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Research Article

Analysis of Factors Predicting Students' Mathematics Achievement According to 2018 PISA Data

2018 PISA Verilerine Göre Öğrencilerin Matematik Başarısını Yordayan Faktörlerin Analizi

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Abstract

This study aims to determine the factors affecting students' success in mathematics with PISA 2018 Data-Turkey covering 4473 students out of 6890. The factor analysis is applied to a wide range of 52 variables, including the number of weekly lessons in language, mathematics, and science courses to satisfaction with life, 14 factors are identified. After that, the multiple regression model is derived to find out the determinants of students' success in mathematics. Besides these 14 factors, the gender of the students and the educational status of the parents are considered explanatory variables. Firstly, it is found that males and those whose fathers have higher levels of education have higher performance in mathematics. Among the factors, the wealth of family, use of information and communication technologies both outside and at the school, time spent to learn mathematics and science, perception of reading comprehension, and perception of cooperation at school are significantly positively associated with a student's success. Furthermore, facing discrimination and bullying decreases student success in mathematics. The family's socioeconomic status and access to information-communication technologies are the most important determinants of student success. Finally, it is recommended that reasonable support should be given to disadvantaged students for providing equal opportunity.

Keywords: *Factor Analysis, PISA, Principal Component Analysis Method, Regression Analysis, Student Success.*

Öz

Bu çalışma, 6890 öğrenciden 4473'ünü kapsayan PISA 2018 Türkiye verileri ile öğrencilerin matematik başarısını etkileyen faktörlerin belirlenmesini amaçlamaktadır. Bu kapsamda ilk olarak faktör analizi ile değişken boyutları azaltılmıştır. Faktör analizi, yaşam memnuniyetine yönelik haftalık dil, matematik ve fen dersleri sayısı da dahil olmak üzere 52 değişkene uygulanmış ve analiz sonucunda 14 temel faktör belirlenmiştir. Daha sonra çalışmada öğrencilerin matematik başarısının belirleyicilerini bulmak için çoklu regresyon modeli kullanılmıştır. Modelde değişen varyans sorunu olduğu için robust düzgünleştirme yönteminden faydalanarak değişkenlerin regresyon sonuçları elde edilmiştir. Ayrıca 14 faktörün yanı sıra öğrencilerin cinsiyeti ve ebeveynlerin eğitim durumu da açıklayıcı değişkenler olarak kullanılmıştır. Öncelikle erkek öğrencilerin ve babalarının eğitim düzeyi daha yüksek düzeyde olan öğrencilerin matematik performansının daha yüksek olduğu tespit edilmiştir. Faktörlerden ailenin zenginliği, bilgi ve iletişim teknolojilerinin okul dışında ve okulda kullanılması, matematik ve fen bilimleri öğrenmeye harcanan zaman, okuduğunu anlama algısı ve okuldaki iş birliği algısı öğrencinin başarısı ile anlamlı düzeyde pozitif yönde ilişkilidir.

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Ayrıca ayrımcılık ve zorbalığa maruz kalmak öğrencinin matematik başarısını düşürmektedir. Ailenin sosyoekonomik durumu ve bilgi-iletişim teknolojilerine erişimi öğrenci başarısının en önemli belirleyicileridir. Son olarak dezavantajlı öğrencilere fırsat eşitliği sağlanması konusunda destek verilmesi önerilmektedir.

Anahtar kelimeler: *Faktör Analizi, PISA, Temel Bileşenler Analizi, Regresyon Analizi, Öğrenci Başarısı.*

1. INTRODUCTION

Education provides a quality life to individuals by ensuring progress and living in a peaceful society owing to national and economic development (Barro & Lee, 1993; Barro, 2013). In addition, the contribution of education to personal development is undeniable. Learning begins in the womb and continues throughout life. Furthermore, information is spreading rapidly with the development of technology, and thus the world is constantly changing. Individuals need to get continuous education to adapt and develop in the changing world. Assessment in education is crucial in order to provide education more efficiently.

Progress in International Reading Literacy Study (PIRLS) and International Mathematics and Science Study (TIMSS) are organized by the International Association for the Evaluation of Educational Achievement (IEA). The Program for International Student Assessment (PISA) is organized by the Organization for Economic Co-operation and Development (OECD). These international large-scale assessments help evaluate student achievement, perform analyses, and determine effective policies. PISA aims to evaluate the skills and knowledge of 15-year-old students in the fields of mathematics, reading and science. This assessment is published every three years by the OECD. Not only cognitive tests but also questionnaires are conducted at school, teacher, and student levels. In addition, it also offers a teacher questionnaire and a parent questionnaire. (OECD, 2019).

Measuring success in education: It ensures the evaluation of education programs, determines the quality of the education provided, measures the success of education policy, determines more effective policies, and thus provides more effective education.

When the literature is examined, according to the results obtained in the PISA applications, low achievement in the mathematics course is seen as an essential problem, and this situation is emphasized in the studies conducted (Kulm, 1980; Peker ve Mirasyedioglu, 2003). Mathematics is a branch that is important in the development of human intelligence and abilities that enable rational thinking (Skovsmose, 2016). Thanks to mathematics, students can efficiently understand the integrity and complexity of quantitative relationships and spatial forms (Lin, 2023). Hence, it is essential to measure student achievement and to obtain the factors that determine student's success in mathematics (Figazzolo, 2009; Steiner-Khamsi & Waldow, 2018). The article aims to evaluate the factors affecting student mathematics success in Turkey and sheds light on students, their families, academic researchers, and policymakers by using the most up-to-date PISA 2018 data. The study used literature to determine 56 variables that are thought to affect student success. Compared to the literature, the study examines a broader range of determinants of student achievement, considering more variables.

In the PISA 2018 study, 6890 students and 186 schools participated in Turkey. Since there are missing values in the 56 variables selected in this study, the data of 4473 students will be evaluated. Since 52 variables are continuous and four variables are categorical, factor analysis is applied to only 52 variables. First, factor analysis is applied to the variables by using the principal component analysis method to prevent the multicollinearity problem caused by the high relationship between the variables and to gather similar variables under meaningful factors (Dormann, et al., 2013). Subsequently, the regression analysis is applied to understand to what extent the factors obtained from the principal component analysis and, the educational status of the mother-father and the gender of the student to explain the student's mathematics achievement. Family Wealth, Discrimination and Bullying, Time to Learn Mathematics and Science, Perception of Reading Comprehension, Use of Information and Communication Technologies (ICT) at School, Use of ICT outside of School, Perception of Cooperation at School, Gender of the Student and Educational Status of the Father are essential in explaining student success. Family Wealth, Discrimination and Bullying, Time to Learn Mathematics and Science and Gender of the Student are the variables with the most incredible power in explaining student success.

This article is organised as follows: First, the literature review is summarised. Then, in the methodology, Factor Analysis and Regression Analysis methods to be used in the study are examined in detail. In the next section, the PISA 2018 data to be used in the application is introduced, and the data's characteristics and variables to be used in the application are specified. In addition, the application is made, and the findings are obtained. In the last part, the information obtained from the analysis is evaluated by comparing it with the literature, and suggestions are made.

2. LITERATURE

Academic success in education is a concept that has been globally important for many years. Many ideas have been put forward about achieving academic success, and in the literature, many studies have been carried out to determine student success. For many years, student achievement has been explained by the variables of attitude (Ma, 1997), beliefs (Schommer, 1990; Kloosterman, 1996), employment (Greenberger & Steinberg, 1986), parent education (Ethington & Wolfe, 1984; Walberg & Tsai, 1983), homework (Keith & Cool, 1992) and school size (Lee, Smith & Croninger, 1997). Shavelson et al. (1987) argued that a multivariate model is necessary because a single indicator cannot provide information about a field as complex as education.

