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INVESTIGATING THE MULTILEVEL EFFECTS OF SEVERAL VARIABLES ON TURKISH STUDENTS' SCIENCE ACHIEVEMENTS ON TIMSS

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Abstract. *Two-level hierarchical linear modelling was used to analyse data obtained from TIMSS 1999 database to examine the effect of inquiry-based learning on science achievement of eighth-grade students in Turkey. The influence of teachers' emphasis on scientific reasoning and problem solving and availability of school resources for science instruction on inquiry-based learning and science achievement slopes were also examined. At the student-level, overall plausible values were used as the outcome variable whereas gender, availability of home educational resources, attitude toward science, and inquiry-based learning were predictor variables. At the school level, there were two predictor variables: teachers' emphasis on scientific reasoning and problem solving and availability of school resources for science instruction. While statistically significant and negative relationship was found between inquiry-based learning and within-school science achievement, there were nonsignificant effects of school-level predictors on inquiry-based learning and science achievement slopes.*
Key words: *HLM, inquiry learning, science achievement, TIMSS.*

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Introduction

Examination of student achievement in the international arena has always been an interest to the education community. Especially science and mathematics achievements have been particular interest not only to education community but also to policy makers and administrators of all levels because superiority in science and mathematics meant superiority in technology and economics (NAS, 2006). Countries such as U.S and Russia have competed many years to reach technological superiority over one another until the collapse of the Soviet Union. Neither of these countries could afford to stay behind. Therefore, educational systems in these countries gone through a series reforms in which teaching and learning real science constituted the heart of these reforms.

It appears that science education reforms that have taken place in the USA since 1950s put teaching and learning science through inquiry at the centre (AAAS 1993, 2000; Bybee, 1993; NRC 1996, 2000). Inquiry based approach is suggested because the science education literature in these countries reports a positive relationship between inquiry learning and student science achievement.

Turkish science education has also gone through a major reform back in 2005. Similar to the science education reform effort in the developed nations, the science education reform initiated in 2005 put inquiry at the centre. It is import for Turkish policy-makers and educators to understand the effect of inquiry science instruction, students' attitudes toward science, school resources and other variables on students' science achievements so that they could make the necessary modifications to best accommodate the needs of Turkish students.

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Although inquiry based science instruction is a key element of many reform efforts, it is yet not perfectly clear what is meant by inquiry teaching and how successful inquiry teaching can be performed in K12 classrooms (Anderson, 2002). It is especially important to understand what inquiry means for practicing teachers as they are the key players in successfully implementing science education reform.

Colburn (1996) identifies three different types of inquiry, from simplistic to complicated: structured, guided and open inquiry. In structured inquiry activities, students are given a problem to solve, a procedure to follow and materials, and expected to find the right answers. In guided inquiry, teachers provide students with a problem, but this time students must decide on a method for solving the problem given. In open inquiry, students are allowed to formulate their own questions and design their own investigation. Open inquiry investigations are the type of inquiry that most resemble what scientist do. In open-ended inquiry activities, the difficulty for students is to formulate questions that are testable, meaningful and consistent with scientific theories. In this regard, asking the right questions requires basic knowledge of the phenomenon under investigation. For this reason, open-ended inquiries seem to be much more challenging for students.

For Bybee (1997), inquiry constitutes the heart of science as a discipline and true scientific literacy cannot be achieved without employing inquiry skills. Science education literature suggests that inquiry science classes provide the best environment in order for students to develop and enhance their scientific reasoning abilities (Keys & Bryan, 2001).

Research on inquiry science learning reports positive relationship between inquiry approach and students' science achievement. As an example, Johnson & Lawson (1998) investigated the factors influencing students' success in expository and inquiry classes. Johnson & Lawson (1998) tested the hypothesis that prior knowledge was the primary determinant of student achievement in expository classes whereas in inquiry classes the primary determinant for student achievement was their reasoning ability. They described expository classes as classroom settings where lecturing and whole class demonstrations are the primary means of instruction. Inquiry classes are described as classroom settings where students are provided with required materials and support in order to conduct hands on minds on activities. As achievement variables, they used students' final examination, reasoning ability posttests, semester examinations and quiz scores. The authors found that the students exposed to inquiry approach demonstrated significantly higher posttest reasoning skills than the expository students did, which suggests that inquiry classes really can help students develop their reasoning skills.

