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The Examination of The Variables Affecting Mathematics Behavior and Mathematics Literacy by Multi-Group Hybrid Model in the Sample of PISA 2012 Turkey

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Abstract

This study aims to test the hybrid model structured by the variables of instrumental motivation for mathematics, mathematics self-concept, mathematics self-efficacy, mathematics anxiety and mathematics interest that are considered to have affected mathematics behavior and mathematics literacy of the PISA 2012 Turkey sample, and to examine if the model varies in terms of gender and school type (general high school, Anatolian school and vocational high school). The population of this correlational study consists of 4848 students who attended PISA 2012 from Turkey and the sample consists of 15-year-old 1441 students who took B form of the Student Questionnaire. PISA 2012 "Student Questionnaire-B Form" and "Mathematics Literacy Test" were used as data collecting tools in the research. When fit indices were analyzed, it was found that model-data fit was achieved for the hybrid model structured at the first phase and the model didn't vary according to gender and school type. In addition, when path coefficients were examined, it was seen that mathematics self-efficacy was the best predictor of the mathematics literacy variable and mathematics interest was the best predictor of the mathematics behavior variable. It was observed that mathematics self-efficacy had a great positive effect in predicting mathematics literacy, and mathematics interest had a great positive effect in predicting mathematics behavior. The results of the study revealed that structured model explained 44% of the mathematics behavior and 39% of the mathematics literacy.

Keywords

Mathematics Literacy
Mathematics Behavior
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Multigruop Hybrid Model
School Type
Gender

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Introduction

The rapid developments in the knowledge era have resulted in important changes in the education system. The focus of the education systems of different countries is to train individuals who can adapt themselves into globalization. In order for each country to be able to evaluate and compare its own education system, there are some examinations to determine student success at an international level. PISA (Program for International Student Assessment), TIMMS (The Trends in International Mathematics and Science Study) and PIRLS (Progress in International Reading Literacy Study) are some of the examples of such international exams. By means of these exams, some information about variables such as students, parents and teachers and learning environment can be gathered via students, parents and school questionnaires. Associating these variables with learning outcomes and getting feedback on the current education system is the most important feature of these exams.

PISA (Program for International Student Assessment), which is held once in three years by OECD (Organization for Economic Cooperation and Development) is a survey study which assesses 15-year-old students' knowledge and skills in terms of reading skills and science and mathematics literacies (OECD, 2002). In PISA, it is focused on one of the reading skills, science and mathematics literacies cyclically. Turkey first attended PISA in 2003. In PISA, it is predicted that how students can use what they learn in and out of the school rather than the determination of the their knowledge In short, it comes into prominence to determine how much of their current knowledge individuals will use in the future comes into prominence. PISA studies starting for this purpose focus on the public policies and educational conditions firstly. Besides, PISA aims to collect the data helping policy makers and educators to reveal the performance levels of the students and the reasons related to their levels categorically (OECD, 2014).

PISA 2012 from which the latest data were collected is the fifth cycle of PISA and a study dealing mainly with mathematics literacy. In PISA 2012, mathematics literacy was defined as the capacities of individuals' to be able to formulate aiming at various scopes and contents and to use and interpret mathematics. Mathematics literacy is an auxiliary factor helping individuals to realize the role of mathematics, to make decisions and judgments having strong basis which are required by constructive, sensitive and reflective citizens (OECD, 2014). Total 65 countries, 34 of which are members of OECD attended PISA 2012. Turkey is in the 44th rank in mathematics literacy among 65 countries and 31st among 34 OECD countries. Furthermore, Turkey is in the second competency level under the first degree of OECD average (OECD 2014, MEB, 2015).

Considering that mathematics literacy has an impact on individuals in making important decisions for the future, it is useful to determine this skill area and related variables to develop the skill in question in individuals. There is a great number of studies about mathematics literacy and intending to determine the factors affecting it in PISA data in the literature (Marsh & Hau, 2004; Pekrun & Zirngibl, 2004; Yılmaz, 2006; Shin, Lee, & Kim, 2006; Guiso, Monte, Sapienza, & Zingales, 2008; Ferla, Valcke, & Cai, 2009; Liu, 2009; Lee, 2009; Liu & Wilson, 2009; Akyüz & Pala, 2010; Sarıer, 2010; Yıldırım, 2011; Akyüz & Satıcı, 2013; Lee & Stankov, 2013; Segeritz & Pant, 2013; Stankov, 2013; Ada, 2015; Karabay, Yıldırım, & Güler, 2015; Koğar, 2015; Koyuncu, 2015; Özbay, 2015, Uysal, 2015; Akgül, Çokamay, & Demir, 2016; Erten Tatlı, Atalan Ergin, & Demir, 2016; Zhang & Liu, 2016).

When national and international studies related to PISA were examined, it was found that generally mathematics self-efficacy, mathematics interest, mathematics anxiety, mathematics self-concept and instrumental motivation variables were dealt with concerning to determine the factors affecting mathematics literacy. Some of these studies are tried to be described here. Lee (2009) examined whether the structural model he designed with mathematics self-concept, mathematics self-efficacy, and mathematics anxiety using PISA 2003 data differs in 41 countries attending the implementation. Accordingly, he defined his model in five different ways and observed that the model adjusted well in the countries when he didn't set measures to it. Liu (2009) investigated the factors affected by gender differences in mathematics literacy in PISA 2003 US and Hong Kong data. In the research the effects of the variables of mathematics interest, mathematics self-efficacy, learning strategies, instrumental motivation, self-concept, mathematics anxiety and learning situations on mathematics literacy were investigated.

Using the data from PISA 2003, Yıldırım (2011) analyzed the relation between mathematics self-efficacy and mathematics success for the data collected from Turkey, Japan and Finland. When the data from Turkey was taken into consideration, mathematics self-efficacy predicted 12% of mathematics success, and when intrinsic motivation and anxiety were added into the model as moderator variables, it predicted 15% of math success. Lee and Stankov (2013) tested the impact of student related variables (mathematics interest, instrumental motivation for mathematics, mathematics self-efficacy, mathematics self-concept, mathematics anxiety etc.) on mathematics literacy via three-level factor analysis by using structural equation model (SEM) in his study he employed the data of 41 countries in PISA 2003. The results of the study revealed that while mathematics self-efficacy and mathematics self-concept affected mathematics literacy in a positive way, mathematics anxiety and mathematics interest were affected negatively. In the study Segeritz and Pant (2013) conducted by using the data of PISA 2003 Germany, measurement invariance was examined by employing multi-group confirmatory factor analysis with variables determined for German, Turkish and Russian origin students (instrumental motivation, mathematics interest, mathematics self-efficacy, mathematics self-concept, learning strategies etc.) with.

Koğar (2015) aimed to determine the direct and indirect factors affecting mathematics literacy by using PISA 2012 data. The results revealed that the independent variables of gender, economic, social and cultural conditions indexes and the time spent on learning mathematics had significant impact on mathematics literacy. The strongest predictors of the moderator variables were stated respectively as mathematics self-efficacy, mathematics anxiety and the gained experience by mathematics tasks given at school.