Table 1 examines which other factors are generally used to determine student achievement. In the literature examined in Table 1, PISA and a few TIMMS studies are examined. In another study, Gamazo and Martínez-Abad investigated whether factors such as metacognitive strategies, achievement motivation, and socioeconomic indicators are more important in predicting student performance with educational data mining (Gamazo & Martínez-Abad, 2020). Bernardo's work examines the relationship between students' evolving mindsets and learning in math and science using hierarchical linear modelling (Bernardo, 2020). Hu and Ju studied how students' ICT-based social media use affected their reading performance (Hu & Ju, 2021).

When we consider the findings of multivariate models applied in literature (Gamazo & Abad, 2020; Anderson, Lin, Treagust, Ross, & Yore, 2007; Dolu, 2018; Lee & Wu, 2013; Mutluer & Büyükkıdık, 2017; Nonoyama, 2005; Yore et al., 2007; Papanastasiou, 2002; Sülkü & Abdioglu, 2015), it has been concluded that variables such as gender, parents' educational status, socioeconomic status, regional differences are in the foreground in explaining student achievement.

Table 1. Literature

Author	Data	Method Used	Factors Affecting Student Success
(Papanastasiou, 2002)	TIMSS (1995)	Structural Equation Modeling	School climate, attitudes, teaching, beliefs, education level of family, reinforcement
(Hammouri, 2004)	TIMMS (1999)	Structural Equation Modeling	Educational aspiration, attitude, success attribution, confidence in ability, perception of math importance
(Nonoyama, 2005)	PISA (2000,2003)	Regression Analysis, Sensitivity Analysis	Family background, socio-economic status
(Macneil, Prater & Busch, 2009)	29 schools in Texas	Multivariate analysis of variance	School climate and atmosphere
(Enck, 2011)	TIMMS (2007)	Hierarchical linear modeling	There is no relationship between class size and student achievement.
(Yıldırım, 2012)	PISA (2006)	Factor and Regression Analysis	Home, family and student characteristics, teaching processes, institutional-environment factor
(Lee and Wu, 2013)	PISA (2009)	Mediation Analysis	Gender, socioeconomic status

(Sülkü & Abdioglu, 2015)	TIMMS (2011)	Regression Analysis	Economic status of family, sex, education level of fathers, educational instruments owned
(Gülleroglu, Demir & Demirtaslı, 2014)	PISA (2003, 2006, 2009)	Stepwise Multiple Regression Analysis	Educational resources at home, educational status of family, cultural opportunities
(Mutluer & Büyükkıdık, 2017)	PISA (2012)	Logistic Regression	Educational status of the family, self-perception, quick learning, enjoying, perseverance - giving up
(Dolu, 2018)	PISA (2015)	Hierarchical Linear Modeling (HLM)	Gender, socioeconomic status, grade retention, school type and region
(Tan & Hew, 2019)	PISA (2012)	Markov Chain, HLM Latent Class Analysis	Use of information technology
(Gamazo &Abad, 2020)	PISA (2018)	Educational Data Mining	Metacognitive strategies or achievement motivation, socioeconomic indicators
(Bernardo, 2020)	PISA (2018)	Hierarchical Linear Modeling (HLM)	Growth mindset.
(Hu &Ju, 2021)	PISA (2009, 2012, 2015, 2018)	Hierarchical Linear Modeling (HLM)	ICT-based social media use outside of school and at school

According to Table 1, hierarchical linear modelling, structural equation modelling, regression modelling, and factor analysis are used to determine student achievement. It has been revealed that variables such as the educational status of the family, gender, grade retention, school type, region socioeconomic status, school status, student's emotional state, and technology use are essential variables in determining student success.

Many studies have looked at the factors that determine student success. These often include factors such as the school and home environment, learning styles, motivation, and academic performance (Rugutt & Chemosit, 2005; Diaconu-Gherasim & Iacob, 2011). The results of a study that examines these factors together can provide more detailed information on how student success can be determined. Looking at the factors together allows for a more comprehensive understanding of the factors that influence student success and how they interact with each other. Therefore, in this study, student mathematics achievement is explained with 56 variables.

3. METHOD

The high correlation between variables causes a multicollinearity problem (Daoud, 2017). In addition, interpreting the regression model applied to many variables, such as 52, becomes difficult. For this reason, collecting more interrelated variables under certain factors is necessary. Using the principal component analysis, factor analysis is applied to identify the factors affecting students' math success with Turkey 2018 PISA data. In the continuation, the students' mathematics success is determined by regression model with multiple by taking the necessary explanatory variables into analysis in addition to the identified factors, adhering to the literature.

3.1. FACTOR ANALYSIS AND REGRESSION ANALYSIS

Four levels of measurement scales are generally used in the literature: ordinal, nominal, interval and ratio. In the SPSS program, three levels of measurement are seen: 'nominal, ordinal and scale'. Interval and ratio scales are under the 'scale' variable measurement. Each of the nominal, ordinal, interval and ratio scales can be used in systems of structural equations. However, it is not recommended to mix variable types in factor analysis (Avsar, 2007). For this, we used the 52 scale variables in factor analysis. These are shown in Table 2.

Table 1Variables

No.	PISA CODE	Variable Description
V1	ST016Q01NA	Satisfaction with Life
V2	ST059Q01TA	Number of Weekly Lessons in Language Classes
V3	ST059Q02TA	Number of Weekly Lessons in Mathematics Class
V4	ST059Q03TA	Number of Weekly Lessons in Science Class
V5	ST060Q01NA	How many lessons do you have to attend at school in a week?
V6	ST061Q01NA	How Many Minutes Are On Average In A Lesson (Time)?
V7	MMINS	Mathematics Learning Time (Minutes per Week)
V8	LMINS	Language Learning Time (Minutes per Week)
V9	SMINS	Time to Learn Science (Minutes per Week)
V10	TMINS	Total Learning Time (Minutes per Week)
V11	ESCS	Economic, Social and Cultural Status Index
V12	ICTHOME	ICT Available at Home (Index)
V13	ICTSCH	ICT Available at School (Index)
V14	HOMEPOS	Household Items (shows household and property items in the house)
V15	CULTPOSS	Cultural Items at Home
V16	HEDRES	Home Educational Resources
V17	WEALTH	Family Wealth
V18	ICTRES	ICT Resources
V19	DISCLIMA	Disciplinary Climate in Test Language Lessons
V20	TEACHSUP	Teacher Support in Test Language Lessons
V21	DIRINS	Teacher-Directed Instruction
V22	PERFEED	Perceived Feedback
V23	EMOSUPS	Parents' Emotional Support Perceived by Student
V24	STIMREAD	Teacher's Stimulation of Reading Engagement Perceived by Student
V25	ADAPTIVITY	Adaptation of Instruction
V26	TEACHINT	Perceived Teacher’s Interest
V27	JOYREAD	Joy/Like Reading
V28	SCREADCOMP	Self-Concept of Reading: Perception of Competence
V29	SCREADDIFF	Self-Concept of Reading: Perception of Difficulty
V30	PISADIFF	Difficulty Perception of the PISA Test
V31	PERCOMP	Perception of Competitiveness at School
V32	PERCOOP	Perception of Cooperation at School
V33	ATTLNACT	Attitude Towards School: Learning Activities
V34	COMPETE	Competitiveness

V35	WORKMAST	Work Mastery
V36	GFOFAIL	General Fear of Failure
V37	EUDMO	Eudaemonia: Meaning in Life
V38	SWBP	Subjective Well-Being: Positive Impact
V39	RESILIENCE	Resilience
V40	MASTGOAL	Mastery Goal Orientation
V41	DISCRIM	Discriminating School Climate
V42	BELONG	Subjective Well-Being: Sense of Belonging to School
V43	BEINGBULLIED	Student's Experience of Being Bullied
V44	ENTUSE	ICT Use Outside of School (Leisure Time)
V45	HOMESCH	Use of ICT Outside of School (for School Work Activities)
V46	USESCH	Use of ICT at School in General
V47	INTICT	Interest in ICT
V48	COMPICT	Perceived ICT Competence
V49	AUTICT	Perceived Autonomy Related to ICT Use
V50	SOIAICT	ICT in Social Interaction
V51	ICTCLASS	Use of ICT Related to the Subject During Lessons
V52	ICTOUTSIDE	Use of ICT Related to the Subject Outside of Lessons

* ICT: Information and Communication Technologies

Descriptive statistics for these 52 variables are given in Appendix 1. Except for the first ten variables up to V1-V10, all other variables are index values calculated from nominal variables. For instance, V14, the HOMEPOS-coded variable, is the index value calculated from household and possession items. The definition of each index variable is explained in detail in "PISA 2018 Results (Volume III): What School Life Means for Students' Lives" (OECD, 2019). V1 "Satisfaction with Life" is a Likert-scale variable from 0 to 10 in ascending order. Variables V2, V3, V4 vary between 0 and 40. V5 refers to the number of weekly lessons the student must attend. Variables V6, V7, V8, V9, V10 are expressed in minutes.

