TIMSS 2011 CROSS COUNTRY COMPARISONS: RELATIONSHIP BETWEEN STUDENT- AND TEACHER-LEVEL FACTORS AND 8TH GRADE STUDENTS' SCIENCE ACHIEVEMENT AND ATTITUDE TOWARD SCIENCE

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ABSTRACT

TIMSS 2011 CROSS COUNTRY COMPARISONS: RELATIONSHIP BETWEEN STUDENT- AND TEACHER-LEVEL FACTORS AND 8TH GRADE STUDENTS' SCIENCE ACHIEVEMENT AND ATTITUDE TOWARD SCIENCE

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The purpose of this study is to investigate the relationship between student- and teacher-level characteristics and 8th grade students' science achievement (SA) and attitude toward science (ATS) in Turkey, Finland and England through the use of TIMSS 2011 data. Hierarchical Linear Modeling (HLM) was used in the analysis of student-level (gender, HER, parental involvement, time spent on homework and bullying) and teacher-level (confidence, career-satisfaction, collaboration, science-investigations, experience and professional development). The present study was a quantitative research with non-experimental study.

Home educational resources (HER) showed significant relationship with SA and ATS in all countries whereas teachers' professional development and collaborate to improve teaching were statistically non-significant. In addition to HER, gender, parental involvement, and teacher experience were significant in Turkey, Finland and England models explaining ATS. HER explained great variance in SA; moreover, both parental involvement and HER explained great variance in ATS in all three countries.

Amount of total explained variance in SA was 16.6 %, 11.7 % and 20.5 % and in ATS it was 6.4 %, 10.9 % and 12.8 % respectively in Turkey, Finland and England. This conceptual model explained more variance in SA than ATS in each country. Highest percentage of variance both in SA and ATS was explained by England. Generally teacher-level variables explained more variance in SA and student-level variables explained more variance in ATS. Recommendations to improve science education in Turkey and future research suggestions were stated based on the findings of this study.

KEYWORDS: Science Achievement, Attitude toward Science, Teacher Effect, TIMSS, HLM

ÖZ

TIMSS 2011 ÜLKELER ARASI KARŞILAŞTIRMALAR: 8. SINIF ÖGRENCİLERİN FEN BAŞARISI VE FENE YÖNELİK TUTUMU İLE ÖĞRETMEN VE ÖĞRENCİ ÖZELLİKLERİ ARASINDAKİ İLİŞKİ

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Bu çalışmanın amacı Türkiye, Finlandiya ve Ingiltere'deki 8. sınıf öğrencilerin fen başarısı (FB) ve fene yönelik tutumu (FYT) ile öğrenci ve öğretmen özellikleri arasındaki ilişkiyi TIMSS 2011 datasını kullanarak incelemektir. Öğrenci özellikleri (cinsiyet, evde kullanılan eğitim materyalleri, ailenin katılımı, ödeve ayrılan süre, ve okulda sözlü ve fiziksel şiddete maruz kalma) ve öğretmen özellikleri (kendine güven, kariyer memnuniyeti, fen araştırmalarının önemini vurgulamak, deneyim ve profesyonel gelişim) "Hiyerarşik Lineer Modelleme" (HLM) kullanılarak analiz edilmiştir. Bu çalışma deneysel olmayan nicel bir araştırmadır.

Evde kullanılan eğitim kaynakları (EKEK) tüm ülkelerin hem FB hem de FYT modellerinde istatiksel olarak anlamlı bulunurken, öğretmenlerin profesyonel gelişimi ve fen öğretimini arttırmak için öğretmen işbirliği değişkenleri bu modellerin hiç birinde istatiksel olarak anlamlı bulunmamıştır. EKEK'e ek olarak, cinsiyet, ailenin katılımı ve öğretmen deneyimi FYT'yi açıklayan Türkiye, Finlandiya ve Ingiltere modellerinde istatiksel olarak anlamlı bulunmuştur. Buna ek olarak, FB’deki varyansı yüksek oranda EKEK açıklarken, her 3 ülkede FYT varyansını yüksek oranda hem ailenin katılımı hem de EKEK açıklar.

Tam model tarafından açıklanan toplam varyansın miktarı Türkiye, Finlandiya ve Ingiltere sırasıyla olmak üzere FB için % 16.6, % 11.7 ve % 20.5, FYT için ise % 6.4, % 10.9 ve % 12.8’dir. Bu kavramsal model her bir ülkede FYT’ye göre FB’de daha çok varyans açıklamıştır. Hem FB hem de FYT’de en çok varyansı Ingiltere modeli açıklamıştır. Genel olarak, FB’deki varyans daha çok öğretmen-düzeyi değişkenleri ile açıklanırken, FYT’deki varyans öğrenci-düzeyi değişkenleri ile açıklamıştır. Bu çalışmanın bulgularına dayanarak, Türkiye’de fen öğretimini geliştirmek ve geleceğe yönelik araştırma sunmak açısından öneriler sunulmuştur.

ANAHTAR KELİMELER: Fen Başarısı, Fene Yönelik Tutum, Öğretmen Etkisi, TIMSS, HLM

To the Next Genarations

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LIST OF ABBREVIATIONS

ACACA	Australian Curriculum, Assessment and Certification Authorities
ACER	Australian Council for Educational Research
BIS	Department for Business, Innovation and Skills
BSCS	Biological Sciences Curriculum Study
CERI	Centre for Educational Research and Innovation
DfE	Department for Education
DIF	Differential Item Functioning
ECES	Early Childhood Education Study
ETLS	English Teaching and Learning Study
FIMS	First International Mathematics Study
FNBE	Finnish National Board of Education
HLM	Hierarchical Linear Modeling
IBE	International Bureau of Education
ICC	Intra-class Correlation
ICCS	International Civic and Citizenship Education Study
IEA	International Association for the Evaluation of Educational Achievement
ICILS	International Computer and Information Literacy Study
IIEP	International Institute for Educational Planning
MoNE	Ministry of National Education
OECD	Organization for Economic Co-operation and Development
PIRLS	Progress in International Reading Literacy Study
PISA	Program for International Student Achievement
SCCRE	Swiss Coordination Centre for Research in Education
SEM	Structural Equation Modeling
SES	Socio-economic Status
SIMS	Second International Mathematics Study
STA	Standards of Testing Agency
QIRC	Questionnaire Item Review Committee
TIMSS	Trends in Mathematics and Science Study
UIE	UNESCO Institute of Education
UNESCO	United Nations Educational Scientific and Cultural Organization

CHAPTER 1

INTRODUCTION

Educational innovations gain speed day by day. As the 21st century individuals, we need to move with this precocity. The new age is information age. Only the communities that can think, criticize, and raise productive generations, can remain standing in this new age. Moreover, as a result of globalization, countries aim to develop education systems steer economy with more qualified people (Neumann, Bernholt & Nentwig, 2012). Apart from economic benefits and requirements of this information age, education plays a vital role in a nation's development as every individual has the fundamental right to have a full education in connection with his/her skills and interests (Ayas, 2012; UNESCO, 2007). Therefore, monitoring educational systems and analyzing the educational outcomes of these systems within and between the countries play an essential role in the development of a country.

Rosier (1990) states that professionals in education (e.g. Ministry of Education) have the responsibility to make periodical monitoring and evaluation of the ongoing educational activities in order to reveal whether there is continual improvement in students' learning outcomes or not. Monitoring the changes of educational systems has shifted to monitoring the outcomes of education, presumably as a result of international comparative studies. International large-scale studies give opportunity to countries to assess their education systems' strengths and weaknesses (Stanat & Lüdtke, 2013). International comparative studies like TIMSS and PISA has increased the countries' interest in increasing mathematics and science achievement level; which give rise to focus on examining which factors affect students' science and mathematics achievement (Lamb & Fullarton, 2001) and how these factors affect students' mathematics and science achievement across countries (Baker, Fabrega, Galindo, & Mishook, 2004). Furthermore, pupils all over the world take science lessons systematically in order to get familiar with science; which increase the interest of understanding the differences in students' science competencies by making international comparisons in science learning and teaching (Prenzel, Seidel, & Kobarg, 2012).

