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The Analysis of Factors Affecting the Mathematical Success of Turkish Students in the Pisa 2006 Evaluation Program with Structural Equation Modeling

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Abstract: In the scope of this research, of PISA 2006, it has been aimed to establish a structural equation modeling by constructing relations between the variables that are believed to be related to the Mathematical success grades and success grades of 15 year olds in Turkey. When the established structural equation modeling is analyzed; it has been determined that the variable that best predict the Mathematical success of students is "time". It has been stated that the second factor determining the Mathematical success is "education" which means that the education level of parents and an increase in the number of books in the house positively contributes to the Mathematical success of the students. In the model, established, it has been determined that there has been meaningful relationship on the positive way among Mathematical success and "environmet". In the model, there has been determined a positively low but incoherent relationship between the richness of the family "culture" and Mathematical success.

Key words: PISA 2006 · Structural equation modeling · Mathematical success

INTRODUCTION

In the various stages of education in our country, central examinations are held in order to select and place students wishing to continue the next educational institute. A vast majority of the central examinations held in Turkey are held by the Center for Student Selection and Placement (OSYM) and the rest are held by the Ministry of National Education. Apart from the measure and evaluation studies evaluating student success on a national level, The Ministry of National Education wish to compare our education system with other countries by participating in studies held internationally. Our country has joined the PISA study in the year 2003 which is a project of Evaluating the Success of International Students of OECD of whom we are, as a country, a founder member. Projects like TIMSS-R, PIRLS and PISA which compare international students, are projects which don't carry the characteristics of a competition and enables the participating countries to evaluate the development of their own education systems, mathematics and science knowledge of the students and knowledge and skill in the fields of reading in terms of years [1]. By focusing on reading skills and basic skills on mathematics and science The PISA project evaluates the degree to which students have gained these knowledge and skills in order to be able to completely take part in the society. On the basis of evaluating the success of international students project (PISA) 2006, this research aims to establish a linear structural model by establishing relationships between the variables that are believed to be related to the Mathematical success of 15 year old students in Turkey and the success in the given replies to the student survey.

The Aim and Importance of the Research: On the basis of evaluating the success of international students (PISA) 2006, this research aims to establish a linear structural model by establishing relationships between the variables that are believed to be related to the Mathematical success of 15 year old students in Turkey and the success in the given replies to the student survey.

In determining the factors affecting the academic success of our students, surveys applied in the PISA examination carry great importance. Determining the factors affecting the success of students and having modeling studies between success grades and student survey information state important results and holds an important place in the holding of scientific research.

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Problem Sentence: What is the general structural equation modeling explaining the relations between the mathematical success grades of students and the variables determining the learning time, the cultural richness of the family, the education environment, the education level of the parents in the program of evaluating the success of international students (PISA) of 15 year old students in Turkey?

METHOD

In this section, the type of research, determining of system and sampling and the explanation related to the analysis of the data has been stated.

Type of Research: The type of the research is an relational research as the relationship between the level of success in the Mathematical field and the survey results applied on the basis of evaluating the success of international students (PISA) of 15 year old students in Turkey is analyzed in the research.

A structural equation modeling has been established using exploratory and confirmatory factor analysis in this study. Structural equation model is a detailed statistical approach used in the trying "casual" relations between the measured and the hidden variables. The structural equation modeling joining the predicting structural relationship between the variables in the regression model and the hidden factor structures in the factor analysis [2]. With this aspect, this research is also a study which states the degree of the relationship between the variables.

The System and the Sampling of the Research: Population of the research is represented by 15 years old students in Turkey. The Sampling of the research is made up of 4942 15 year old students randomly chosen from 160 schools of 7 different geographical regions, 51 cities by categorizing according to region and type of school.

