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Investigation of the Variables Affecting the Students' Science Achievement with Multilevel Regression Model *

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Abstract
This study investigated the variables affecting the science achievement of eighth-grade students by multi-level regression analysis. The variables included in this research were students' attitudes, confidence level, value, engagement in science, socioeconomic status, school type, school region, and teacher experience. The study group consisted of 1049 students and 41 teachers. In the first research question, differences in students' science achievement scores among their schools were investigated. According to the results, the students' achievements differed among their schools. Approximately 16.3% of the differences observed in science achievement were stem from the differences among schools, and 83.6% stem from the differences among students. In the second research question, student characteristics that explain the differences among the science achievements of the schools have been examined. Students' socioeconomic level, attitude, and confidence level were only variables that have statistically significant relationship with achievement. Socioeconomic and confidence level variables have a positive effect on achievement, but attitude variable has a negative effect on achievement. In the third research question, student and school characteristics that affect science achievement have been examined simultaneously. The school characteristics that have been included in the regression model were teacher experience, region, and school type. It was determined that none of the regression coefficients for the school characteristics variables were statistically significant in the regression model.

Key Words: Multi-level regression analysis, TEOG science exam, affective characteristics of students, school characteristics.

INTRODUCTION

The rapidly developing technology, the growth of the economy, and the changes in priorities of social life lead to the differentiation of the needs of our lives. Particularly, the rapid progression of technology makes science fields more prominent. Therefore, in recent years, countries started to emphasize science education and encourage students to enter science-related jobs more than the other fields. According to the report of the Scientific and Technological Research Council of Turkey (Türkiye Bilimsel ve Teknolojik Araştırma Kurumu-TUBİTAK), science and technology will be the foundation of the professions which will be needed in the future (TUBİTAK, 2016). To be able to enter the occupational fields related to science, it is very important for individuals to have an interest in science and concrete science education. However, it is noteworthy that nowadays individuals are not inclined toward science-related occupational fields. The lack of employees in these areas is expected to affect the productivity and technological development of countries significantly. For this purpose, the importance of science education and the factors affecting the success of students should be examined, and interest in these fields should be increased. In this context, many studies on the science achievement of students at both national and international levels were done, and the factors affecting the students' success of science were examined in Turkey.

When the studies concerning the national examinations administered in Turkey on science were examined, various variables affecting the science achievement of students have been determined.

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According to the literature, these variables are socioeconomic level, value, self-efficacy, attitude, perception, education level of the family, gender, time allocated to study, teacher characteristics, and school characteristics (Acar, 2009; Anıl, 2011; Atalmış, Avgın, Demir & Yıldırım, 2016; Ötken, 2012; Şahin, 2011; Uzun, Gelbal & Öğretmen, 2010).

In addition to national exams, variables affecting the science achievement of the Turkish students at international exams such as PISA (Program for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) were also investigated in the literature. These variables are attitude, self-efficacy, value, socioeconomic level, education level of a family, gender, home resources, material resources, computer environment teacher characteristics, and school location (Abazoğlu & Taşar, 2016; Acar & Öğretmen, 2012; Akıllı, 2015; Akyüz, 2006; Anıl, 2009; Atar & Atar, 2012; Berberoğlu, Çelebi, Özdemir, Uysal & Yayan, 2003; Büyüköztürk, Çakan, Tan & Atar, 2014; Pektaş, 2010; Uçar & Öztürk, 2010).

These variables were investigated in various combinations in the related research. For example, Anıl (2011) investigated the factors that predict PISA science achievement of the Turkish students with the parents' level of education, attitude, computer, and family's wealth of culture variables. Pektaş (2010), on the other hand, evaluated the students' TIMSS science scores with the variables of attitude, self-efficacy, value, and education level of the family. In another study, 8th-grade students' science achievement in TIMSS were examined via attitudes, values towards science, and self-efficacy variables (Akıllı, 2015).

These types of studies have only addressed student characteristics. In addition to student characteristics, there are also studies dealing with the characteristics of teachers and schools. For instance, in the TIMSS-2011 study conducted by Abazoğlu and Taşar (2016), teacher characteristics that affect students' science achievement were determined as job satisfaction, computer use in class, and participation in professional development activities. In terms of teacher characteristics, Atar (2014) found that some teacher characteristics measured by TIMSS 2011 were determiners of the students' science and technology achievement. Those teacher characteristics were participation in in-service training programs related to information technologies, importance given by teachers to academic achievement, gender of teachers, and cooperation among colleagues.