Exploratory Factor Analysis (EFA) is a statistical method to obtain significantly unrelated factors from correlated variables (Johnson & Wichern, 2007). In this study, only the EFA method is used. EFA is obtained with seven different factor-extraction methods: Principal Component Analysis (PCA), Principal Axis Factor Analysis, Maximum Likelihood Analysis, Image-Factor Analysis, Unweighted Least Squares Analysis, Generalized Least Squares Analysis and Alpha Analysis (Brown, 2006). PCA has two primary purposes: eliminating the dependency structure and reducing the dimension (Robert, 2002); (Timm, 2002). Based on these principal purposes, PCA is used to determine the factors that affect student achievement in the study.

If there is no correlation between the factors, varimax, quartermax and equamax orthogonal rotation methods are used. If there is a relationship between the factors, direct oblimin and promax oblique rotation methods are used. We used the multiple regression model in the study. As a result of the use of correlated factors in the multiple regression model, the problem of multicollinearity can occur. In order not to fall into the multi-connection problem, it is necessary to eliminate the dependency structure. When we look at correlation values, we see correlation values higher than 0.3 between the variables. Therefore, we prefer oblique rotation. The direct oblimin method works well with small data, while the promax method works well with big data (Field, 2013). Owing to missing values, 4473 out of 6890 students and 52 variables are used. The Promax method, one of the oblique rotation methods, is preferred because the observation data is relatively high.

Kaiser-Mayer-Olkin (KMO) and Bartlett test of sphericity should be applied to test whether the data are suitable for factor analysis (Kaiser, 1974); (Aldrich & Cunningham, 2016). It is concluded that the KMO sample criterion is higher than 60%, with a value of 73%. The null hypothesis of Barlett's test, The correlation Matrix Equal to the Identity Matrix, was rejected because $p=0.00 <\alpha=0.05$ (Ünsal & Sülkü, 2020). As a result of the test applied, it is concluded that the data are suitable for factor analysis. Factor clusters are created using PCA, and there are 14 main factors with eigenvalues greater than 1. These 14 factors are presented in Table 3.

Table 3. Eigenvalues of factors and total explained variance

Component	Initial Eigenvalues			Post Rotation Loads		
	Eigenvalue	Variance	Cumulative Variance	Eigenvalue	Variance	Cumulative Variance
1	6,813	13,102	13,102	6,813	13,102	13,102
2	4,683	9,006	22,108	4,683	9,006	22,108
3	3,652	7,023	29,131	3,652	7,023	29,131
4	2,596	4,993	34,124	2,596	4,993	34,124
5	2,282	4,388	38,511	2,282	4,388	38,511
6	1,855	3,567	42,079	1,855	3,567	42,079
7	1,755	3,374	45,453	1,755	3,374	45,453
8	1,686	3,242	48,695	1,686	3,242	48,695
9	1,530	2,943	51,637	1,530	2,943	51,637
10	1,516	2,916	54,554	1,516	2,916	54,554
11	1,166	2,242	56,795	1,166	2,242	56,795
12	1,079	2,075	58,871	1,079	2,075	58,871
13	1,033	1,986	60,856	1,033	1,986	60,856
14	1,017	1,956	62,813	1,017	1,956	62,813
15	,977	1,879	64,692			
16	,945	1,817	66,509			
17	,940	1,807	68,316			
…						
52	,004	,008	100,000			

When the variance explanation percentages of the 14 factors obtained are examined, it is concluded that the crucial factors could explain approximately 63% of the total variance. Examining the factor loadings in Table 3, we determined the common point between the variables and named the factors according to these standard features. The identified 14 factors are respectively: 1. “The Wealth of Family” (13.10%), 2. “Teacher's Attitude” (9.01%), 3. “Use of ICT Out of School” (7.02%), 4. “Time to Learn Mathematics and Science” (4.99%), 5. “Self-efficacy” (4.39%), 6. “Perception of Reading Comprehension” (3.57%), 7. “Language Learning Time” (3%), 8. “Satisfaction with Life” (3.24%), 9. “Use of ICT at School” (2.94%), 10. “General Learning Time” (2.92%), 11. “Discrimination and Bullying” ” (2.24%), 12. “Perception of Cooperation at School” (2.07%), 13. “Lesson Time at School” (1.99%) and 14. “Learning Activities” (1.96%). According to Table 3, the Wealth of Family factor has the highest percentage of variance among other factors. The Wealth of the Family factor load values, respectively, consist of

Cultural Items at Home, Household Items, Family Wealth, ICT Resources, Economic, Social and Cultural Status Index, Home Educational Resources, and ICT Available at Home.

Table 4. Variables Loaded Under the Factors

Variables Loaded Under Factor 1 **Factor name: The Wealth of Family**	**Factor Load Value**
Household Items	0,982
Family Wealth	0,929
ICT Resources	0.911
Economic, Social and Cultural Status Index	0,808
Home Educational Resources	0,764
ICT Available at Home	0,748
Cultural Items at Home	0,619
Variables Loaded Under Factor 2 **Factor name: Teacher's Attitude**	**Factor Load Value**
Adaptation of Instruction	0,792
Teacher's Stimulation of Reading Engagement Perceived by Student	0,777
Perceived Feedback	0,754
Teacher-Directed Instruction	0,716
Perceived Teacher’s Interest	0,688
Teacher Support in Test Language Lessons	0,677
Disciplinary Climate in Test Language Lessons	0,346
Variables Loaded Under Factor 3 **Factor name: Use of ICT Out of School**	**Factor Load Value**
Perceived ICT Competence	0,861
Perceived Autonomy Related to ICT Use	0,816
ICT in Social Interaction	0,798
Interest in ICT	0,789
ICT Use Outside of School (Leisure Time)	0,529
Variables Loaded Under Factor 4 **Factor name: Time to Learn Mathematics and Science**	**Factor Load Value**
Number of Weekly Lessons in Science Class	1,008
Time to Learn Science (Minutes per Week)	0,968
Number of Weekly Lessons in Mathematics Class	0,598
Mathematics Learning Time (Minutes per Week)	0,498
Variables Loaded Under Factor 5 **Factor name: Self-efficacy**	**Factor Load Value**
Competitiveness	0,744

Work Mastery	0,728
General Fear of Failure	0,531
Mastery Goal Orientation	0,437
Resilience	0,414
Variables Loaded Under Factor 6 **Factor name: Perception of Reading Comprehension**	**Factor Load Value**
Self-Concept of Reading: Perception of Competence	0,751
Self-Concept of Reading: Perception of Difficulty	-0,751
Joy/Like Reading	0,676
Difficulty Perception of the PISA Test	-0,589
Variables Loaded Under Factor 7 **Factor name: Language Learning Time**	**Factor Load Value**
Number of Weekly Lessons in Language Classes	1,018
Language Learning Time (Minutes per Week)	0,866
Variables Loaded Under Factor 8 **Factor name: Satisfaction with Life**	**Factor Load Value**
Satisfaction with Life	0,878
Subjective Well-Being: Positive Impact	0,801
Eudaemonia: Meaning in Life	0,521
Subjective Well-Being: Sense of Belonging to School	0,335
Variables Loaded Under Factor 9 **Factor name: Use of ICT at School**	**Factor Load Value**
Use of ICT Related to the Subject During Lessons	0,780
Use of ICT Related to the Subject Outside of Lessons	0,759
Use of ICT at School in General	0,475
Use of ICT Outside of School (for School Work Activities)	0,401
ICT Available at School (Index)	0,377
Variables Loaded Under Factor 10 **Factor name: General Learning Time**	**Factor Load Value**
How many lessons do you have to attend in total in a week at school?	1,042
Total Learning Time (Minutes per Week)	0,878
Variables Loaded Under Factor 11 **Factor name: Discrimination and Bullying**	**Factor Load Value**
Discriminating School Climate	0,798
Student's Experience of Being Bullied	0,515
Variables Loaded Under Factor 12 **Factor name: Perception of Cooperation at School**	**Factor Load Value**