The Analysis of the Data: First of all, the questions taking place in the student survey have been determined in the analysis of the data by making use of basic component annoting factor analysis in order to determine the factors affecting Mathematical success. Factor Analysis is a widely used method enabling to define the factor with a new name by summing (grouping) the large number of units that can be used in explaining a formation (event, phenomenon) which is not related to each other especially in fields like social sciences, education sciences, medicine, psychology and sociology [3]. Whether the data is suitable for factor analysis has been checked with the Kaiser-Meyer-Olkin (KMO) coefficient and Barlett Sphericity test before proceeding to factor analysis [4]. The factor loads of the mass of questions and the core values of the factors has been analyzed by making use of the SSPS 15.0 program. Not all the questions in the survey have been taking into account in the study but the survey questions with the highest factor loads have been included in the study. The most important criterion here is using at least three questions in every single dimension [5]. The indices established by taking into account the factor analysis have been determined as the variables that are believed to predict the Mathematical success.

In the year of 1968, Karl Jöreskog has suggested casual models holding single staged analysis by using suitable statistical techniques. In this study, the LISREAL 8.7 program has been used in model establishing by using the observed variables determined by factor analysis and the implied variables these observed variables have predicted. With the help of this program, the data has been cleaned using the "listwise" method in the correlation matrixes established to test the different models. Kline [6] has stated that using the Asymtotic Covariance Matrix is suitable in cases where a part of the variables are linear and a part are continuous and using the Asymtotic Correlation Matrix is suitable where all the variables are linear. The Robust Maximum Likelihood Method and Asymtotic Covariance Matrix have been used in this research because the studies in this research are held on PISA data and because the variables on the survey are linear and categorical. In this research, variables and the relationship between them have been determined by using structural equality model and the degree of suitability of the suggested relations pattern and real data has been determined. There are different consistency benefaction indexes used in the evaluation of model suitability and there are statistical functions these indexes have. The most commonly used index in the suggested indexes are Ki Square suitability test ($\chi 2$), Root Mean Square Error of Approximation (RMSEA), the Square Root of Average Squares of the Standardized Errors (S-RMR), Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) [7]. The other Suitability measures Comparative Fit Index (CFI) and Non-Normed Fit Index (NNFI) values.

FINDINGS AND COMMENTS

The finding and the comments made out of the analysis of the data have been stated in this section of the research. As stated in the method section, indices

Table 1: The Consistency Index Values of the Model for the Mathematical Success

Chi-Square	DF	P-Value	CFI	NFI	AGFI	IFI	GFI	SRMR	RMSEA	90% C.I RMSEA
1602,18	177	0.00	0.99	0.99	0,82	0.99	0.86	0.10	0.043	0.041 ; 0.045