In another study, Von Secker (2002) conducted a study on 4,377 10th grade students in 1,406 classes in the 50 states and the District of Colombia to explore the influence of inquiry-based instruction on the academic excellence of the students, regardless of their social context. She analysed 10th grade students' science achievement scores, biology teacher questionnaires and demographic data of participants using two-level hierarchical linear models (HLMs). In her quantitative analysis, she found that inquiry based teaching had a positive effect on students' science achievements. In the same study, she further found that inquiry-teaching methods have the potential of either increasing or decreasing the gap in achievement scores of students belonging to different social context.

Reforms are put into practice by developing new or revising existing standards. Schmidt, Wang & McKnight, (2005) state that the presence content standards are not sufficient to enhance student achievements. Students are tested locally and nationally on these standards to see how well they are doing. While these local and national tests help to determine the status of the education reform and monitor progress at a local and national level they lack to provide information in regards to progress being made at the international level. In order to monitor student achievements both within and across countries international organizations such as the International Association for the Evaluation of the Education Achievement sponsor tests that are administered internationally. Trends in Mathematics and Science Study (TIMSS) is administered on a four-year cycle to monitor science and mathematics achievements of students in more than 60 countries (TIMSS, 2011).

Earlier studies indicate that student achievements on standardized tests are impacted by test taking motivation (Zhu & Leung, 2011), subject matter (Sabah & Hammouri, 2010), gender (Kahle,

2004) and teachers' assessment practices (Rodriguez, 2004). Sabah & Hammouri (2010) found that while availability of school resources negatively effected Jordanian eight grade students' mathematics achievement, it did not significantly affect students' science achievements. Gender also influences students' science achievements. Boys generally achieve higher in math and science than girls in science (Kahle, 2004). In his analysis of PISA 2000 data Ma (2008) found no significant differences between science achievements of boys and girls.

Self confidence also influences students' science achievements (Wilkins, 2004). Wilkins (2004) also found that the effect of self confidence on science achievement changed based on the unit of analysis used in the study. Specifically, the overall effect of self confidence in science achievement at the student level was found to be positive whereas the effect was found to be negative at the country level. Parental support, school quality and family background characteristics were also found to be significantly related to students' academic achievements. (Engin-Demir, 2009).

Kaya & Rice (2009) examined the effects of student and classroom factors on students' science achievements within and across five developed countries using TIMSS 2003 fourth grade science data. Student factors included gender, home resources and self-confidence in science whereas teacher level factors included teacher characteristics, instructional variables and classroom composition. They found that self confidence and availability of home resources positively effected students' science scores whereas teacher characteristics, instructional variables a classroom composition did not significantly influenced the students' science scores. They also found that some of the variables on students' science scores were not consistent across countries. For instance, they found that the emphasis on science inquiry was positively related science achievement in Singapore whereas it was negatively related in the USA and Australia.

Aypay, Erdogan & Sozer (2007) examined the effects of student centered activities, teacher centered activities, attitudes toward technology and socioeconomic status (SES) on students' TIMSS 1999 science achievements who are attending to low and high performing schools. They found in their overall analysis that girls outperformed boys and that technology use was negatively related to science achievement. They also found that students attitude toward science was positively but not significantly related to students' science achievement. Finally, teacher centred instruction was also found to be significantly related to science achievement, especially in high performing schools.

Science education literature indicates that the effect of inquiry science instruction, gender, motivation, self-confidence and other variables on students' science achievement changes from one country to another. (Kaya & Rice, 2009; Yilmaz, 2009). This suggests that in addition to looking up the science education literature, each country needs to examine the factors that influence their fellow students' science achievement before making any policy decisions regarding inquiry based science instruction. Also, it appears from the science education literature that there is a lack of studies that examined the effects of student and classroom level factors on student science achievements in developing countries. In this regard, the purpose of this study is to examine the effect of inquiry-based learning on student science achievement across the population of schools in Turkey. In this study, the influence of gender, students' attitudes toward science, teachers' emphasis on scientific reasoning and problem solving and availability of school resources for science instruction on the strength of the relationship between inquiry-based learning and within the school science achievement was also investigated.

Research Questions

1. How does gender, students' attitude toward science and learning science through inquiry impact student achievement in Turkey?
2. How does teachers' emphasis on scientific reasoning and problem solving effect the relationship between inquiry learning and science achievement?
3. To what extent availability of school resources effect the relationship between inquiry learning and science achievement?