Koyuncu (2015) created a hybrid path analysis model handling the variables of mathematics anxiety, mathematics self-efficacy and gender and analyzed it in his PISA 2012 study. The results showed that gender was a predictor of mathematics self-efficacy, and mathematics self-efficacy was the predictor of mathematics anxiety. Özbay (2015), using the data from PISA 2012, made a comparison between the performance differences of mathematics literacy, reading skills and science literacy on the basis of the school type and geographical region. The results for mathematics literacy revealed that there was a significant difference in the geographical regions according to the OECD average. Within pairwise comparison of the schools, there was a significant difference in all comparisons except for general high school - multi-program high school.

When studies dealing with mathematics self-efficacy, mathematics interest, mathematic anxiety, mathematics self-concept and instrumental motivation variables were examined, it was seen that the effect of these variables to mathematics literacy was investigated frequently and they were related to each other. Since the variables were related to each other and they predicted mathematic literacy very well, they were dealt with as part of this research. However, these variables weren't dealt with in only one hybrid model but it was also investigated whether this model changed in terms of gender and school type. Unlikely, inter-variables relations were included in only one hybrid model in this study and it was investigated whether this model changed in terms of gender and school type. In addition, unlike these frequent variables, mathematical behavior variable which was studied little and of which data was firstly collected in PISA 2012 was also included in the constituted model. The reason of that mathematical behavior model was included in the study is that there are a few studies related to the variable and it isn't known how this variable is affected by the other variables included in the model. Accordingly, external variables of the research are mathematics self-concept and instrumental motivation and internal variables are mathematics self-efficacy, mathematics interest, mathematics anxiety, mathematics literacy and mathematical behavior. In the light of all this information, the accordance of the hybrid model constituted by the variables affecting the mathematical behavior and mathematics literacy of the students attending PISA 2012 in Turkey and whether the model changed according to gender and school type in this study.

The variables included in the study can be defined as follows: *Mathematics Interest*, being independent from students' general motivation to learn, is a preference of intrinsic motivation affected by the frequency and permanency of mathematical study. *Instrumental Motivation for Mathematics* can be defined as an important predictor of course selection, career selection and career performance. *Mathematics Anxiety* is related to despair and emotional stress while studying mathematics and *Mathematics Self-Concept* is about students' evaluation of their own mathematic performances based on social comparison process. According to Bandura (1986), *Mathematics Self-Efficacy* concept is the capability of self-evaluation process and a belief of that whether one can or cannot do something independently. *Mathematics Self-Efficacy* is about how a person feels confident in doing a given mathematic task (as cited in OECD, 2005). Mathematical behavior variable of which data was obtained in PISA 2012 for the first time provides information of that how often students conduct the behaviors and activities related to mathematics in and out of their school life (OECD, 2014). Mathematical literacy is students' skills of recognizing a problem they face in their world, interpreting it, converting it into a mathematical content and solving a problem in the mathematical content by using various information and methods. Mathematical literacy is also the skill of interpreting the obtained results and considering on the methods associated with the results and applied (OECD, 2002).

The Purpose and the Importance of the Study

The purpose of this study is to test the hybrid model structured with the variables of instrumental motivation for mathematics, mathematics self-concept, mathematics self-efficacy, mathematics anxiety and mathematics interest which are considered to have affected mathematical behavior and mathematics literacy of the students who attended PISA 2012 from Turkey, and to examine if the model varies in terms of gender and school type.

The affective characteristics for mathematics in structural equation model which was structured in PISA 2012 national report were defined by eight observable variables. The variables of instrumental motivation for mathematics, mathematics self-concept, mathematics self-efficacy, mathematics anxiety, mathematics interest and mathematics behavior are the affective characteristics defined aiming at maths, and student success often increases as the level of having affective characteristics for mathematic raises (MEB, 2015). It is important to examine the relationship between mathematics literacy and these variables, and to analyze the differentiation of these relationship patterns in terms of gender and school type for both teachers, school administrator and politicians in terms of the actions to be taken for student success. Furthermore, mathematics behavior was handled for the first time in PISA 2012, and the relationship between this variable and other variables is to be determined both in gender and school type groups. Thus, this study will contribute to the literature in which there are only few studies on mathematics behavior.

Problem of Study

The sub problems in line with the purpose of the study are as follows: For the hybrid model structured by the variables of mathematics behavior, mathematics literacy, instrumental motivation for mathematics, mathematics self-concept, mathematics self-efficacy, mathematics anxiety and mathematics interest of the students who attended PISA 2012

1. What are the values related to the consistency of this model?
2. Does hybrid model vary by gender (male-female)?
3. Does hybrid model vary by school type (Anatolian high school, general high school and vocational high school)?

Method

Type of Research

In this study, the model which examined the impact of instrumental motivation for mathematics, mathematics self-concept, mathematics self-efficacy, mathematics anxiety, mathematics interest on mathematics behavior and mathematics literacy was tested in the sample of Turkey PISA 2012, and multi group hybrid model was used to examine if the model varies in terms of gender and school type. This is a correlational study as it structured a hybrid model between the variables considered to be related with each other. Correlational studies investigate the probability of the relationship between two or more variables as well as their implications for cause and effect (Fraenkel, Wallen, & Hyun, 2012).

Population and Sample

The population of this study consisted of 15-year-old 4848 students from 170 schools in Turkey who attended PISA 2012. Three types of student questionnaires were applied in PISA 2012 and not all of the students joined all of these questionnaires. As only B form included all the variables examined in the study, the students who didn't take this form were excluded from the study. Similarly, the students who had missing data related to the variables were also excluded from the study by using the listwise method.

In terms of gender, the sample of the study consisted of 1441 students (723 (50,20 %) female, 718 (49,80%) male). When analyzed in terms of school type, the population of the study consisted of 4848 students (1462 (%30,16) general high school students, 1050 (%21,66) Anatolian high school students and 1216 (%25,08) vocational high school students). As the population of the study mostly consisted of these high schools (76,9%), these were included in the scope of the study. Therefore, 1102 students (420 (%38,12) general high school students, 326 (%29,58) Anatolian high school students and 356 (%32,30) vocational high school) constituted the sample of the study in terms of school type as the students who didn't answer the questions in any of the two forms and had the missing data were excluded from the study.

Data Collection Tools

Student questionnaire-B form used in the mathematics intensive PISA exam organized by OECD in 2012 was used as the data collection tool in this study. The predictor variables included in the mathematics learning section in B form are Mathematics Interest and Instrumental Motivation variables under the title of "To what extent do you agree with the statements given below when you consider your opinions about mathematics? (ST29)", Mathematics Self-Efficacy variable under the title of "To what extend do you feel confident in doing mathematic tasks given below? (ST37)", Mathematics Anxiety and Self-Concept under the title of Mathematics Interest and Instrumental Motivation for Mathematics; Mathematics Self-efficacy; "To what extent do you agree with the statements given below when you think about studying mathematics? (ST42)", and finally Mathematical Behavior variable under the title of "How often do you do the given activities below inside or outside school? (ST49)". These variables were obtained from respectively ST29, ST37, ST42 and ST49 subscales. All subscales are scored between 1 and 4. ST29 and ST42 subscales indicate the state of agreement and 1 means "Strongly Agree", 2 "Agree", 3 "Disagree" and 4 "Strongly Disagree." ST37 subscale indicates self-confidence and 1 means "Very Confident", 2 "Confident", 3 "Unconfident" and 4 "Very unconfident." ST49 subscale indicates frequency and 1 means "Always or Almost Always", 2 "Often", 3 "Sometimes" and 4 "Never or Rarely." Items included in these scales and stated as "recode" in PISA technical report were recoded again and included in the analyses.