1.1. Purpose of the Study

The purpose of this study was to investigate the relationship between teacher- and student-level characteristics and science achievement and attitude toward science of 8th grade Turkish, Finnish and English students through the use of the data from the International Association for the Evaluation of Educational Achievement's (IEA's) Trends in Mathematics and Science Study (TIMSS) 2011. This study included international comparisons between Turkey, Finland and England, and TIMSS data was used for the analysis, as international comparisons (especially gathering information altogether) requires international co-operation of professionals in each participating country; which is only possible through large-scale studies (Rosier, 1990).

8th grade Turkish students performed lower performance in science than the OECD average in TIMSS 2011. 8th grade Finnish and English students performed higher performance in science than the OECD average in TIMSS 2011 and as well as the other TIMSS assessments. This study compared the models obtained by HLM related to student and teacher characteristics and their relations with science achievement and attitude toward science in Turkey (low performer), Finland (high performer) and England (high performer). Possible similarities and differences among these three countries were examined according to TIMSS 2011 data. The results of this study may be illuminating in understanding the student and teacher characteristics associated with high science achievement and higher levels of attitude toward science.

Reasons behind Cross-Country Comparisons between Turkey, England and Finland:

In the present study, cross-country comparisons between Turkey, England and Finland were performed. There are more than 60 countries joining to TIMSS

2011 assessment. In this study, selecting Turkey, England and Finland was on purpose. The reasons for comparing and contrasting Turkey with Finland and England are as follows:

- Finland and England are two countries which are showing higher science performance (than OECD average) consistently in TIMSS studies since 1995. Specifically in TIMSS 2011, Finland was ranked as the fifth country and England was the ninth country according to the 8th grade science achievement performance of the all 63 participating countries (Martin, Mullis, Foy, & Stanco, 2012). These two countries are well known with their success in science education and there are so many studies held to explain the reasons behind this educational success especially in Finland (Chung, 2009; Chung & Crossley, 2013; Darling-Hammond, 2010; Kupiainen, Hautamaki, & Karjalainen, 2009; Pehkonen, Ahtee & Lavonen, 2007; Öztürk, 2013; Sahlberg, 2007; Simola, 2005).
- Turkey is in the European Union Membership Process, and as a part of this process Turkey has made several reforms in financial services, regional policy and also education. In education area, Turkey continues to improve its performance according to the Europe 2020 targets (European Commission, 2013). Initiatives in Turkish Education System have been developed with the European Union to improve alignment with European Standards (OECD, 2013b). Therefore, as Turkey performs continuous reforms to reach European Standards, in this study top performing European countries are preferred instead of Far East top performing countries like Singapore, Japan, or South Korea.

Possible similarities and differences among these three countries that participated in TIMSS 2011 were investigated in terms the relationship between student- and teacher-level characteristics and 8th grade students' science achievement and attitude toward science. Student-level characteristics included gender, home educational resources, parental involvement, time spent on homework and bullying at school. Teacher-level characteristics included confidence in teaching science, teacher career satisfaction, collaborate to improve teaching, teachers' emphasis on science investigations, teachers' professional development and teacher experience. As TIMSS is a cross sectional study (Schneider, 2009), in the present study, home educational resources was controlled, in order to reveal the relationship between student-level characteristics and science achievement and attitude toward science more accurately. As Mullis & Martin (2013) states in TIMSS analysis researchers should introduce controls for students' home background as each pupil comes to school from different home backgrounds which can hinder or help student.

TIMSS 2011 Science Results for 8th Grade Students in Turkey, Finland and England

Both major national and international studies show that the outcomes of science and mathematics education are problematic and far below the desired level in Turkey. Turkish students' science and mathematics achievement was found to be far below the international average in reputable international studies such as Program for International Student Assessment (PISA) and TIMSS (Martin, et al., 2012; Martin, Mullis & Foy, 2008; Martin, Mullis, Gonzales, Gregory, Smith, Chrostowski, Garden, O'Connor, 2000; OECD, 2007, 2010, 2014d, 2014e). To be more precise, 8th grade Turkish students had an average score of 483 where TIMSS scale center point (mean) was 500. Among 45 countries and 14 benchmarking participants Turkey ranked as the 21th country according to the science performance among 8th graders; which is below the OECD average according to the TIMSS 2011 results (Martin, et al., 2012, pg. 40-48). When the previous Turkey results are examined according to previous TIMSS studies, it is observed that 8th grade Turkish students did not show a bright science achievement in previous assessments. In 1999, Turkish students had an average science score of 433 (international mean is 488) with the rank of 33, and in 2007 they had an average science score of 454 (international mean is 465) with the rank of 31 (Martin, et al., 2008, 2000). Interpreting only the ranking and the average score does not help to understand the students' performance details. Which competence level has an average student reached is an important point to focus on. To clarify the 8th grade Turkish, Finnish and English students' performance in international benchmarks in science, the Table 1.1 can be beneficial.

Table 1.1 Performance at the International Benchmarks of Science Achievement at 8th Grade

	Advanced International Benchmark (625)	High International Benchmark (550)	Intermediate International Benchmark (475)	Low International Benchmark (400)	Competence Level of the Country
Finland	13 %	53 %	88 %	99 %	High Level (552)
England	14 %	44 %	76 %	93 %	Inter. Level (533)
Turkey	8 %	26 %	54 %	79 %	Inter. Level (483)

Note. Revised from “*TIMSS 2011 international results in science”* by M.O. Martin, I.V.S. Mullis, P. Foy, and G.M., Stanco, 2012, pg. 114. Copyright 2012 by IEA.

International benchmarks are categorized as advanced, high, intermediate and low. While interpreting Table 1.1, it should be kept in mind that intermediate level students can perform low levels; high level students can perform intermediate and low levels; and finally advanced level students can perform high, intermediate and low levels. Table 1.1 can be interpreted more effectively with the definition of international benchmarks; which is clearly explained by IEA in TIMSS 2011 international results in science report. IEA states that students at the advanced international benchmark “… communicated an understanding of complex and abstract concepts in biology, chemistry, physics, and earth science. They also combined information from several sources to solve problems and draw conclusions, and provided written explanations to communicate scientific knowledge” (Martin, et al., 2012, pg.110-111). Students at the high international benchmark “… demonstrated understanding of concepts related to science cycles, systems, and principles. They also demonstrated some scientific inquiry skills, and combined and interpreted information from various types of diagrams, contour maps, graphs, and tables; selected relevant information, analyzed, and drew conclusions; and provided short explanations conveying scientific knowledge" (Martin, et al., 2012, pg. 110-111). Students at the intermediate international benchmark "… recognized and applied their understanding of basic scientific knowledge in various contexts. They interpreted information from tables, graphs, and pictorial diagrams, drew conclusions, and communicated their understanding through brief descriptive responses" (Martin, et al., 2012, pg. 110-111). Furthermore, students at the low international benchmark "… recognized some basic facts from the life and physical sciences, as well as interpreted simple pictorial diagrams, completed simple tables, and applied their basic knowledge to practical situations" (Martin, et al., 2012, pg. 110-111). Starting from this international benchmark of science achievement definition, Turkey performs a bleak science performance. Only 8 % of the 8th grade Turkish students could communicate an understanding of complex and abstract concepts or could combine several sources to solve problems and draw conclusions, whereas this ratio was 13 % in Finland, 14 % in England, and 40 % in Singapore which is the top science performer country at the 8th grade in TIMSS 2011. Furthermore, in terms of low international benchmark only 79 % of Turkish students could recognize some basic facts; interpret simple diagrams, complete simple tables, whereas this ratio was 99 % in Finland, and 93 % in England. In other words, nearly all of the students who are about to graduate from elementary schools in Finland and England complete the low competence level, whereas almost 21 % of the students can't even complete the low competence level before graduation from elementary school.