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Methodology of Research

Background Information

Data for this study was obtained from the TIMMS (Third International Mathematics and Science Study) 1999 international database that contains student achievement data, student, teacher and school background data.. TIMMS 1999 was conducted by the International Association for the Evaluation of Educational Achievement (IEA). 38 countries participated in TIMMS 1999 and eighth-grade students were assessed in both mathematics and science.

Sample of Research

Two-stage stratified cluster sampling design was used. At the first stage, schools were sampled based on a systematic probability-proportional-to-size (PPS) technique (Martin, Gregory & Stemler, 2000). A replacement school was used in the case that the selected school was unable to participate in the assessment. At the second stage, classrooms for the target grade were sampled with equal selection probabilities. Then all students in the selected classrooms were tested. Students with physical disability, mental disability, or a language difference were excluded from the assessment.

A total of 7841 students from 206 schools in Turkey participated in the TIMMS 1999 study. 42.1 % of the students were female (3301 female students) and 57.9 % of the students were male (4540 male students).

Variables

Student-Level Variables. Overall science plausible values were used as the outcome variable in the student-level model. Four predictor variables – gender, home educational resources, students' attitude toward science, and inquiry based learning - were included in the model. Gender (GENDER) variable was coded as "1" for females and "0" for males. Home educational resources (HER) was a composite variable consisting of parents' highest education level, number of books in the home, and educational aids in the home such as computer, study desk for own use, and/or dictionary. The variable was coded as "3" if either one of the parents had a college degree, and there were more than 100 books and all three educational aids listed above in the home. The variable was coded as "1", if neither of the parents had a college degree and there were less than 25 books and only one or two of the educational aids in the home. The measure of students' attitudes toward science (ATS) variable was based on the students' responses to ten statements. Example of these statements are as the following: "I like science", "I enjoy learning science", "Science is boring", and so on. A 4-point Likert scale of strongly agree, agree, disagree and strongly disagree was used for each statement. Reverse scaling was used for positive statements such that the students obtained four points for a strongly agree, three points for an agree, two points for a disagree, and one point for a strongly disagree statement. Therefore, total points for student attitudes toward science variable were ranged between 10 and 40. The measure of the inquiry based learning (IBL) variable was also based on 10 statements. Examples of these statements are as follows: "Work in small groups", "Do experiments in classroom", and so on. These statements were purposefully selected from TIMSS student questionnaire based on their consistency with the inquiry definition made by NRC (1996). Reverse scaling was used such that the students obtained four points for an "almost always", three points for a "pretty often", two points for a"once in a while", and one point for a "never" statement Therefore, total points for inquiry-based learning variable were ranged between 10 and 40, as well.

School-Level Variables. Two predictor variables - teachers' emphasis on scientific reasoning and problem solving and availability of school resources for science instruction were used as predictor variables. The measure of the teachers' emphasis on scientific reasoning and problem solving (EOPS) variable was based on the teachers' responses to five statements. The teachers obtained one point for a "never or almost never", two points for a"some lessons", three points for a "most lessons" and four points for a "every lesson" statement. Therefore, total points for teachers' emphasis on scientific reasoning and problem solving variable were ranged between 5 and 20. The measure of the availability of school resources for science instruction (ASRS) variable was based on the principals' responses to ten statements regarding inadequacies that affect capacity to provide instruction. The principles were assigned one point for a "none", two points for a "a little", three points for a "some", and four points for a "a lot" statement. Therefore, total points for availability of school resources for science instruction variable were ranged between 10 and 40.

Data Analysis

Hierarchical Linear Modelling 5 (HLM 5) (Raudenbush S.W., et. al., 2001) software was used for data analyses. In the specification of student-level model, predictor variables were centred around their group means. On the other hand, in the specification of the school - level model, predictor variables were centred around their grand means.

Missing value analysis was run in SPSS for inquiry-based learning variable at the student-level. Listwise deletion option in the HLM analysis was selected for handling the missing data problem. A total of 5216 students were included in the analyses.

Overall plausible values as the outcome variable and weighting variables at both student and school-level were used in the HLM analysis. First, HLM was run for a random effects ANOVA model in order to obtain information about variation in student science achievement among schools in Turkey. Second, random-coefficient model analysis was conducted in order to gain information about the variability of inquiry-based learning and science achievement association across schools. In the third and final analysis, HLM was run for intercepts-and-slopes-as-outcomes model in order to examine the effects of teachers' emphasis on scientific reasoning and problem solving and availability of school resources for science instruction on inquiry-based learning and student science achievement relationship.