The variables such as attitude and self-efficacy discussed in these studies are the individual characteristics of the students, whereas the variables such as teacher experience and school type are characteristics of students' groups. In other words, there are variables related to the students and student groups. That is, the data obtained from the students and their schools show a hierarchical structure such as students, classes and schools. If this hierarchical structure is ignored when examining the predictors of science achievement, the principle of independence required for regression analysis is violated, and the result of the analysis may be biased. In hierarchical data, more complex error structure should be added to the model to take account of the dependence between observations within the group (Heck, Thomas, & Tabata, 2010). Multilevel modeling, on the other hand, ensures that the predictor variables are analyzed in accordance with the hierarchical structure of the data and obtain unbiased results (Heck et al., 2010).

The studies aiming at determining the variables affecting the students' science achievement are generally performed with single-level analysis for both the national (e.g. high school entrance examinations, etc.) and international (PISA and TIMSS, etc.) exams administered in Turkey (e.g. Acar, 2009; Ötken, 2012; Süer, 2014; Şahin, 2011). Most of these studies were conducted without considering the hierarchical structure of the data. In the TIMSS and TEOG (Transition from Basic Education to Secondary Education) exams, the hierarchical structure of the data necessitates the examination of variables predicting achievement at different levels (individual and school). The use of multi-level analysis in the examination of structures at different levels is more appropriate than the use of single-level models due to the fact that the observations are not independent of each other and the design effect (Hox, 2010). Multilevel analyses are methods of analysis that examine the relationship between variables that characterize individuals and groups. In multilevel analyses, the data structure within the group is hierarchical, and the data should be taken from this hierarchical group (Hox, 2010).

In the literature there are multi-level analysis studies examining students' science achievement in the TIMSS exam (Abazoğlu & Taşar, 2016; Acar & Öğretmen, 2012; Atar, 2014; Atar & Atar, 2012) and in the TEOG exam for subjects such as mathematics and Turkish (Acar, 2013; Doğan & Demir, 2015; Yavuz, Odabaş & Özdemir, 2016). However, in the literature, there are no studies investigating the individual and group level variables affecting the science achievement for the national exams carried out in Turkey by multilevel analysis. In this study, it was aimed to investigate the variables that predict the students' science achievement by multilevel analysis in accordance with the hierarchical structure of the TEOG data. Thus, the extent to which the variables related to individuals and schools related to achievement will be examined in a more unbiased manner. Examination of the students' science achievement by multilevel analysis for a national exam, provides an opportunity to compare the findings of this study with those of single-level analysis and also helps to fill the gap in the literature on this issue. TEOG is a test conducted by the Ministry of National Education (MONE) for the evaluation of student achievement in an integrated manner with the learning process and applied for the evaluation of science achievement. The aim of this study is to examine the science achievement of eighth-grade students who participated in the TEOG science sub-test. By providing scores that are on the same scale, TEOG allows the comparison and inclusion of students (with different characteristics) from different cities and districts of Turkey. Thus, the relationship between the variables included in this study and a national science exam scores can be examined across Turkey. The school-level variables in this study are school region, school type, and teacher experience; and the student-level are the students' socioeconomic level, value given to science, interest in science, self-efficacy and attitude. By using these variables, in this study, the answer to the question To what extent do the school and student level variables predict students' science achievements? is examined. Furthermore, the following research questions guided this study:

1. Do students' science scores show a significant difference among their schools?
2. To what extent do students' science scores are predicted by level-1 (student) variables (interest, value, self-efficacy, attitude, and socioeconomic status)?
3. To what extent do students' science scores are predicted by level-1 and level-2 (school) variables (regional population, type of school, and teacher experience)?

Within the scope of the research, it is assumed that the students answered the questionnaire items in a sincere manner. This research is limited to the answers of the students and teachers to the questionnaire items selected from the TIMSS 2011 measurement tool and the variables determined in the measurement tool.

METHOD

The related information about the method of the study is presented at the parts below.