As clarified in detail, 8th grade Turkish students' performance is bleak, however, higher levels of science performance is emphasized clearly in curriculum. The vision of Science and Technology course in Turkey is to develop scientifically literate citizens regardless of their individual differences (MoNE, 2013, pg. 1). MoNE (2005) states that all of the societies especially the developed countries are in the struggle for developing the quality of science education as the science plays a critical role in future of society in this information and technology age. As science achievement provides a critical foundation for students' future careers and life success (Martin, et al., 2012), how to increase science achievement is a vital concern. Besides science achievement, attitude towards science is also emphasized as a part of science education in Turkish, England and Finnish science education curriculum and also in international studies (Department for Education, 2013; Finnish National Board of Education, 2004b; Martin, et al., 2012; MoNE, 2013). In terms of attitude, 49 % of 8th grade students state that they like science, 40 % of 8th grade Turkish students state that they value science and only 25 % of 8th grade Turkish students state that they are confident in science (Martin, et al., 2012, pg. 335- 346). These percentages are quite low.

To sum up, it is clear that Turkish students' science performance and attitude toward science are far below the desired level. Determining which factors show correlation with science achievement and attitude towards science may be an essential point in developing science achievement and attitude. With the growing emphasis on science education worldwide, it is important to investigate more closely the factors improving students' science achievement and attitude towards science within and across nations.

1.2. Research Questions

1. Which student characteristics are significantly related to 8th grade students' science achievement in Turkey, Finland and England after home educations resources (HER) is controlled?
2. Which teacher characteristics are significantly related to 8th grade students' science achievement in Turkey, Finland and England?
3. How much of the variance in 8th grade students' science achievement is explained by teacher- and student-level characteristics in Turkey, Finland and England?
4. Which student characteristics are significantly related to 8th grade students' attitude toward science in Turkey, Finland and England after HER is controlled?
5. Which teacher characteristics are significantly related to 8th grade students' attitude toward science in Turkey, Finland and England?
6. How much of the variance in 8th grade students' attitude toward science is explained by teacher- and student-level characteristics in Turkey, Finland and England?

Based on these research questions' findings, 'How can the results inform national education policy of Turkey to improve science achievement and attitude toward science?' will be discussed in discussion and suggestion part.

1.3. Significance of the Study

In general, education has two main problems which are access and quality. In Europe, we do not have access problem but the quality is a problematic case for both developed and developing countries, hence countries aim to develop more qualified education systems to have better educational outcomes. United Nations Educational Scientific and Cultural Organization [UNESCO] (2006), states that quality of education is the main concern although education is a right of every child and is fundamental in human, social and economic development. Even well-developed countries may have some problems in education and also need to monitor and investigate the quality of their education systems (Bybee, 2008). Turkey is a developing country and also performing many reforms in education to enhance quality in education system. MoNE (2005) states that in this information and technology age, all of the societies especially the developed countries are in the struggle for developing the quality of science education as science plays a critical role in future of society. In order to make the appropriate and accurate attempts for developments in the quality of science education, firstly we need to monitor and understand our own working system. This study may be helpful in monitoring the student and teacher level influences on educational outcomes like science achievement and attitude toward science in Turkey, Finland and England. The first rule of enhancing development is to monitor the existing system, seeing the gap between idealism and reality and understanding the weak and strong points of the system. This study may contribute to monitor the educational outcomes and see the weak and strong points of the Turkish education system in terms of student and teacher characteristics. In addition to monitoring the existing system, the results of this study may be used to compare Turkey results with high performing European countries like Finland and England. Turkey is a country which is making reforms in education in order to improve alignments to European Standards (OECD, 2013b). Evaluating teacher and student characteristics and their influences on students' science achievement and attitude towards science in Turkey by comparing with higher performing European countries may give extensive information to Turkish policy makers, school principals and teachers. Therefore, comparing Turkey with two high performing European countries may be illuminating for understanding which further reforms can be done in Turkish Education System in terms of teacher and student characteristics and qualifications. The results of this study may be helpful in developing concrete and constructive suggestions to close the gap between the educational outcomes of Turkey and European Union countries. Moreover, the results of this study might provide extensive information for the educators and policy makers who are also interested in cross country comparisons in educational outcomes of different educational systems.

Developing science achievement should be the main concern of countries' education policies because from maintaining and enhancing human health to understanding environmental issues, science has direct applications to life and society. Science is a vital part of our life. Students' effective science learning in both knowledge and thinking skills is important because it helps students to be thoughtful citizens engaged in science related public discussions and to choose a wide range of careers in science, medicine and technology (Martin, et al., 2012). Yet, students' learning outcomes will affect their future lives in terms of employment and salary. An individual may not be productive in business life, or be unemployed or may earn less if s/he cannot have qualified education which develops required skills (ERG, 2014). In a similar way, OECD (2013a) states that compared to poorly skilled adults, highly skilled adults are twice likely to be employed and almost three times more likely to earn above-median salary. As clear, learning outcomes provide a critical foundation for students' future careers and life success, how to increase science achievement as well as other learning outcomes is an important question. In order to understand how to raise science achievement, first of all we need to understand which student and teacher characteristics are associated with science achievement. Therefore, it was expected that the results of this study may show a concrete picture of science education in Turkey. The results of this study may be informative for taking required precautions to enhance science achievement of students and may be a good advisor for science teachers, school principals and policy makers in Turkey while developing new education policies and shaping instructions.

Both in mathematics and science domain, there is an interest to investigate which factors affect achievement (Lamb & Fullarton, 2001), and how these factors influence achievement across countries as a result of international studies (Baker, Fabrega, Galindo, & Mishook, 2004; Prenzel, Seidel, & Kobarg, 2012). There are some studies revealed the relationship between science achievement and student and teacher level characteristics in Turkey through the use of TIMSS data e.g., Aktas (2011); Kaya (2008); Korkmaz, (2012); Pektaş, (2010); Yaman, (2004). However, some of these studies did not take into account the nested structure of the data while performing analysis. In order to take necessary steps, more research should be done in science achievement; unfortunately the number of these studies is limited. Furthermore, all these studies focused on only science achievement, but not on other learning outcomes. As stated in curriculums of Turkey (MoNE, 2013), Finland (FNBE, 2004b), and England (Department of Education, 2014b) and also in studies dealing with models for international comparisons of science education (Rosier, 1990), it is clearly stated that science achievement is not the unique output of science education. Other learning outcomes should also be assessed although the main focus is on the student achievement (Akyüz, 2006; and Neumann, Kauertz & Fischer, 2012). Attitude toward science as well as science achievement should be taken into consideration while studying international comparisons of science education. UNESCO (2007) states that for a successful education program, learning outcomes should be defined and also assessed in knowledge, skills, attitudes and values. Moreover, World Bank (2006) strongly recommends focusing on investigating the factors which influence all learning outcomes. Accordingly, in the present study not only science achievement but also attitude toward science was on focus. Moreover, the present study could be accepted as the first study focusing on cross country comparisons by using two different outcome variables namely science achievement and attitude towards science through the TIMSS 2011 data.