First, principal component analysis was conducted to provide evidence for the validity of the scales employed for instrumental motivation, self-concept, mathematics interest, mathematics anxiety, mathematics self-efficacy and mathematical behavior. Before conducting principal component analysis, Kaiser-Meyer-Olkin (KMO) and Barlett sphericity values were examined. In accordance with the KMO values (≥0,80) obtained for all groups and scales and as a result of that Barlett sphericity values were significant, it was seen that the data were compatible with the principal component analysis. As a result of the principal component analysis, it was seen that all scales were with one factor in all groups and explained variances were 39% and above. The ranges of the factor loads obtained from the analysis were given in Table 1.

Table 1. The Ranges of Factor Loadings for Each Group and Each Scale

Variables	Groups				
	Females	Males	Anatolian High School	General High School	Vocational High School
Mathematics Self-Concept	0,795-0,856	0,796-0,864	0,674-0,864	0,796-0,864	0,528-0,866
Instrumental Motivation for Mathematics	0,810-0,877	0,830-0,866	0,783-0,874	0,839-0,880	0,806-0,854
Mathematics Interest	0,853-0,919	0,848-0,897	0,870-0,915	0,841-0,896	0,821-0,917
Mathematics Anxiety	0,584-0,815	0,633-0,825	0,630-0,812	0,651-0,825	0,628-0,817
Mathematics Self-Efficacy	0,565-0,747	0,582-0,724	0,531-0,715	0,526-0,728	0,639-0,749
Mathematical Behavior	0,404-0,765	0,433-0,788	0,455-0,831	0,310-0,746	0,530-0,835

When Table 1 was examined it was seen that factor loads for all groups and for all scales weren't equal. It was also seen that the mean and standard deviations (variances) of each item were not equal. Accordingly, it was decided that measurements obtained with these scales were not parallel measurements but congeneric measurements. So, McDonald's ω coefficient based on factor model was used to calculate the variability coefficients (McDonald, 1999). First, confirmatory factor analysis was conducted for all groups and each variable to calculate McDonald's ω coefficient and hereat it was calculated by using non-standardized factor loads obtained and non-standardized errors for each item.

After the principal component analysis, McDonald ω reliability coefficient was calculated for each variable dealt with in the research. McDonald ω reliability coefficients calculated for all groups and variables were given in Table 2. Since all reliability coefficients are over 0,90, it can be said that the reliability of the scales are appropriate.

Table 2. McDonald ω Reliability Coefficients Calculated for Each Group and Scale

Variables	Groups				
	Females	Males	Anatolian High School	General High School	Vocational High School
Mathematics Self-Concept	0,937	0,968	0,952	0,934	0,971
Instrumental Motivation for Mathematics	0,930	0,925	0,922	0,935	0,924
Mathematics Interest	0,946	0,959	0,940	0,948	0,943
Mathematics Anxiety	0,903	0,912	0,908	0,919	0,908
Mathematics Self-Efficacy	0,950	0,956	0,958	0,943	0,944
Mathematics Behavior	0,927	0,923	0,943	0,917	0,926

"Mathematics Literacy Test" from PISA 2012 was used to predict the variable of mathematics literacy. However, five plausible values included in the questionnaire and related to mathematics literacy were used instead of the total score obtained from the items in the test. The mathematics literacy test consists of three types of items which are open ended or unstructured, structured and multiple choice items. There are also seven content areas of mathematics literacy in this test: "Change and Relationships", "Space and Shape", "Quantity", "Uncertainty and Data" and "Formulating", "Interpreting", "Employing" which were added in 2012 (OECD, 2014).

The latent predictor and observed variables gathered from the questions of ST29, ST37, ST42 and ST49 are given in Table 3. Mathematics Literacy variable is a latent variable and the observed variables of this are "plausible value-1", "plausible value -2", "plausible value -3", "plausible value -4" and “plausible value -5”. As it was advised in PISA technical report, the model was established again for all these probable values and it was examined by calculating the means of fit indexes and path coefficients (OECD, 2014, p.147).

Table 3. Latent Predictor Variables and Observed Values of the Latent Variables

Latent Variables	Item Code	Observed Variables (Item)
Mathematics Interest	ST29Q01	I enjoy reading about mathematics.
	ST29Q03	I look forward to my mathematics lessons.
	ST29Q04	I do mathematics because I enjoy it.
	ST29Q06	I am interested in the things I learn in mathematics.
Instrumental Motivation for Mathematics	ST29Q02	Making an effort in mathematics is worth it because it will help me in the work that I want to do later on.
	ST29Q05	Learning mathematics is worthwhile for me because it will improve my career <prospects, chances>.
	ST29Q07	Mathematics is an important subject for me because I need it for what I want to study later on.
	ST29Q08	I will learn in mathematics many things in mathematics that will help me get a job.
Mathematics Self-Efficacy	ST37Q01	Using a <train timetable> to work out how long it would take to get from one place to another.
	ST37Q02	Calculating how much cheaper a TV would be after a 30% discount.
	ST37Q03	Calculating how many square meters of tiles you need to cover a floor.
	ST37Q04	Understanding graphs presented in newspapers.
	ST37Q05	Solving an equation like 3x+5= 17.
	ST37Q06	Finding the actual distance between two places on a map with a 1:10,000 scale.
	ST37Q07	Solving an equation like 2(x+3) = (x + 3) (x - 3).
	ST37Q08	Calculating the petrol consumption rate of a car.
Mathematics Anxiety	ST42Q01	I often worry that it will be difficult for me in mathematics classes.
	ST42Q03	I get very tense when I have to do mathematics homework.
	ST42Q05	I get very nervous doing mathematics problems.
	ST42Q08	I feel helpless when doing a mathematics problem.
	ST42Q10	I worry that I will get poor <grades> in mathematics.
Mathematics Self-Concept	ST42Q02	I am just not good at mathematics.
	ST42Q04	I get good <grades> in mathematics.
	ST42Q06	I learn mathematics quickly.
	ST42Q07	I have always believed that mathematics is one of my best subjects.
	ST42Q09	In my mathematics class, I understand even the most difficult work.
Mathematics Behavior	ST49Q01	I talk about mathematics problems with my friends.
	ST49Q02	I help my friends with mathematics.
	ST49Q03	I do mathematics as an <extracurricular> activity.
	ST49Q04	I take part in mathematics competitions.
	ST49Q05	I do mathematics more than 2 hours a day outside of school.
	ST49Q06	I play chess.
	ST49Q07	I program computers.
	ST49Q08	I participate in a mathematics club.

