USING PISA 2003, EXAMINING THE FACTORS AFFECTING STUDENTS' MATHEMATICS ACHIEVEMENT

ÖĞRENCİLERİN MATEMATİK BAŞARISINA ETKİLEYEN FAKTÖRLERİN PISA 2003 KULLANILARAK İNCELENMESİ

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ABSTRACT: The purpose of this study is to examine the effects of learning strategies on mathematics achievement. The sample was compiled from students who participated in Programme for International Student Assessment (PISA) in Turkey. The data consisted of 4493 15 years old Turkish students in 158 schools, and analyzed by two levels Bernoulli model as a special case of hierarchical generalized linear models. These clustered data set with a two level hierarchical structure examined students nested within different schools. Two levels Bernoulli model was used to estimate coefficients and modeled differences across schools. Results from this study indicate that school location, gender and interest in and enjoyment of mathematics variables had positive effects, and elaboration learning strategies variable had strong negative effects on mathematics achievement.

Keywords: hierarchical generalized linear model, learning strategies, mathematics achievement, pisa, two-level bernoulli model.

ÖZET: Bu çalışmanın amacı, öğrenme stratejilerinin matematik başarısı üzerine etkilerini incelemektir. Örneklem Türkiye'deki Uluslararası Öğrenci Değerlendirme Programına (PISA) katılan öğrencilerden oluşmaktadır. Bu veri 158 okulda 15 yaşındaki 4493 Türk öğrenciden oluşmaktadır. Analiz genelleştirilmiş hiyerarşik lineer modellerin özel bir durumu olan iki aşamalı bernoulli modeli ile yapılmıştır. Okullar ve okullar içindeki öğrencilerden meydana gelen kümelenmiş veri seti iki aşamalı hiyerarşik bir yapıda incelenmiştir. Çok aşamalı regresyon analizi kullanılarak katsayılar tahmin edilmiş ve okullar karşısında farklılıklar modellenmiştir. Bu çalışmanın sonucunda matematik başarısı için lokasyon, cinsiyet ve matematiğe olan ilgi değişkenlerinin pozitif ve detaylı öğrenme stratejisi değişkeninin de güçlü negatif etkiye sahip olduğu gösterilmiştir.

Anahtar Sözcükler: genelleştirilmiş hiyerarşik lineer model, öğrenme stratejileri, matematik başarısı, pisa, iki aşamalı bernoulli modeli.

1. INTRODUCTON

Programme for International Student Assessment (PISA) is based on a dynamic model of lifelong learning in which new knowledge and skills necessary for successful adaptation to a changing world are continuously acquired throughout life. PISA focuses on skills that 15 years olds will need in the future and seeks to assess their ability to perform them. PISA does assess students' knowledge, but it also examines their potential to reflect on their knowledge and experiences, and to apply that knowledge and those experiences to real-world issues (OECD, 2005a). PISA is an ongoing survey with a data collection every three years. The first PISA survey was conducted in 2000 in 32 countries. The second PISA survey was conducted in 2003 in 41 countries. This survey consisted of 4855 Turkish students in 159 schools.

There are three factors used in PISA 2003 to measure the strategies of learning mathematics. These are memorization/rehearsal learning strategies, elaboration learning strategies and control learning strategies. The studies show that the more the strategies are good, the more achievement in mathematics increases. We have chosen two of them and examined whether memorization/rehearsal learning strategies and elaboration learning strategies have a positive effect on achievement in learning mathematics.

In terms of memorization/rehearsal learning strategies there are different ways of learning such as; some students go over some problems in mathematics so often that they feel as if they could solve

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the problems in their sleep; when students study mathematics, some try to learn the answers to problems off by heart; in order to remember the method for solving a mathematics problem, they go through examples again and again, and they try to remember every step in a procedure. On the other hand, in terms of elaboration learning strategies there are also different ways of learning such as; some students often think of new ways to get the answer when the they are solving mathematics problems; some of them think how the mathematics they have learnt can be used in everyday life; some try to understand new concepts in mathematics by relating them to things they already know; some often think about how the solution might be applied to other interesting questions; and some try to relate the work to things they have learnt in other subjects.