Participants

In the study, 1049 8th grade students who took the TEOG exam attending 30 different schools (26 state schools and 4 private schools) in Düzce, Erzurum, Çankırı, Antalya, and Ankara in 2015-2016 school year were participants. 597 of the students were female, and 452 of them were male. In addition, a total number of 41 teachers, 37 of whom were working in a state, and 4 of whom were working in a private school, participated in the study voluntarily. School-level data were collected from the teachers. Participants of the study were selected from conveniently available schools. Therefore, convenience sampling was used in the study.

Data Collection Instrument

Some of the TIMSS 2011 student and teacher questionnaire items were selected and used in the data collection tool of this study. The reasons for using TIMSS items are the research support for items' validity and reliability; comprehensiveness of the items for the related variables and finally comparability property. The relevant TIMSS items were administered to the students and the teachers. Students' TEOG science scores were obtained based on their statements.

The first part of the measurement tool for the students includes 12 demographical items. These are about gender, age, parents' educational level and occupation, home resources (number of books at home, computer, desk, separate room, and internet), and TEOG science score. The second part includes 26 affective items from TIMSS 2011 student questionnaire. The codes for the original TIMSS items were BSBS17A-F, BSBS19A-N, and BSBS18A-E. These items were related to attitude, self-efficacy, interest in science, value given to science. The specific item codes for interest variable are BSBS18A, BSBS18B*, BSBS18C, BSBS18D, BSBS18E; for self-efficacy BSBS19A, BSBS19B*, BSBS19C*, BSBS19D, BSBS19E*, BSBS19F, BSBS19G, BSBS19H, BSBS19I*; for attitude BSBS17A, BSBS17B*, BSBS17D*, BSBS17E, BSBS17F; and for value variable BSBS19J, BSBS19K, BSBS19L, BSBS19M, BSBS19N, BSBS17G'. * items were coded inversely in the study. The measurement tool for the teachers consists of items about teachers' year of experience, regional population of the school, and school type.

Data Analysis

In order to reduce the number of variables to be included in the multi-level regression analysis, the questionnaire items were subjected to exploratory factor analysis, and the obtained variables were used in the regression analysis. The appropriateness of collected data for factor analysis was analyzed by the Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's sphericity test. In the study, KMO coefficient was calculated as .935, and this value was found to be good (.80 < KMO < .90) in order to continue factor analysis (Büyüköztürk, 2015). In the Bartlett Sphericity Test, the chi-square value (χ^2 = 2067.004; p = .000 < .05) was found to be significant. According to the obtained results, the data showed multivariate normality (Büyüköztürk, Şekercioğlu & Çokluk, 2014). In the factor analysis, the items were analyzed in separate groups for the factors as in the analysis of the 2011 TIMSS measurement tools. Table 1 shows the number of items in each factor, the total explained variance, and KMO. After factor analysis, for interest, value, attitude, self-efficacy, socioeconomic status of the students factor scores were obtained. In addition to these student-level variables, teacher experience, the population in the school region, type of school were considered as independent variables in the regression model. The participant students' TEOG science scores were considered as the dependent variable.

Table 1. Factor Analysis Results for Attitude, Self-Efficacy, Value, Interest and Socioeconomic Status Variables

Variable	Number of Items	KMO	Total explained variance (%)
Attitude	6	.828	52.736
Self-efficacy	9	.877	50.002
Value	6	.827	53.745
Interest	5	.751	46.750
Socioeconomic status	3	.771	39.365

In the collected data, there were 35 cases with missing data. In the study, the mean values were assigned for these missing data, and the analyses were performed with 1049 participants. The students' TEOG science scores showed normality. In the analysis, condition indices (CI), variance inflation factor (VIF) and tolerance values were examined for collinearity among the independent variables. The tolerance values of the variables were greater than .20; variance inflation factor (VIF = 1 / (1-R^2)) values were less than 10; CI were found to be less than 30. The internal consistency reliability coefficients of each factor were calculated with Cronbach Alpha. The Cronbach Alpha coefficient was α = .83 for the value variable, α = .88 for the self-efficacy variable, α = .81 for the attitude variable, and α = .69 for the interest variable. The Cronbach's Alpha coefficient for the whole measurement tool (α = .921) is over .70, indicating the reliability of the measuring instrument. The data were analyzed with a mixed model (SPSS 20.0). In the following section, multi-level regression analysis and regression models used in this study are explained.