Perception of Competitiveness at School	0,793
Perception of Cooperation at School	0,768
Parents' Emotional Support Perceived by Student	0,323
Variables Loaded Under Factor 13 **Factor name: Lesson Time at School**	**Factor Load Value**
How Many Minutes Are on Average In A Lesson (Time)?	1,018
Variables Loaded Under Factor 14 **Factor name: Learning Activities**	**Factor Load Value**
Attitude Towards School: Learning Activities	0,809

*** ICT:** Information and Communication Technologies

Linear regression analysis is examined under two main headings: simple linear regression and multiple linear regression. Simple linear regression is a regression analysis that uses one dependent variable and one independent variable. Multiple linear regression has one dependent variable and more than one independent variable. (Stock & Watson, 2011).

$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_k X_{ki} + u_i$, Y_i, is the dependent variable that shows "The Mathematics Achievement Score of Students". Xj, j = 1,…,k represent the explanatory variables that affect the dependent variable. β_0 specifies the constant. β_j; They are the parameters that show the partial regression coefficients of j. u_i; shows error term.

Regression assumptions;

1. When X_i is known, the expected value of the error term u_i is equal to 0 $E(u_i \backslash X_i)=0$;

2. (X_i, Y_i), i=1,…,n X_i and Y_i's are drawn independently from their combined distributions with identical distributions.

3. The probability of encountering outliers is low: X_i and Y_i have finite fourth-order moments.

4. There should be no high correlation between independent variables.

5. The variance of the error term $E(\varepsilon\varepsilon^{\iota}) = \delta^2 I = \sigma^2$ should be constant (Stock and Watson, 2011).

As seen in Appendix 2, there is a high correlation between the independent variables. Factor analysis is applied to the variables to eliminate the multicollinearity problem (Farrar & Glauber, 1967).

In the article study, alternative multiple linear regression models are used to determine students' success. Besides the 14 factors obtained, the educational status of the mother-father and the gender of the student are added to the analysis. The dependent variable and three independent variables are given in Table 5.

Table 5. Descriptive statistics

Variables	PISA CODE	N	Min	Max	Average	Std. Deviation
Mathematics Achievement Score	PV5MATH	6890	141.19	741.87	454.294	87.39794
Student's Gender	ST004D01T (Revised)	6890	0	1	0.5071	0.49999
Educational Status of the Mother	MISCED	6835	0	6	2.66	1.951
Educational Status of the Father	FISCED	6833	0	6	3.12	1.941

Note: The student's gender variable has been changed to Female: 0, Male: 1.

Student gender is a dummy variable that is 1 if "Male" and 0 if "Female". Indexes related to parent education are created by coding educational qualifications: "(0) None, (1) ISCED level 1 (primary education), (2) ISCED level 2 (lower secondary), (3) ISCED level 3B or 3C (vocational/pre-vocational upper secondary), (4) ISCED level 3A (general upper secondary) and/or ISCED level 4 (non-tertiary post-secondary), (5) ISCED level 5B (vocational tertiary) and (6) ISCED level 5A and/or ISCED level 6 (theoretically oriented tertiary and post-graduate)." Indexes with these categories are provided for MISCED and FISCED (OECD, 2015).

Since the sampling for the PISA application is determined by stratified random sampling method, the data have a complex survey design. Due to this complex structure, we must analyze the data by weighting (OECD, 2017). The IDB analyzer is a Windows-based tool that generates SAS or SPSS syntax to perform analysis with PISA data for weighting. This SAS code or SPSS syntax from IDB Analyzer processes the information from the sampling design to calculate sampling variance. The plausible values are handled in this process (OECD, 2019). For this reason, regression analysis is first applied to the obtained 14 factors and mathematics achievement variable in the IDB Analyzer application. Multiple linear regression analysis is applied in the SPSS program to observe whether the complex questionnaire design has a significant effect without weighting the factors and variables. As a result of the analysis obtained from both programs, it is observed that there is no significant difference in the significance of the variables. The study continued with the SPSS program because more statistical criteria and alternative test results could be obtained as a result of the regression analysis obtained in SPSS.

The Mathematics Achievement variable representing the mathematics scores is expressed as the dependent variable. Independent variables are respectively; Our factors obtained from the factor analysis from X_1 to X_{14}; X_{15} are the gender of the student; X_{16} and X_{17} are the educational status of the mother and father.

Table 6. Variables

X_1 (WEALTH) : The Wealth of Family	X_2 (TEACHATTITUTE): Teacher's Attitude
X_3 (ICTENT): Use of ICT Out of School	X_4 (MSMINS): Mathematics and Science Lesson Learning Time
X_5 (SELFEF): Self-Efficacy	X_6 (READCOMP): Reading Comprehension Perception
X_7 (LMINS) : Language Learning Time	X_8 (SLIFE): Satisfaction with Life
X_9 (ICTSCH): Use of ICT at School	X_{10} (GLEARNTIME): General Learning Time
X_{11} (DISCBULLYI): Discrimination and Bullying	X_{12} (SCOOPERATION): Perception of Cooperation at School
X_{13} (LESSONTIME) : Lesson Time at School	X_{14} (LEARNACT): Learning Activities
X_{15} (GENDER): Student's Gender	X_{16} (MEDUS): Mother's Educational Status
X_{17} (FEDUS): Father's Educational Status	

The applied multiple regression model is shown in its general form in 3.1.

$$Y_M = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12}+\beta_{13}X_{13} + \beta_{14}X_{14}+\beta_{15}X_{15}+\beta_{16}X_{16} + \beta_{17}X_{17} + u_M \quad (3.1)$$

The Breusch Pagan test is applied to the 3.1 model to understand whether heteroskedasticity exists. The statistical value is obtained as a result of the applied test, χ^2 is found to be 18.902 and the probability value is 0.001. The null hypothesis of Breush Pagan test, H_0: No heteroskedasticity, is rejected at 0.05 significance level, since p=0.001 <α=0.05. It is understood that there is heteroskedasticity in the model. Therefore, five different regression models obtained with robust standard errors for parameter estimations of mathematical achievement models are given in Table 7.

4. FINDINGS

The mathematics achievement scores of the students obtained as a result of the PISA application to 9th-grade students in Turkey are used as the dependent variable. In Model 1, the 14 principal factors and the variables of Mother's Educational Status, Father's Educational Status and Student's Gender are used as explanatory variables. In Model 2, Mathematics Achievement is explained only with the factors obtained by factor analysis. When we look at Model 1 in Table 7, it is seen that the coefficients of "Language Learning Time" and "Mother's Educational Status" are statistically insignificant at the 0.05 significance level according to the t-test values. In Model 2, only the coefficient of the "Language Learning Time" variable is statistically insignificant. It is seen that the other 16 variables in Model 1 and the other 13 variables in Model 2 are statistically significant in determining mathematics achievement according to their t values. For this reason, the statistically insignificant variables are removed in Model 3. Then, Model 4, which includes all variables whose coefficients are statistically significant, is established. Since we apply factor analysis, we do not expect multicollinearity problems between factors under normal conditions. For this reason, all the variables that do not meet our a priori expectation and/or are statistically insignificant are removed from the model. Model 5, which consists of statistically significant variables that met our a priori expectation, is formed.