Models

Random Effects ANOVA Model

Random effects ANOVA model is the simplest hierarchical linear model. There are level-1 and level-2 equations without any predictor variables. The random effects ANOVA model analysis provides the point estimate of the grand-mean science achievement and the confidence interval for the grand-mean science achievement. It also provides the estimate of the intraclass correlation that is the proportion of variance in science achievement among schools. The amount of the intraclass correlation provides justification for the further HLM analyses.

Student-Level (Level-1) Model

$$Y_{ij} = B_{0j} + r_{ij}$$

where, Y_{ij} is the science achievement of student *i* in school *j*, B_{0j} is the mean science achievement for the j^{th} school, and r_{ij} is the deviation of achievement of student *i* in school *j* from mean achievement of school *j*,

School-Level (Level-2) Model

$$B_0j = G_{00} + u_{0j}$$

where, G_{00} is the grand-mean science achievement for the population of schools and u_{0j} is the deviation of mean achievement of school *j* from grand-mean achievement.

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Random-Coefficients Model

Predictor variables are included into level-1 equation to explain the variance in science achievement among students in the random coefficients model. Intercept and slope coefficients of the level-1 model are allowed to vary randomly at level-2 model.

Student-Level (Level-1) Model

$$Y_{ij} = B_{0j} + B_{1j}\,(\text{GENDER}) + B_{2j}\,(\text{HER}) + B_{3j}\,(\text{ATS}) + B_{4j}\,(\text{IBL}) + r_{ij}$$

where, Y_{ij} is the science achievement of student *i* in school *j*, B_{0j} is the mean science achievement in school *j*, B_{1j} is the within-school effect of gender on science achievement for school *j*, controlling for other variables, B_{2j} is the within-school effect of home educational resources on science achievement for school *j*, controlling for other variables, B_{3j} is the within-school effect of student attitudes toward science on science achievement for school *j*, controlling for other variables, B_{4j} is the within-school effect of inquiry-based learning on science achievement for school *j*, controlling for other variables, and r_{ij} is the deviation of achievement of student *i* in school *j* from average science achievement of school *j* when gender, home educational resources, student attitudes toward science, and inquiry-based learning are controlled.

School-Level (Level-2) Model

$$B_0j = G_{00} + u_{0j}$$
$$B_1j = G_{10} + u_{1j}$$
$$B_2j = G_{20} + u_{2j}$$
$$B_3j = G_{30} + u_{3j}$$
$$B_4j = G_{40} + u_{4j}$$

where, G_{00} is the average of the school means on science achievement across the population of schools and u_{0j} is the variance of the average school means on science achievement in the population of schools, G_{10} is the average within-school effect of gender on science achievement across those schools and u_{1j} is the variance of the within-school effect of gender on student science achievement across those schools G_{20} is the average within-school effect of home educational resources on science achievement across those schools and u_{2j} is the variance of the within-school effect of home educational resources on student science achievement across those schools, G_{30} is the average within-school effect of student attitudes toward science on science achievement across those schools and u_{3j} is the variance of the within-school effect of student attitudes toward science on student science achievement across those schools, G_{40} is the average within-school effect of inquiry-based learning on science achievement across those schools and u_{4j} is the variance of the within-school effect of inquiry-based learning on student science achievement across those schools.

Intercepts-and-Slopes-As-Outcomes Model.

Student-Level (Level-1) Model

The level-1 equation of the random coefficients model remains the same in the intercepts-and-slopes-as-outcomes model. Predictor variables are included in the level-2 equations to explain the variance in science achievement and gender-achievement, home educational resources-achievement, attitudes toward science-achievement, and inquiry-based learning-achievement slopes among schools.