Learning strategies refer to mental processes which help learners understand new information. Past studies have shown that students who use learning strategies that are more sophisticated typically show higher achievement (Lau and Chan, 2001; Valentine, DuBois & Cooper, 2004; Vermunt and Vermetten, 2004). Although researchers have devised various classification systems for learning strategies, nearly all of them include surface cognitive strategies, deep cognitive strategies (Gall, Gall, Jacobsen, & Bullock, 1990). Surface cognitive strategies refer to memorization skills, of which the most common is rehearsal (which includes repeating and reciting, e.g., Nolen, 1988; Graham and Golan, 1991). As memorizing information adds to one's knowledge base, especially during its early development, strategies that enhance memory performance are important for learning. For example memorization of mathematics rules fosters the mastery of basic mathematics skills, which provide a foundation to help students to solve more complex mathematics problems (Kantrowitz and Wingert, 1991). In the most of the studies in social sciences it is really useful, we also want to see whether it is useful for learning of mathematics or not.

One possible way of increasing learning is to transfer previously learned information to new situations through elaboration. Elaboration is a learning strategy that involves elaborating mathematics concepts beyond the topic at hand such as making connections to related areas and thinking about alternative solutions. These strategies help students' process information more deeply and flexibly transform it to facilitate successful problem solving. Therefore, we want to know whether a student who tries to make connection to related areas and who thinks more detailed about the subject is more successful or not.

The purpose of this study is to examine the effects of learning strategies on achievement in mathematics and to determine variables explaining successful and unsuccessful students on mathematics by two levels Bernoulli model approach. Students' mathematics achievement is a comprehensive result of multiple personal and educational factors. Therefore, this model has been used to estimate coefficients and modeled differences across schools.

1.1. Literature Review

Turkish 15-year-old students appear to be well motivated to learn mathematics. While they were just as interested in mathematics and enjoyed it as much as students in other countries as a whole, they believed more strongly in its usefulness to their future employment and education. So, we believed that interested in mathematics is important for mathematics achievement.

International scientific journals show that there are many studies on educational achievement in which the researchers, generally, have worked on mathematics, readings and science achievements of the students, and used multilevel regression analysis to test the level of achievements, by making comparative studies among countries,

The sources we have reviewed in our study are the studies deduced from PISA and TIMSS data sets. PISA is applied to 15 years old students whereas TIMMS is applied to the secondary school attending students, and in both studies, the mathematics achievements are measured.

One of the most important studies we have reviewed is Hammouri's analysis (2004) which examines the effects of student-related variables on achievement in mathematics. The sample consisted of 3736 13 years old Jordanian 8th-graders who participated in the Third International Mathematics and Science Study (TIMSS). TIMSS assesses the trends in students' mathematical and scientific achievement on a regular four year cycle. Results from this study indicate that four

attitudinal and motivational variables had strong positive total and two variables had negative total on mathematics achievement.

Some researches carried out comparative studies. As a comparative study between the United States and Hong Kong Wang (2004) used The Third International Mathematics and Science Study (TIMSS) data compare students from the US on the mathematics achievement and on a series of family background factors such as mothers' expectations, parental education, living with family members and extracurricular time spent in various activities. Results indicate that Hong Kong students outperformed their US counterparts in mathematics scores and some of the factors influenced Hong Kong and US students differently.

Throughout out investigations we have faced also large N comparative studies conducted among many countries. As a sophisticated example, Chow et al. (2007) examined whether strategies of memorization, transfer through elaboration and meta-cognition accounted for reading, science and mathematics achievement across 34 countries or not.158848 fifteen years old completed a reading literacy test and a questionnaire. Of these students, 88401 completed a science test and 88590 completed a mathematics test. It was analyzed the data using multilevel regressions and modeled differences across countries and across schools. Students who reported using memorization strategies often scored lower in all subjects. Transfer through elaboration wasn't significantly linked to any achievement scores.

Another large N comparative study is carried out by Chiu and Xihua (2008). They profoundly investigated family and motivation effects on student mathematics achievement across 41 countries. Family structure effects were stronger in individualistic or richer countries. Richer countries showed stronger family cultural communication effects, intangible resource effects.

The study of Mathematics and Science Self-Concept which is conducted on 290.000 students in 41 countries by Wilkins (2004) is the other large N study we reviewed. In this study Wilkins investigates the relationship between mean country mathematics and science self-concept, and respective mean country achievement and geographic region. Findings showed, at the student level, an overall positive relationship between achievement and self-concept in the countries investigated. However, at the country level, a negative relationship was found.