Multilevel analysis

In studies that examine the relationship between individual and society/group, data can be observed at different hierarchical levels, and variables can be defined for each level. Multilevel analyses are methods that examine the relationship between variables that characterize individuals and groups (Hox, 2010). If the data structure is ignored, aggregation and disaggregation problems appear. In the aggregation, researchers are interested in group-level data, so they aggregate the variables that characterize individuals in each group to a higher level (group level). In disaggregation, to analyze data at a single level the variables belonging to the upper level are assigned to the individual level. However, aggregation and disaggregation may cause some errors (Heck et al., 2010). In the hierarchical groups, individual observations are generally not completely independent. Therefore, the mean correlation between the variables measured on students from the same school (so-called intra-class correlations) is higher than the average correlation between the variables measured in different schools. If the sample is not random, participants from the same geographical region will be more similar to each other compared to participants from different geographical regions. Being nonrandom sample (having similar characteristic) leads to standard error estimates that produce incorrect results. To prevent incorrect results design effect has to be considered in analysis. Intra-class correlation (ρ) is used to calculate the design effect. Intra-class correlation is defined as the ratio of variance between the groups compared to the total variance. Intra-class correlation can also be interpreted as the expected correlation between two randomly selected individuals in the same group. Intra-class correlation is calculated by the formula shown in Equation 1.

$$\rho = \sigma_b^2 \big/ \sigma_b^2 + \sigma_w^2 \qquad (1)$$

The design effect (Deff) depends on both the intra-class correlation and the sample size. Deff for a model with a two-level data structure is shown in Equation 2.

$$\text{Deff}=1+ \rho(n-1) \qquad (2)$$

In this study there are two levels. Level-1 is student-level and level-2 is school-level. The participants' TEOG science scores (Y) were used as the dependent variable. The independent variables at the student level (Level 1) and the variables included in the model at the school level (Level 2) are stated below.

Table 2. Independent Variables of Level- 1 (Student) and Level-2 (School)

Level-1 Student level	**Independent variables**
Socioeconomic status	SES (X_1)
Attitude	TUT(X_2)
Value	DEĞ (X_3)
Interest	ILG (X_4)
Self-efficacy	OZY(X_5)
Level-2 School level	
School region population	BOL(X_6)
School type	TUR(X_7)
Teacher experience	OGR(X_8)

The first question of this research is do students' science scores show significant difference among their schools? In order to answer this question, the intra-class correlation and design effect was calculated for the available data. For this purpose, the one-way ANOVA model was established in multilevel analysis.

In the multilevel analysis, the one-way ANOVA model examines the between and within-group components of variances (Heck et al., 2010). This model provides information about intra-class correlation and determines whether a multilevel model is required or not (Tabachnick & Fidell, 2007). One-way ANOVA model is presented in Equation 3.

$$Y_{ij}= \beta_{0j}+ \varepsilon_{ij} \tag{3}$$

The equation of level 2 of the model is given in Equation 4.

$$\beta_{0j}= \gamma_{00}+ u_{0j} \tag{4}$$

Equation 5 is obtained when the Equation 4 is inserted in Equation 3.

$$Y_{ij}= \gamma_{00}+ u_{0j}+ \varepsilon_{ij} \tag{5}$$

This model provides the level of dependence in level 2 through intra-class correlation (ρ). After determining the necessity of multilevel analysis, first level predictor model (level-1 model-random intercepts- constant slope with fixed estimators) was established to answer the second research problem. The model obtained by adding a predictor to the equation used in the estimation of student success is called *the first level predictive model* (Tabachnick & Fidell, 2007). The level-1 estimators are indicated by X. The equation for the student level model is given below in Equation 6. In this equation, the absence of j index in the β_1 coefficient indicates that the slope is constant for the groups.

$$Y_{ij}= \beta_{0j}+ \beta_1 X_{ij} + \varepsilon_{ij} \tag{6}$$

Equation 7 is used to predict the slope.

$$\beta_1= \gamma_{10} \tag{7}$$

Equation 7 and Equation 4 are inserted in Equation 6, and Equation 8 is obtained. In this equation, when the fixed parameters (γ_{00} and γ_{10}) and random parameters (u_{0j} and ε_{ij}) are edited, Equation 8 is obtained.

$$Y_{ij}= \gamma_{00}+ \gamma_{10}X_{ij}+u_{0j}+ \varepsilon_{ij} \tag{8}$$

By considering student level variables, the Equation 9 is obtained.