School-Level (Level-2) Model

$$B_0j = G_{00} + G_{01}\,(EOPS) + G_{02}\,(ASRS) + u_{0j}$$
$$B_1j = G_{10} + G_{11}\,(EOPS) + G_{12}\,(ASRS) + u_{1j}$$
$$B_2j = G_{20} + G_{21}\,(EOPS) + G_{22}\,(ASRS) + u_{2j}$$
$$B_3j = G_{30} + G_{31}\,(EOPS) + G_{32}\,(ASRS) + u_{3j}$$
$$B_4j = G_{40} + G_{41}\,(EOPS) + G_{42}\,(ASRS) + u_{4j}$$

where, G_{00} is the average of school mean science achievement across population of schools, G_{01} =is the effect of teachers' emphasis on scientific reasoning and problem solving (EOPS) on the school mean science achievement, controlling for the availability of school resources for science instruction (ASRS). G_{02} is the effect of the availability of school resources for science instruction (ASRS) on the school mean science achievement, controlling for the teachers' emphasis on scientific reasoning and problem solving (EOPS), and u_{0j} is the remaining variance of the school mean science achievement over schools after the effects of EOPS and ASRS have been removed. G_{10} is the average of within school effect of gender on science achievement over schools, G_{11} is the effect of teachers' emphasis on scientific reasoning and problem solving (EOPS) on the within school effect of gender on science achievement, controlling for the availability of school resources for science instruction (ASRS), G_{12} is the effect of availability of school resources for science instruction (ASRS) on the within school effect of gender on science achievement, controlling for the teachers' emphasis on scientific reasoning and problem solving (EOPS), and u_{1j} is the variance of the within school effect of gender on science achievement over schools after the effects of EOPS and ASRS have been controlled. The rest of the coefficients are interpreted similarly.

Results of Research

Random Effects ANOVA Model

The results of the random effects ANOVA model analysis are given in Table 1. The grand-mean science achievement was estimated as 437.21 with a standard error of 12.23. The 95% confidence interval for the grand mean science achievement was calculated as below:

$$437.21 \pm (1.96)(6.24) = 437.21 \pm 12.23 = (424.98, 449.44)$$

Table 1. Results of random effects ANOVA model analysis.

Fixed Effects	Coefficient	SE	p-value
Grand mean achievement, G00	437.21	6.24	< 0.001

Random Effects	Variance	Chi-square	df	p-value
School (Level-2) effect, u0j	1327.96	1782.34	181	< 0.001
Student (Level-1) effect, rij	4649.73			

As seen in Table 1, the estimate of the within-group variability (the variance of student achievements around the school mean) and the estimate of the between-group variability (the variance of school mean achievements around the grand mean) are 4649.73 and 1327.96, respectively. The estimated value of between-group variability is found to be statistically significantly ($p < 0.001$) indicating that significant variation exists among schools in their science achievements. The intraclass correlation (ICC), which represents the proportion of variance in science achievement among schools, is found to be 22%. This indicates that about 22% of variation in science achievement lies among schools.

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Random Coefficients Model

The results of random coefficient model analysis are provided in Table 2. The average within-school effect of gender on science achievement is estimated as -12.05 with a standard error of 4.84. The estimate for the average within-school effect of home educational resources on science achievement is 14.51 with a standard error of 3.74. The estimate for the average within-school effect on student attitudes toward science on science achievement is 3.69 with a standard error of 0.43. The estimated average within-school effect of inquiry-based learning on science achievement is -2.55 with a standard error of 0.52. p-values smaller than $\alpha = 0.05$ indicate that, gender, home educational resources, student attitudes toward science, and inquiry-based learning are significantly related to average within-school science achievement.

Table 2. Results of random coefficients model analysis.

Fixed Effects	Coefficient	SE		p-value
Grand mean achievement, G_{00}	437.24	6.25		< 0.001
Mean gender-achievement slope, G_{10}	-12.05	4.84		0.032
Mean HER-achievement slope, G_{20}	14.51	3.74		< 0.001
Mean ATS-achievement slope, G_{30}	3.69	0.43		< 0.001
Mean IBL-achievement slope, G_{40}	-2.55	0.52		< 0.001
Random Effects	**Variance**	**Chi-square**	**df**	**p-value**
School mean, u_{0j}	1354.22	1918.33	162	< 0.001
Gender-achievement slope, *u10*	115.37	221.94	162	0.001
HER-achievement slope, u_{20}	152.14	268.26	162	< 0.001
ATS-achievement slope, u_{30}	1.22	236.36	162	< 0.001
IBL-achievement slope, u_{40}	2.68	252.92	162	< 0.001
Student (Level-1) effect, r_{ij}	4063.10			

In Table 2, the estimated variance among school means is 1354.22 with a p–value < 0.001. Therefore, it can be concluded that significant differences exist among school means. The remaining p-values for the random effects in Table 2 also indicate that the relationship between gender and science achievement, home educational resources and science achievement, student attitudes toward science and science achievement, and inquiry-based learning and science achievement within schools vary significantly across the population of schools.