In the related literature the studies on the causes of low performance attract attention as cause and effect relationship analysis. Ramirez (2006) investigated causes for low performance in mathematics using TIMSS 1998/99 data in Chile. Hierarchical linear models found that, in Chile, school assets were unequally distributed across social classes, with schools in socially advantaged areas more likely to have their own mathematics curriculum and better prepared teachers who emphasized more advanced mathematics content. However, Yayan and Berberoğlu (2004) used principal component analysis on the same data, that is, TIMSS 1998/99. In this study, a linear structural model analyzed to explore factors that were influential in explaining students' achievement in mathematics.

Researchers and scholars often use multilevel models in the studies on students. As a matter of fact Wilcox and Clayton (2001) presented a multilevel model of weapon possession by students. It estimated multilevel main effects using hierarchical logistic regression methods and data from more than 6,000 students in 21 schools in Louisville, Kentucky. Results indicated that the likelihood of carrying a weapon to school varies not only across individuals but across schools. School-level structural characteristics - especially SES - were significant in accounting for some of this cross-school variation. Further, the effects of SES on weapon carrying were mediated by school capital and school deficits.

Diagnostic Readiness Test (DRT) scores and Pre-Admissions Test scores predict successes or failures of students taking examinations. Schmidt (2000) has conducted a study to examine the degree to which Diagnostic Readiness Test (DRT) scores and Pre-Admissions Test scores could predict success or failure on the National Council Licensure Examination for Registered Nurses (NCLEX-RN). Data were obtained from 5,698 students in 135 schools of nursing on three measures: DRT scores, Pre-Admissions Test scores, and success or failure on the NCLEX-RN. An approximation of a hierarchical logistic regression model was used in the analysis. Results indicate that the IRT was the

only significant predictor of NCLEX-RN performance and that the DRT was a stronger predictor for baccalaureate graduates than for non-baccalaureate graduates.

As a final one, we have reviewed Dunn, Chambers and Rabren study (2004) which is on learning disabilities and mental retardation. Actually, they examined factors predictive of dropping out of high school for students with learning disabilities (LD) and mental retardation (MR). The sample was composed of 228 students with LD or MR who dropped out of school and 228 students with LD or MR who had not dropped out. Two sets of predictor variables (student demographics and interview responses) were analyzed using hierarchical logistic regression analysis in terms of their relationship to the outcome variable of dropout.

2. METHODOLOGY

2.1 Data

The data analyzed in this research were obtained from PISA 2003 study. The PISA is a collaborative effort, involving 30 OECD countries and 11 partner countries, to measure how well 15-year-old students are prepared to meet the challenges of today's knowledge societies. The assessment looks to the future, focusing on young people's ability to use their knowledge and skills to meet real-life challenges, rather than on the mastery of specific school curricula.

The Turkish data for PISA 2003 were collected from a sample of 4855 fifteen-year-old students (girls and boys) who attend primary education in 159 schools (n=119), General high school (n=2414), Anatolian high school (n=200), High school with foreign language (n=624), Science high schools (n=63), Vocational high schools (n=619), Anatolian vocational high schools (n=435), Technical high schools (n=123) and Anatolian technical high schools (n=258) across78 provinces and 7 geographical provinces.

2.2. Measures and Variables

The data for this study include only 4493 students in 158 schools during the 2002-2003 academic year, because all students did not answer all questions. In this study, dependent variable is mathematics achievement (Y=1 if the score is over the Turkey's mathematics average score; Y=0 if not). Student level (level-1) variables consist of measure of interest in and enjoyment of mathematics, memorization/rehearsal learning strategies, elaboration learning strategies and one dummy variable indicating gender. School locations, student morale and commitment, school offering mathematics activities are the school level (level-2) variables.

2.3. Student level variables

Mathematics Achievement (Y_{ij}): Mathematics performance of a student has measured four subjects: Geometry, Algebra, Arithmetic and Probability. 85 different questions were asked to the students by means of a questionnaire. Outcome variable $\underline{Y}_{ij}$ = 1 if the score is over the Turkey's mathematics average score; Y_{ij} = 0 if not.

Gender (G): Student gender is recoded as 1 = male and 0 = female. 43.1% of the total sample was female and 56.9% male.