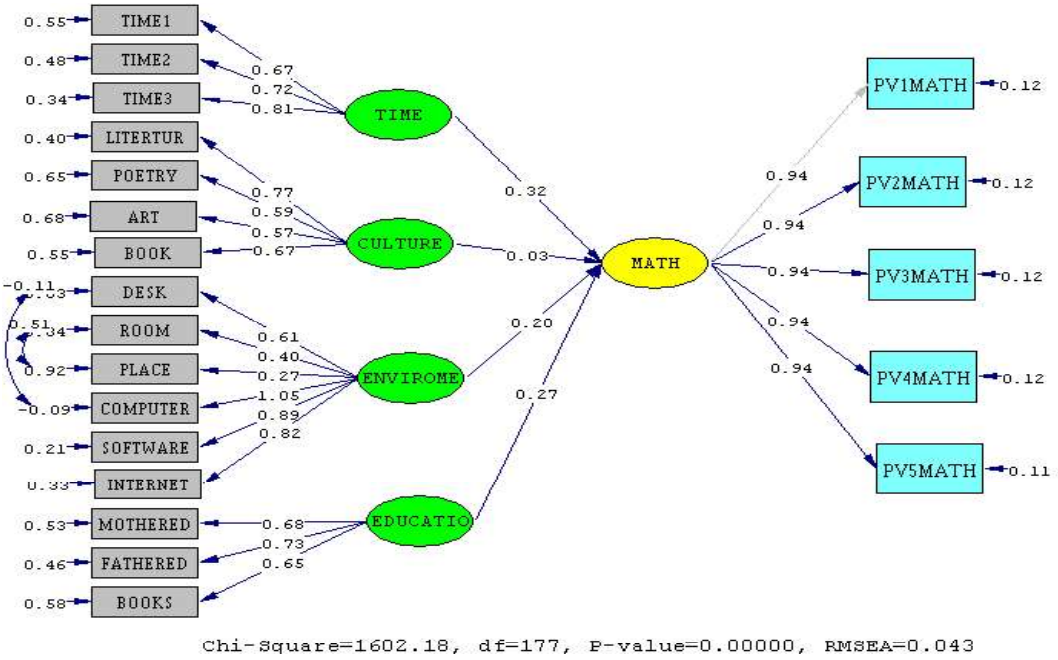

Fig. 1: Mathematical Structural Equation Model

established by taking into account the factor analysis have been determined as variables that are believed to predict the Mathematical success. Questions with the highest factor load have been included in this study and implied variables have been defined for the structural equating model with using LISREL 8.7 program [8].

After the determination of the Observed variables and the implied variables; the level of suitability of the suggested relations imply and the real data has been determined by specifying the variables that are believed to predict the Mathematical success and relations between them. In the development of the model, the correlations between some of the variables have been discharged by analyzing the modification indexes. The correlations between the room, working area, study desk and the computer have been discharged for this aim and the model has been tested again.As explained in the method section, the goodness of fit statistics used in the evaluation of model suitability and the found values are given in Table 1 below.

In Table 1; when the the consistency index results of the structural equation modeling have been analyzed, it is seen that the suitability between the model and the data is very high. The ki-square value of the the consistency statistics has been found to be meaningful. As McDonalds and M.Ho (2002), S.Engel, Moosbrugger and Müller (2003) & Thompson (2000) have stated, it is almost always very meaningful especially with very big sampling because the ki-square value is very sensitive to the sampling value. Jöreskog ve Sorbom (1993) & Marsh and Hocevar, (1988) state that the calculated GFI and AGFI values being higher than 0.90 and RMR and RMSEA values being 0.05 and lower show the perfect model-data suitability [9].The GFI consistency index value (0.86) and the AGFI consistency index value (0.82) of the model established in this study show that there is a quite sufficient level of suitability in model data suitability. The NFI (0.99), SRMR (0.10) and RMSEA (0.043) value found show that there is a perfect model-data suitability. The CFI (0,99) and IFI (0,99) values calculated through analysis show that the model data suitability is perfect. When all of the model data suitability related values are taken into consideration it is seen that the data suitability of the established model is very good. According to this, it is seen that the indexes found can explain the relations between the established models. LISREL analysis relation coefficients related to the variables that are believed to predict the Mathematical success and the relations between them are given in Figure 1.

When the Mathematical structural equation modeling is analyzed, it has been determined that the variable that best predict the Mathematical success of students and the most important factor determining success is "time". Relationship coefficient value has been found as γ=0,32. It has been determined that there is a positive linear relation between the time spared to learning and mathematical success. As they have stated in a study where Kubitschek, W.N & Hallinan, M.T & Arnett, S.M and Galipeau, K.S [10] researched the effects of differences made in a high school course program and the time lost, time is an important source for school [11,12,13]. But it is also stated that time is not an enough factor on its own and that a lot of factors such as the individual skill of the student, the quality of the teacher in teaching and school organization effect learning. Time spared to learning being determined as the variable that best predict success with the model established with this study puts forward that students increasing the time spared to Mathematics will enable to them to increase their Mathematical success as well. The variable with the highest factor load among the components of "time" implied variable is the student studying to the Mathematics classes at school and the time devoted (time 3) in order to do the home works related to the course is the observed variable. Time is a very important source for school. When the model is analyzed, the second most important factor determining Mathematical success is "education" which means that the education level of the parents and the increase on the number of books at home make a positive affect on the Mathematical success of the student. Connection coefficient value has been found as γ=0,27. In the modeling study he held with data of the 8th grade Cyprus students who joined the TIMSS, Papanastasiou [14] has found results indicating that the variable of family characteristics (the education level of the parents, the number of books at home) has a positive affect on the Mathematical success of the students. The variable with the highest factor among the components of the "education" implied variable is the father's level of education. According to this, the increase of the father's level of education positively affects the "education" implied variable and this makes a positive attribution to the student's Mathematical success. In the structural equality model established, it has been determined that there has been meaningful relationship on the positive way among Mathematical success and "environmet" and the coefficient value calculated as y=0.20. Accordingly, it has been observed that the opportunities students get such as having their own rooms, study desks, computers, computer programmes and the internet asist in students' Mathematical success in a positive way. In the model, there has been determined a positively low but incoherent relationship between the richness of the family "culture" and Mathematical success. Connection coefficient value is calculated as y = 0.03. The calculated relation having a value close to zero but incoherent also shows that there is not a relationship between two variables.