International studies like TIMSS, PIRLS and PISA are important as they give opportunity to make comparisons between the educational outcomes of different education systems, and give information about how qualified their educational outcomes. TIMSS gives valid measures of competencies in international context and moreover, it gives detailed information to look closely at the factors related with educational outcomes for countries. Furthermore, TIMSS study is a 4 year-cycled study; therefore it will be repeated in the coming years. Analyzing the student and teacher characteristics and the influences of these characteristics on students' science achievement may be important to see the change in science education and hence it was expected that findings of this study may be beneficial for the future comparisons.

Choosing the appropriate analyzing methods and models is essential in educational comparisons. There is a range of different interpretations about the effect of teacher characteristics on student achievement as a result of researchers' different models (Rowan, Correnti, & Miller, 2001). TIMSS 2011 data set is nested in the way that students are nested into classes and classes are nested in schools. Nested data structure should be taken into account while analyzing TIMSS data. Multilevel analysis should be used with nested data structure in order to have more precious analysis results (Raudenbush & Bryk, 2002). In this study, using HLM overcomes the shortcoming of traditional regression analysis models and helps to have more accurate results to interpret by reducing the errors. Yet, another important aspect of this study was to contribute to the literature by employing hierarchical-linear modeling to examine the role of student- and teacher-level variables on students' science achievement and attitude toward science in Turkey, Finland and England.

To sum up, the contributions of this study can be summarized as (1) monitoring the educational outcomes and showing the weak and strong points of the education systems in Turkey, Finland and England in terms of student and teacher characteristics, (2) comparing Turkey results with two high performing European countries (Finland and England) in this European Union membership process to improve alignment with European Standards (3) focusing more than one science learning outcome, namely science achievement and attitude toward science (4) providing information for possible future comparisons and for observing the changes in science education, (5) conducting Hierarchical Linear Modeling analyses due to the nested data structure to overcome the shortcoming of traditional regression analysis models and have more accurate results to interpret by reducing the errors.

1.4. Variables of the Study

Present study investigated the relationship between student- and teacher-level characteristics and 8th grade students' science achievement and attitude toward science in Turkey, Finland and England. In the Table 1.2, student level and teacher level characteristics and the dependent variables are stated with their sub dimensions.

Table 1.2 Variables of the Study

Student Level Characteristics	**Teacher Level Characteristics**	**Dependent Variables**
1. Gender 2. Home educational resources 3. Time spent on homework 4. Students bullied at school 5. Parental Involvement	1. Confidence in teaching science 2. Career satisfaction 3. Collaborate to improve teaching 4. Teachers' emphasize on science investigations 5. Teachers' experience 6. Professional development	1. Science achievement 2. Attitude toward science - Students' confidence with science - Students like learning science - Students value science

1.4.1. Student Level Characteristics

In the present study, student level characteristics were gender, home educational resources (HER), parental involvement, time spent on homework, and students bullied at school. These student-level variables were described below.

1.4.1.1.Gender

TIMSS 2011 collected data about the gender of the students by the use of student questionnaire. Each student state whether s/he is a female or male.

1.4.1.2.Home Educational Resources

Students attending to TIMSS 2011 answered student questionnaire which also collected data about their home educational resources. This index includes information about how many books students have in their home, their home study supports like having own room, and/or internet connection, and also highest education level of either parent (Martin, et al., 2012).

1.4.1.3.Parental Involvement

Students attending to TIMSS 2011 answered student questionnaire which also collected data about parents' involvement to their children's learning process. The items were as follows: "How often do your parents ask what you learned in school?, How often do you talk about your schoolwork with your parents?, How often do your parents make sure that you set aside time for your homework?, How often do your parents check if you do your homework?" (Foy, Arora, & Stanco, 2013b, pg. 166).

1.4.1.4.Time Spent on Homework

8th grade students responded about how often their teacher give homework in science and how much time they usually spend on doing the homework (Martin, et al., 2012). Time spent on homework in a week was calculated by multiplying frequency of homework given by the teacher by the amount of time spent by the student.

1.4.1.5.Students Bullied at School

TIMSS 2011 formed 'Students Bullied at School' scale and students attending to TIMSS 2011 answered this scale which had 6 items by stating that how often they experience these bullying behaviors. The scale included the following items "I was made fun of or called names; I was left out of games or activities by other students; Someone spread lies about me; Something was stolen from me; I was hit or hurt by other student(s); and I was made to do things I didn't want to do by other students" (Martin, et al., 2012, pg. 277).

1.4.2. Teacher Level Characteristics

In the present study, teacher level characteristics were teachers' confidence in teaching science, teacher career satisfaction, teachers collaborate to improve teaching, teachers' emphasize on science investigations, teachers' professional development and teacher experience.

1.4.2.1.Confidence in Teaching Science

TIMSS 2011 scale was designed to collect information about teachers' confidence in teaching science. Teachers responded to TIMSS 2011 teacher questionnaire including 5 items about their confidence in teaching science which were how confident they feel about "answering students' questions about science; explaining science principles or concepts by doing science experiments; providing challenging tasks for capable students; adapting their teaching to engage students' interest; and helping students appreciate the value of learning science" (Martin, et al., 2012, pg. 307).

1.4.2.2.Teacher Career Satisfaction

TIMSS 2011 scale was designed to collect information about teachers' career satisfaction in science. Teachers responded how much they agreed with TIMSS 2011 teacher questionnaire including 6 items which were: "I am content with my profession as a teacher; I am satisfied with being a teacher at this school; I had more enthusiasm when I began teaching than I have now (reverse coded); I do important work as a teacher; I plan to continue as a teacher for as long as I can; and, I am frustrated as a teacher (reverse coded)" (Martin, et al., 2012, pg.322).

1.4.2.3.Collaborate to Improve Teaching

Teachers responded to TIMSS 2011 teacher questionnaire including 5 items about collaborate to improve teaching. TIMSS 2011 scale was designed to collect information about teachers' collaboration with colleagues to improve teaching in five areas. These areas were as follows: "discuss how to teach a particular topic; collaborate in planning and preparing instructional materials; share what I have learned about my teaching experiences; visit another classroom to learn more about teaching; and work together to try out new ideas" (Martin, et al., 2012, pg. 365).

1.4.2.4.Teachers' Emphasis on Science Investigations

Teachers responded to TIMSS 2011 teacher questionnaire including items about emphasis on science investigations. These items were whether they ask students to “observe natural phenomena and describe what they see, design or plan experiments or investigations, conduct experiments or investigations, give explanations about something they are studying, relate what they are learning in science to their daily lives, do field work outside of class, use computer to look up ideas and information, use computer to do scientific procedures and experiments, use computer to study natural phenomena through simulations, use computer to process and analyze data” (Martin, et al., 2012, pg. 411).

1.4.2.5.Teacher Experience

Teachers responded to TIMSS 2011 teacher questionnaire about how many years they would have been teaching altogether by the end of this school year (Martin, et al., 2012). Teachers answers were categorized as ‘10 years or less’, and ‘more than 10 years’

1.4.2.6.Teachers’ Professional Development

Teachers responded to TIMSS 2011 teacher questionnaire including 7 items about their professional development. TIMSS 2011 scale was designed to collect information about whether teachers attend to some seminars, workshops or meetings to develop their knowledge and skills in science content, science pedagogy/ instruction, science curriculum, integrating information technology into science, improving students’ critical thinking or inquiry skills, science assessment, and/or addressing individual students’ needs in last two years (Foy, Arora, & Stanco, 2013b).

1.4.3. Dependent Variables

1.4.3.1.Science Achievement

Science achievement score (5 plausible values) at 8th grade on TIMSS 2011 test was another dependent variable of the present study. TIMSS 2011 science assessment at 8th grade included both content and cognitive domain. Content domain included biology with 35 % of the whole science assessment content, chemistry with 20 %, physics with 25 5, and earth science with 20 %. Moreover, cognitive domain included knowing, reasoning and applying with the percentages of 35 %, 35 % and 30 % respectively (Mullis, Martin, Ruddock, O’Sullivan, & Preuschoff, 2009, pg. 50).