$$Y_{ij}= \beta_{0j} + \beta_1(SES)_{ij} + \beta_2(ILG)_{ij}+ \beta_3(DEG)_{ij}+ \beta_4(OZY)_{ij}+ \beta_5(TUT)_{ij}+ \varepsilon_{ij} \tag{9}$$

Through this analysis, β values are determined for the independent variables (SES, ILG, DEG, OZY, and TUT). These values indicate at what level these variables predict the students' science scores. In addition, in order to determine to what extent individual level independent variables added to the model explain the difference between schools, the difference between the variance values for the first level predictive model and the variance values in the one-way ANOVA model are examined. This reduction at variance is calculated by between- and within-group variance estimation (R^2). To calculate reduction in variance, Equation 10 is used for between- and within- group variance.

$$\left(\sigma^2_{M1} - \sigma^2_{M2}\right) / \sigma^2_{M1} \tag{10}$$

To answer the third and last research question, school-level variables have been added to the multi-level regression model. Group-level variables are added to the multi-level model (random intercepts fixed slope).

$$\beta_{0j} = \gamma_{00}+ \gamma_{01}W_j+ u_{0j} \tag{11}$$

Adding the independent variables (W and X) at the group level and at the individual level yields the Equation 12. Equation 12 is reached when the terms are arranged.

$$Y_{ij} = \gamma_{00} + \gamma_{01}W_j + \gamma_{10}X_{ij} + u_{0j} + \varepsilon_{ij} \quad (12)$$

Thus, at the school level, variables are added to the equation to explain the variability of the intercepts between schools. Three independent variables in level 2 (school level) have been added to the model. The Equation 13 is obtained when they are placed in Equation 10 at the school level as independent variables.

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(BOL)_j + \gamma_{02}(TUR)_j + \gamma_{03}(OGR)_j + u_{0j} \quad (13)$$

When Equation 13 is combined with the level 1 (student level) variables,

$$Y_{ij} = \gamma_{00} + \beta_1(SES)_{ij} + \beta_2(TUT)_{ij} + \beta_3(DEG)_{ij} + \beta_4(ILG)_{ij} + \beta_5(OZY)_{ij} + \gamma_{01}(BOL)_j + \gamma_{02}(TUR)_j + \gamma_{03}(OGR)_j + u_{0j} + \varepsilon_{ij}$$

is obtained. Through this analysis, the levels of school level (TUR, OGR, BOL) are predicted in terms of predicting student science scores.

RESULTS

Results for the First Research-Problem

The results of the one-way ANOVA model analysis are given in Table 3. In this model, the average of the students' science scores is determined as 72.76. The standard error of the estimated value is 1.56. In the 95% confidence interval, the real value of the overall science achievement average is in the range of 75.83 - 69.70 points.

Table 3. One-way ANOVA Model Results

Fixed effects	**Coefficient**	**Standard error**	**df**	**t**
Average science score	72.76*	1.56	30.53	46.54
Random effects	**Variance**	**Standard error**		**Wald Z**
level-1 within-group variation, student level	308.98*	13.67		22.60
Level-2 between group variation, school level	60.37*	18.56		3.25

*$p < .01$

The variance of the students' science achievement for the school average is estimated as 308.99 (within-group variability), and the variance of the difference of the school means from the general average is 60.37 (between-group variability). Intra-class correlation coefficient is calculated by Equation 1. By using these variance values, it is calculated as 60.37 / (60.37 + 308.98) = 0.163 or 16.3%. When Table 3 is examined, there is a significant difference among TEOG achievement scores (Wald Z = 22.60, $p < .05$). Approximately 16.3% of the differences observed in the students' science scores arise from the differences between schools. Similarly, by using within-group variance: 308.98 / (308.98 + 60.37) = 0.836 or 83.6% is obtained. This value indicates that 83.6% of the total variance stems from the differences among the students. In addition to these values, the design effect (Deff) is calculated in the following way.

$$Deff = 1 + 0.163\,((1049/30) - 1) = 5.537$$

Since Deff is 5.537 > 1, it is seen that the data requires multilevel modeling. The results show that, with the average score difference among schools, the development of the model can be continued.

