-0.01	-0.13
Colombia	0.12	0.28	-0.09	0.33	-0.02	-0.18	0.12	-0.05	-	-0.25
Costa Rica	0.13	0.25	-0.13	0.33	-	-0.19	0.08	-	-	-0.24
Spain	0.33	0.18	-0.06	0.25	-0.03	-0.14	0.07	0.05	-0.08	-0.07
Greece	0.32	0.12	-	0.23	0.02	-0.20	-	-0.06	-0.02	-0.03
Croatia	0.45	0.10	-0.10	0.18	0.03	-0.19	-	-0.05	-0.08	-0.10
Hungary	0.38	0.10	-0.11	0.31	0.03	-0.17	0.08	-	-	-0.06
Indonesia	0.24	-0.20	-	0.25	0.01	-0.15	0.10	-0.09	-	-0.10
Israel	0.40	0.15	-0.01	0.27	0.10	-0.10	-	-0.04	-0.14	-0.28
Italy	0.39	0.14	-0.11	0.19	0.03	-0.14	0.06	-0.02	-0.05	-0.08
Jordan	0.15	0.28	-0.11	0.20	0.05	-0.27	0.06	0.09	-	-0.14
Kazakhstan	0.23	0.12	-0.10	0.19	0.07	-0.11	0.17	0.03	-0.14	-0.16
Lithuania	0.32	0.26	-0.06	0.24	0.02	-0.20	0.02	-	-	-0.21
Luxembourg	0.35	-	-0.05	0.27	0.06	-0.21	-	-	-	-
Mexico	0.21	0.23	-0.12	0.22	-0.03	-0.22	0.16	0.06	-0.07	-0.22
Montenegro	0.25	0.12	-0.10	0.24	-	-0.25	0.12	-	-0.15	-0.18
Malaysia	0.31	-	-0.10	0.30	-	-0.15	0.06	-	-	0.03
Peru	0.17	0.22	-0.05	0.36	-0.11	-0.15	0.08	0.02	-	-0.31
Qatar	0.29	-	-	0.17	0.05	-0.31	0.18	0.06	-0.04	-0.15
Romania	0.27	0.01	-0.10	0.32	0.01	-0.24	0.03	-0.03	-0.02	-
Russian Federation	0.32	0.12	-	0.19	0.01	-0.28	-	-	-0.13	-0.09
Serbia	0.32	0.22	-0.15	0.17	-	-0.16	-	-	-0.05	-0.19
Slovak Republic	0.35	0.10	-0.06	0.34	-	-0.23	-	-	0.00	-0.11
Sweden	0.25	0.32	-	0.19	-0.02	-0.19	0.01	-	-0.13	-0.12
Thailand	0.23	-	-0.11	0.37	-	-0.20	0.14	-0.02	-	-0.05
Tunisia	0.19	0.20	-0.17	0.26	-0.06	-0.13	-	0.11	0.07	-0.17
Turkey	0.40	-	-	0.26	0.15	-0.19	-	-0.06	-0.08	-0.15
Uruguay	0.22	0.26	-0.09	0.36	-	-0.18	-	-	-0	-0.26
United States of America	0.39	0.18	-	0.22	0.08	-0.19	0.01	-0.06	-0.12	-0.22

Table 7 included β values of mathematics literacy factors. These values demonstrated relationship between related factors and mathematics achievement showing a change important across low achieving countries.

Compared the level of positive relationships between mathematics achievement and mathematics-related factors, there is a statistically significant relationship between mathematics achievement *and index of economic, social and cultural status*. In addition, *mathematics self-efficacy* shows strong relationship with mathematics achievement in all-achieving countries. In other words, *index of economic, social and cultural status* and *mathematics self-efficacy* associate with mathematics achievement directly. Other positive relationships are observed among mathematics achievement and *mathematics self-concept, mathematics teacher's classroom management* and *attitude towards school: learning outcomes*. Unlike others, Tunisia demonstrates positive relationship between *sense of belonging to school* and mathematics achievement.

On the other hand, the most negative mathematics-related factor is *mathematics anxiety* in low-achieving countries. Except Luxemburg and Malaysia, *mathematics interest* has significant relationship with mathematics achievement negatively. Since, *mathematics interest* shows a positive relationship with mathematics achievement in Malaysia while it has no relationship with mathematics achievement in Luxemburg. In addition, mathematics teacher's classroom management is related to mathematics achievement negatively in Brazil, Colombia, Spain, Mexico, Peru, Sweden and Tunisia.

Distinct patterns for related factors across high-, normal- and low-achieving countries

High-achieving countries

Standardized coefficients from the linear regression analyses were used in cluster analysis based on hierarchical clustering method. Result of this analysis is given in the dendrogram shown in Figure 5.

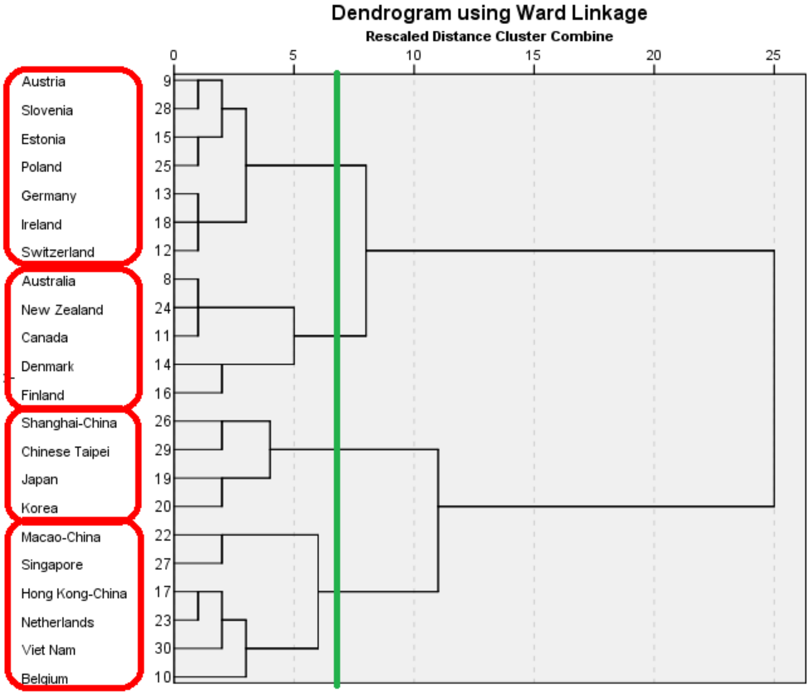

Figure 5. Dendrogram for high-achieving countries

According to the dendrogram, the green line bound was chosen between point 5 and point 10 of the rescaled distance. This bound was determined at a closer to 10 rather than 5 in order to balance number of clusters and number of countries within each cluster. Red rectangles were drawn to show four clusters in these ability strata. In the first group of cluster includes Austria, Slovenia, Estonia, Poland, Germany, Ireland and Switzerland while second group has Australia, Nez Zealand, Canada, Denmark and Finland. In the third group contained four Far East countries: Shanghai-China, Chinese Taipei, Japan, and Korea. The last group in this figure had Macao-China, Singapore, Hong Kong-China, Netherlands, Viet Nam and Belgium.

Normal-achieving countries

Standardized coefficients from linear regression analysis were used in cluster analysis based on hierarchical clustering method. Result of this analysis is given in the dendrogram shown in Figure 6.

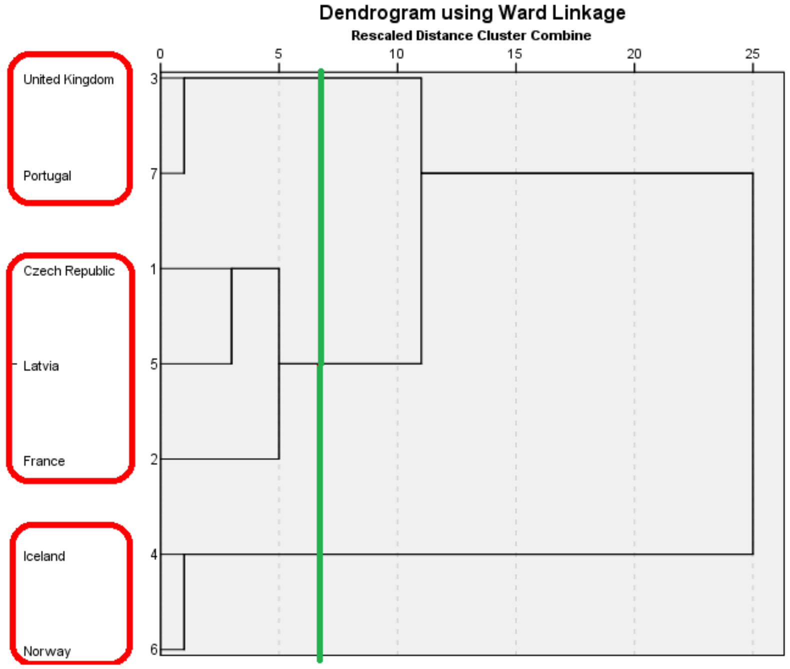

Figure 6. Dendrogram for normal- achieving countries

According to the dendrogram for normal-achieving countries, the green lines was chosen between 5 point and 10 point rescaled distance. This rescaled distance was determined to get more number of and a variety of cluster. Red rectangles were used to show clusters including average achieving countries. In the first group of cluster has just two countries of United Kingdom and Portugal and second cluster contains three countries of Czech Republic, France and Latvia. In the third group of cluster covers Iceland and Norway.