1.4.3.2.Students' Attitude toward Science

IEA states that students' attitude toward science consists of students' like learning science, students' value science, and students' confident in science based on much research (Martin, et al., 2012). Therefore, in the present study attitude toward science dependent variable was created based on students' like learning science, students' value science and students' confident in science variables. 8^{th} grade students responded to TIMSS 2011 student questionnaire including 5 items about students' like learning science, which were "enjoy learning science, wish not to have study science (reverse coded), science is boring (reverse coded), learn many interesting things in science, like science" (Martin, et al., 2012, pg.336). 8^{th} grade students responded to TIMSS 2011 student questionnaire including 6 items about students' value science, which were "I think learning science will help me in my daily life; I need science to learn other school subjects; I need to do well in science to get into the university of my choice; I need to do well in science to get the job I want; I would like a job that involves using science; It is important to do well in science" (Martin, et al., 2012, pg. 338). 8^{th} grade students responded to TIMSS 2011 student questionnaire including 9 items about students' confident in science, which were "I usually do well in science; science is more difficult for me than for many of my classmates (reverse coded); science is not one of my strengths (reverse coded); I learn things quickly in science; science makes me confused and nervous (reverse coded); I am good at working out difficult science problems; my teacher thinks I can do well in science programs/classes/lessons with difficult materials; my teacher tells me I am good at science; science is harder for me than any other subject (reverse coded)" (Martin, et al., 2012, pg. 347).

1.5. Conceptual Model

Evaluation can be broadly defined as making decisions about an educational programme through the collection and use of information. This educational programme may be a single pupil's educational experiences, a single school's instructional activities or a nation's instructional materials (Cronbach, 2000). Making evaluations by comparing programs to find the most effective one is also possible although it is difficult to accomplish (Phillips, 2014).

Cronbach emphasizes the role of testing in program evaluation with the following statement: “If you wish to know how well a curriculum is achieving its objectives, you fit the test to the curriculum; but if you wish to know how well the curriculum is serving the national interest, you measure all the outcomes that might be worth striving for.” (Cronbach, 1963, p.680). As Cronbach (1963) states not a unique learning outcome but learning outcomes which are worth striving for should be in the focus. As learning outcomes are essential in enhancing meaningful learning, as they inform diagnosis and hence improve teaching and learning process (OECD, 2012a), deciding on which learning outcome to focus on plays an important role in education. In order to decide on which learning outcomes to focus, the curriculum and learning outcomes of the countries of interest should be analyzed in detail. Detailed information about the aimed learning outcomes of countries interest of the present study and as well as their curriculum and vital features of their science education is explained in detail in section 2.4 and section 2.5 of literature review chapter. Based on review about science education in Turkey, Finland and England explained in chapter 2 and the literature review about science education outcomes explained below, which learning outcomes to focus in the present study was decided.

The main focus is on the science achievement in the studies focusing on science education (Akyüz, 2006; Neumann, Kauertz, & Fischer, 2012) although student attitude, student engagement, student discipline problems as well as student achievement should be taken into account as dependent variables while exploring the effect of teacher and/or classroom factors. Educational policy makers should identify and prioritize the valued educational outcomes. High science achievement and improved attitude toward science are the outcomes of effective teaching process in science education (Chidolue, 1996). Moreover, objectives of a school lesson should also focus on pupils’ meta-cognition, and the learning of ‘how to learn’ as a part of cognitive domain of learning (Creemers & Kyriakides, 2008), and on pupils’ societal and democratic values, social skills, attitudes, ability to work with others, initiative-taking competences (beyond cognitive domain of learning) (Creemers & Kyriakides, 2008; Eisner, 1993; and Raven, 1991) and self-reported emotions and motivation (Lipowsky, 2006). Within developing countries, cognitive outcomes suggest economic returns (Hanushek, & Wössmann, 2007); however, the main focus should not be only on cognitive outcomes, as the cognitive beyond outcomes are also important in science education. It is clear that science achievement is not the unique output of science education (Akyüz, 2006; and Rosier, 1990) and hence, as science teachers we need to develop students' attitude, meta-cognition, social skills, and initiative-taking competences … etc. That is why it is important to assess students' cognitive and cognitive beyond student outcomes, and investigate the student and teacher level characteristics affecting these learning outcomes. Moreover, attitude is stated as an affective dimension that should be developed during science education in the science curriculums of Turkey, Finland and England (Department for Education, 2014b; Finnish National Board of education, 2004b; MoNE, 2013). Therefore, in the present study, science achievement and attitude toward science were included as learning outcomes; however, students' meta-cognition, demographic values or initiative-taking competencies could not have taken into account in this study as TIMSS 2011 does not collect data about these student outcomes like meta-cognition, demographic values or initiative-taking competences ... etc.

As this study was a cross country comparative study, related models in science education were also reviewed. Rosier (1990) created a model in science education based on international studies and specifically IEA's TIMSS study. Rosier (1990) examines how to make international comparisons in science education between educational systems of countries or district educational regions like states or cantons. Rosier (1990) proposes a new model for the international comparisons of science education, which is shown in Figure 1.1.

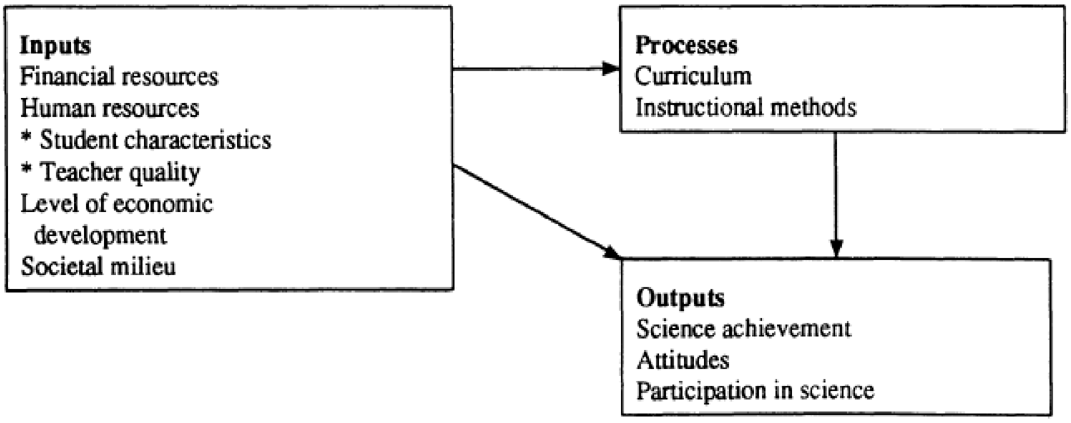


Figure 1.1 Model for International Comparisons of Science Education

In this model, Rosier (1990) states that financial resources, human resources like student characteristics and teacher quality, economic development level and societal milieu are the inputs of science education, which can affect both the processes (curriculum and instructional methods) and science education outputs (science achievement, attitudes, and participation in science). This model makes difference as it does not focus on only science achievement as an output, but also on attitudes and participation in science. Participation in science is the competence of science education as a preparation for entry to the workforce and/or further education. Rosier (1990) defines participation in science the extent to which students remain at school and continue to study of science. Depending upon the Rosier's model, science learning outcomes are defined as science achievement, attitudes and participation in science, moreover, input is determined as human resources specifically teacher and student characteristics in the present study. As clear in the Figure 1.1, Rosier (1990) separately defines attitude and participation in science, however, participation in science (which also includes aiming a career in science or science-related work and the value of science) is investigated as a sub-dimension of attitude toward science in recent studies (Kerr & Murphy, 2012; Tytler & Osborne, 2012) and also in IEA's TIMSS 2011 (Martin, et al., 2012). Since TIMSS data was used in the present study, TIMSS's attitude approach was used in the present study and the variable participation in science is loaded under attitude factor. On the basis of the discussed literature so far, apart from the studies only focusing on the science achievement, present study focuses on students' science achievement and students' attitude towards science as science learning outcomes in these three countries Turkey, Finland and England.