Table 7. Math achievement regression model

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	424,427	474,298	425,213	424,976	415,317
(Standard error)	(4,186)	(1,053)	(4,144)	(4,062)	(4,073)
(t)	(101.385)	(450,356)	(102.619)	(104.61)	(101,963)
WEALTH	11,509	16,330	12,173	12,117	10,914
(Standard error)	(1,434)	(1,241)	(1.414)	(1,372)	(1,383)
(t)	(8,028)	(13,164)	(8,608)	(8,831)	(7,894)
TEACHATTITUTE	-4,405	-4,022	-4,206	-4,215	
(Standard error)	(1,194)	(1,210)	(1,190)	(1,187)	
(t)	(-3,690)	(-3,324)	(-3,535)	(-3,550)	
ICTENT	4,132	6,191	4,030	4,070	2,105
(Standard error)	(1,172)	(1,157)	(1,171)	(1,169)	(1,197)
(t)	(3,525)	(5,351)	(3,440)	(3,480)	(1,759)
MSMINS	23,598	25,671	23,605	23,579	23,115
(Standard error)	(1,298)	(1,308)	(1,232)	(1,231)	(1,214)
(t)	(18,178)	(19,630)	(19,157)	(19,157)	(19,043)
SELFEF	-2,329	-3,170	-2,429	-2,406	
(Standard error)	(1,204)	(1,215)	(1,199)	(1,196)	
(t)	(-1,935)	(-2.610)	(-2,026)	(-2.011)	
READCOMP	11,119	8,572	11,101	11,104	8,712

(Standard error)	(1,189)	(1,177)	(1,187)	(1,184)	(1,158)
(t)	(9,348)	(7,283)	(9,352)	(9,379)	(7,521)
LMINS	-0.364	-1,222			
(Standard error)	(1,223)	(1,234)			
(t)	(-0.298)	(-0.991)			
SLIFE	-6,1081	-4,907	-6,179	-6,141	
(Standard error)	(1,258)	(1,273)	(1,256)	(1,253)	
(t)	(-4,836)	(-3,853)	(-4,921)	(-4,901)	
ICTSCH	6,341	4,942	6,315	6,318	3,456
(Standard error)	(1,182)	(1,192)	(1,181)	(1,180)	(1,159)
(t)	(5,363)	(4,145)	(5,349)	(5,355)	(2,982)
GLEARNTIME	-2,081	-2,648	-2,149	-2,197	
(Standard error)	(1,203)	(1,205)	(1,192)	(1,190)	
(t)	(-1,730)	(-2,198)	(-1,803)	(-1,845)	
DISCBULLYI	-17,812	-14,755	-17,878	-17,897	-20.548
(Standard error)	(1,251)	(1,215)	(1,246)	(1,245)	(1,228)
(t)	(-14,243)	(-12,143)	(-14,343)	(-14,379)	(-16,735)
SCOOPERATION	12,695	12,597	12,839	12,785	7,273
(Standard error)	(1,231)	(1,247)	(1,231)	(1,230)	(1,130)
(t)	(10,314)	(10,104)	(10,425)	(10,394)	(6,437)
LESSONTIME	-2,542	-2,843	-2,637	-2,597	
(Standard error)	(1,253)	(1,263)	(1,229)	(1,228)	
(t)	(-2,030)	(-2,252)	(-2,145)	(-2,115)	
LEARNACT	-12,686	-15,468	-12,910	-12,895	
(Standard error)	(1,212)	(1,214)	(1,206)	(1,204)	
(t)	(-10,471)	(-12,743)	(-10,708)	(-10,706)	
GENDER	23,365		23,647	23,581	27,256
(Standard error)	(2,342)		(2,338)	(2,334)	2,366
(t)	(9,976)		(10,113)	(10,104)	11,518
MEDUS	0.200		-0.218		
(Standard error)	(0.669)		(0.665)		
(t)	(0.298)		(-0.327)		
FEDUS	4,525		4,496	4,405	5,700
(Standard error)	(0.686)		(0.680)	(0.626)	0.636
(t)	(2,298)		(6,611)	(7,039)	8,966
Adjusted $\mathbf{R^2}$	0.318	0.297	0.319	0.320	0.282
Mean Error Squared	4769,277	4942,569	4775,861	4771,627	5039,888

While it is concluded that there is a statistically insignificant relationship between the Mother's Educational Status and the Students' Mathematics Achievement in Model 1, there is a negative and significant relationship in Model 3. In many studies in the literature, it has been observed that there is a positive relationship between the educational status of the mother and the academic success of the

student. Model 1 and Model 3 do not meet our expectations of a positive and significant relationship between student achievement and the mother's educational status. This situation suggests that there may be a multicollinearity problem between the mother's educational status and other variables. Therefore, the mother's educational status is used as the only dependent variable to explain mathematics achievement. It is concluded that the coefficient of the mother's educational status variable has a statistically significant and positive effect on explaining student achievement. Alternative models are established to find the variables that cause the multicollinearity problem in the model. Regression analysis was performed by modeling statistically significant variables, variables meeting our a priori expectation, educational status of parents, and gender. As a result of these analyses, it is concluded that a relationship causes multicollinearity problems due to the high correlation between the mother's educational status variable and the wealth of the family, ICT use at school, gender, and the father's educational status variables. For this, an alternative model with the term interaction has been created. The mother's educational status variable is removed from the model, and the mother's educational and professional status variables are used as interaction terms. However, according to the result obtained, although the interaction term is statistically significant, the coefficient of the father's educational status variable is statistically insignificant. Therefore, in Model 4 and Model 5, the "Father's Education Status" variable, which can represent the "Mother's Education Status" variable, is included in the model, and the "Mother Education Status" variable is excluded from the model.

According to the first four models, the variables that provide our statistical and a priori expectation are the Wealth of Family, Discrimination and Bullying, Time to Learn Mathematics and Science, Perception of Reading Comprehension, Use of ICT at School, Use of ICT Out of School, Perception of Cooperation at School, Student's Gender and Father's Educational Status. It is understood that these variables are important in explaining student mathematics achievement.

Upon revisiting the initial four models, it becomes apparent that while the coefficients of variables such as 'Teacher Attitude,' 'Self-efficacy,' 'Language Learning Time,' 'Satisfaction with Life,' 'General Learning Time,' 'Lesson Time at School,' and 'Learning Activities' are statistically significant, they do not align with our expectations.

When we look at the corrected R^2 values of all models, Model 4 has the most significant value. A variable in Model 4 does not meet our a priori expectation. However, the model statistically meets the expectations and contains the variables with the highest explanatory power. For this reason, the results are evaluated based on Model 4, which has statistically significant variables that meet our statistical expectations. Ceteris- Paribus, when "Time to Learn Mathematics and Science" increases by 1 unit, "Mathematics Achievement" increases by approximately 23.5 points. "Time to Learn Mathematics and Science" and "Gender" have the highest coefficients and are the most critical variables in determining mathematics achievement. In the field of mathematics, male students are approximately 23.5 points more successful than female students. The variable "Discrimination and Bullying" is the second variable that is important in determining mathematics achievement. All other things being constant, when "Discrimination and Bullying" increases by 1 unit, student achievement in mathematics drops by about 18 points. The Wealth of Family variable also has great power in determining math achievement. When "The Wealth of Family" increases by 1 unit, student achievement in mathematics increases by about 12 points.

5. DISCUSSION AND CONCLUSION

Student achievement measures a student's success in completing the educational process in a school or educational institution. Student achievement can be measured by factors such as a student's grade point average, test scores, class participation, and similar factors. Student achievement is often also considered a predictor of future success (Garavalia & Gredler, 2002).