Results for the Second Research-Problem

In the level-1 student model, within- and between-group intercept and slope equations are examined. In order to determine the student characteristics associated with the students' science scores at level 1, some predictive variables are included in the model. These variables are the students' socioeconomic level (SES), attitude (TUT), value (DEG), interest (ILG) and self-efficacy (OZY). Table 4 shows the estimated values of the fixed and random effects of the level 1 model. When the intercept coefficient (208.23) level-1 variables are taken into account in Table 4, it gives the variance value of the differences of the students' science achievement from the school average.

The slope coefficients of independent variables with high t value and statistical significance are socioeconomic level, attitudes, and self-efficacy variables. According to Table 4, the socioeconomic level ($\beta_1 = 7.36$, $p < .05$) is among the variables affecting student achievement. In addition to this variable, students' attitudes towards science ($\beta_2 = -3.19$, $p < .05$) affect student achievement at individual level. Self-efficacy perceptions of students ($\beta_5 = 10.03$, $p < .05$) are also among the variables that affect student achievement. It is concluded that the students' interest in science ($\beta_4 = -0.32$, $p > .05$) and the value that students give to science ($\beta_3 = 0.87$, $p > .05$) do not statistically affect student science scores. According to these coefficients, the socioeconomic level ($\beta_1 = 7.36$) and the self-efficacy ($\beta_5 = 10.03$) levels of students affect the science achievement positively. The attitude variable shows a significant negative relationship with the students' TEOG science scores. However, the interest (p =.640 >. 05) and value variables (p = .161 > .05) are not statistically significant. These results show that students with higher socioeconomic levels and higher self-efficacy have higher science scores.

Table 4. Random Intercept Model Results

Fixed effect	**Coefficient**	**Standard error**	**df**	**t**
Average science score	73.10	0.84	21.94	87.35
SES	**7.36***	0.63	481.11	11.63
Attitude	**-3.19***	0.76	1042.05	-4.19
Value	0.87	0.62	1034.09	1.40
Interest	-0.32	0.70	1035.25	-0.47
Self-efficacy	**10.03***	0.64	1038.67	15.56
Random effect	**Variance**	**Standard error**		**Wald Z**
Within-group variance, student level (Level-1)	208.23	9.27		22.46
Between group variance, school level (Level- 2)	12.97	6.02		2.15

*p < .01

In order to examine the influence of socioeconomic status, attitude, self-efficacy, interest, and value variables as within-group variables on the model, the variance between ANOVA and first level predictor model is examined. For this purpose, the estimation of reduction in variance (R^2), (308.99-208.23) / 308.99 = 0.326 or 32.6% is obtained.

This result shows that 32.6% of the level-1 variability in student science scores is explained by the variables of student socioeconomic level, attitude, self-efficacy, interest, and value. For the reduction in variance between schools, (60.37-12.97) / 60.37 = 0.785 or 78.5% is obtained.

This result is due to the socioeconomic level, attitude, self-efficacy, interest, and value variables of the students. Between and within-group variance components obtained in the one-way ANOVA model decreased when socioeconomic level, attitude, self-efficacy, interest, and value variables are added to the model. In other words, approximately four-fifths of the variance between schools arises from the differences in the socioeconomic level, attitude, self-efficacy, interest and value status of the students in those schools. Even after socioeconomic level, attitude, self-efficacy, interest, and value variables are included in the model, there is still a significant difference in between- and within-school variability (Wald Z = 2.15, p < .05). In this case, variables at the school level are included in the analysis.

Results for the Third Research-Problem

Level 2 (school level) model is established to determine the predictors of the students' science scores related to school characteristics. In order to explain the difference between school averages in the model, level-1 variables which are socioeconomic level (SES), attitude (TUT), value (DEG), interest (ILG), self-efficacy (OZY) and school-level variables which are school type (TUR (private, state), teacher experience (OGR), and school district (BOL) are included in the model. The results of the analysis are presented in Table 5. Table 5 shows that there is a significant difference between the schools in terms of socioeconomic level, affective characteristics, type of school, teacher experience, and TEOG science achievement scores (Wald Z = 22.46, $p < .05$). In this case, it is stated that the students' science scores vary between schools. To calculate variance change (R^2), between and within-group variances are compared as in the following equation for between groups: (60.37-15.56) / 60.37 = 0.742 or 74.2%. This result indicates that the socioeconomic level, attitude, self-efficacy, interest and value variables of individual level explain 74.2% of the variance between the schools. On the other hand, the coefficient R^2 for within-group variances: (308.99-208.01) / 308.99 = 0.327 or 32.7%.