Interest in and enjoyment of mathematics (INTMAT): The PISA 2003 index of interest in and enjoyment of mathematics is derived from students' responses to the four items. A four-point scale with the response categories recoded as "strongly agree" (=0); "agree" (=1); "disagree" (=2); and "strongly disagree" (=3) is used. All items are inverted for IRT scaling and positive values on this index indicate higher levels of interest and enjoyment in mathematics.

Memorization/rehearsal learning strategies (MEMOR): The PISA 2003 index of memorization/rehearsal learning strategies is derived from students' responses to the four items measuring preference for memorization/rehearsal as a learning strategy for mathematics. A four-point scale with the response categories recoded as "strongly agree" (=0), "agree" (=1), "disagree" (=2) and "strongly disagree" (=3) is used. All items are inverted for IRT scaling and positive values on this index indicate preferences for this learning strategy.

Elaboration learning strategies (ELAB): The PISA 2003 index of elaboration learning strategies is derived from students' responses to the five items measuring preference for elaboration as a learning

strategy. A four-point scale with the response categories recoded as "strongly agree" (=0), "agree" (=1), "disagree" (=2) and "strongly disagree" (=3) is used. All items are inverted for IRT scaling and positive values on this index indicate preferences for this learning strategy.

2.4. School level variables

School locations (SLOC): School location is coded as 1 = village, 2 = small town, 3 = town, 4 = city and 5=large city. 9.6% of the total sample was small town, 32.7% town, 31.4% city and 26.3% large city.

Student morale (STMORALE): The PISA 2003 index of school principals' perceptions of student morale and commitment is derived from school principals' responses to measure the school principal's perceptions of students at school. The categories "disagree" and "strongly disagree" were transformed into one category for IRT scaling because of very few responses in the category of "strongly disagree". Response categories of four-point scale items are recoded as "strongly agree" (=1), "agree" (=2), and "disagree/strongly disagree" (=3). All items are inverted for IRT scaling and positive values on this index indicate principals' reports of higher levels of teacher morale and commitment.

School offering mathematics activities (MATHACT): The PISA 2003 index of mathematics activity index is derived from five items measuring what activities to promote engagement with mathematics occur at their school. The number of different activities occurring at school is counted.

2.5. Two levels Bernoulli models

Many social researches involve hierarchical data structures. Multilevel models recognize the existence of such data hierarchies by allowing for residual components at each level in the hierarchy. For example, a two-level model which allows for grouping of child outcomes within schools would include residuals at the child and school level. Thus the residual variance is partitioned into a between-school component (the variance of the school-level residuals) and a within-school component (the variance of the child-level residuals). The school residuals, often called 'school effects', represent unobserved school characteristics that affect child outcomes. These are unobserved variables which lead to correlation among outcomes for children from the same school.

There may be important cases that the assumptions of linearity and normality are not provided. For example binary outcome, *Y*, indicating graduation in the secondary school (*Y*=1 if a student graduates on time; *Y*=0 if not). The use of the standard level-1 model in these cases would be inappropriate. Because the predicted value of a binary outcome *Y*, must lie in the interval (0,1). A nonlinear transformation of the predicted value, such as a logit or probit transformation will satisfy this constraint. Given the predicted value of the outcome, the level-1 random effect can take on only one of two values and therefore, can not be normally distributed. The level-1 random effect can not have homogeneous variance (Raudenbush and Bryk, 2002). The level-1 model in Hierarchical Generalized Linear Models (HGLM) consists of three parts: a sampling model, a link function, and a structural model. The binary outcome model uses a binomial sampling model and a logit link.

Level-1 Sampling Model: Let Y_{ij} be the number of successes in m_{ij} trials and let φ_{ij} be the probability of success on each trial. Then we write

$$Y_{ij}\big|\varphi_{ij} \sim B\big(m_{ij},\varphi_{ij}\big) \tag{1}$$

to denote that Y_{ij} has a binomial distribution with m_{ij} trials and probability of success per trial as φ_{ij}. According to the binomial distribution, the expected value and variance of Y_{ij} are then

$$E\big(Y_{ij}\big|\varphi_{ij}\big) = m_{ij}\varphi_{ij}, \qquad Var\big(Y_{ij}\big|\varphi_{ij}\big) = m_{ij}\varphi_{ij}\big(1-\varphi_{ij}\big) \tag{2}$$

When $m_{ij} = 1$, Y_{ij} is a binary variable taking on a value of either zero or unity. This is a special case known as the Bernoulli distribution. The actual level-1 variance may be larger that assumed

(overdispersion) or smaller than that assumed (underdispersion). In this case a scaler variance component σ^2 can be estimated, so that the level-1 variance will be $\sigma^2 m_{ij} \varphi_{ij} \left(1 - \varphi_{ij} \right)$.