In this study, which aims to measure student achievement, the component with the highest power to explain the variance is the wealth of family factor. It has been determined that household items, family wealth, ICT resources, economic, social and cultural status index, home education resources, ICT at home, and cultural items at home are included under the factor wealth of family. In addition, two critical factors that determine student success in mathematics are the use of ICT at school and the use of ICT outside of school. These mutually supportive results once again demonstrate the importance of equality

of opportunity. It shows that disadvantaged students need academic support, especially regarding "ICT Resources and Educational Resources". So, providing ICT resources to disadvantaged students is of great importance.

In the multiple regression analysis applied in this study, it is concluded that the family's wealth has a higher value than the other variables in determining students' success. These findings support the literature; For instance, McNeal (1999), Hoschschild (2003) and Eamon, (2005) commented that students' mathematics achievement increases more than other students because families with high income can offer richer educational resources to their children. For this reason, it is recommended to carry out studies to ensure equality of opportunity in education for students with low socioeconomic levels.

In our study, the effect of the parent's educational status on the student's success in education is evaluated simultaneously in the regression analysis. However, due to their high correlation, only the father's educational status is kept in the regression models to avoid causing the multicollinearity problem. Similar to the literature (Puklek, Zupancic & Socan, 2013; Desforges & Abouchar, 2003), it has been seen that the education level of the father positively affects the success of the student. Since parents with a high level of education will be aware of the importance of education, they will provide all kinds of support for their children to receive a better education. Therefore, it has been determined that the children of uneducated parents are disadvantaged.

One of the remarkable issues is the socioeconomic status and family factors, which are seen as the main determinants of the student's success in their education life, as well as the social environment and learning skills at school are of great importance.

According to the regression analysis, "Discrimination and Bullying", "Perception of Cooperation at School", "Time to Learn Mathematics and Science", and "Perception of Reading Comprehension" are essential variables in determining student success. The social environment and learning skills at school are essential in determining student success. "Discriminating School Climate" and "Student's Experience of Bullied" are the components of the " Discrimination and Bullying" factor, which negatively affects the academic achievement of the student. This situation firstly shows that a unit that monitors the discriminatory school climate is necessary. Secondly, sanctions should be applied to those who discriminate and bully. Finally, it is recommended to provide psychological support to students exposed to discrimination and bullying.

According to research results the combination of factors that determine student success provides a better understanding of student's success and the development of more effective learning strategies. In future studies, so-called pseudo-panel data models can be applied to PISA data published regularly in Turkey. Pseudo-panel data are theorized by the seminal work of Deaton (1985) and later technically developed by Verbeek and Vella (2005). The cross-section form can be converted to pseudo-panel data. That is, analyses can be arranged to perform panel data analysis. The study can be expanded by re-examining self-efficacy, life satisfaction and maternal education status in new practices and/or studies.

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Araştırma Makalesi

Analysis of Factors Predicting Students' Mathematics Achievement According to 2018 PISA Data

2018 PISA Verilerine Göre Öğrencilerin Matematik Başarısını Yordayan Faktörlerin Analizi

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Genişletilmiş Özet

Eğitim, ulusal ve ekonomik kalkınma sayesinde ilerlemeyi ve huzurlu bir toplumda yaşamayı sağlayarak bireylere kaliteli bir yaşam sağlar (Barro ve Lee, 1993; Barro, 2013). Ayrıca bireylerin değişen dünyaya uyum sağlamak ve gelişmek için sürekli eğitim alması gerekmektedir. Eğitimde başarının ölçülmesi; eğitim programlarının değerlendirilmesini, verilen eğitimin kalitesinin belirlenmesini, eğitim politika başarısının ölçülmesini, daha etkili politikalar belirlenmesini ve bu sayede daha etkili eğitim verilmesini sağlar.

Literatür incelendiğinde PISA uygulamalarından elde edilen sonuçlara göre matematik dersinde düşük başarı önemli bir sorun olarak görülmekte ve yapılan çalışmalarda bu durum vurgulanmaktadır (Kulm, 1980; Peker ve Mirasyedioğlu, 2003). Matematik, insan zekasının ve rasyonel düşünmeyi sağlayan yeteneklerin gelişiminde önemli olan bir daldır (Skovsmose, 2016). Matematik sayesinde öğrenciler niceliksel ilişkilerin ve mekansal formların bütünlüğünü ve karmaşıklığını etkin bir şekilde anlayabilirler (Lin, 2023). Bu nedenle öğrenci başarısını ölçmek ve öğrencinin matematik başarısını belirleyen faktörleri elde etmek önemlidir (Figazzolo, 2009; Steiner-Khamsi ve Waldow, 2018). Türkiye'de öğrenci matematik başarısını etkileyen faktörleri değerlendirmeyi amaçlayan makale, en güncel PISA 2018 verilerini kullanarak öğrencilere, ailelerine, akademik araştırmacılara ve politika yapıcılara ışık tutuyor. Çalışmada, PISA 2018 verisi incelenmiş ve literatürden faydalanılarak öğrenci başarısını etkileyeceği düşünülen 52 sürekli veri özelliğine sahip bağımsız değişken ve 3 kategorik özelliğe sahip bağımsız değişken (öğrencilerin cinsiyeti, annenin eğitim durumu ve babanın eğitim durumu) belirlenmiştir. Literatürle karşılaştırıldığında, bu çalışmada daha fazla değişken göz önünde bulundurularak daha geniş yelpazede öğrenci başarısının belirleyicileri değerlendirilmiş ve bu belirleyiciler üzerine çalışılmıştır.

PISA 2018 Türkiye uygulamasına, 6890 öğrenci ve 186 okul katılım sağlamıştır. Bu makalede sürekli değişken özelliğine sahip 52 değişkenin ve kategorik özelliğe sahip 3 değişkenin değerinde kayıp değerler mevcuttur. Bu sebeple 6890 öğrenci verisinden 4473 öğrencinin verisi çalışmada kullanılabilmiştir. Değişkenlerin öğrenci başarısını belirlemedeki etkisini ölçmek için çoklu regresyon modeli kullanılmıştır. Öncelikle, değişkenler arasındaki yüksek ilişkiden kaynaklı çoklu doğrusal bağlantı sorununu önlemek, birbirine benzer değişkenleri anlamlı faktörler altında toplayabilmek ve değişken boyutunu azaltmak amacıyla sürekli değişken özelliğine sahip olan değişkenlere "Temel Bileşenler Analizi" yönteminden yararlanarak "Faktör Analizi" uygulanmıştır. Faktörler arasında korelasyon yoksa varimax, quartermax ve equamax dik döndürme yöntemleri kullanılır. Faktörler arasında ilişki varsa direkt oblimin ve promax eğik döndürme yöntemleri kullanılır. Çalışmada çoklu regresyon modeli kullanılacağından çoklu bağlantı sorununa düşmemek için bağımlılık yapısının

ortadan kaldırılması gerekmektedir. Korelasyon değerlerine baktığımızda değişkenler arasında 0,3'ün üzerinde korelasyon değerleri görmekteyiz. Bu nedenle oblique rotasyonu tercih ediyoruz. Direct oblimin yöntemi küçük verilerde iyi sonuç verirken, promax yöntemi büyük verilerde iyi sonuç vermektedir (Field, 2013). Eğik döndürme yöntemlerinden biri olan Promax yöntemi, gözlem verilerinin nispeten yüksek olması (4473) nedeniyle tercih edilmektedir. Verilerin faktör analizine uygun olup olmadığını test etmek için Kaiser-Mayer-Olkin (KMO) ve Bartlett küresellik testi uygulanmalı (Kaiser, 1974); (Aldrich ve Cunningham, 2016). KMO örneklem kriterinin %73 değeriyle %60'ın üzerinde olduğu sonucuna varılmıştır. Barlett testinin Kimlik Matrisine Eşit Korelasyon Matrisi sıfır hipotezi $p=0,00 <\alpha=0,05$ olduğu için reddedildi (Ünsal ve Sülkü, 2020). Uygulanan test sonucunda verilerin faktör analizine uygun olduğu sonucuna varılmıştır. Faktör kümeleri PCA kullanılarak oluşturulmakta olup, özdeğeri 1'den büyük 14 ana faktör bulunmaktadır. Bu 14 faktör Tablo 3'te sunulmaktadır. Devamında, temel bileşenler analizden elde edilmiş faktörler ile faktör analizine alınması uygun olmayan kategorik özelliğe sahip değişkenler olan öğrencinin cinsiyeti, annenin eğitim durumu ve babanın eğitim durumu değişkenlerinin matematik alanındaki öğrencilerin başarısını ne derecede açıkladığını anlamak amacıyla değişkenlere çoklu regresyon analizi uygulanmıştır.