Low-achieving countries

Hierarchical clustering method were used in cluster analysis by using regression data. Result of this analysis gave dendrogram. This dendrogram result was shown below in Figure 7.

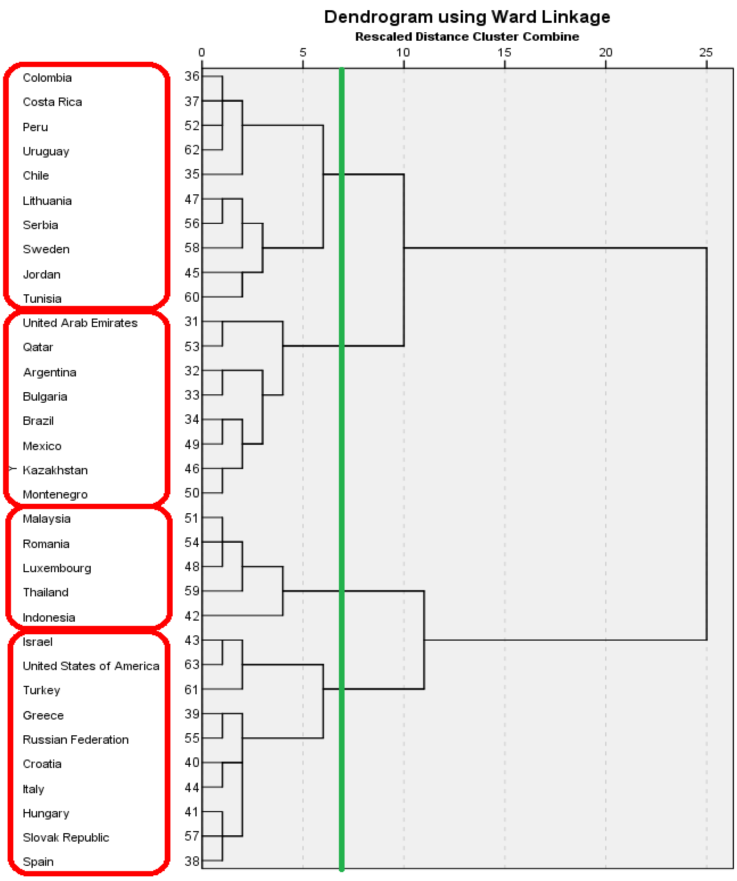

Figure 7. Dendrogram for low-achieving countries

Examining the dendrogram, the green line bound which is between 5 point and 10 point represented analysis rescaled distance. The more number of cluster and a variety of cluster were determined with the help of this bound.

In figure 14, red rectangles demonstrated four clusters containing low achieving countries. In the first group includes Colombia, Costa Rica, Peru, Uruguay, Chile, Lithuania, Serbia, Sweden, Jordan and Tunisia and second one contains United Arab Emirates, Qatar, Argentina, Bulgaria, Brazil, Mexico, Kazakhstan and Montenegro. In the third cluster covered three Southeast Asian countries (Malaysia, Thailand and Indonesia) and Romania while fourth cluster had a variety of countries from different area like Israel, United States of America, Turkey, Croatia, Italy, Hungary, Slovak Republic, Spain, Greece, Luxemburg and Russian Federation.

Graphs of standardized regression coefficient based on each distinct patterns

High-achieving distinct patterns graphs

Figures 8 to 11 show the standardized regression coefficients of each math-related variable of high-achieving countries (Figure 8, 9, 10, and 11 for clusters 1, 2, 3, and 4 respectively).

Figures showed, in general, that high achieving countries cluster have positive relationship among mathematics achievement and factors of *mathematics self-efficacy, mathematics self-concept, and index of economic social and cultural status*. Analyzing figures in terms of negative relations, all clusters except third cluster countries mathematics achievement has influenced noticeably by *mathematics anxiety* factor. Mathematics self-efficacy factor had more effect on first, second, and third clusters compared to the fourth one and mathematics self-concept influenced the third cluster much more contrary to mathematics self-efficacy. In third cluster groups of countries, a weaker relationship is observed between mathematics achievement and *index of economic, social and cultural status*. Generally, the *sense* *of belonging to school* has a weak negative effect on all clusters. *Mathematics interest* factors negatively influences especially first cluster's countries. Lastly, *attitude towards school (learning activities)* have a weaker negative relationship with mathematics achievement in first and second clusters than other clusters.

In Figure 8, *mathematics self-efficacy* is the one strongest positive relationship with mathematics achievement among other related factors. In addition, *index of economic, social and cultural status* and *mathematics self-concept* has observable relationship with mathematics achievement in this high achievement cluster group. The mathematics achievement of Estonia, Germany and Ireland associate with factors of *mathematics teacher's classroom management positively*. However, this related factor relationship with mathematics achievement is weaker than other related factors.

On the other hand, factors of *mathematics anxiety* and *mathematics interest* have the strongest negative relationship with mathematics achievement in first high achievement cluster group. Except other countries, mathematics achievement of Slovenia and Austria demonstrate a negative relationship with *teacher-student relations.* In addition, Estonia, Germany, Ireland and Poland have a negative relationship between mathematics achievement and *sense of belonging to school.*

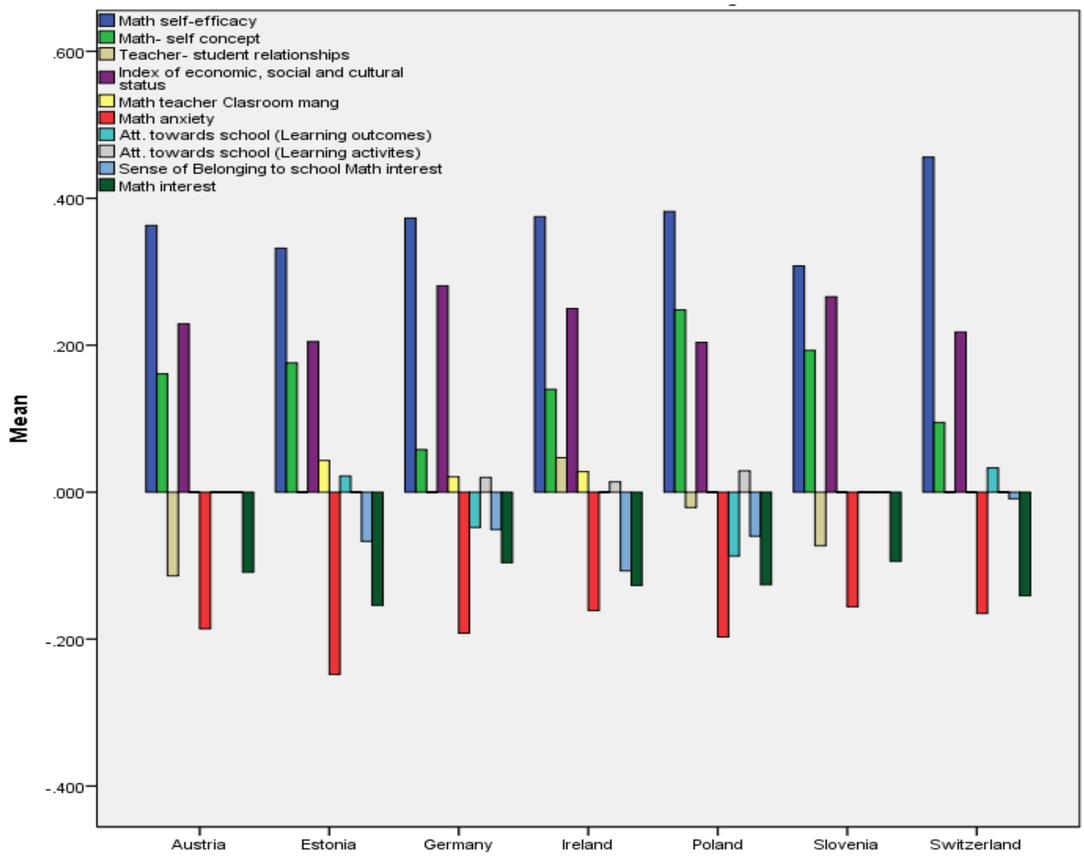

Figure 8. High-achieving countries - Cluster 1

Compared to other cluster groups, *mathematics self-concept* shows a significant positive relationship with mathematics achievement as much as *mathematics self-efficacy* in Figure 9. In addition, Figure 9 demonstrates that in*dex of economic, social and cultural status* has noticeable positive relationships with mathematics achievement. Unlike Denmark, *attitude towards school (learning outcomes)* is related to mathematics achievement positively in second cluster group countries.

In negative relationships, a significant negative relationship is observed among mathematics achievement and *mathematics anxiety, mathematics interest, sense of belonging to school.* Only Finland shows a negative relationship with *mathematics teacher's classroom management* and there is a weak negative relationship between mathematics achievement and *attitude towards school (learning outcomes*) in Denmark.