There is still an interest to investigate which factors affect achievement in science and mathematics domain although so many models are created to reveal the relationship between student-, teacher-, school-level factors and students' learning outcomes (Lamb & Fullarton, 2001), and how these factors influence achievement across countries as a result of international studies (Baker, Fabrega, Galindo, & Mishook, 2004). Only single complete model cannot explain the relationship between all student-, teacher-, and school-level factors and students' learning outcomes due to time, energy, and statistical concerns. Interpreting a single complete model is also very difficult to perform in terms of statistical issues as it creates computational problems. Researchers should focus on more limited models that take their interest due to their theoretical problems and also proven in previous studies (Hox, 2010). Therefore, in the present study a new model was created based on previous studies to see the effect of student- and teacher-level factors on students' science achievement and attitude toward learning.

In order to better understand how student and teacher characteristics relate to students' science achievement and attitude toward science, the following conceptual model (Figure 1.2) was developed based on related studies in literature. Due to the fact that the effect of classroom level characteristics is stronger than the effect of school level characteristics on student learning outcomes (Kyriakides, Campbell, & Gagatsis, 2000; and Muijs & Reynolds, 2010), in the present study teacher level characteristics are analyzed instead of school level characteristics. In order to decide which student and teacher characteristics to include in the model a detailed literature review about the student and teacher characteristics on students' achievement and attitude was performed. A brief summary of this literature review is explained below.

Student characteristics affecting students' academic achievement and attitude include gender (Beaton, Mullis, Martin, Gonzalez, Kelly & Smith, 1996; Biggs & Moore, 1993; Brotman & Moore, 2008; Dawson, 2000; Furnham, Chamorro-Premuzic, & McDougall, 2002; Greenfield, 1995; Hattie, 2012; Kahle, 2004; Kerr & Murphy, 2012; Mullis, et al., 2009; Murphy & Beggs, 2003; Murphy & Whitelegg, 2006; Roiser, 1990), students' home educational resources (Beaton et al, 1996; Bradley & Corwyn, 2002; Brooks-Gunn, Han, & Waldfogel, 2010; Duncan, Ziol-Guest, & Kalil, 2010; Farooq, Chaudhry, Shafiq, & Berhanu, 2011; Hattie, 2012; Magnuson, 2007; Mullis, et al., 2012; Sirin, 2005; and Willms, 2006), parental involvement (Dearing, Kreider, & Weiss, 2008; Fan & Williams, 2010; Grolnick & Slowiaczek, 1994; Hattie, 2012; Hill & Tyson, 2009; Jeynes, 2005, 2007; LaRocque, Kleiman & Darling, 2011; Lee & Bowen, 2006; Lyons, 2006; Mullis, Martin, Foy & Drucker, 2012), time spent on homework (Holmes & Croll, 1989; Maltese, Tai, & Fan, 2012; and McMullen, 2010), and also bullying at school (Baker-Henningham, Meeks-Gardner, Chang, & Walker, 2009; Brophy, 1988; Kaur, Areepattamannil, Lee, Hong, & Su, 2014; Ladd, 2005, 2013; Martin, et al., 2012; Mullis, et al., 2012). Furthermore, teacher characteristics affecting students' academic achievement and attitude are teachers' confidence in teaching science (Al-Alwan, & Mahasneh, 2014; Bandura, 1997; Caprara, Barbarabelli, Steca, & Malone 2006; Henson, 2002; Martin, et al., 2012; Mojavezi, & Tamiz, 2012; Ross, 2013; Tschannen-Moran, & Woolfolk Hoy, 2001), teacher career satisfaction (Martin, et al., 2012; Michaelowa, 2002; and Mullis, Martin, Foy, Drucker, 2012), teachers' collaboration to improve teaching (Lomos, Roelande & Bosker, 2011; Martin, et al., 2012; Pil & Lena, 2009; Wheelan & Kesselring, 2005; and Wimberley, 2011), teachers' emphasis on science investigations (House, 2009; Martin, et al., 2012; and National Research Council, 2011), teachers' professional development (Blank, de las Alas & Smith, 2008; Hattie, 2012; Jarrett, Evans, Dai, Williams & Rogers, 2010; Myrberg, 2007; Yoon, Duncan, Lee, Scarlos & Shapley, 2007; Timperley, Wilson, Barrar, & Fung, 2007; and Tinoca, 2004) and teacher experience (Buddin & Zamarro, 2009; Chidolue, 1996; Harris & Sass, 2008; Rivkin, Hanushek, & Kain, 2005).

TIMSS gives the opportunity to measure a variety of the variables measuring students' outcomes. As testing all the variables for educational effectiveness is not feasible, selection of variables based on literature review (explained above) was performed while creating the conceptual model of this study. Within this model, gender, home educational resources, parental involvement, time spent on homework and students' bullied at school were selected as student-level characteristics and teachers' confidence in teaching science, teacher career satisfaction, collaborate to improve teaching, teachers emphasize on science investigations, teachers' professional development and teacher experience were selected as teacher-level characteristics, which were drawn from the TIMSS 2011 data set. As clear in Figure 1.2, both student and teacher level characteristics directly influence students' science achievement and attitude. Literature review in previous models, and variables were discussed in details in Chapter 2. Conceptual model of the present study is stated in .