Modelde değişen varyans sorunu olup olmadığını anlamak için 3.1 modeline Breusch Pagan testi uygulanmıştır. Uygulanan test sonucunda elde edilen istatistiksel değer 18,902, olasılık değeri ise 0,001 olarak bulunmuştur. Breush Pagan testinin sıfır hipotezi: Değişen varyans yoktur, $p=0,001 <\alpha=0,05$ olduğundan 0,05 anlamlılık seviyesinde reddedilir. Test sonucunda modelde değişen varyans sorunu olduğu ortaya çıkmıştır. Bu sebeple matematik başarısı modellerinin parametre tahminleri robust standart hatalarıyla elde edilen 5 farklı regresyon modeli kullanılarak modellerin performansları karşılaştırılmış ve en iyi model elde edilerek yorumlanmıştır.

Model 1'de Matematik Başarısını açıklayabileceği düşünülen faktör analiziyle elde edilen faktörler ile Annenin Eğitim Durumu, Babanın Eğitim Durumu ve Öğrencinin Cinsiyeti değişkenleri açıklayıcı değişken olarak kullanılmıştır. Model 2'de sadece faktör analizi ile elde edilen faktörler ile Matematik Başarısı açıklanmıştır. Model 3'te sadece istatistiksel olarak anlamsız olan bir değişken modelden çıkarılmıştır. Daha sonra katsayısı istatistiksel olarak anlamlı olan tüm değişkenlerin bulunduğu Model 4 kurulmuştur. Son olarak Model 5'te önsel beklentileri karşılayan ve istatistiksel olarak anlamlı olan değişkenler modele alınmıştır. Modellerin performanslarını değerlendirmek için modelin açıklanma gücünü gösteren Düzeltilmiş R^2 ve modelin ortalama hata kareleri ortalamaları incelenmiştir. En yüksek açıklama gücüne sahip olan 4. model (0,320) olarak belirlenmiştir. Ortalama hata karelerine baktığımızda en iyi modelin Model 1 (4769,277) ve çok yakın sonuç veren Model 4 (4771,627) olduğu görülmüştür. Bu nedenle istatistiksel beklentimizi karşılayan değişkenlere sahip olan Model 4 baz alınarak sonuçlar değerlendirilmiştir.

Öğrenci Başarısını açıklamada Ailenin Refahı, Ayrımcılık ve Zorbalık, Matematik ve Fen Dersi Öğrenme Süresi, Okuduğunu Anlama Algısı, Okulda Bilgi ve İletişim Teknolojileri (BİT) Kullanımı, Okul Dışında BİT Kullanımı, Okulda İş birliği Algısı, Öğrencinin Cinsiyeti ve Babanın Eğitim Durumu değişkenlerinin önemli olduğu sonucuna ulaşılmıştır. Ailenin Refahı, Ayrımcılık ve Zorbalık, Matematik ve Fen Dersi Öğrenme Süresi ve Cinsiyet değişkenleri öğrencinin başarısını açıklama en büyük güce sahip olan değişkenler olduğu sonucu elde edilmiştir.

Eğitimin ölçülmesini amaçlayan bu çalışmada, faktör analizi sonucunda varyansı açıklamada en yüksek güce sahip olan bileşenin ailenin refahı faktörü olduğu tespit edilmiştir. Ailenin refahı faktörünün altında ev eşyaları, aile serveti, bilgi iletişim teknoloji kaynakları, ekonomik sosyal ve kültürel durum indeksi, evde eğitim kaynakları, evde bilgi iletişim teknolojisi, evde kültürel eşyalar değişkenlerinin yer aldığı belirlenmiştir. Ayrıca matematik alanında öğrenci başarısını belirlemede önemli olduğu ortaya çıkan iki diğer faktör okulda bilgi iletişim teknolojileri kullanımı ile okul dışında bilgi iletişim teknolojileri kullanımıdır. Bu birbirini destekleyen sonuçlar; fırsat eşitliğinin önemini bir kez daha ortaya koymaktadır. Dezavantajlı öğrencilerin özellikle "Bilgi İletişim Teknoloji Kaynakları ve Eğitim Kaynakları" açısından akademik desteğe ihtiyaç duyduğunu göstermektedir. Bu anlamda dezavantajlı öğrencilere bilgi iletişim teknoloji kaynakları sağlamak büyük önem arz etmektedir.

Bu çalışmada, uygulanan çoklu regresyon analizinde ise öğrencilerin matematik alanında başarısını belirlemede ailenin refahının diğer değişkenlere göre daha yüksek bir değere sahip olduğu sonucu elde

edilmiştir. Bu bulgularımız literatürü destekler niteliktedir; örneğin, McNeal (1999) Hoschschild (2003) ve Eamon, (2005), yüksek gelir seviyesi olan ailelerin, çocuklarına daha zengin eğitim kaynakları sunabilmelerinden dolayı öğrencilerin matematik başarısının diğer öğrencilere göre daha fazla arttığı yorumunu yapmışlardır. Bu sebeple sosyo-ekonomik seviyesi düşük olan öğrenciler için eğitimde fırsat eşitliğini sağlamak adına çalışmalar yapılması önerilmektedir.

Regresyon analizinde anne ve babanın eğitim durumlarının öğrencinin eğitimdeki başarısına etkisi eşanlı değerlendirilmiştir. Ancak aralarındaki yüksek korelasyondan dolayı çoklu doğrusallık sorununa sebep olamamak için babanın eğitim durumu sadece regresyon modellerinde tutulmuştur. Literatüre benzer şekilde (Puklek, Zupancic ve Socan'ın, 2012; Desforges ve Abouchar, 2003), regresyon analizinde babanın eğitim seviyesinin öğrencinin başarısını olumlu yönde etkilediği görülmüştür. Eğitim düzeyi yüksek olan anne ve babalar, eğitimin öneminin farkında olacaklarından, çocuklarının daha iyi bir eğitim almaları için her türlü desteği sağlayacaklardır. Bu sebeple ebeveynleri bilinçlendirmeye yönelik çalışmalar yapılabilir.

Ayrıca regresyon analizi sonucunda "Ayrımcılık ve Zorbalık", "Okulda İş birliği Algısı", "Matematik ve Fen Dersi Öğrenme Süresi", "Okuduğunu Anlama Algısı" değişkenlerinin de öğrenci başarısını belirleme de önemli değişkenler olduğu anlaşılmaktadır. Bu kapsamda dikkat çeken konulardan biri de öğrencilerin eğitimi-öğrenim hayatındaki başarısının temel belirleyicisi olarak görülen sosyo-ekonomik durum ve ailesel faktörlerin olması kadar öğrenci başarısını belirlemede okuldaki sosyal ortam ve öğrenme becerilerinin de büyük öneme sahip olduğudur. Öğrencinin akademik başarısını negatif yönde etkileyen "Ayrımcılık ve Zorbalık" faktörünün bileşenleri altında "Ayrımcı Okul İklimi" ve "Öğrencinin Zorbalığa Maruz Kalma Deneyimi" değişkenleri bulunmaktadır. Bu durum ilk olarak ayrımcı okul iklimini denetleyici bir birimin gerekli olduğunu göstermektedir. İkinci olarak ayrımcılık ve zorbalıkta bulunanlara yaptırım uygulanmalıdır. Son olarak ayrımcılık ve zorbalığa maruz kalan öğrencilere psikolojik destek verilmesi önerilmektedir.