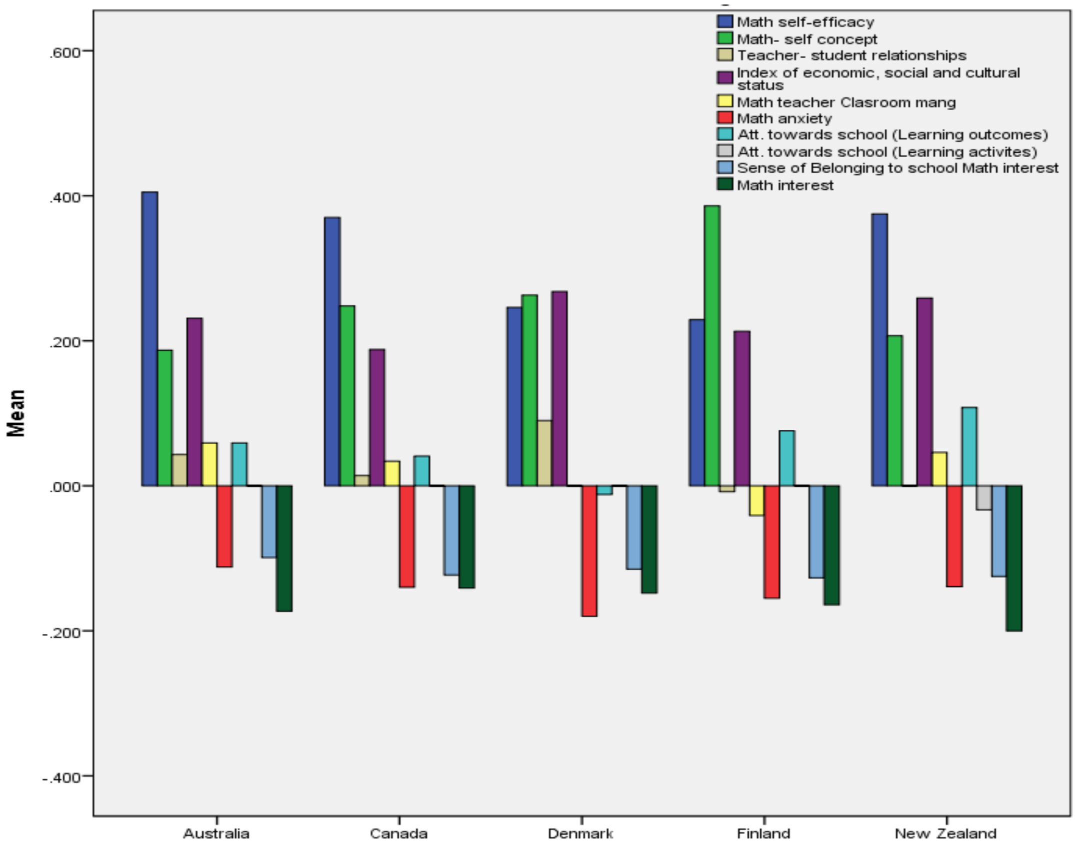

Figure 9. High-achieving countries - Cluster 2

When analyzing Figure 10, *mathematics self-efficacy* factor shows an appreciable positive relationship with mathematics achievement of all third cluster group countries. In addition, *index of economic, social and cultural status* relates to mathematics achievement. A positive relationship is observed between *mathematics self-concept* and mathematics achievement in Chinese Taipei, Korea, and Shanghai-China. Except Chinese Taipei, other countries' mathematics achievement associate with factor of *mathematics teacher's classroom management*.

However, *sense of belonging to school* demonstrates negative relationship with mathematics achievement except Korea. In addition, *attitude towards school: learning outcomes* has negative relationship with mathematics achievement in with Korea, Japan and Shanghai-China. A negative relationship is observed between mathematics achievement and *mathematics interest* in Shanghai-China.

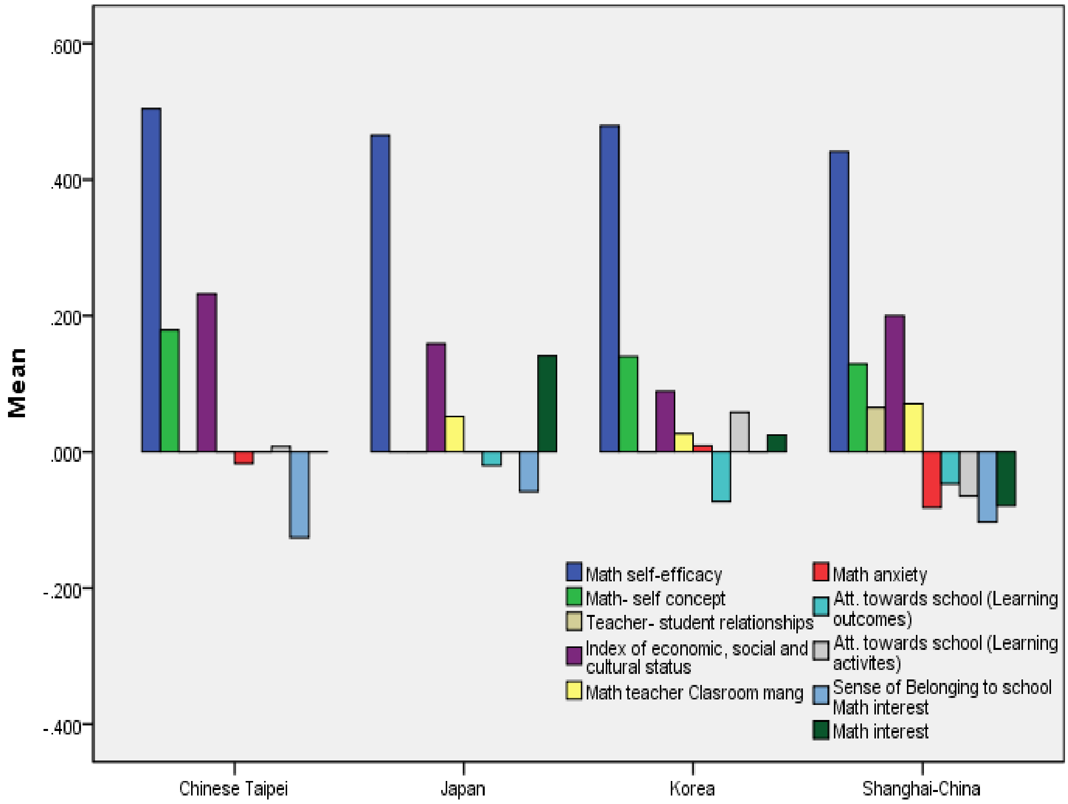

Figure 10. High-achieving countries - Cluster 3

In last figure, the most important positive relationship are shown between *mathematics self-efficacy* and mathematics achievement in all fourth cluster countries. The *index of economic, social and cultural status* has positive relationship with mathematics achievement. Belgium, Macao-China and Singapore indicate observable positive relationships between *mathematics teacher's classroom management* and mathematics achievement. Besides, mathematics achievement of

Macao-China, Netherlands and Singapore related to *attitude towards school: earning outcomes* positively. The factor of *mathematics self-concept* associates with mathematics achievement in Viet Nam directly while it shows inverse relationship with mathematics achievement in Netherlands. Four countries of Hong Kong-China, Macao-China, Netherlands and Singapore indicate positive relationship between *attitude towards school: learning outcomes* and mathematics achievement.

Unlike positive relationships, *mathematics anxiety* has an observable inverse relationship with mathematics achievement of all this cluster countries. In addition, *sense of belonging to school* has negative relationship with mathematics achievement in Belgium, Hong Kong-China, Macao-China, Netherlands and Singapore. In this cluster, only mathematics achievement of Singapore relates to *mathematic interest* negatively. The factor of *teacher-student relations* shows inverse relationship with mathematics achievement in Hong Kong-China and Viet Nam. Lastly, a negative relationship is noticed between *mathematics teacher's classroom management* and mathematics achievement in Viet Nam.

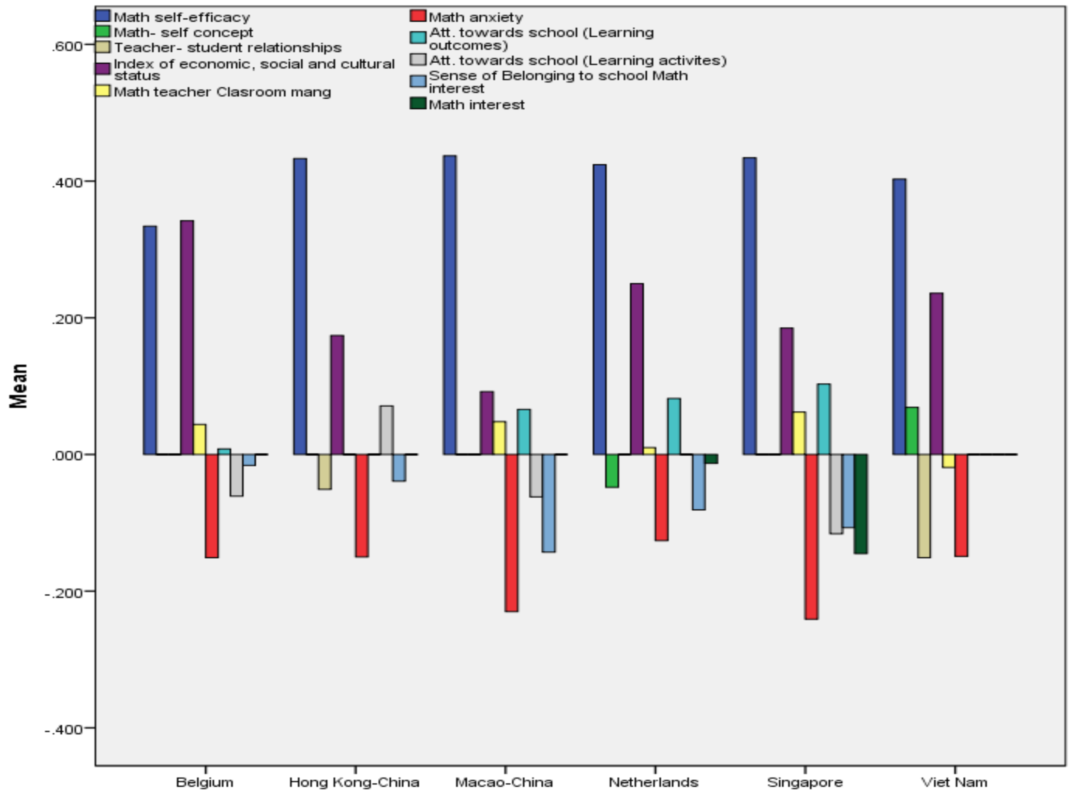

Figure 11.High-achieving countries - Cluster 4

Normal-achieving distinct patterns graphs

Figures 12 to 14 demonstrate the standardized regression coefficients of each math-related variable of normal-achieving countries (Figures 12, 13, and 14 for clusters 1, 2, and 3, respectively.).