<u>Level-1 Link Function:</u> Several link functions are possible when the level-1 sampling model is binomial (Hedeker and Gibbons, 1994). The most common and convenient is the logit link, that is,

$$\eta_{ij} = log \left(\varphi_{ij} \, / \, 1 - \varphi_{ij} \right)$$

(3)

where η_{ij} is the log of the odds of success.

<u>Level-1 Structural Model:</u> A predicted log-odds can also be converted to a predicted probability by computing

$$\varphi_{ij} = \left(1 \, / \, 1 + exp \left(-\eta_{ij} \right) \right)$$

(4)

Clearly whatever the value of η_{ij}, applying Equation (4) will produce a value of φ_{ij} between zero and one.

<u>Level-2 and Level-3 Models:</u> In the case of two level analyses, the level-3 model has the same form as the level-2 model.

$$\beta_{qj} = \gamma_{q0} + \sum_{s=1}^{S_q} \gamma_{qs} W_{sj} + u_{qj}$$

(5)

where the random effects u_{qj}, $q=0,\ldots$, Q, constitute a vector u_j having a multivariate normal distribution with component means of zero and variance-covariance matrix T (Raudenbush et al., 2004).

3. FINDINGS AND RESULTS

Descriptive statistics are found in Table 1.

Table 1: Descriptive Statistics of the Continuous Predictors of School Performance

Variable Name	N	Mean	sd	Minimum	Maximum
ELAB	4493	0.44	1.09	-3.26	3.26
INTMAT	4493	0.56	1.06	-1.78	2.37
MEMOR	4493	0.09	0.98	-3.48	3.29
STMORALE	158	-0.26	1.20	-2.77	2.59
MATHACT	158	1.41	1.20	0	5

In this study, level-1 model is;
$$\eta_{ij} = \beta_{0j} + \beta_{1j}(G) + \beta_{2j}(ELAB) + \beta_{3j}(INTMAT) + \beta_{4j}(MEMOR)$$
where the level-2 model is;

(6)

$$\beta_{0j} = \gamma_{00} +) + \gamma_{01}(SLOC_{STOWN}) + \gamma_{02}(SLOC_{TOWN}) + \gamma_{03}(SLOC_{CITY})$$
$$+ \gamma_{04}(STMORALE) + \gamma_{05}(MATHACT) + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20} \qquad\qquad\qquad\qquad (7)$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$

Table 2 shows the multiple regression model output.

Table 2: Multiple Regression Model Output

Fixed Effects	Coefficients	Standard Deviation	Odds Ratio	Confidence Intervals
Intercept, γ_{00}	-0.3112*	0.3327	0.7325	(0.380;1.412)
Student Characteristics	Coefficients	Standard Deviation	Odds Ratio	Confidence Intervals
G, γ_{10}	0.5564*	0.0813	1.7444	(1.487;2.046)
ELAB, γ_{20}	-0.1066*	0.0463	0.8988	(0.821;0.984)
INTMAT, γ_{30}	0.4945*	0.0433	1.6396	(1.506;1.785)
MEMOR, γ_{40}	0.0460	0.0482	1.0471	(0.953;1.151)
School Characteristics	Coefficients	Standard Deviation	Odds Ratio	Confidence Intervals
SMALL TOWN, γ_{01}	-2.0578*	0.5555	0.1277	(0.043;0.382)
TOWN, γ_{02}	-1.0178*	0.3763	0.3613	(0.172;0.759)
CITY, γ_{03}	-0.6610**	0.3777	0.5163	(0.245;1.088)
LARGE CITY[a]	-			
STMORALE, γ_{04}	0.2666*	0.1313	1.3055	(1.008;1.692)
MATHACT, γ_{05}	0.3229*	0.1338	1.3811	(1.061;1.799)
Random Effects	Variance Components		df	Chi-square(χ^2)
u_{0j}	2.8048*		151	1310.0365

*p<.05, **p<.01, ***p<.001, [a]: Reference category

      Table 2 shows that, in general, school location was the most important variable on the mathematics achievement, because in the east part of Turkey there are lots of underdeveloped areas such as Muş, Batman, Şırnak. Therefore, education quality of those areas was not enough for a higher quality education. Also, lack of qualified teacher of schools in such type of areas is another problem in Turkey. Furthermore, students who live in a large city were more successful than students who live in a small city.