Table 5. Level-2 Random Intercept Model Results

Fixed effect	Coefficient	Standard error	df	t
Average science score	7.29	4.83	23.08	15.17
SES	**7.17***	0.66	723.50	10.90
Attitude	**-3.14***	0.76	1039.39	-4.11
Value	0.86	0.62	1029.22	1.38
Interest	-0.33	0.70	1031.38	-0.48
Self-efficacy	**10.02***	0.65	1033.17	15.48
School type	-1.25	3.67	18.63	-0.34
Teacher experience	-0.01	0.57	56.86	-0.01
School region	0.32	0.69	42.30	0.46
Random effect	**Variance**	**Standard error**		**Wald Z**
Level-1 variance	208.01	9.27		22.46
Level-2 variance	15.56	7.15		2.18

*$p < .01$

This result shows that the student socioeconomic level, attitude, self-efficacy, interest and value variables constitute 32.7% of the school variability in the students' science scores. According to Table 5, socioeconomic level ($\beta_1 = 7.17$, $p < .05$), students' attitudes towards science ($\beta_2 = -3.14$, $p < .05$) and self-efficacy perceptions of students towards science course ($\beta_5 = 10.02$, $p < .05$) affect the students' science scores. However, the students' interest in science ($\beta_4 = -0.33$, $p > .05$) and value to science ($\beta_3 = 0.86$, $p > .05$) do not affect the students' science scores. When Table 5 is examined, it is seen that the school type ($\gamma_{01} = -1.25$, $p > .05$), teacher experience ($\gamma_{02} = -0.01$, $p > .05$), location of school ($\gamma_{03} = -0.32$, $p > .05$) variables do not affect the students' science scores at the school level.

The results of the multilevel analysis can be summarized in the following equation:

Science Scores = 73.29 + 7.17 (SED) – 3.14 (TUT) + 0.86 (DEG) – 0.33 (ILG) + 10.02 (OZY) – 1.25 (BOL) – 0.004 (TUR) + 0.32 (OGR) + $u_{0j} + \varepsilon_{ij}$

In summary, the socioeconomic level, attitude and self-efficacy variables have a significant effect on the students' TEOG science scores. The teacher experience, value, school location, interest, and school type do not have a significant effect on the students' TEOG science scores.

DISCUSSION and CONCLUSION

In this study, the predictor variables for the 8th grade students' TEOG science scores which are the attitude towards the science, self-efficacy, the value of the science, the students' interest in the science, the student's socioeconomic status, school location, school type, and teacher experience were examined by multi-level regression analysis.

According to the results of the first research problem, there is a significant difference between the average achievement scores of the schools. 16.3% of this difference arises from the schools and 83.7% from the students. This finding aligns with the studies that examined the effect of school and student characteristics variables on student achievement. In these studies, it was expected that most of the variance in achievement will be explained by student characteristics (Odden, Borman & Fermanich, 2009).

In the second research problem, the characteristics of the students were examined to explain the achievement differences among the students and the schools participating in the TEOG exam. The effect of socioeconomic status, attitude, value, interest, self-efficacy variables on science scores were investigated. In the analysis, socioeconomic status, attitude and self-efficacy variables were found to have a statistically significant effect on science achievement, but interest and value variables do not have a statistically significant effect on science achievement. While the socioeconomic status and self-efficacy affected science achievement positively, the attitudes of the students towards science negatively affected the achievement. According to the findings of the analysis, 78.5% of the variance among the schools stems from the students' socioeconomic level, attitude, value, interest, and self-efficacy. In relation to self-efficacy, Atar and Atar (2012) found that students' self-efficacy was a statistical predictor of their science achievement. However, in the study of Akıllı (2015), it was concluded that the students' self-efficacy affected their achievements in a negative way. In another study, it was seen that the socioeconomic status of the students was one of the most important factors affecting the achievement (Öksüzler & Sürekçi, 2010). In addition, in his meta-analysis, Sarıer (2016) found that the most important factors affecting students' achievement were socioeconomic status and self-efficacy. However, Yavuz et al. (2016) stated that the effect of the average socioeconomic status of schools on mathematics achievement was not statistically significant. In our study, the students' socioeconomic status was investigated. The level (individual/group) of the variable included in the analysis also affects the results. The reason for the different findings among the research can stem from the differences between the statistical techniques applied, measurement tools, content, and exam types. In terms of attitude, similar to the results obtained in this study, Kılıç (2016) also concluded that the attitude variable has a negative effect on students' mathematics achievement. On the other hand, Şahin (2011) found that the attitude variable had no significant effect on students' SBS (Achievement level determination exam) science achievement. Regarding attitude, there are also studies showing different results from the findings of this study. For example, in his study, Akıllı (2015) found that the attitudes of 8th grade students predict the TIMSS science scores positively. Pektaş (2010) also stated that attitudes towards science, students' self-efficacy beliefs, the value given to science, and the education level of a family are significant predictors of TIMSS science achievement scores. There are studies in the literature supporting the findings that the value variable does not predict success (Yavuz, Demirtaşlı, Yalçın & Dibek, 2017). Regarding interest in science in some studies in the literature, it has been shown that the interest of students in science significantly predicts success in science (Singh, Mo & Chang, 2006). Obtaining different results from the literature may be due to different analysis methods. In this study, multilevel analysis was used. In multilevel analysis, the problems of aggregation and disaggregation are avoided, and the predictor variables are included in the model at appropriate levels. Therefore, different results may arise from single level analysis methods.