Appendix

Appendix 1. Descriptive Statistics

Variable	N	Minim.	Maxim.	Mean	Std. Dev.	Variable	N	Minim.	Maxim.	Mean	Std. Dev.
V1	6643	0	10	5,61	3,054	V27	6821	-2,7316	2,6574	,683140	,9756913
V2	6620	0	40	5,06	1,762	V28	6691	-2,4403	1,8839	,027817	,9749167
V3	6622	0	40	5,66	1,729	V29	6699	-1,8876	2,7752	-,094477	,9510424
V4	6617	0	40	4,94	2,781	V30	6740	-1,2720	3,0064	,214773	,9435110
V5	6458	10	80	41,26	12,205	V31	6604	-1,9892	2,0378	,342463	1,096567
V6	6674	10	120	41,41	11,587	V32	6567	-2,1428	1,6762	-,01048	1,154736
V7	6537	0	1600	234,00	93,611	V33	6765	-2,5375	1,0844	-,113484	1,069259
V8	6535	0	1600	209,13	91,277	V34	6771	-2,3450	2,0054	,321747	1,215095
V9	6533	0	1710	202,86	122,286	V35	6719	-2,7365	1,8164	,019930	1,090619
V10	5923	100	3000	1572,79	385,519	V36	6745	-1,8939	1,8905	,118726	1,007863
V11	6855	-4,7546	2,7617	-1,17125	1,17807	V37	6749	-2,1464	1,7411	,149970	1,009339
V12	6792	0	11	6,22	2,668	V38	6691	-3,0666	1,2386	-,259834	1,123959
V13	6738	0	10	5,39	2,797	V39	6789	-3,1675	2,3693	,352079	1,144051
V14	6857	-6,6795	5,7608	-1,17903	1,06685	V40	6703	-2,5252	1,8524	-,054692	1,128984
V15	6769	-2,7469	2,0760	-,771617	1,17882	V41	6673	-1,1549	3,1825	,358424	1,030091
V16	6819	-4,4911	1,2099	-,481112	1,04842	V42	6787	-3,2569	2,7562	-,142820	1,023950
V17	6853	-5,0913	4,5046	-1,35618	,96943	V43	6525	-,7823	3,8591	-,043640	1,052625
V18	6837	-3,8145	3,6010	-1,09136	,97212	V44	6475	-3,5940	4,2444	-,112249	1,341264
V19	6830	-2,7124	2,0345	-,071193	,95879	V45	6425	-2,3008	3,3102	,121810	,9854572
V20	6820	-2,7426	1,3411	,216539	,93515	V46	6429	-1,7161	3,3041	-,173759	1,069559
V21	6822	-2,9425	1,8202	,227326	1,00374	V47	6441	-2,9505	2,6672	-,155287	1,165721
V22	6766	-1,6391	2,0165	,022515	1,01931	V48	6423	-2,6033	2,0652	-,124156	1,051772
V23	6675	-2,4468	1,0346	,014734	1,06732	V49	6409	-2,5144	2,0258	-,207729	1,07157
V24	6808	-2,3003	2,0871	,070383	1,01828	V50	6392	-2,1763	2,3635	,205155	1,039275
V25	6776	-2,2652	2,0073	,066683	,97394	V51	6442	-1,2188	2,4394	,231307	1,027687
V26	6817	-2,2177	1,8245	-,097250	1,0881	V52	6387	-1,3048	2,4969	-,021478	1,003796

Appendix 2. Correlation Table

	X_{15}	X_{16}	X_{17}	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X_{15}	1	,027	,019	,014	-,070	,173	-,005	-,137	-,230	-,031	,047	-,016	-,056	,290	-,085	-,086	-,090
X_{16}	,027	1	,565	,476	-,009	,123	,134	,003	,045	,045	,014	,084	,034	-,014	,046	,015	-,037
X_{17}	,019	,565	1	,502	-,037	,133	,188	,001	,0610	,030	-,005	,068	,019	-,036	,063	,024	-,078
X_1	,014	,476	,502	1	,044	,319	,156	,027	,117	,109	,152	,245	,055	,064	,133	-,001	,095
X_2	-,070	-,009	-,037	,044	1	,090	-,001	,251	,226	,035	,304	,187	,048	-,087	,287	,011	,249
X_3	,173	,123	,133	,319	,090	1	-,002	,106	,090	,027	,148	,195	-,010	,216	,188	-,052	,208
X_4	-,005	,134	,188	,156	-,001	-,002	1	,071	,047	,325	-,028	,026	,213	-,154	,097	,256	-,048
X_5	-,137	,003	,001	,027	,251	,106	,071	1	,275	,021	,143	,055	,027	-,038	,272	,118	,232
X_6	-,230	,045	,061	,117	,226	,090	,047	,275	1	,049	,268	,006	,009	-,102	,262	,017	,069
X_7	-,031	,045	,030	,109	,035	,027	,325	,021	,049	1	,076	,029	,243	-,009	,058	,293	,087
X_8	,047	,014	-,005	,152	,304	,148	-,028	,143	,268	,076	1	,070	,077	,027	,407	-,102	,252
X_9	-,016	,084	,068	,245	,187	,195	,026	,055	,006	,029	,070	1	,036	,237	,041	,010	,220
X_{10}	-,056	,034	,019	,055	,048	-,010	,213	,027	,009	,243	,077	,036	1	-,058	,058	,299	,066
X_{11}	,290	-,014	-,036	,064	-,087	,216	-,154	-,038	-,102	-,009	,027	,237	-,058	1	-,189	-,068	,203
X_{12}	-,085	,046	,063	,133	,287	,188	,097	,272	,262	,058	,407	,041	,058	-,189	1	-,032	,151
X_{13}	-,086	,015	,024	-,001	,011	-,052	,256	,118	,017	,293	-,102	,010	,299	-,068	-,032	1	,002
X_{14}	-,090	-,037	-,078	,095	,249	,208	-,048	,232	,069	,087	,252	,220	,066	,203	,151	,002	1

Appendix 3. Regression Model Obtained with IDB and SPSS Program

Variables	Coefficient (IDB)	Coefficient (SPSS)
Constant	472,64	452,610
(Standard error)	(2,12)	(0,982)
(t)	(222,64)	(460,94)
WEALTH	17,23	17,914
(Standard error)	(2,16)	(1,086)
(t)	(7,96)	(16,496)
DISCBULLYI	-15,12	-16,188
(Standard error)	(1,82)	(1,101)
(t)	(-8,29)	(-14,698)
LMINS	-2,15	-1,388
(Standard error)	(1,59)	(1,090)
(t)	(-1,35)	(-1,273)
GLEARNTIME	-3,72	-4,091
(Standard error)	(1,64)	(1,060)
(t)	(-2,27)	(-3,861)
MSMINS	26,23	26,398
(Standard error)	(2,11)	(1,094)
(t)	(12,43)	(24,129)
READCOMP	9,44	9,243
(Standard error)	(1,54)	(1,075)
(t)	(6,14)	(8,598)
ICTENT	7,33	7,699
(Standard error)	(1,68)	(1,094)
(t)	(4,36)	(7,035)
ICTSCH	4,52	4,588
(Standard error)	(1,99)	(1,077)
(t)	(2,27)	(4,261)
LESSONTIM	-1,97	-2,441
(Standard error)	(1,26)	(1,095)
(t)	(-1,56)	(-2,228)
SCOOPERATION	10,75	11,435
(Standard error)	(1,46)	(1,169)
(t)	(7,39)	(9,778)
LEARNACT	-15,05	-15,916
(Standard error)	(1,65)	(1,101)

(t)	(-9,12)	(-14,454)
TEACHATTITUTE	-4,95	-4,750
(Standard error)	(1,98)	(1,110)
(t)	(-2,5)	(-4,280)
SELFEF	-3,33	-3,057
(Standard error)	(1,52)	(1,091)
(t)	(-2,19)	(-2,802)
SLIFE	-5,35	-5,309
(Standard error)	(1,4)	(1,157)
(t)	(-3,81)	(-4,587)