Data Analysis

Multigroup hybrid model was used to analyze the data. Hybrid model, known as structural regression model or LISREL model, is a synthesis of path and measurement models. For this reason, it can be defined as the most general model of all structural equation models. Hybrid model provides testing the hypotheses about the reason effect pattern as it is in the path analysis. Unlike path analysis, these effects can also include implicit variables since hybrid model can also combine with a measurement model representing the observed variables as an indicator of the factors as it is in the confirmatory factor analysis. The advantage of the hybrid model is that it is more flexible since it examines the tests of hypothesis related to the analysis of both structural and measurement relations in one model (Kline, 2005). Briefly stated, hybrid model is used when the relations between implicit variables are needed to be examined and when there are observed variables related to these implicit variables. Multigroup hybrid modeling is used to examine if the established hybrid model differentiates in different groups. The diagrams and fit indices were examined by means of LISREL program. Also it was tested whether hybrid model varies by gender and school type being based on these fit indices. The Values of X^2/df, RMSEA, SRMR, CFI, NFI and NNFI from LISREL outputs were analyzed and interpreted. Kelloway (1998) states that R^2 determination coefficient should also be indicated in the studies. Therefore, R^2 coefficients were also analyzed in this study. Defined as explained or predicted variance R^2 shows the level of observed variables' explaining the latent variables or the level of independent variables' explaining the dependent variables (as cited in Haşlaman, 2005; Haşlaman and Aşkar, 2007). The fit indices values which are used to make interpretations for model fit are given in Table 4 (Kline, 2005):

Table 4. The Criterion Values for Fit Indices

Fit Indices	RMSEA	SRMR	GFI/ CFI/ NFI /NNFI
Perfect Fit	0,05	≤0,05	≥0,95
Good Fit	≤0,08	≤0,08	≥0,90

X^2/sd statistics were also examined to interpret the model fit as well as criterion values given in Table 4 although it is affected by the size of the sample and ignored in the researches because of this. If X^2/df is lower than 5, it shows adequate fit (Marsh and Hocevar, 1988, as cited in Sümer, 2000). Kline (2005) states that it means perfect fit if this is lower than 3.

In this step, the effect size of the path coefficients was examined as well as R^2 and fit indices. Kline (2005) states that if the path coefficient is lower than 0.10, it may be considered as "smaller" effect; values around 0.30 as "typical" or "medium" effect; and values > 0.50 as "larger" effect. The inter-variables path coefficients were interpreted according to these criteria in this study.

All missing data for gender and school type were deleted by listwise method before structuring the model, and then multi variable and single variable normality was checked in all data sets prepared for the analysis. Then it was found that most of the variables did not provide a normal distribution. Therefore, RMLE (restricted maximum likelihood estimation) method was used in the analysis and asymptotic covariance matrixes were created. Firstly, the model was structured and then the model fit, standardized factor loadings, error values, path coefficients and the level of significance were examined for each plausible value. Then the model was tested for all groups and model fit was analyzed for each group and each plausible value. Finally, the model was tested in terms of gender and school type as part of multi group according to each plausible value, the means of fit indexes and path coefficients of the model were calculated and their significances were examined together, and standardized factor loads and error values were studied separately for all plausible values.

Findings and Interpretation

In this section, findings and interpretations for each sub problem are included.

In the first sub problem of the study, the levels and the significance of the relationships in the hybrid model structured with instrumental motivation for mathematics (INSMOT), mathematics self-concept (SCONCEPT), mathematics anxiety (ANXMAT), mathematics interest (INTMAT), mathematics self-efficacy (SEFFICAC), mathematics behavior (BEHMAT) and mathematics literacy (PV1MATH-PV5MATH) were examined. In this direction, the path diagram in which the plausible value of PV1MATH was used as the variable was given in Figure 1 as an example.

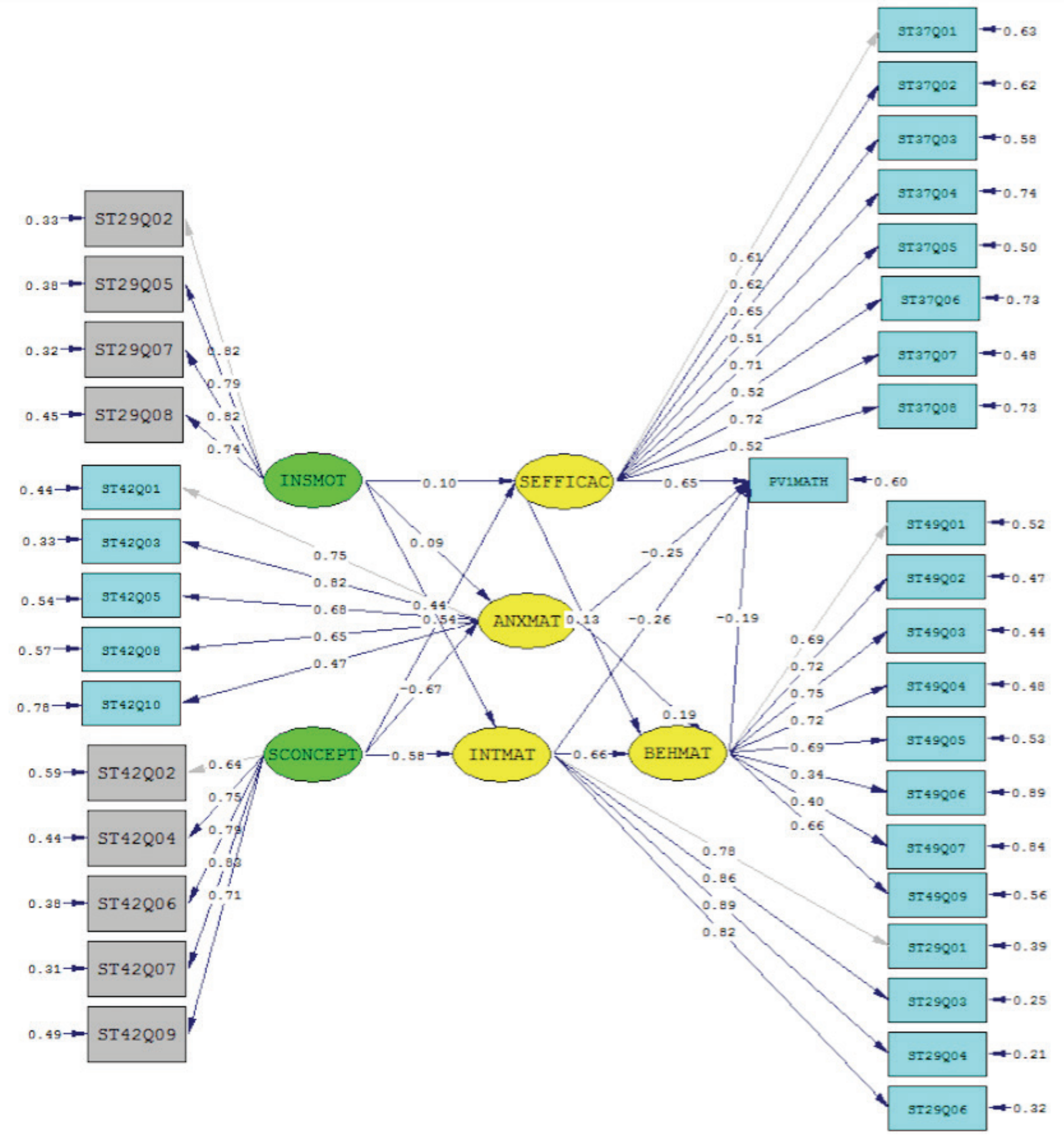

Figure 1. Path Diagram Related to Structured Hybrid Model (The example of PV1MATH)

When the models established for all probable values are examined as in Figure 1, it is seen that standardized factor loads for mathematical behavior range between 0,34 and 0,75 for all probable values, standardized errors related to the items range between 0,44 and 0,89 for all probable values except PV1MATH and between 0,43 and 0,89 for PV1MATH. It is seen that standardized factor loads for mathematics self-efficacy are between 0,51 and 0,72 for all probable values, standardized errors are between 0,48 and 0,74 for all probable values except PV4MATH and between 0,48 and 0,74 for PV4MATH. It is seen that standardized factor loads for mathematics anxiety are between 0,47 and 0,82 for PV1MATHT and PV4MATH; between 0,46 and 0,81 for PV12MATH and 0,46 and 0,82 for PV3MATH and PV5MATH; and standardized error values range between 0,33 and 0,78 for PV1MATH, PV3MATH and PV5MATH, and between 0,34 and 0,78 for PV2MATH and PV4MATH. The standard factor loadings for mathematics interest, instrumental motivation for mathematics and mathematics self-concept are respectively 0,78-0,89; 0,74-0,82 and 0,64-0,83 for all plausible values. In addition, the standardized error terms for those variables are respectively 0,21-0,39; 0,32-0,45 and 0,31-0,59 for all plausible values. Due to the fact that all the standardized factor loadings were higher than 0.30 and standardized error values were lower than 0.90, no items were excluded. When t values related to path diagram were analyzed, all of the values were found to be significant. All path coefficients and effect sizes obtained in the path diagram can be seen in Table 5.