In the third research problem, the student and school characteristics that explain the difference between the students' science scores were examined simultaneously. According to the results, the characteristics of the students and the schools explained 32.7% of the between-school variability. It is found that the school type, the school region, and the teacher experience variables added in Level-2 did not significantly explain the students' science scores. These findings contradict some of the existing research. In one study, it was determined that the less experienced, novice teachers' students had higher scores for application and reasoning questions in TIMSS 2011 (Güner, Sezer & Akkuş-İspir, 2013). In another study, it is stated that teachers with more than five years of experience are more efficient (Greenwald, Hedges & Laine, 1996). While in the literature it was concluded that school type and region variables predicted success (Acar, 2013; Berberoğlu & Kalender, 2005; Karabay, Yıldırım & Güler, 2015), in this study, it was determined that these variables did not predict the students' science scores statistically. However, to investigate this conflicting finding in detail, the school type variable was included in the analysis alone without including the individual level students' characteristics. Then it was found that the school type is the predictor of the students' science scores. In other words, the school type is not the predictor variable of achievement, if it is included in the model with the student characteristics. This finding suggests that it is not the type of schools that matters, but the students who attend those schools. In terms of change in variance with school-level predictors, another interesting result has been observed. The variance between schools increased while it was expected to decrease when level-2 predictor variables are included in the regression model.

According to the findings of this study, the self-efficacy variable has a positive effect on science achievement. For this reason, it is suggested that studies should be conducted to increase the self-efficacy of the students towards the science course. In order to help students to develop self-efficacy, their strengths and positive aspects should be pointed out, emphasized, and supported in the teaching-learning process. In addition, it was determined that the socioeconomic levels of the students had a major significant effect on their achievement. The factors determining the socioeconomic level are parents' education and home resources. In order to increase the achievement of the students, it was determined that the family should be educated first. In Turkey, it may be necessary to follow the innovations in education and to update the education system accordingly to these developments in order to have a positive effect on science achievement. New studies can be done for students to be motivated to learn and understand the importance of science. For example, activities can be planned to show students the relationship of the science courses to real life. Awareness may be raised about the scientific events taking place in Turkey and in the world. Although the experience of the teachers did not have a significant effect on student achievement, there are studies in which teacher experience is determined as an important variable affecting success (Güner et al., 2013). In order to increase the positive effect of teachers on student achievement, new studies should be carried out for teachers who are novice in the profession and competent/experienced teachers in their fields. Teachers may be advised to organize activities for students to love science. The variables that affect the 8th grade students' TEOG science scores were investigated with the items selected from TIMSS 2011 questionnaires. The effect of other variables on achievement can be examined by using other variables from the TIMSS questionnaire. Since the findings of the study were limited to this group of participants, the study could be repeated with participants with different demographic characteristics. In this study, some of the variables that predict achievement differences between schools were determined. From this point of view, the question of what should be emphasized to increase students' science achievement has been answered relatively. However, the undisclosed difference between schools in this study is as high as 20%. In order to explain this ratio, studies that take into account other variables not considered in this study are needed.

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