The estimated variance in the random effects ANOVA model in which gender, home educational resources, student attitudes toward science, and inquiry-based learning were not included as level-1 predictor variables was 4649.73 (Table 1). However, as seen in Table 2, the estimated variance in random coefficients model is 4063.10 (Table 2). This means that adding gender, home educational resources, student attitudes toward science, and inquiry-based learning as predictors of science achievement reduces the within-school variance by 13%.

Intercepts-and-Slopes-as-Outcomes Model

As seen in Table 3, teachers' emphasis on scientific reasoning and problem solving ($p = 0.426$) and availability of school resources for science instruction (p=0.169) do not have a significant effect on the school mean science achievement. Similarly, teachers' emphasis on scientific reasoning and problem solving and availability of school resources for science instruction do not exhibit significant effect on the within-school effect of gender, home educational resources, student attitudes toward science, and inquiry-based learning on science achievement.

Table 3. Results of intercepts-and-slopes-as-outcomes model analysis.

Fixed Effects	Coefficient	SE		*p*-value
Model for school means				
INTERCEPT, G_{00}	437.36	6.21		< 0.001
EOPS, G_{01}	1.08	1.35		0.426
ASRS, G_{02}	-1.02	0.74		0.169
Model for gender-achievement slopes				
INTERCEPT, G_{10}	-11.84	4.84		0.084
EOPS, G_{11}	-0.94	1.57		0.558
ASRS, G_{12}	0.18	0.47		0.711
Model for HER-achievement slopes				
INTERCEPT, G_{20}	14.89	3.61		< 0.001
BEOPS, G_{21}	-0.90	1.50		0.561
ASRS, G_{22}	-0.63	0.54		0.254
Model for BATS-achievement slopes				
INTERCEPT, G_{30}	3.66	0.44		< 0.001
EOPS, G_{31}	0.07	0.14		0.607
ASRS, G_{32}	0.01	0.05		0.888
Model for IBL-achievement slopes				
INTERCEPT, G_{40}	-2.52	0.51		< 0.001
EOPS, G_{41}	0.03	0.18		0.874
ASRS, G_{42}	-0.09	0.08		0.296
Random Effects	**Variance**	**Chi-square**	**df**	***p*-value**
School mean, u_{0j}	1312.82	1863.01	160	< 0.001
Gender-achievement slope, u_{10}	110.56	219.46	160	0.002
HER-achievement slope, u_{20}	136.63	265.39	160	< 0.001
ATS-achievement slope, u_{30}	1.23	236.02	160	< 0.001
IBL-achievement slope, u_{40}	2.52	249.67	160	< 0.001
Level-1 effect, r_{ij}	4057.09			

Finally, in Table 3, the estimated variance of the school mean science achievement is 1312.82 with a *p*-value < 0.001. It can be concluded that significant variation in the school mean achievement remains unexplained after controlling for EOPS and ASRS. The variance of the gender-achievement, home educational resources-achievement, student attitudes toward science-achievement, and inquiry-based learning-achievement slopes have *p*-values smaller than $\alpha = 0.05$ indicating that significant variation in the within school effect of gender, home educational resources, student attitudes toward science, and inquiry-based learning on science achievement remains unexplained even after controlling for EOPS and ASRS.

Discussion

The random effects ANOVA model shows that schools in Turkey differs statistically significantly in their science achievements. Specifically, it has been found that 22% of variation in science achievement exists among schools. The results of the fixed effects in the random-coefficients model indicate that gender, home educational resources, student attitudes toward science, and inquiry-based learning are significantly related to science achievement within schools. It has been found that adding gender, home educational resources, student attitudes toward science, and inquiry-based learning as predictors of science achievement reduced the within-school variance by 13%. Furthermore, the findings of the random effects in the random-coefficients model indicate that the intercept and all of the slopes exhibit significant variation among schools.

In the intercepts and slopes as outcomes model analysis, it was found that teacher's emphasis on scientific reasoning and problem solving did not have a significant effect on the within-school effect of inquiry-based learning on science achievement controlling for the availability of school resources for

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science instruction. It was also found that when controlling for teachers' emphasis on scientific reasoning and problem solving, availability of school resources for science instruction had a non-significant effect on the relationship between inquiry-based learning and within-school science achievement. In other words, significant variation in the within school effect of inquiry-based learning on science achievement remained unexplained even after controlling for two school-level variables. Similarly, in their analysis of TIMSS 2007 data Sabah & Hammouri, (2010) found that the availability of school resources did not have any significant impact on the Jordanian students' science achievements. Sabah & Hammouri (2010) argue that this may be due to teachers not being able to effectively use the resources available to them.