      Also, from the most to the least important variables on mathematics achievement are gender, interest in and enjoyment of mathematics, and school offering mathematics activities, respectively.

      In previous studies, it was shown that effect on mathematics achievement of gender was statistically significant in most countries. Overall, girls tended to outperform boys in overall reading

comprehension, where as boys outperformed girls in mathematics and science (Halpern, 2000). In this study, it was shown that males were more successful than females because the odds ratio for gender variable was 1.74. This means that males were 1.74 times more successful than females.

Student morale effected not only mathematics achievement but also students' daily life, so students' mood was important for mathematics achievement. Also good mood of students' in the school effects school achievement positively on mathematics. If one unit increases in student morale, results in the odds of mathematics achievement increase by the factor 1.31.

Elaboration learning strategy has significant and negative effect on mathematics achievement. However, effect of memorization/rehearsal learning strategy on success is not statistically significant.

It is shown that one unit increases in interest in and enjoyment of mathematics, results in the odds of mathematics achievement increase by the factor 1.64. Offering mathematics activities or number of mathematics activities in schools were related to mathematics achievement. Also one unit increases in school offering mathematics activities, results in the odds of mathematics achievement increase by the factor 1.38

4. CONCLUSIONS AND DISCUSSION

In this study, we have examined the factors affecting students' mathematics achievement, by using PISA 2003. We used multivariate statistical techniques to investigate the relationships between mathematics achievement, and gender, learning strategies, school locations, interest in and enjoyment of mathematics, student morale and school offering mathematics activities. Descriptive statistics of the continuous predictors of school performance are presented in Table 1. In the sample, of the participators 43.1% is female and 56.9% is male. However, the percentage of students living in each location ranged from 32.7% town, 31.4% city, 26.3% large city and 9.6% small town. Multiple regression model output is given in Table 2.

Mathematics achievement based on PISA has been discussed extensively elsewhere (eg., Chiu and Xihua, 2008, Chiu et al., 2008) and are discussed here only as it relates to the other variables on mathematics achievement using two level Bernoulli model which is a part of generalized hierarchical models.

This study used PISA 2003 data from Ministry of Education in Turkey. Data from 4493 students in 158 schools during the 2002-2003 academic years were used in the analysis. Only the students who have replied all questions on the questionnaire have been included in the sample. We analyzed the data with multilevel analyses using SPSS and HLM 6.04.

In our study, effects of all variables except memorization/rehearsal learning strategies variable are statistically significant. It was shown that school location is the most important variable on the mathematics achievement. Also, from the most to the least important variables on mathematics achievement are gender, interest in and enjoyment of mathematics and school offering mathematics activities, respectively.

The finding that memorization was negatively associated with achievement; researchers have argued that memorization is an inefficient strategy for learning new material (e.g., Czuchry and Dansereau, 1998). But the result that memorization was not linked to achievement. However, effect of memorization/rehearsal learning strategies on success is not statistically significant.

A substantial literature shows that promoting transfer from one aspect of learning to another, even within a domain, is extremely difficult (e.g., Bransford et al., 1986; Halpern, 1998). Although several studies (e.g., Czuchry and Dansereau, 1998) have indicated that relating material to one's own past experiences tends to learning, the results from this study suggest that questionnaire responses might not adequately measure student ability to transfer through elaboration. Also we observed that elaboration learning strategies have significant and negative effect on mathematics achievement.

As a result of this study, we suggest that mathematics activities which are offered by school management and interest in and enjoyment of mathematics should be increased for better mathematics achievement. In order to do that school management may arrange some mathematics activities such as mathematics competitions or seminars about using mathematics in daily life.

The most important variable on mathematics achievement is school location so that small areas such as villages and towns need for more moral and financial support. Because the mathematics

achievement in these types of areas is lower than other type of areas such as city and big city. Increasing the part of the national budged to be used for educational reforms in underdeveloped areas may be solved this problem.

The findings are very important for Turkish education system due to the fact that improving the learning strategies are much easier for achievement than changing background factors affecting students' performance. We thought that this study could be a resource for further national and international researches.