Table 5. The Path Coefficients and Effect Sizes Defined in the Model

Paths	Path Coefficients	Effect Sizes
INSMOT->INTMAT	0,44 (p<0,05)	Medium Effect
INSMOT->ANXMAT	0,09 (p<0,05)	Small Effect
INSMOT->SEFFICAC	0,10 (p<0,05)	Small Effect
SCONCEPT->INTMAT	0,58 (p<0,05)	Large Effect
SCONCEPT->ANXMAT	-0,67 (p<0,05)	Large Effect
SCONCEPT->SEFFICAC	0,54 (p<0,05)	Large Effect
INTMAT->BEHMAT	0,66 (p<0,05)	Large Effect
INTMAT->MATLIT	-0,26 (p<0,05)	Medium Effect
ANXMAT ->BEHMAT	0,19 (p<0,05)	Small Effect
ANXMAT->MATLIT	-0,26 (p<0,05)	Medium Effect
SEFFICAC->BEHMAT	0,13 (p<0,05)	Small Effect
SEFFICAC->MATLIT	0,64 (p<0,05)	Large Effect
BEHMAT->MATLIT	-0,18 (p<0,05)	Small Effect

When Table 5 is analyzed, it is observed that the highest path coefficient is the coefficient predicting mathematics anxiety from mathematics self-concept (-0.67) and the coefficient predicting mathematics behavior from mathematics interest (0.66). The lowest path coefficients are the predict mathematics anxiety from instrumental motivation (0,09) and the coefficient predicting mathematics self-efficacy from instrumental motivation (0,10).

When the coefficients related to predicting mathematics behavior variable were analyzed, it was found that the highest path coefficient belonged to mathematics interest (0.66) and the lowest one belonged to mathematics self-efficacy (0.13). The coefficient of determining mathematics behavior for Hybrid model was R^2=0,44.

When the coefficients which are related to predicting mathematics literacy were analyzed, it was found that the highest path coefficient was the one belonging to mathematics self-efficacy was (0.64) and the lowest one belonged to mathematics behavior (-0.18). The coefficient of determination for mathematics literacy for structured hybrid model was R^2=0,39. The fit indices for hybrid model indicated that RMSEA= 0,065; SRMR=0,069; X^2/df=7,13; CFI=0,96, NFI=0,95 and NNFI=0,96. RMSE and SRMR values pointed out that the model showed great fit, and CFI, NFI and NNFI showed perfect fit. X^2/df was higher than 5.00, which indicated that this model was discordant. However, as the sample is very big in terms of the study and X^2 is a statistics affected easily by the sample size, this value can be ignored.

In the second sub problem of the study, in order to examine if the hybrid model structured with instrumental motivation for mathematics, mathematics self-concept, mathematics anxiety, mathematics interest, mathematics self-efficacy, mathematics behavior and mathematics literacy vary in terms of gender and school type, apart from the other research problem, multi group hybrid model was structured and the fit indices were examined for all plausible values. In Table 6, the average of fit indices by each gender type and overall can be seen.

Table 6. The Average of Fit Indices for Gender

	RMSEA	SRMR	X^2/df	CFI	NFI	NNFI
Females	0,064	0,066	3,94	0,96	0,95	0,96
Males	0,061	0,074	3,69	0,96	0,95	0,96
Gender	0,064		3,93	0,96	0,95	0,96

The values in Table 6 were compared to the critical values in Table 3. Accordingly, in the hybrid model structured only for males and only for females, X^2/df showed adequate fit as it was lower than 5, RMSEA and SRMR showed good fit as they were lower than 0.08, and CFI, NFI and NNFI values showed perfect fit as their values were equal to 0.95 or higher than this. As a result, model-data fit was achieved for each group (male group and female group) separately. When the multigroup hybrid model was analyzed in terms of gender, RMSEA showed a good fit (≤0,08) and CFI, NFI and NNFI values indicated perfect fit (≥0,95).This fit values prove that the structured model is the same for females and males.

When the path diagram in terms of gender is analyzed, it is seen that the standard factor loadings for mathematics behavior change between 0.31 and 0.74 for all plausible values, the standard error related to items changes between 0.46 and 0.91 except for PV3MATH; only PV3MATH they are between 0,45 and 0,91. The standard factor ladings for mathematics self-efficacy change between 0.51 and 0.74, and the standard error related to items changes between 0.45 and 0.74 for all plausible values. It is seen that standardized factor loads for mathematics anxiety are between 0,47 and 0,82 for PV1MATH and PV4MATH, between 0,46 and 0,81 for PV2MATH, between 0,46 and 0,82 for PV3MATH and PV5MATH, and standardized error values are between 0,33 and 0,78 for PV1MATH, PV3MATH and PV5MATH, between 0,34 and 0,78 for PV2MATH and PV4MATH. The standard factor ladings for mathematics interest, instrumental motivation for mathematics and mathematics self-concept respectively change between 0,78 and 0,89; 0,74 and 0,82; 0,64 and 0,83, the standard errors related to items are respectively 0,21-0,39; 0,33-0,45 and 0,31-0,58 for all plausible values. When t values related to path diagram were analyzed, all of the values were found significant. In addition, all path coefficients and effect sizes can be seen in Table 7.

Table 7. Path Coefficients and Effect Sizes Related to the Structured Model According to Gender

Paths	Path Coefficient	Effect Sizes
INSMOT->INTMAT	0,44 (p<0,05)	Medium Effect
INSMOT->ANXMAT	0,11 (p<0,05)	Small Effect
INSMOT->SEFFICAC	0,12 (p<0,05)	Small Effect
SCONCEPT->INTMAT	0,57 (p<0,05)	Large Effect
SCONCEPT->ANXMAT	-0,69 (p<0,05)	Large Effect
SCONCEPT->SEFFICAC	0,53 (p<0,05)	Large Effect
INTMAT->BEHMAT	0,67 (p<0,05)	Large Effect
INTMAT->MATLIT	-0,25 (p<0,05)	Medium Effect
ANXMAT ->BEHMAT	0,18 (p<0,05)	Small Effect
ANXMAT->MATLIT	-0,26 (p<0,05)	Medium Effect
SEFFICAC->BEHMAT	0,11 (p<0,05)	Small Effect
SEFFICAC->MATLIT	0,64 (p<0,05)	Large Effect
BEHMAT->MATLIT	-0,20 (p<0,05)	Medium Effect

When Table 7 was analyzed, it was seen that the highest path coefficient that belonged to mathematics self-concept as the predictor of mathematics anxiety was -0,69 and the second highest coefficient that belonged to mathematics interest as the predictor of mathematics behavior was 0,67. The lowest path coefficient that belonged to instrumental motivation for mathematics as the predictor of mathematics anxiety was 0,11 and the second lowest coefficient that belonged to instrumental motivation for mathematics as the predictor of mathematics self-efficacy was 0,12.