For all cluster groups' graphs, the common point is that *mathematics self-efficacy* shows a significant positive relationship with mathematics achievement in all clusters in average achieving countries. In particular, *mathematics self-concept* associates with mathematics achievement positively in Figure 13 and 14, while it has a weaker relationship with mathematics achievement in cluster1. In all normal-achieving figures, *attitude towards school: learning outcome* indicate a weak relationship with mathematics achievement.

Moreover, the strongest negative relations are noticed among mathematics achievement and *mathematics anxiety, mathematics interest, sense of belonging to school* in all normal-achieving countries' figures. In Figure 13, *attitude towards school: learning activities* shows negative relationship with mathematics achievement while it has positive relationship with mathematics achievement in Figure 12 and 14.

In Figure 12, a positive relationship is observed between *mathematics self-efficacy* and mathematics achievement in Portugal and United Kingdom. Also, *index of economic, social and cultural status, mathematics self-concept* and *attitude towards school: learning outcome* are related to mathematic achievements in a positive way. Different from Portugal, United Kingdom has a positive relationship between *teacher-student relations* and mathematics achievement. On the other hand, a negative relationship among mathematics achievement and *sense of belonging to school, mathematics anxiety, mathematics interest* for both countries.

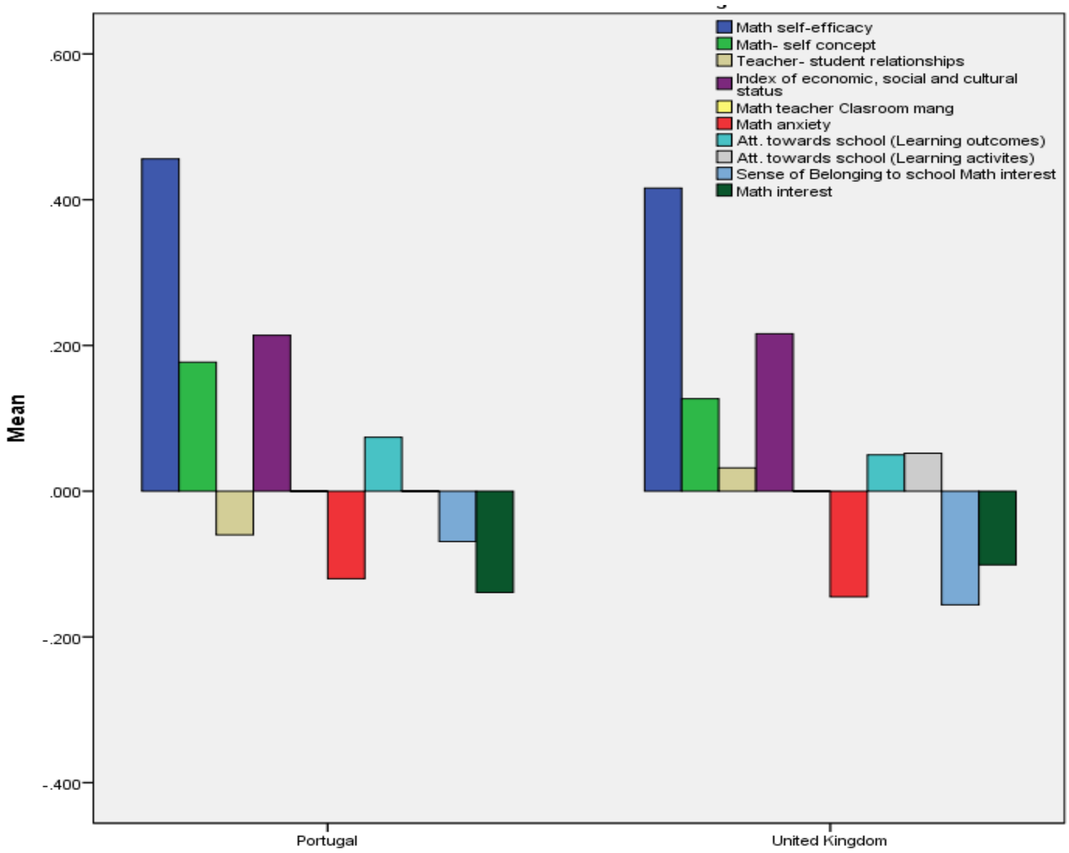

Figure 12. Normal-achieving countries - Cluster 1

In figure 13, *mathematics self-efficacy*, *mathematics self-concept* and *index of economic, social and cultural status* have observable positive relationship with math achievement for all countries. Compared to relationship level, *attitude towards school: learning outcome* shows a positive relationship with mathematics achievement less than factors of *mathematics self-efficacy*, *mathematics self-concept* and *index of economic, social and cultural status*. Different from other countries, only mathematics achievement of Czech Republic associates with influenced by *mathematics teacher's classroom management* positively.

Analyzing inverse related factors, mathematics anxiety and mathematics interest indicate an important negative relationship with mathematics achievement in Figure13. The countries of Latvia and Czech Republic demonstrated negative relationship among mathematics achievement and *sense of belonging to school*, *teacher-student relations*. Also, Latvia indicates a weak negative relationship between *teacher-student relations* and mathematics achievement.

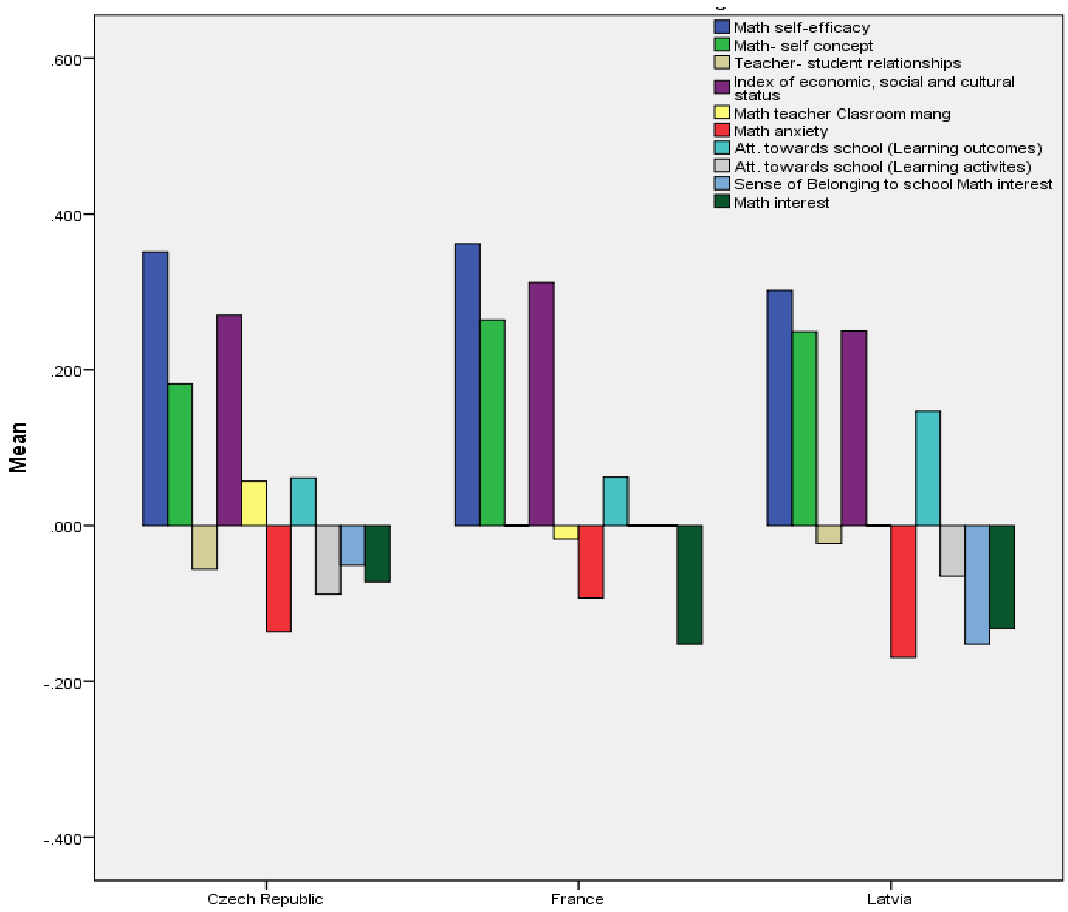

Figure 13. Normal-achieving countries - Cluster 2

In last figure, *mathematics self-efficacy* and *mathematics self-concept* apparently has positive relationship with mathematics achievement in Iceland and Norway. Different from previous figure, *mathematics self-concept* has stronger relationship than *mathematics self-efficacy*. In addition, *index of economic, social and cultural* *status* is related to mathematics achievement less than *mathematics self-efficacy* and *mathematics self-concept*. Different from Norway, Iceland has a positive relationship among mathematics achievement and *attitude towards school: learning outcomes*, *attitude towards school: learning activities*.