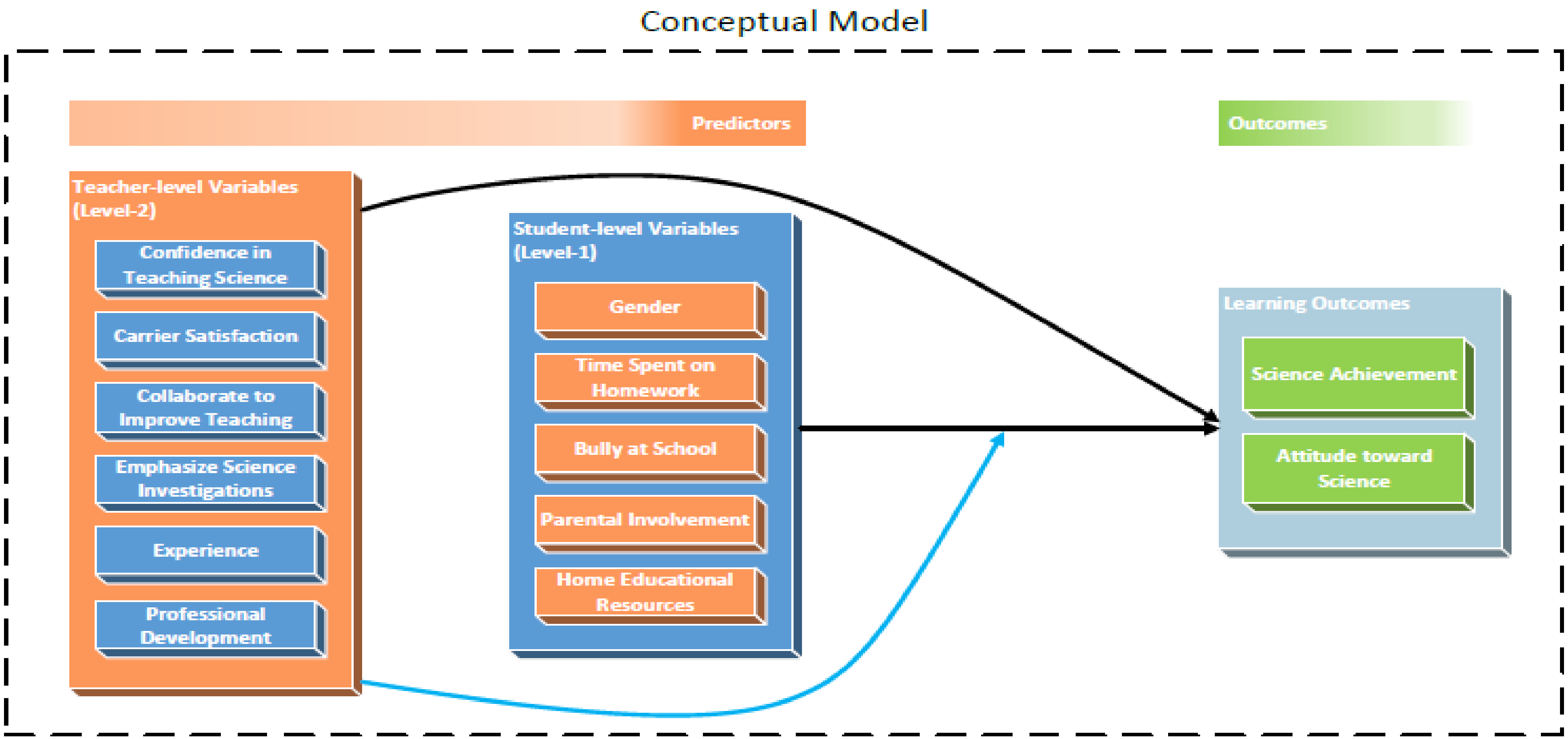


Figure 1.2 Conceptual Model of the Relationship between Student- and Teacher- Level Characteristics and Students' Science Achievement and Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on level-1 predictors and outcome variable

1.6. Design of the Study

The present study was a quantitative research with non-experimental study. Hierarchical linear modeling techniques were used to investigate the relationship between student- and teacher-level characteristics and 8th grade Turkish, Finnish and English students' science achievement and attitude toward science. Therefore, the present study was a correlational study as it was performed with no-causal concern between student- and teacher-level variables and students' science achievement and attitude toward science. Due to the nature of the TIMSS 2011 data, this study was cross-sectional study.

CHAPTER 2

LITERATURE REVIEW

The first section of this chapter described the importance and applications of comparative studies. Second section focused on TIMSS by explaining TIMSS framework and the impact of TIMSS results in Turkey, Finland and England. In the following third section, hierarchical linear modelling (HLM) was defined and importance of using HLM was explained. In fourth section, learning outcomes in science education were discussed with their definitions, purposes and applications in different countries. In fifth and sixth section of this chapter, education systems and then science education in Turkey, Finland and England were explained in detail. In the last section of this chapter, the influences of student- and teacher-level characteristics on students' science achievement and attitude toward science were discussed respectively.

2.1. Comparative Studies

Comparative research in education is related to international education. Comparative education got off the ground in 1817 by Marc-Antoine Jullien who is accepted as the founding father of comparative education and afterwards westernization, modernization and more recently globalization started to feed the movements in comparative research in education since the second half of the twentieth century (Keeves, 2001). Descriptive studies, developmental studies and studies of relationships and processes are the three types of comparative research in education. Descriptive studies focus on descriptive information about how education is conducted in different countries; basically they document the characteristics of educational systems in terms of practices and outcomes (National Research Council, 1990). Developmental studies focus on societal developments and their origins in education in different countries. Moreover, studies of relationships and processes focus on understanding the dynamics of teaching and learning, how variables relate and affect one another, and how these relationships and processes vary across countries. IEA has leaded the field of studies of relationship and processes in comparative education (Keeves, 2001).

The quality and outcomes of educational systems is an important topic investigated worldwide. Therefore, international large-scale assessment studies are investigated in order to reveal comparative information to participating countries about the school system outcomes (Stanat & Lüdtke, 2013). UNESCO and OECD began a comparative study in a number of countries by collecting data about some specific features of education systems in 1950s; which lead to a discussion of assessing learning outcomes on an international basis by implementing First International Mathematics Study (FIMS) in which 12 countries participated. At the present day, Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS) are conducted by International Association for the Evaluation of Educational Achievement (IEA) on an international base. At the beginning of 21st century, OECD began to assess 15-year-old students' performance on an international base by Programme for International Student Assessment (PISA) in science, mathematics, and reading domains every 3 years (OECD, 2010; Stanat & Lüdtke, 2013). In our day, World Bank, UNESCO, OECD, IEA, the International Institute for Educational Planning (IIEP) in Paris, the International Bureau of Education (IBE) in Geneva, UNESCO Institute of Education (UIE) in Hamburg, and Centre for Educational Research and Innovation (CERI) focus on educational issues within and between countries (Keeves, 2001).

International studies like TIMSS use student, teacher and school questionnaires and/or classroom videos in order to collect information about teaching and learning processes. TIMSS studies made it possible to investigate instruction and study the relationship between instructional characteristics and students' achievement particularly as a result of video analysis of the lessons (Neumann, Kauertz, & Fischer, 2012). However, due to its high costs, classroom videos commonly focus on small number of selected countries. Student and teacher questionnaires costs are less compared to video studies but, reliability and validity of the results are under discussion as students from different countries can use different frames of references while answering student questionnaires and also similar problems can occur for teacher questionnaire results (Prenzel, Seidel & Kobarg, 2012). In order to eliminate reliability and validity problems occurring due to the country differences, some implementations are performed to ensure cross-cultural equivalence and cross-linguistic equivalence in data. Firstly, it should be ensured that assessment domains are defined in a meaningful way for all participating countries for cross-cultural equivalence. In order to ensure cross-cultural equivalence, there are two common approaches which are curriculum-oriented approach and literacy-oriented approach. IEA studies like TIMSS use curriculum-oriented approach in which a common core of learning goals are identified by examining the curricula of all participating countries and this common core of learning outcomes are assessed by test items. Additionally, for cross-linguistic equivalence, factors that may potentially bias students' responses due to the language and cultural differences between the countries should be examined carefully. In order to ensure cross-cultural equivalence, national experts in each participating countries should review items to see whether there are some misleading items as a result of language and cultural differences, moreover, double translation of items and analysis of differential-item functioning (DIF) based on pretest-data should be performed (OECD, 2009c; and Stanat & Lüdtke, 2013). Yet, another important point in international large-scale assessments is to ensure that test administration standardization occurs in all participating countries and each country has a representative sample of target population. Countries not being able to obtain a representative sample of target population are excluded from the analysis or these countries are stated as a non-representative sample of target population in the international reports (Stanat & Lüdtke, 2013).

International large scale assessments are used for three functions which are namely benchmarking, analytic and inventory. Benchmarking function enhances comparable indicators on student performance and schooling practices across countries, therefore, by making analysis we can understand which countries do better than others; which gives us the opportunity to learn from one another. Analytic function suggests hypotheses about areas that students have common strengths and weaknesses and also about the relationship between student outcomes and the factors might have an influence on. Inventory function enhances information about what people know and can do (IEA, 2011). As a result of these functions of international large scale assessments, comparative studies like TIMSS and PISA provide a basis for gaining fundamental knowledge about differences in cultures, curriculum and school organization (Goldstein, 2004) and a political impact on policy making as a result of attention to the rankings (Riley & Torrance, 2003).