When the coefficients that predicted mathematics behavior, it was found that the highest path coefficient that belonged to mathematics interest was 0.67 and the lowest path coefficient that belonged to mathematics self-efficacy was 0.11. The coefficient for gender variable to determine mathematics behavior was R^2=0,45.

When the coefficients that predicted mathematics literacy, it was found that the highest path coefficient that belonged to mathematics self-efficacy was 0,64 and the lowest path coefficient that belonged to mathematics behavior was -0.20. The coefficient for gender variable to determine mathematics literacy was R^2=0,38.

In the third and the last sub problem of the study, multigroup hybrid model was structured in order to examine if the hybrid model structured with instrumental motivation for mathematics, mathematics self-concept, mathematics anxiety, mathematics interest, mathematics self-efficacy, mathematics behavior and mathematics literacy vary in terms of school type, and the fit indices were examined for all plausible values. In Table 8, you can see the average of fit indices by each school type and overall.

Table 8. The Average of Fit Indices for School Type

	RMSEA	X^2/df	SRMR	CFI	NFI	NNFI
General High School	0,063	2,67	0,078	0,96	0,94	0,96
Anatolian High School	0,062	2,26	0,076	0,97	0,94	0,97
Vocational High School	0,067	2,62	0,083	0,96	0,93	0,95
School Types	0,068	2,67		0,95	0,93	0,95

The values in Table 8 were compared to the critical values in Table 4. In the structural equation model which was created separately for each school type, X^2/df showed good fit as it was lower than 3. RMSEA and SRMR showed good fit as they were lower than 0.08, and CFI, NFI and NNFI values showed perfect fit as their values were equal to 0.95 or higher than this. As a result, model-data fit was achieved for each group separately. When the multi group hybrid model was analyzed in terms of school type, RMSEA showed a good fit (≤0,08) and CFI, NFI and NNFI values indicated perfect fit

(≥0,95). As a result, this model-data fit was the same for each school type (general high school, Anatolian high school and vocational high school) individually.

When the multi group hybrid model was analyzed in terms of school type, it was found that X^2/df, RMSEA and NFI (RMSEA≤0,08; NFI≥0,90) had a good fit, X^2/df, CFI and NNFI (X^2/df≤3,CFI; NNFI≥0,95) had a perfect fit. These fit values prove that the structured model is the same for all school types (general high school, Anatolian high school and vocational high school).

When the path diagram in terms of school type is analyzed, it is seen that the standard factor loadings for mathematics behavior change between 0.33 and 0.76 for PV2MATH, PV3MATH and PV5MATH, 0,33 and 0,75 for PV1MATH and PV4MATH, the standard error related to items changes between 0.43 and 0.89 for all of plausible values. The standard factor ladings for mathematics self-efficacy change between 0.48 and 0.66 except for PV3MATH, only for PV3MATH they are between 0,47 and 0,66, the standard error related to items changes between 0.57 and 0.77. The standard factor loadings for mathematics interest, mathematics anxiety, instrumental motivation for mathematics and mathematics self-concept change respectively between 0,78 and 0,89; 0,49 and 0,82; 0,72 and 0,82; 0,65 and 0,84, the standard errors related to items are respectively 0,20-0,40; 0,33-0,76; 0,34-0,48 and 0,29-0,58 for all plausible values. When t values related to the path diagram were analyzed, all of the values were found to be significant. All path coefficients and effect sizes can be seen in Table 9.

Table 9. Path Coefficient And Effect Sizes Related to the Structured Model in Terms of School Type

Paths	Path Coefficients	Effect sizes
INSMOT->INTMAT	0,44 (p<0,05)	Medium Effect
INSMOT->ANXMAT	0,07 (p<0,05)	Small Effect
INSMOT->SEFFICAC	0,13 (p<0,05)	Small Effect
SCONCEPT->INTMAT	0,57 (p<0,05)	Large Effect
SCONCEPT->ANXMAT	-0,64 (p<0,05)	Large Effect
SCONCEPT->SEFFICAC	0,54 (p<0,05)	Large Effect
INTMAT->BEHMAT	0,58 (p<0,05)	Large Effect
INTMAT->MATLIT	-0,12 (p<0,05)	Small Effect
ANXMAT ->BEHMAT	0,16 (p<0,05)	Small Effect
ANXMAT->MATLIT	-0,24 (p<0,05)	Medium Effect
SEFFICAC->BEHMAT	0,21 (p<0,05)	Medium Effect
SEFFICAC->MATLIT	0,44 (p<0,05)	Large Effect
BEHMAT->MATLIT	-0,16 (p<0,05)	Small Effect

When Table 9 is analyzed, it is observed that the highest path coefficients that belong to mathematics self-concept as the predictor coefficient of mathematics anxiety is -0.64, mathematics interest as the predictor coefficient of mathematics literacy is 0.58, mathematics self-concept as the predictor of math interest is 0.57. The lowest path coefficient belongs to instrumental motivation for mathematics as the predictor coefficient of mathematics anxiety (0,07) and instrumental motivation for mathematics as the predictor of mathematics self-efficacy (0,13).

When the coefficients related to predicting mathematics behavior variable are analyzed, it is observed that the highest path coefficients that belong to math interest was 0,58 and the lowest one that belongs to mathematics anxiety is 0.16. The coefficient for school type to determine mathematics behavior is R^2=0,43.

When the coefficients related to predicting mathematics literacy were analyzed, it was found that the highest path coefficients that belonged to mathematics self-efficacy was 0.48 and the lowest one that belonged to mathematics interest was -0.12. The coefficient for school type to determine mathematics literacy was R^2=0,22.

Conclusion and Suggestions

In the study, the hybrid model constructed by the instrumental motivation for mathematics, mathematics self-concept, mathematics self-efficacy, mathematics anxiety and mathematics interest, mathematics behavior and mathematics literacy of the students who attended PISA 2012 from Turkey was tested, and it was examined whether the model varies in terms of gender and school type (general high school, Anatolian school and vocational high school). Because the students' interest towards mathematics is high, it can be considered that this interest has an important role for students in speaking to friends about mathematics, helping friends or attending mathematical activities. The results of the study revealed that structured model predicted 44% of mathematics behavior and 39% of mathematics literacy.

The results of the study revealed that the strongest predictor of mathematics literacy was mathematics self-efficacy. It can be stated that the increase of mathematics self-efficacy level of the students helped students' mathematics literacy level to increase. There are similar studies about the mathematics self-efficacy as a predictor of mathematics literacy (Pajares & Miller, 1994; Bourquin, 1999; Migray, 2002; Yılmaz, 2006; Kitsantas, Cheema, & Ware, 2011; Duran, & Bekdemir, 2013). There are also some other studies which examine that mathematics self-efficacy is a strong predictor of mathematics literacy in international exams (Ferla et al., 2009; Liu, 2009; Doğan & Barış, 2010; İş Güzel & Berberoğlu, 2010; Yıldırım, 2011; Lee & Stankov, 2013; Koğar, 2015). If the students feel confident in mathematic questions, it is possible that the level of anxiety and stress decreases and mathematics literacy increases. One of the reasons for these relations is that mathematics self-efficacy items in PISA 2012 have some similar points with the items that are used to determine mathematics literacy since mathematics self-efficacy items are often the ones which include the cognitive processes like "I can solve the problems like 3x+5=17".