Furthermore, both countries have apparent negative relationships among mathematics anxiety, mathematics interest, sense of belonging to school and mathematics achievement.

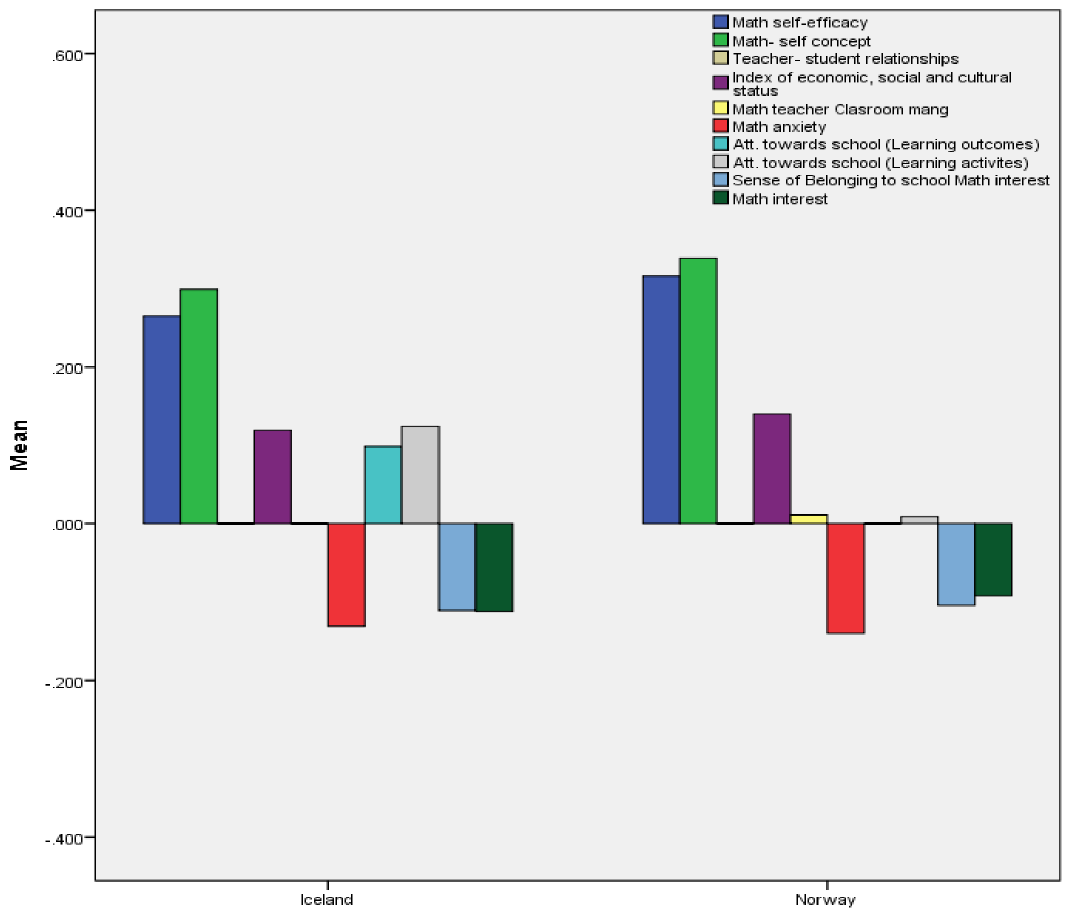

Figure 14. Normal-achieving countries - Cluster 3

Low-achieving distinct patterns graphs

Figures 15 to 18 indicate the β coefficient for each related variables with respect to low-achieving countries (Figures 15, 16, 17, and 18 for clusters 1, 2, 3, and 4, respectively).

Compared low-achieving countries' graphs, the first and second graphs show that there is a statistically significant relationship between mathematics achievement and *index of economic, social and cultural status* positively. In third and fourth graphs, a strong positive relationship is observed between mathematics achievement and *mathematics self-efficacy*. Only Indonesia has positive relations between *mathematics self-concept* and mathematics achievement in low- achieving countries' graphs. Also, *attitude towards school: learning activities* shows a weak positive relationship with mathematics achievement in Figure 15 and 16 while it demonstrates negative relationship with mathematics achievement in Figure 17.

Furthermore, *mathematics anxiety* negatively affects mathematics achievement in all low-achieving countries' groups. In addition, *teacher student relations* has inverse relationship with mathematics achievement in all graphs. In particular, except Figure 17, *mathematics interest* has a noticeable negative effect on mathematics achievement. The factor of *sense of belonging to school* has an inverse relationship with mathematics achievement in Figure 15 except Tunisia, 16 and 18 while it demonstrates no relationship with mathematics achievement in Figure 17.

In Figure 15, the strongest relationship is observed between *index of economic, social and cultural status* and mathematics achievement. *Mathematics self-efficacy* and *mathematics self-concept* have a strong positive relationship with math achievement in this graph. Six countries of Chile, Columbia, Costa Rica, Jordan, Lithuania, Peru and Sweden has a slight relationship between *attitude towards school: learning outcomes* and mathematics achievement. On the other hand, only Jordan, Peru, and Tunisia demonstrate a positive relationship between *attitude towards school: learning activities* and mathematics achievement. In addition, Jordan and Lithuania have positive relationship between *mathematics teacher's classroom management* and mathematics achievement. The factor of *sense of belonging to school* shows positive effect on mathematics achievement in Tunisia.

Analyzing the inverse relationships, it was evident that *mathematics anxiety* and *mathematics interest* have a significant negative effect on mathematics achievement in this graph's low-achieving countries. In addition, a negative relationship is noticed between mathematics achievement and *teacher-student relations*. The mathematics achievement of Colombia, Peru, Sweden, and Tunisia are related to *mathematics teacher's classroom management negatively*. Also, *sense of belonging to school* associates mathematics achievement in Chile, Serbia and Sweden negatively. Lastly, only achievement of Colombia shows a negative relationship with *attitude towards school: learning activities.*

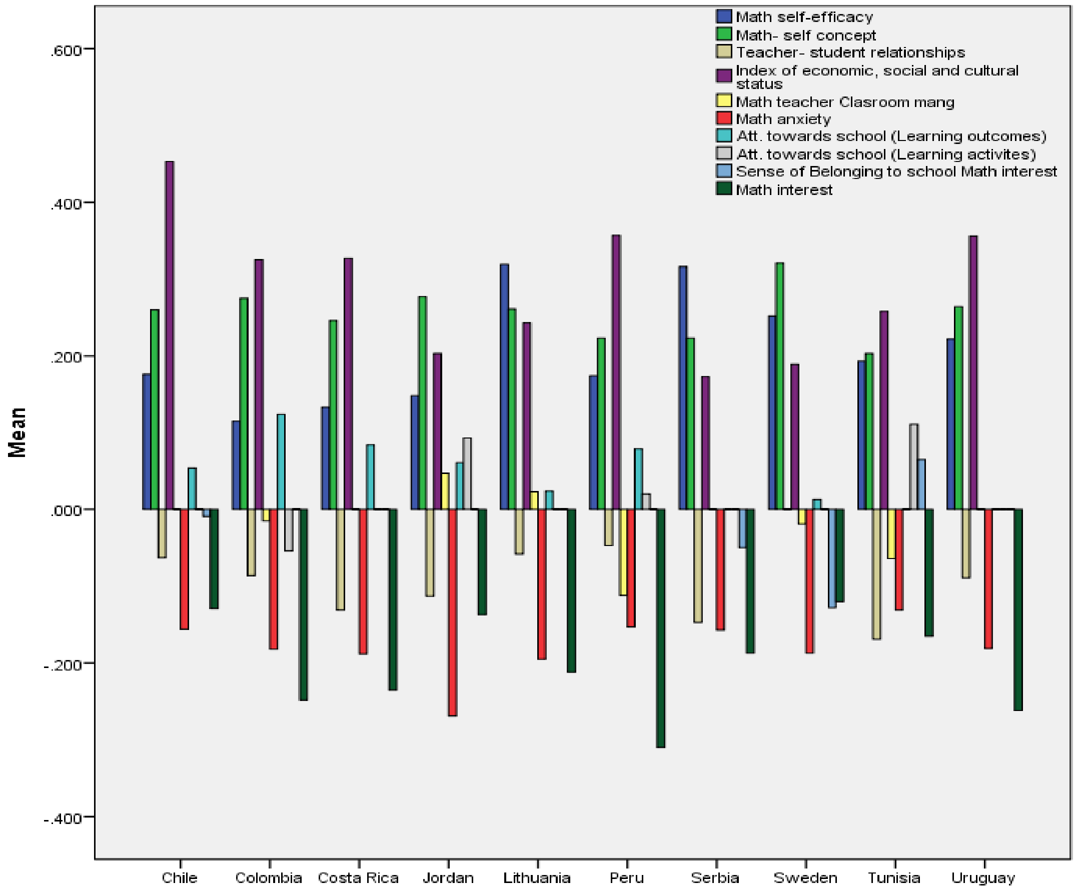

Figure 15. Low-achieving countries - Cluster 1

Analyzing the positive side of the Figure 16, *index of economic, social and cultural status* and *mathematics self-efficacy* have a noticeable significant positive effect on mathematics achievement for all countries in this graph's countries. In addition, *mathematics self-concept* and *attitude towards school: learning outcomes* demonstrate similar relationship with mathematics achievement. However, Qatar does not show any relationship between *mathematics self-concept* and mathematics achievement. A weak positive relationship is seen between *attitude toward school: learning activities* and mathematics achievement in Brazil, Kazakhstan, Mexico and Qatar. Unlike Brazil and Mexico, the factor *mathematics teacher's classroom management* affects mathematics achievement in Bulgaria, Kazakhstan and Qatar positively.