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GENIŞLETİLMİŞ ÖZET

Türk eğitim sistemi demokratik, modern, laik ve karma eğitim özelliklerine sahiptir. Bu sistemin amacı milli birlik ve bütünlüğe uygun olarak Türk toplumunun refah düzeyini arttırmak, ekonomik, sosyal ve kültürel gelişimini hızlandırıp desteklemektir.

Eğitim alanında yapılan ulusal değerlendirme çalışmalarının yanı sıra, uluslararası düzeyde konumumuzu belirlemek amacıyla eğitim göstergelerine ihtiyaç duyulmaktadır. Bu nedenle belirli referans noktalarına göre ülkemizin eğitim alanında hangi düzeyde olduğunun, giderilmesi gereken eksikliklerin ve alınması gereken tedbirlerin belirlenmesi ve bu sayede de eğitim düzeyinin yükseltilmesi amacıyla ülkemiz Uluslararası Öğrenci Değerlendirme Programı (PISA), Üçüncü Uluslararası Matematik ve Fen Araştırması (TIMSS), Uluslararası Okuma Becerilerinde Gelişim Projesi (PIRLS) gibi birçok projede yer almaktadır. OECD ülkesi olarak ülkemiz PISA projesine ilk olarak 2003 yılında katılmıştır. Ekonomik İşbirliği ve Kalkınma Örgütü OECD'nin bir eğitim projesi olan PISA, OECD Eğitim Direktörlüğü'ne bağlı PISA Yönetim Kurulu tarafından yürütülmektedir. PISA çalışması önde gelen endüstrileşmiş ülkelerdeki 15 yaş dolayındaki çocukların kazandıkları bilgi ve beceriler üzerinde 3'er yıllık aralarla yapılan bir çalışmadır. 2003 yılında uygulanan çalışmanın ana amacı matematik başarısını ölçmek olmasına rağmen genel başarı düzeyini ölçmekte de kullanılmaktadır.

PISA 2003 projesine 159 okul 4855 öğrenci katılmıştır. Bu çalışmanın veri seti Türkiye'de PISA 2003 çalışmasına katılan öğrencilerden oluşmaktadır. Kayıp veriler silindikten sonra 158 okuldaki 4493 öğrenci analize dahil edilmiştir. Bu çalışmanın amacı, matematikte öğrencilerin öğrenme stratejileri, okulun bulunduğu konum, okulun sağladığı matematik aktiviteleri, öğrencinin morali ve cinsiyeti değişkenlerinin matematik başarısı üzerindeki etkisini incelemektir. Bu amaç doğrultusunda çalışmada genelleştirilmiş lineer modellerden iki aşamalı Bernoulli modeli kullanılmıştır. Veri seti matematik ile ilgili değişkenler seçildikten sonra SPSS ve HLM 6.04 paket programları kullanılarak analiz edilmiştir. PISA verisi ile çok aşamalı Bernoulli modellerinin uygulandığı ulusal bir çalışmaya rastlanmamıştır, fakat eğitim alanında diğer projelerin verisi de kullanılarak uluslararası birçok çalışma yapılmıştır. Hammouri'nin (2004) yapmış olduğu çalışmada matematik başarısı üzerinde öğrencilerle ilgili değişkenlerin etkilerini incelemiştir. Veri seti Üçüncü Uluslararası Matematik ve Fen araştırmasına (TIMSS) katılan 13 yaşındaki 3736 Ürdünlü öğrenciden oluşmaktadır. TIMSS öğrencilerin matematik ve fen başarısını her dört yılda bir kere değerlendirmektedir. Bu çalışmanın sonuçları, matematik başarısı üzerinde kullanılan tutum ve psikolojik değişkenlerden dördünün pozitif, geriye kalan ikisinin negatif etkiye sahip olduğunu göstermektedir. Chow ve arkadaşları (2007) ise 34 ülke için okuma, fen ve matematik başarısı üzerinde öğrenme stratejilerinin etkilerini incelemişlerdir. Çalışmada çok aşamalı modeller kullanılarak analiz yapılmıştır, böylece ülkeler ve okullar arasındaki farklılıklar da modellenmiştir. Okuma, fen ve matematik başarısı üzerinde ezberlemeye dayalı öğrenme stratejisinin diğer stratejilere göre daha düşük puana sahip olduğu sonucuna ulaşılmıştır. Halpern (2000) ve Kantrowitz'in (1991) yapmış olduğu çalışmalarda da cinsiyet ve öğrenme stratejileri değişkenleri kullanılmıştır ve bu değişkenlerin matematik başarısını etkilediği gösterilmiştir.