Mathematics interest is a negative predictor of mathematics literacy in the structured model; that is to say, even though the students have a strong interest in mathematics, it can be said that PISA mathematics literacy levels are low or vice versa. There are PISA studies in the literature that have similar results to this study (Liu, 2009; İş Güzel & Berberoğlu, 2010; Akyüz & Satıcı, 2013; Lee & Stankov, 2013). There may be many other reasons of the negative relationship between mathematics interest and mathematics literacy. Mathematics literacy is considered differently from mathematics success and in the event of that the students show great performance for mathematic, mathematics interest may decrease, and this may be one of these reasons (İş Güzel & Berberoğlu, 2010).

It was found that mathematics anxiety predicted mathematics literacy negatively in the structured model. It can be stated that the increase in the level of mathematics anxiety may cause mathematics literacy level to decrease or vice versa. There are PISA studies in the literature that have similar results to this study (Thomson, Cresswell, & De Bortoli, 2004; Lee, 2009; Liu, 2009; Yıldırım, 2011; Ferla et al., 2009; Lee & Stankov, 2013). As low success in mathematics and negative experiences in the past may increase negative feelings such as anxiety and fear, a decrease in students' mathematics literacy level may occur.

It was determined that mathematics behavior predicted mathematics literacy negatively in the model. It can be stated the mathematics behavior of the students may cause mathematics literacy level to decrease. In Akyüz and Satıcı's study (2013), which was carried out for PISA 2003, it was stated that the group activities they carried out affected mathematics literacy significantly in a negative way.

In the analysis conducted to see if the structured model showed a significance in terms of gender, it was determined that the model showed a good degree of fit in both groups. It can also be stated that the hybrid model is the same for male and female students, that is to say it is valid. In PISA 2012 Turkey reports, it was stated that mathematics literacy variable didn't reveal a significant difference in gender groups in terms of (MEB, 2015). In addition, the variables included in the study predict 45% of mathematics behavior and 38% of mathematics literacy.

When all predictor variables for mathematics behavior in terms of gender were examined, it was observed that all of these variables are positive predictors. Furthermore, it was found that mathematics interest had the strongest effect whereas mathematics self-efficacy had the weakest effect. When all predictor variables of mathematics literacy were analyzed, it was found that mathematics self-efficacy was a positive predictor which had the greatest effect. It was seen that mathematics behavior, mathematics interest and mathematics anxiety variables were negative predictors which had medium effect. Therefore, it can be concluded that mathematics self-efficacy variable was a stronger predictor than mathematics behavior, mathematics anxiety and mathematics interest. Similar to the results of this study, Liu (2009) stated that mathematics self-efficacy was the best predictor of mathematics literacy at significant and positive level in the data of United States and Hong Kong. In addition, mathematics interest was found to be a negative and significant predictor in terms the data from the USA and, unlike the results of this study, mathematics interest was found to a positive and significant predictor in the data of Hong Kong.

According to the analysis in terms of school type, it was stated that the structured model showed a good fit for each school type. It can be said that this model-data fit was the same or relevant for each school type (general high school, Anatolian high school and vocational high school) individually. In addition, the variables included in the structured model explain 43% of mathematics behavior and 22% of mathematics literacy. It may be stated that there may be other variables which affect mathematics literacy. The average success of each school is different (MEB, 2015). This difference may have caused the increase in the variance which shows mathematics literacy. When all predictor variables for mathematics behavior in terms of school type were examined, it was observed that all of these variables are positive predictors. Furthermore, it was observed that mathematics self-efficacy had the strongest effect whereas mathematics behavior, mathematics anxiety and mathematics interest were the negative predictors. In addition, mathematics self-efficacy had the strongest effect while mathematics interest had the weakest effect in predicting mathematics literacy. It can be stated that, compared to mathematics behavior, mathematics anxiety and mathematics interest, mathematics self-efficacy is a stronger predictor.

According to the results of this research, it was found that the best precursor of mathematics literacy was mathematics self-efficacy. When the subscale employed to measure mathematics self-efficacy, it is observed that there are items related to the students' self-confidence in solving mathematical problems and using mathematics in daily life. Thus, existing of the activities to increase students' self-confidence in curriculums, associating mathematics with daily life in classroom environment and teachers' considering these in mathematics tasks they give to the students will increase mathematics self-efficacy of the students and as well as being helpful to increase their mathematics literacy. Besides, since the best precursor of the mathematical behavior is mathematics interest, it can be recommended to vary in school mathematics activities and apply them regularly by the cooperation of school administrators and teachers in order to increase the mathematics interest of the students. The field of application will be provided to be wider by reflecting such changes to curriculums and educational environments by policy makers.

In this study, a hybrid model, which is considered to affect mathematics literacy and mathematics behavior in PISA 2012 project, was structured. Model validity was tested in terms of gender and school type. The comparisons of the structured model can be made in terms of different countries. Applying different models by adding different latent variables into this model will help to determine mathematics literacy and mathematics behavior more clearly. In addition, researchers can structure a new multi-group hybrid model by addressing science literacy and reading skills instead of the mathematical literacy variable that handled in this research, or can examine the variables that affected mathematical, science literacy and reading skills by using different statistical methods (hierarchical linear model, path analysis, multiple regression, etc.).

References

Ada, S. (2015). Looking for PISA 2012 problem solving indices in terms of different countries. *International Journal of Innovative Research in Education, 2*(1), 32-38.

Akgül, G., Çokamay, G., & Demir, E. (2016). Predictors of teacher support: Turkey and Shanghai in the programme for international student assessment, 2012. *Eurasian Journal of Educational Research*, *63*, 115-132.

Akyüz, G., & Pala, N. M. (2010). The effect of student and class characteristics on mathematics literacy and problem solving in PISA 2003. *Ilkogretim Online*, *9*(2), 668-678.

Akyüz, G., & Satıcı, K. (2013). PISA 2003 verilerine göre matematik okuryazarlığının çeşitli değişkenler açısından incelenmesi: Türkiye ve Hong Kong-Çin modelleri. *Kastamonu Eğitim Dergisi*, *21*(2), 503-522.

Bourquin, S. (1999). *The relationship among math anxiety, math self-efficacy, gender and math achievement among college students at an open admissions commuter ınstitution* (Unpublished doctoral dissertation). Ohio State University, Ohio. Retrieved form http://search.proquest.com/pqdtglobal/docview/304525484/fulltextPDF/255BB6DBE5A84D30PQ/1?accountid=11054"

Doğan, N., & Barış, F. (2010). Tutum, değer ve özyeterlik değişkenlerinin TIMSS-1999 ve TIMSS-2007 sınavlarında öğrencilerin matematik başarılarını yordama düzeyleri. *Eğitimde ve Psikolojide Ölçme ve Değerlendirme Dergisi*,*1*(1), 44-50.

Duran, M., & Bekdemir, M. (2013). Görsel matematik okuryazarlığı özyeterlik algısı görsel matematik başarısının anlamlı bir yordayıcısı mıdır?. *Pegem Eğitim ve Öğretim Dergisi*, *3*(3), 27-40.