The stated coefficient value of the model has been determined as 0.35 when the regression equation of the implied variables predicted by the variables included in the structural equation model;

MAT = 0.32*time + 0.03*culture +0.20*environment + 0.27*education

Errorvar.= 0.65, R^2 = 0.35

With the four predicting variable stated and included in the regression equation it has been seen that %35 of the total variance in the mathematical success grade that is a dependent variable. As it is also seen in the regression equation; it has been determined that "time" variable devoted to learning is the variable that best predict the science success of the students.

RESULTS

On the basis of evaluating the success of international students program (PISA) 2006, this research aims to establish a structural equation modeling by constructing relations between the variables that are believed to be related to the Mathematical success grades and success grades of a group of 15 year olds in Turkey.

First of all, the questions taking place in the student survey have been determined in the analysis of the data by making use of basic components elucidating factor analysis in order to determine the factors affecting Mathematical success. The indices established by taking into account the factor analysis have been determined as the variables that are believed to predict the Mathematical success. In this study, structural equation modeling has been established in model establishing by using the observed variables determined by factor analysis and the implied variables these observed variables have predicted. By calculating the variables determined with the structural equality model established with this study and the relations between them, the degree of suitability of the

suggested relations patterns with the real data is specified. When the consistency index results of the structural equation established in the research is analyzed, it has been determined that the suitability between the model and the data is very high. When all the data related to the model-data suitability is taken into account, it is seen that the data suitability of the established model is very good. According to this, it is seen that the indexes found can explain the relations between the established models. When the Mathematical structural equation model is analyzed, it has been determined that the variable that best predict the Mathematical success of students and the most important factor determining success is "time". It has been determined that there is a positive linear relation between the time spared to learning and mathematical success. When the model is analyzed, the second most important factor determining Mathematical success is "education" which means that the education level of the parents and the increase on the number of books at home make a positive affect on the Mathematical success of the student. In the modeling study he held with data of the 8th grade Cyprus students who joined the TIMSS, Papanastasiou [14] has found results indicating that the variable of family characteristics (the education level of the parents, the number of books at home) has a positive affect on the Mathematical success of the students. In this model; the third factor affecting Mathematical success has been determined as "environment". In the light of this fact, it has been observed that the opportunities students get such as having their own rooms, study desks, computers, computer programmes and the internet asist in students' Mathematical success in a positive way. In the model, there has been determined a positively low but incoherent relationship between the cultural richness of the family "culture" and Mathematical success.

SUGGESTIONS

- If it is taken into account that the variable that best predict Mathematical success is "time", then it can be suggested that in order for students to increase their Mathematical success students should be efficient in order to increase the time they spare to Mathematical classes and related subjects. Connecting the information the student has gained with daily life, providing the student to notice where the student will need what he has learnt.
- When it is taken into account the second most important factor affecting Mathematical success is "education", it has been determined that an increase in the level of education of the parents positively effects the Mathematical success of the student. Apart from that it has been determined that the number of books in the house also make positive contribution to mathematical success. On this basis it can be suggested that parents hold activities that enable them to increase their level of education. Apart from that it can be suggested that parents spare time to reading at home and having suitable books for children at the house.
- It can be suggested that the structural equality model established by analyzing the PISA 2006 data be tried in different sub groups and conducting different studies by adding other variables.

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