Furthermore, these graphs of countries mathematics achievement have a significant relationship with *mathematics anxiety* and *mathematics interest*. Except Qatar, the other countries show negative relationships between *teacher-student relations* and mathematics achievement. In addition, the mathematics achievement of Brazil, Kazakhstan, Mexico, Montenegro and Qatar are influenced negatively by *sense of belonging to school*. Only Brazil and Mexico indicate a negative relationship between *mathematics teacher's classroom management* and mathematics achievement.

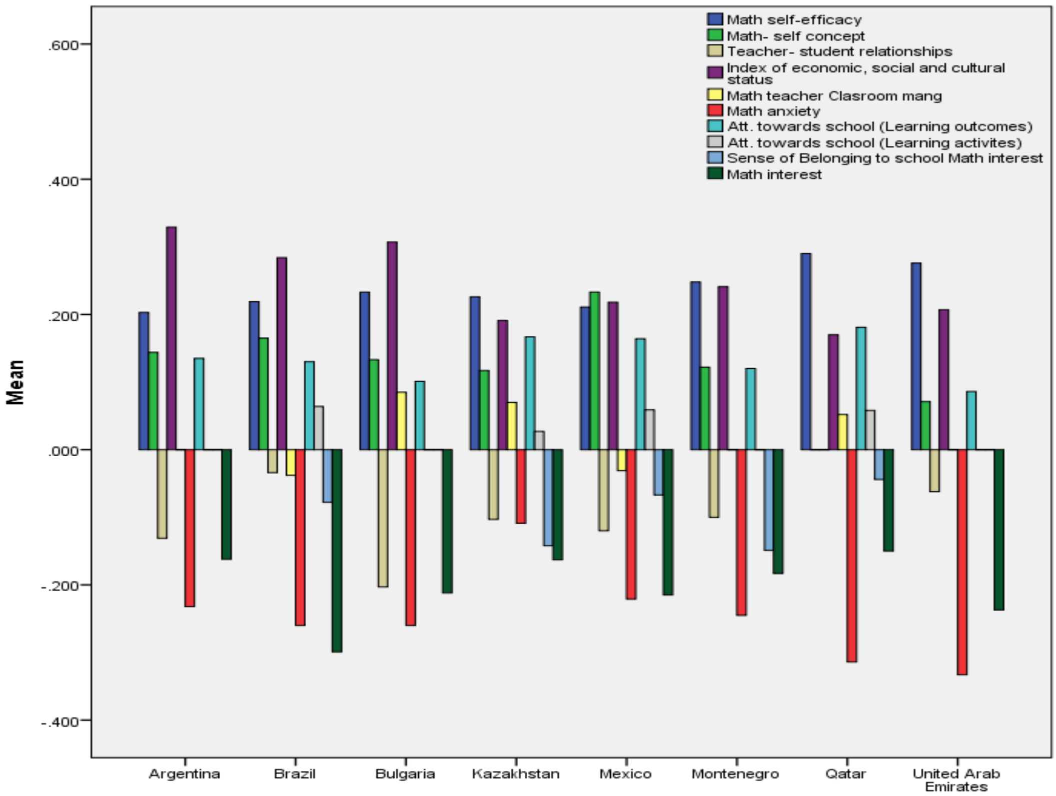

Figure 16. Low-achieving countries - Cluster 2

In Figure 17, *index of economic, social and cultural status* and *mathematics self-efficacy* demonstrate an important positive relationship with mathematic achievement. Except Luxemburg, others mathematics achievement have been influenced positively by *attitude towards school: learning outcomes*. In particular, only Indonesia had an observable positive relationship between *mathematics teacher's classroom management* and mathematics achievement. However, this graph shows that *mathematics anxiety* has a negative effect on mathematics achievement. In addition, except Indonesia, *teacher-student relations* negatively affected all other countries' mathematics achievement. A negative relationship is observed between *mathematics interest* and mathematics achievement in Indonesia and Thailand. Only Indonesia mathematics achievement demonstrate an important relationship with *mathematic self-concept*.

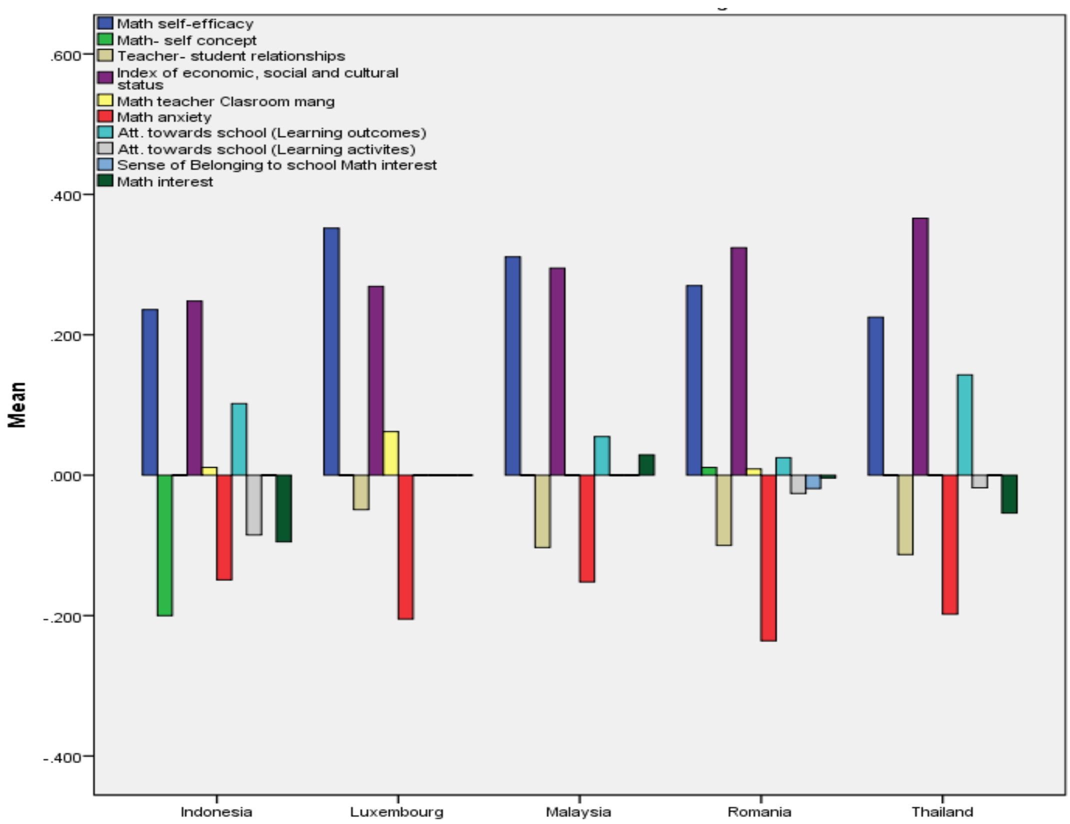

Figure 17. Low-achieving countries - Cluster 3

In Figure 18, there is a significant relationship among *mathematic self-efficacy*, *index of economic, social and cultural status* and mathematics achievement. Except Turkey, all countries' mathematics achievement have been positively affected by *mathematics self-concept*. However, there is no association between *mathematics self-concept* and mathematics achievement in Turkey. In addition, *attitude towards school: learning outcomes* shows a positive relationship with mathematics achievement in Hungary, Italy, and Spain .The factor of *attitude towards school: learning activities* affected negatively only mathematics achievement of Spain while it indicate a negative relationship with mathematics achievement in Croatia, Greece, Israel, Italy, Turkey and the United States of America. Unlike Spain, a positive relationship is observed between mathematics achievement and *mathematics teacher's classroom management* in others.

Moreover, the most significant relationship is noticed between *mathematics anxiety* and mathematics achievement negatively. In this graph, mathematics achievement of low-achieving countries indicates negative relationships with *mathematics interest* except Greece, Israel, Russian Federation, Turkey and the United Sates. Besides, the *sense of belonging to school* affects negatively mathematics achievement of Croatia, Greece, Israel, Italy, Russian Federation, Spain, Turkey and the United States of America. The six countries of Croatia, Greece, Israel, Italy, Turkey, and the United States of America demonstrate a negative relationship between *attitude towards: learning activities* and mathematics achievement. Lastly, the *teacher-student relations* has negative effects on mathematics achievement of Croatia, Hungary, Italy, Slovakia Republic, and Spain.