Erten Tatlı, C., Atalan Ergin, D., & Demir, E. (2016). PISA 2012 türkiye verilerine göre öğrencilerin matematik anksiyetesinin sınıflandırıcıları. *İlköğretim Online*, *15*(2), 696-707.

Ferla, J., Valcke, M., & Cai, Y. (2009). Academic self-efficacy and academic self-concept: Reconsidering structural relationships. *Learning and Individual Differences*, *19*(4), 499-505.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th edt.). New York: McGram-Hill Companies.

Guiso, L., Monte, F., Sapienza, P., & Zingales, L. (2008). Culture, gender, and math. S*cience-New York then Washington*, *320*(5880), 1164.

Haşlaman, T. (2005). *Programlama dersi ile ilgili özdüzenleyici öğrenme stratejileri ile başarı arasındaki ilişkilerin incelenmesi: bir yapısal eşitlik modeli* (Unpublished master's thesis). Hacettepe University, Graduate School of Science and Engineering, Ankara.

Haşlaman, T., & Aşkar, P. (2007). Investigating the relationship between self-regulated learning strategies and achievement in a programming course. *Hacettepe University Journal Of Education*, *32*(32), 110-122.

İş Güzel, Ç., & Berberoğlu, G. (2010). Students' affective characteristics and their relation to mathematical literacy measures in the programme for international student assessment (PISA) 2003. *Eurasian Journal of Educational Research*, *40*, 93-112.

Karabay, E., Yıldırım, A., & Güler, G. (2015). Yıllara göre PISA matematik okuryazarlığının öğrenci ve okul özellikleri ile ilişkisinin aşamalı doğrusal modeller ile analizi. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, *1*(36), 137-151.

Kitsantas, A., Cheema, J., & Ware, H. W. (2011). Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics*, *22*(2), 310-339.

Kline, R. B. (2005). *Principles and practice of structural equation modeling: Methodology in the social sciences*. New York: The Guilford Press.

Koğar, H. (2015). Examination of factors affecting PISA 2012 mathematical literacy through mediation model. *Egitim ve Bilim*, *40*(179), 45-55.

Koyuncu, İ. (2015, April). PISA 2012 Türkiye verileri üzerinde matematik kaygısı, matematik özyeterliği ve cinsiyet değişkenlerinin yapısal eşitlik modellemesi ile incelenmesi. Paper presented at the *24. Ulusal Eğitim Bilimleri Kongresi.* Niğde University, Faculty of Education, Niğde.

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. *Learning and Individual Differences*, *19*(3), 355-365.

Lee, J., & Stankov, L. (2013). Higher-order structure of noncognitive constructs and prediction of PISA 2003 mathematics achievement. *Learning and Individual Differences*, *26*, 119-130.

Liu, O. L. (2009). An investigation of factors affecting gender differences in standardized math performance: Results from US and Hong Kong 15 year olds. *International Journal of Testing*, *9*(3), 215-237.

Liu, O. L., & Wilson, M. (2009). Gender differences in large-scale math assessments: PISA trend 2000 and 2003. *Applied Measurement in Education*, *22*(2), 164-184.

Marsh, H. W., & Hau, K. T. (2004). Explaining paradoxical relations between academic self-concepts and achievements: Cross-cultural generalizability of the internal/external frame of reference predictions across 26 countries. *Journal of Educational Psychology*, *96*, 56-67.

McDonald, R. P. (1999). *Test theory*. New Jersey: Lawrence Erlbaum.

MEB. (2015). *PISA 2012 ulusal nihai raporu.* Ankara: Eğitim Araştırma ve Geliştirme Dairesi Yayınları. Retrieved from http://pisa.meb.gov.tr/?page_id=22

Migray, K. (2002). *The relationships among math self –efficicay, academic self –concept and math achievement*. Unpublished doctoral dissertation, Arizona State University, Arizona. Retrieved from http://search.proquest.com/pqdtglobal/docview/304808217/fulltextPDF/5C09E640776E42AFPQ/1?accountid=11054

OECD. (2002). *PISA 2000 technical report.* Paris: OECD Publishing. Retrieved from https://www.oecd.org/pisa/pisaproducts/33688233.pdf

OECD. (2005). *PISA 2003 technical report*. Paris: OECD Publishing. Retrieved from https://www.oecd.org/edu/school/programmeforinternationalstudentassessmentpisa/35188570.pdf

OECD. (2014). *PISA 2012 technical report*. Paris: OECD Publishing. Retrieved from https://www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf

Özbay, C. (2015). *Investigation of Turkish students' performance in mathematics, reading, and science literacy in PISA 2012 data* (Unpublished master's thesis). Bilkent University, Ankara.

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: a path analysis. *Journal of Educational Psychology*, *86*(2), 193-203.

Pekrun, R., & Zirngibl, A. (2004). Schülermerkmale im fach mathematik [Student characteristics in mathematics]. In M. Prenzel, J. Baumert, W. Blum, R. Lehmann, D. Leutner, M. Neubrand, R. Pekrun, H. G. Rolff, J. Rost, & U. Schiefele (Eds.), *PISA 2003. Der Bildungsstand der Jugendlichen in Deutschland—Ergebnisse des zweiten internationalen Vergleichs* (pp. 191-210). Münster, Germany: Waxmann.

Sarıer, Y. (2010). Ortaöğretime giriş sınavları (OKS-SBS) ve PISA sonuçları ışığında eğitimde fırsat eşitliğinin değerlendirilmesi. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi*, *11*(3), 107-129.

Shin, J., Lee, H., & Kim, Y. (2006). Student and school factors affecting mathematics achievement international comparisons between Korea, Japan and the USA. *School Psychology International*, *30*(5), 520-537.

Segeritz, M., & Pant, H. A. (2013). Do they feel the same way about math? Testing measurement invariance of the PISA "students' approaches to learning" instrument across immigrant groups within Germany. *Educational and Psychological Measurement*, *73*(4), 601-630.

Stankov, L. (2013). Noncognitive predictors of intelligence and academic achievement: An important role of confidence. *Personality and Individual Differences*, *55*(7), 727-732.

Sümer, N., (2000). Yapısal eşitlik modelleri: Temel kavramlar ve örnek uygulamalar.*Türk Psikoloji Yazıları*, *3*(6), 49-73.

Thomson, S., Cresswell, J., & De Bortoli, L. (2004). *Facing the future: A focus on mathematical literacy among Australian 15-year-old students in PISA 2003*. Australia: Australian Council for Educational Research.

Uysal, S. (2015). Factors affecting the Mathematics achievement of Turkish students in PISA 2012. *Educational Research and Reviews*, *10*(12), 1670-1678.

Yıldırım, S. (2011). Öz-yeterlik, içe yönelik motivasyon, kaygı ve matematik başarısı: Türkiye, Japonya ve Finlandiya'dan Bulgular. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, *5*(1), 277-291.

Yılmaz, E. T. (2006). *Uluslararası öğrenci başarı değerlendirme programı (PISA)'nda Türkiye'deki öğrencilerin matematik başarılarını etkileyen faktörler* (Unpublished master's thesis). Hacettepe University, Institute of Social Sciences, Ankara.

Zhang, D., & Liu, L. (2016). How Does ICT Use Influence Students' Achievements in Math and Science Over Time? Evidence from PISA 2000 to 2012. *Eurasia Journal of Mathematics, Science & Technology Education*, *12*(9), 2431-2449.