Sağlık, eğitim, şirketlerin performans çalışmaları ve sosyal içerikli araştırmaların çoğu hiyerarşik veri yapısına sahiptir. Hiyerarşik lineer modeller regresyon yöntemlerinin genelleştirilmesidir. Bu modeller kümelenmiş ya da hiyerarşik yapıya sahip verilere uygulanabilmesi ve neden sonuç ilişkilerini daha iyi yansıtabilmesi sebebiyle oldukça önemlidir. Kümelenmiş yapıya sahip verilerle çalışırken, klasik doğrusal regresyon yönteminin varsayımlarından biri olan gözlemlerin birbirinden bağımsız olması varsayımı bozulduğundan bu tip verilere çok aşamalı regresyon modelleri uygulanmaktadır.

Bu çalışmada kullanılan çok aşamalı modellerde ilk aşama öğrencilerden, ikinci aşama ise öğrencilerin oluşturduğu okullardan meydana gelmektedir ve her aşama için ayrı regresyon modelleri kurulmuştur. Modeller birleştirilerek birleştirilmiş model meydana getirilmiş ve istatistiksel analizler yapılmıştır.

Uygulamamızda örneklemin %43'ünü kız öğrenciler, %57'sini ise erkek öğrenciler oluşturmaktadır. Bununla birlikte, mevcut veri setinin %9.6'sını küçük kasabalar, %32.7'sini kasabalar, %31.4'ünü şehirler ve %26.3'ünü de büyük şehirler oluşturmaktadır.

Yapılan analizler sonucunda ezbere dayalı öğrenme stratejisi dışındaki diğer değişkenlerin etkileri istatistiksel olarak anlamlı bulunmuştur. Matematik başarısı üzerinde ezbere dayalı öğrenme stratejisi değişkeni anlamlı ve negatif etkiye sahiptir. Okulun bulunduğu konum matematik başarısı üzerinde etkili olan önemli bir değişkendir. Öğrencinin morali sadece matematik başarısını değil, öğrencinin günlük yaşantısını da etkilemektedir. Bu yüzden öğrencinin moralinin yüksek olması okuldaki matematik başarısı üzerinde olumlu etkiye sahiptir. Ayrıca, çalışmamızda Halpern'in (2000) çalışmasında da olduğu gibi erkeklerin kızlara göre matematik alanında daha başarılı olduğu görülmüştür. Erkeklerin matematikte başarılı olma şansı, kızların şansından %74 daha fazladır.

Çalışmadan elde edilen bulgulara göre okul yönetimi matematik başarısını arttırmak için matematik aktiviteleri yapılabilir. Bunlar günlük yaşamda matematiğin kullanımı ile ilgili seminerler veya matematik bilgi yarışmaları düzenlenmesi gibi etkinlikler olabilir. Ayrıca matematik başarısında en önemli değişken okulun bulunduğu konumdur. Devlet köy ve kasaba gibi küçük yerleşim yerlerine ek finansal destek sağlamalıdır. Çünkü bu yerleşim birimlerinde okuyan öğrencilerin matematik başarısı şehir ve büyük şehirlerde okuyan öğrencilere göre çok daha düşüktür. Küçük yerleşim yerlerindeki okulların öğretmen yetersizliğinin ve ulaşım zorluğunun da giderilmesi gerektiği görülmektedir. Literatürde kasaba, köy gibi gelişmemiş bölgelerdeki eğitim reformlarını düzeltmek için ayrılan payın artırılması bu sorunu çözmede en büyük etkenlerden biri olarak görülmektedir.

Öğrencilerin öğrenme stratejilerini geliştirilmesi, öğrencilerin sosyo ekonomik statüsü ve okulun bulunduğu yerleşim yeri gibi sosyal ve kültürel altyapısını oluşturan faktörlerin değiştirilmesine göre daha kolay olacağı görüşündeyiz. Sonuç olarak, çalışmamızın bu alanda ülkemizi diğer ülkelerle karşılaştırmada ileride yapılacak olan çalışmalara kaynak olacaktır.