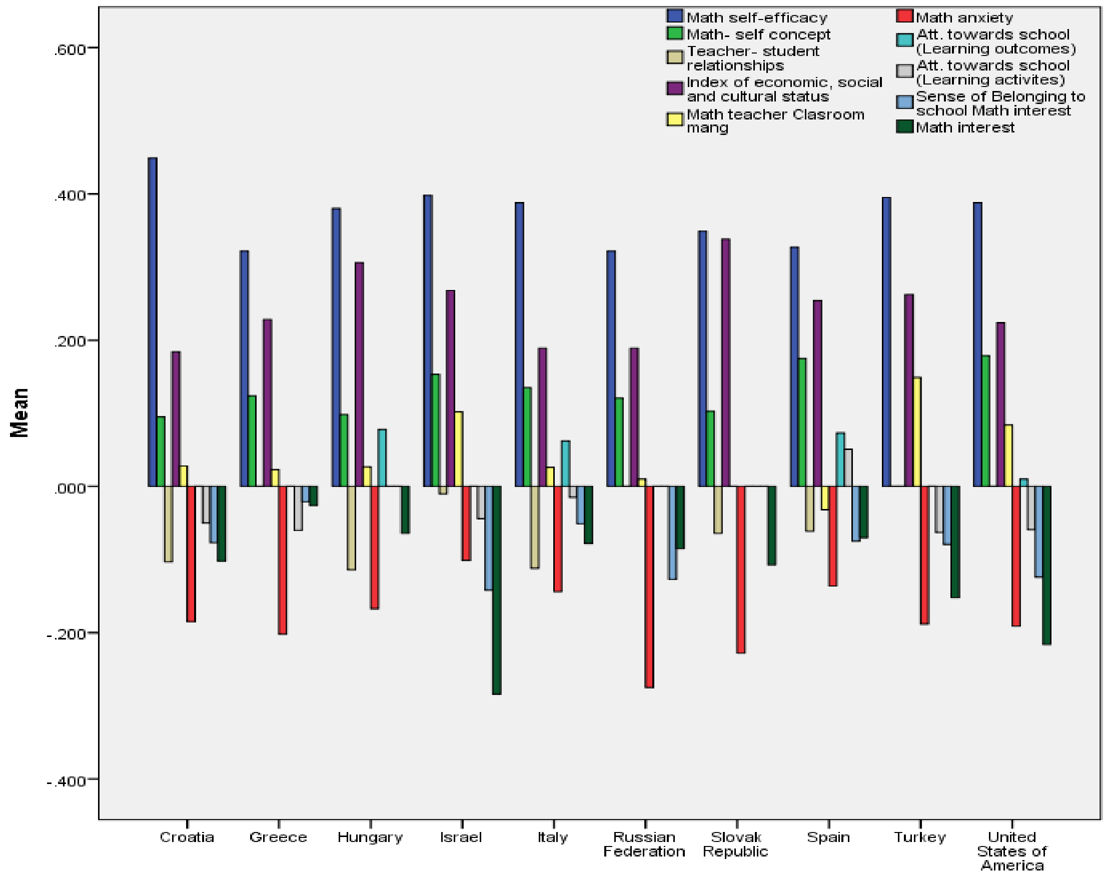

Figure 18. Low-achieving countries - Cluster 4

CHAPTER 5: DISCUSSION

Introduction

This chapter aims to discuss the findings of the study with support from the literature. To this end, an overview of the study including discussion of major findings is presented in this chapter. Furthermore, implications for practice, further research and limitations were among the topics to discuss and evaluate the findings.

Overview of the study

In this study, factors related with mathematics and distinct patterns in participating countries were examined using the PISA 2012 data. The main purpose of this study was to identify the relationship between selected factors and mathematics achievement. The study then aims to demonstrate distinct patters in high-, normal- and low-achieving countries.

In analysis of this study, the countries participated in PISA 2012 were classified by using PISA published result of assessment (OECD, 2014, p7). According to this classification, the groups of high-achieving, normal-achieving, and low-achieving countries were obtained from PISA results. In this city, there are 10 mathematics-related factors: *mathematics self-efficacy, mathematics self-concept , teacher-student relations, index of economic, social and cultural status, mathematics teacher's classroom management, mathematics anxiety , attitude towards school: learning outcomes, attitude towards school: learning activities, sense of belonging to school,* and *mathematics interest*. The researcher looked into what factors are related to mathematics achievement in high-, normal-, and low- achieving countries. In order to determine these factors, five scores of mathematics literacy were used.

As for the analysis, regression analysis was done by using aforementioned mathematics-related factors and scores of mathematics literacy for high- achieving, normal-achieving and low- achieving countries respectively. According to the result of regression analysis, countries from each group were inspected in terms of relationship between mathematics related factors and mathematics achievement. Then, distinct patterns in high-, normal- and low-achieving countries were distinguished by using hierarchical cluster analysis. These distinct patterns were constructed in order to see how these three classes of countries were grouped into classification. At the end of this analysis, 4 different distinct patterns groups in high-achieving countries, 3 different distinct patterns in average-achieving countries and 4 different distinct patterns in low-achieving countries were obtained. Lastly, to identify relationship between mathematics achievement and related-factors in these distinct patterns, bar chart graphs were drew for each distinct patterns.

Major findings

Mathematics has become extremely important for students' academic achievement and future carrier. To assess students' performance and achievement level of mathematics, some international exams have been developed for high school students. Two of these prestigious exams are the Programme for International Students Assessment (PISA) and Trends in Mathematics and Science Study (TIMSS). PISA and TIMMS results allow the participating countries to evaluate their students' mathematics literacy and mathematics achievement, respectively. The results indicate that there is a variety of factors that are significantly related with students' academic performance. For example, these factors are mathematics self-efficacy, mathematics self-concept, mathematics anxiety, classroom management, socio-economic status of family, family education background, gender differences, mathematic interest, attitude towards school and sense of belonging. The effect of abovementioned factors are different in each country.

- What are mathematics-related factors explaining 15-year-old students' mathematics literacy levels in high-, normal- and low-achieving countries based on PISA 2012 data?

Surprisingly, mathematics achievement of Netherlands is related to mathematics self-concept in a negative way, unlike other high-achieving countries. Also, mathematics self-concept does not show effect on mathematics achievement in some countries of Belgium, Hong Kong-China, Macao-China and Singapore. For high-achieving countries, it shows that students who are from these countries could separate mathematics self-concept from their achievement. However, Korea showed positive relationship between mathematics achievement and mathematics anxiety, unlike the result of study conducted by Wang, Lukowski, Hart, Lyons, Thompson, Kovas, Mazzocco, Plomin and Petrill (2015). They concluded that mathematics motivation might cause to have inverted-U relationship between mathematics anxiety and mathematics achievement. It might signify that this positive relationship with mathematics achievement might be related to being high achievement. Since, Korean students have characteristic of self-knowledge and self-awareness and it will support to turn effect of mathematics anxiety in a positive way for their academic achievement. Surprisingly, factors of mathematics interest and sense of belonging to school revealed inverse relationship with mathematics achievement in high-achieving countries. It shows that students who are from high-achieving countries might think that school only academic place. Because of this opinion, if their sense of belonging to school increase, their motivation will decrease and they could not be successful in mathematics. On the other hand, only Japan has positive relationship between mathematics interest and mathematics achievement. According to the study of Takahashi (2006), Japanese teachers tends to create environment and activities in their lesson. It explains why Japan showed positive relationship between mathematics achievement and mathematics interest.

In average-achieving countries, the results are similar to that of high-achieving countries. For example, mathematics self-efficacy, mathematics self-concept and index of economic, social and status indicate a positive relationship with mathematics achievement in all average-achieving countries. These findings show that students who are from average-achieving countries have characteristic of self-awareness and self-knowledge. In addition, similar to high-achieving countries, average-achieving countries are affected negatively by mathematics anxiety, mathematics interest and sense of belonging to school. Therefore, these factors do not make difference between high- and average- achieving countries. Examining other factors, mathematics achievement of only Czech Republic is affected by mathematics teacher’s classroom management in a positive way. In the same country, teacher-student relations have a negative relationship with mathematics achievement. These contradicting results signify that Czech Republic teachers do not allow having good relationship with students during the lesson and they are dominant in the class to increase students’ achievement.

Lastly, it is surprising to see that mathematics self-concept demonstrated an inverse relationship with Indonesia while it did not show any relations with Luxemburg, Malaysia, Qatar, Thailand and Turkey. It means that these countries, except Indonesia, are affected by other factors. Interestingly, Uysal's study (2015) shows that mathematics self-concept has a positive effect on Turkish students; however, this study showed different result from her study. In addition, attitude towards school: learning activities shows both positive and negative effect on performance in some low achieving counties, similar to mathematics teacher's classroom management. The important thing is that when mathematics teacher's classroom management has negative effect on mathematics achievement, attitude towards school: learning activities had positive effect on mathematics achievement. It means that, when teachers does not have classroom management skills, they cannot implement learning activities in lesson and so it might change to students' attitude towards school. Interestingly, while the factor of sense of belonging to school had a negative relationship with low-achieving countries, only Tunisia showed positive relation with it. It is predictable that students do not think that schools are only academics place. On the other hand, mathematics interest had negative effect on mathematics achievement as much as mathematics anxiety in low-achieving countries except Greece, Luxemburg, Malaysia, and Romania. Since, students could lose their academic approach to mathematics when they analyze and investigate mathematics in deep. Lastly, Greece, Indonesia, Israel, Luxemburg, Qatar, Russian Federation, 3Sweden, Turkey and United States of America had no relationship with teacher-student relations while others showed inverse relationship with students' academic performance. For Turkey, Uysal's study (2015) implied that Turkish students' mathematics achievement is positively related to teacher-student relations. It is possible to infer that Turkey have a problem about teacher-student relations in their education system.