In this study, gender was found to be negatively and significantly related to science achievement. This means that girls outperformed boys in their science achievements. Although this is inconsistent with many earlier research (Langen, Bosker, &Dekkers, 2006; Kahle, 2004; Ma, 2003; 2008), it is consistent with the findings of the studies that examined Turkish students' achievements on international exams. For instance, Yilmaz (2009) found that Turkish girls did better in science than boys on PISA 2006. Also, consistent with the findings of Sabah & Hammouri (2010) students' attitudes toward science was found to be a significant predictor of students' science achievements. Specifically, students' attitudes toward science was found to be significantly and positively related to their science achievement. This finding contradicts with Ceylan & Berberoglu's (2007) study, in which they conducted a structural equation modeling(SEM) analysis of TIMSS 1999 science data and found that students attitude toward science was negatively related to their achievements. The conflicting results resulting from the same data set (i.e. TIMSS 1999 data) may be due to the formulation of the students' attitude toward science variable.

Finally, it was found that inquiry-based learning was significantly and negatively related to average within-school science achievement. Although it may sound surprising at first, this finding is consistent with the findings of other studies conducted on students' science achievements on international exams. For instance, using PISA science data Lavonen &Laaksonen, (2009) found that inquiry learning was significantly and negatively related to students' science achievements. They argued that this may be due to the way that the items on PISA surveys were formulated. Specifically, the survey items asked students the frequency and quantity of inquiry activities that they engaged in their weekly schedule but the survey did not include any items regarding the quality of those inquiry activities. It was also found that the influence of inquiry-based learning on science achievement within schools differed significantly across schools. This means that, inquiry-based learning strategies used in one school might have influence on students' science achievements, whereas in another school such strategies might not have much influence on students' science achievements. This is also consistent with the findings of other studies conducted on TIMSS data. In their analysis of TIMSS 1999 data, Berberoğlu, Çelebi, Özdemir, Uysal, & Yayan (2003) found negative effects of inquiry learning on science achievement and concluded that it might have been due to teachers lack of understanding and implementing true inquiry in their classrooms.

Conclusions and Implications

As a European Union (EU) candidate country, Turkey has the intention of entering into the league of developed countries. To meet this goal, Turkey has gone through many minor and major education reform efforts throughout the years. The most recent major educational reform was initiated in 2005. Since then many alterations have been made to the programs and curricula that were developed as part of the reform effort initiated in 2005. This indicates that educational reform is still under way and many are to be implemented (Aksit, 2007).

Despite their differences in their methods and implementation, science education reforms around the world have one simple goal: creating scientifically literate students. There may be many definitions and indicators of a scientifically literate student. One of the indicators may be students' science scores on exams. Students are continually tested on local and national exams to see their progress in achieving the goals of the reform efforts. Although local and national exams are necessary to monitor the progress at national level, they are not sufficient to determine the progress being made at the international level.

Developing countries generally have less educational resources which may have an impact on the implementation of reform In order to ensure the best use of the limited educational resource decisions that are made during the reform process must be based on research, especially research that are conducted at local and national levels. Policy decisions that are made without considering the unique context of a country may have unintended outcomes.

The effect of student level and classroom level factors on student science achievement is a well studied area in developed countries. However, this statement does not seem to hold true in developing countries. The findings of this study indicate that the effect of some of the student and classroom level factors on students' science achievements are similar to that of in the developed countries such as Finland (Lavonen &Laaksonen, 2009) and other developing countries such as Jordan (Sabah & Hammouri, 2010). On the other hand, the effects of some other student and classroom level factors are found to be inconsistent between Turkey and some of the developed countries such as the United States of America (Kahle, 2004). For instance, contrary to the findings of many science education studies that are conducted at local level in many developed countries, the effect of inquiry learning was found to be negative. One need to be cautious before concluding that inquiry learning negatively related to students' science achievements. More studies investigating the effect of inquiry learning on science achievement on international exams are needed. It appears that the formulation of the inquiry learning variable is a critical issue. More studies using international data are also needed to see how inquiry learning impacts science achievement in other developing countries.

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