Overall, high-achieving, average-achieving and low-achieving countries indicate that mathematics self-efficacy, and index of economic, social and cultural status associated with mathematics achievement positively. It means that these variables have an important effect on mathematics achievement as Kung (2009) had same result in his research. Therefore, mathematics self-efficacy and index of economic, social and cultural status did not make a difference in groups of achieving countries. On the other hand, mathematics anxiety showed inverse relationship in all studied countries except Korea. Aforementioned study had concluded that mathematics anxiety could be varied among Asian countries like Korea and Japan and Western European countries like Finland, Singapore, and Switzerland (Lee, 2009). Result of Korea about mathematics anxiety might be obtained country education system and teachers' strategies like pressuring to be successful in examinations (Tan & Yates, 2011).

- What are the different clusters of countries across high-, normal- and low-achieving countries based on PISA 2012 data?

To interpret the cluster groups of high-achieving countries, the first group includes Austria, Estonia, Ireland, Switzerland, Germany, Slovenia and Poland. I think there are common qualities in terms of location and language. Switzerland, Germany, Austria, Slovenia, Estonia and Poland are located in Europe. The second high-achieving cluster has two countries of Australia, New Zealand, Canada, Denmark and Finland. Australia and New Zealand are located in Asia Pacific region. Language-wise, it is understandable Canada, Australia and New Zealand are in the same group. Since, they are using the same language. It can be predicted Denmark and Finland are same group because they are Scandinavia countries. The third cluster of high-achieving countries is Far East countries of Shanghai-China, Chinese Taipei, Japan and Korea. It is obvious that those countries have same culture and similar approaching to education. Lastly, Macao-China, Singapore, Hong Kong-China, Viet Nam, Belgium and Netherlands are in the same group of cluster. This cluster includes two different cultures. They are European and Asia Pacific. To summarize, high-achieving countries have some similar qualities among each other; therefore, they classify in four groups with the help of not only independent variables also culture, region and language variables.

In average-achieving countries form by three groups. The first one has two countries of United Kingdom and Portugal. They have no common points as cultural, same language or region. It can imply that they can be group because of only affected same mathematics-related factors negatively or positively. The second group form with Czech Republic, France and Latvia. It can be predictable Czech Republic and Latvia are in the same group. Since Latvia was in Union of Soviet Socialist Republic and Czech Republic was the one of the oppress country. The last one occur from Scandinavia countries of Iceland and Norway. It obvious that region and similar history can be effective to make them to put in same cluster group.

The most crowded group is low-achieving countries in terms of number of countries. These countries have four cluster groups. The first one of them includes Colombia, Costa Rica, Uruguay, Peru, Chile, Lithuania, Serbia, Sweden, Jordan and Tunisia. Colombia, Costa Rica, Uruguay, Peru and Chile are located in Latin American countries and they speak to same language. Also, Jordan and Tunisia have same qualities in terms of language and location. That's why, it can be understandable they are in same cluster because they have same common point among each other. The second cluster of low-achieving countries has United Arab Emirates, Qatar, Argentina, Bulgaria, Mexico, Montenegro, Brazil and Kazakhstan. Similar with first cluster, they have common cultural and location qualities. Malaysia, Romania, Luxemburg, Thailand and Indonesia are in same cluster group. It is obvious that location quality can be effective for Malaysia, Thailand and Indonesia to make them to be in same cluster. For Romania and Luxemburg, it can be influenced by cluster independent variables to be in that group. The last group contains Israel, United States of America, Turkey, Croatia, Italy, Hungary, Slovak Republic, Spain, Greece, Luxemburg and Russian Federation. That group can be affected by not only independent variables but also common location and cultural qualities because Croatia, Italy, Hungary, Slovak Republic, Spain, Greece and Luxemburg are European countries. It obvious that country's location, culture and their language can be effective factors in low-achieving countries cluster same with mentioned high- and average- achieving countries clusters.

- What are the relationship in different clusters of countries across high-, normal- and low-achieving countries based on PISA 2012 data?

Graphs of high-, normal- and low-achieving countries' groups revealed some interesting findings.

In high-achieving countries, the mathematics achievement of Australia, Canada, and New Zealand indicated similar positive relationship with factors of mathematics teacher's classroom management and attitude towards school: learning outcomes. When thinking about effect of these factors on mathematics achievement, this relationship can be imply that their teachers could calibrate students' attitude towards school with the help of good classroom management. Therefore, both of them might affects students' achievement positively. Nevertheless, Finland had positive relationship with attitude towards school: learning outcomes, while it was influenced mathematics teacher's classroom management in negative way. The reason of this result might come from education system of Finland because they try to use student-centered teaching method in general. That's why, if teachers who work in Finland have a strong classroom management on students, it would be decrease students achievement because of dominant teacher restriction. Additionally, it is interesting to see that Shin, Lee and Kim (2006) concluded that Finland had negative relationship with mathematics achievement and teacher-student relations according to PISA 2003 data even though Finland did not show any relationship between teacher-students relation and mathematics achievement in this study. It shows improving of Finland in teacher-student relations. Lastly, sense of belonging factor associated with mathematics achievement negatively almost all group of graphs in high-achieving countries. It might be implied that students who are from high-achieving countries perceive the schools as an academic place. In other words, if they feel to belong to school more than now, they will lose their motivation because of inadequate social life.

In normal-achieving countries' distinct patterns, there are some common variables. The mathematics achievement of only United Kingdom was positively affected by teacher-student relations and attitude towards school: learning activities. It is possible that teacher-student relations factor supports the factor of attitude towards school in learning activities in U.K. In second group's graph of average achieving countries, it can be predictable that there was a negative relation between sense of belonging to school and mathematics performance in Latvia and Czech Republic like factor of attitude towards school: learning activities while considering the their culture.

If we compare graphs of low-achieving countries' distinct patterns, it is observed that there was a variety of not only differences but also similar points among each group of low-achieving countries. The strongest effect on mathematics achievement can be observed in social economic status. It is obvious that socio-economic status plays a significant role in students' academic achievement. Cueto, Guerrero, Leon, and Zapata (2014) and Freire, (2014) have similar results with the current study. Generally, the first and second graph of low-achieving countries which mostly include European countries demonstrated a negative relationship between mathematics achievement and mathematics interest. It can show that mathematics interest is not regarded an effective variable in European education system. Moreover, mathematics achievement of Indonesia, Malaysia and Thailand, which have similar culture, were affected by attitude towards school: learning outcomes in a same way. It implies that culture could be an effective factor in students' attitude towards school. On the other hand, it is surprising to see that Indonesia had inverse relationship with mathematics performance in mathematics self-concept. Compared the high- and normal- achieving countries groups of relationship with teacher-student relations, the low-achieving countries demonstrated a stronger negative relationship between teacher-students relations and mathematics achievement than high-achieving countries . This result could be explained by low-achieving countries socio-economic status. Generally, they are underdeveloped countries and teachers' income problems could influence their relationship with students. If they do not have good relations, it would reflect on students' academic achievement.

Implications for practice

The results of the current study indicated general implications for each country participated in PISA 2012. In addition, mathematics performance and achievement of effective factors and effects of those factors were obtained according the classifying. For practice,

- Experts working for the Ministry of Education from each country can analyse results closely to identify factors affecting student achievement factors for their curricula or education systems.
- Countries can make a contact and help each other to improve their lacking parts or they can work celebrate to decrease effects of factors.
- Specifically, experts who prepare mathematics curricula and annual plan for schools could identify the effects of negative factors on mathematics achievement. Workshops could be organized for teachers to raise awareness on curricular and instructional issues.
- The researchers can analyse deeply mathematics-related factors in distinct pattern which includes Turkey and they can identify each related factors in detail.
- The Ministry of Education could organize workshops for teachers in order to teach how they can help students with their mathematics anxiety.
- Teachers who are from any subject area can focus on developing students' self-concept in their high school. This may be helpful for their mathematics achievement.
- Teacher could create an engaging learning environment with interesting activities in their lessons. In other words, they can increase students' interest

in mathematics to change the effect of mathematics interest on students' mathematics achievement.

Implications for further research

The main purpose of this study is to show the general framework of the mathematics factors related with participant countries' mathematics performance with the help of their PISA 2012 results. This study could encourage other researchers to further investigate the findings of this. Other studies could develop new perspectives and look into specific factors that are positively or negatively associated with mathematics achievement. Researchers could develop educational policies to be used for improving mathematics achievement in respective countries.

Limitations

Because of possibility of non-invariant scores, some criticize that PISA results are non-comparable across countries. Thus, comparing countries based on (potentially) invariant scores may be misleading. Similarly, cross-cultural differences may be a threat in studies involving comparison. Furthermore, curricular and instructional differences may also explain differences between countries. However, results of this study may provide a preliminary knowledge to trigger further studies.

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