National Research Council (1996) states that international studies present information to the researchers who want to study the identification of factors affecting learning, the identification and examination of pedagogical approaches, and analysis of how curriculum and pedagogy are related to educational and social contexts within and between countries. The identification and examination of pedagogical approaches and analysis of how curriculum and pedagogy are related to educational and social contexts within and between countries can be explained in detail as follows. Researchers can examine identification of factors that affect learning within and between countries with international studies as there is an apparent variation (e.g. class size, the role and nature of assessment, age of school entry…etc.) in educational practices across countries. Researchers can study the identification and examination of pedagogical approaches within and between countries with international studies as teaching practices can be influenced by cultural and political parameters which differ across countries. Researchers can study the analysis of how curriculum and pedagogy are related to educational and social contexts within and between countries with international studies as educational systems can produce high or low qualified educational outcomes as a result of their different cultural, political and social differences; which shape schooling, curriculum and pedagogical approaches across countries.

As mathematics and science link to success in industry and technology, both developed and developing countries examine closer mathematics and science achievement. International studies provide international perspectives for the attained curricula; which can be seen as a “calibrated yardstick” of a country’s education system (Wagemaker, 2002). Therefore, Rosier (1990) states that international comparisons can provide detailed information at the national level to improve science education. Whether there is variation between different schools types or regions of the country within a country and if the variation exists, the possible determinants of this variation within the country can also be analyzed through international large scale assessments.

How to interpret international study results is also an important issue. International studies can be resource-rich information for the further design of educational development although sometimes they are interpreted as a competition among participating countries, which is of course not a productive way to learn from international studies (National Research Council, 1996). Large-scale assessments should give information about students' learning outcomes instead of simply ranking them according to score results (Pellegrino, 2012; and Rutkowski & Prusinski, 2011). Ranking should not overshadow the rich data which can give opportunities to monitor learning and teaching process within and between countries and also to understand the required initiatives to develop educational outcomes. Apart from the ranking focus, still international studies should be interpreted with caution when comparing individuals and educational systems. Due to the complexity of the study design, comparisons should not be performed simply at the individual level (Rutkowski & Prusinski, 2011). Moreover, as cultural and social factors (National Research Council, 1996) and also school systems (Gorard & Smith, 2004) differ in many aspects across countries, comparison between different educational systems is difficult and can have some limitations. Furthermore, when the instruments and conceptual categories of international studies are usable across countries, the limitation of international studies can be overcomed and international comparisons can be useful despite their limitations (Gorard & Smith, 2004).

2.2. TIMSS

2.2.1. Information about IEA and TIMSS

The International Association for the Evaluation of Educational Achievement (IEA) is a non-profit and non-governmental organization which is founded in 1958. Now, there are more than 60 IEA membership countries in TIMSS 2011 (IEA, 2011). TIMSS countries show great differences in terms of population, economy and geographical location (Mullis et al., 2009).

In education field, IEA carries out comparative studies and assessment projects and the aims of these studies and projects are to identify weaknesses and strengths of education systems, supply data about the factors influencing teaching and learning, give opportunity to monitor and develop educational outcomes, and form a global network for researchers in education field (IEA, 2011). In line with these purposes, IEA conducts the several studies. These ongoing studies are namely Early Childhood Education Study (ECES), International Civic and Citizenship Education Study (ICCS), PIRLS, International Computer and Information Literacy Study (ICILS) and TIMSS. Moreover, as an upcoming study IEA aims to assess students' proficiency levels in English by English Teaching and Learning Study (ETLS), which will be held in 2017 (*Ibid*).

IEA's TIMSS aims to give information about countries' teaching and learning in mathematics and science and help countries to improve their educational outcomes (Mullis, Martin, Minnich, Stanco, Arora, Centurino & Castle, 2012a, 2012b). Although TIMSS' participating countries differ in terms of population, economy and/or geographical location, they all aim to compare their educational systems in terms of curriculum, instructional practices and students' achievement in order to improve science and mathematics achievement (Mullis, Martin, Ruddock, O'Sullivan & Preuschoff, 2009).

First International Mathematics Study (FIMS) is conducted in 1964 and with a focus only on mathematics domain. More information about FIMS is available on the FIMS website which is http://www.iea.nl/fims.html. Second International Mathematics Study (SIMS) is conducted in 1980 and 1982. More information about SIMS is available on the SIMS website which is http://www.iea.nl/sims.html. After then, TIMSS has assessed mathematics and science achievement on a 4-year cycle in 1995, 1999, 2003, 2007, and 2011 (Foy, Arora & Stanco, 2013a). Moreover, next study will be conducted in 2015.

IEA draws together "millions of students in testing programs, hundreds of thousands of schools, and thousands of research workers in the field of education from a very ride range of countries" for its studies (Keeves, 2001, pg. 2425). TIMSS provides detailed information hence countries can monitor and evaluate mathematics and science teaching and learning across time (as conducted on a 4-

year cycle) and across grades of fourth and eighth (Mullis, et al., 2009). Although in FIMS, population was defined as the students at the age of 10 (Rosier, 1990), in time IEA changed its population and now TIMSS assesses students at the fourth grade which is at the end of primary school and at the eighth grade which is at the end of lower-secondary school. Therefore, fair and appropriate comparisons between countries and pupils occur as students have the opportunity to learn mathematics and science for an equivalent number of years of formal schooling (Mullis, et al., 2009).

Attending to TIMSS studies give several opportunities to countries. Mullis et al. (2009, pg. 14-15) state that TIMSS participating countries are able to

> have elaborative and internationally comparable data about mathematics and science concepts, teaching and learning processes, students' attitudes at the fourth and eighth grades, monitor progress in mathematics and science outcomes internationally across time and across grades, identify knowledge and skill progress both in mathematics and science domains from fourth and eighth grades, monitor relative effectiveness of teaching and learning process at the fourth grade and compared to the eighth grade as cohort of fourth grade students is assessed again in the eighth grade (in the next TIMSS assessment), understand which curriculum, instruction and resource variables give rise to higher student achievement in both mathematics and science domains by having international comparisons and finally examine equity issues within countries

Similarly, National Research Council (1996, pg.14-15) states that TIMSS investigates the following questions: "How much are the differences in mathematics and science curriculum and teaching due to culture and nation and how much are they really just related to individual teacher and student differences?", "What is meant by national curriculum and what is its role?", "What is the role of the teacher, and how do they learn and develop their practice?", and "How do differences in educational practice among countries affect students?". In the light of the information given, it is clear that TIMSS data is a comprehensive and detailed data, which help to find questions to several complicated problems both in mathematics and science education.

TIMSS 2011 is the fifth trend measure and the most recent in TIMSS series. 63 countries and 14 benchmarking participants attended to TIMSS 2011. TIMSS International Database at fourth and eighth grade for both mathematics and science domains is available at the main website of TIMSS (http://timssandpirls.bc.edu/) for the researchers and analysts who want to use data for in-depth research. TIMSS

2011 database includes data from 608,641 students, 49,429 teachers, 19,612 school principals and the National Research Coordinators of each country (Foy, et al., 2013a). TIMSS 2011 collected data by using student, teacher and school principal questionnaires to give information about the implementation of educational policies and practices for each of the participating countries (Mullis, et al., 2009). For example, teacher questionnaire gives detailed information about teachers' preparation, experience, attitudes, the instructional approaches used in the classroom during science and mathematics courses, and the resources available for teaching and learning mathematics and science at school and classrooms (Mullis, et al., 2009).

TIMSS 2011 science assessment framework consists of two dimensions which are namely content and cognitive dimension. Content dimension defines subject matter domain and cognitive dimension defines cognitive domains or skills and behaviors. Content dimension at the eighth grade includes 35 % biology, 20 % chemistry, 25 % physics, 20 % earth science, furthermore cognitive dimension at the eighth grade includes 35 % knowing, 35 % applying, 30 % reasoning (Mullis, et al., 2009, pg. 50). TIMSS items are prepared by care in order to eliminate favoring gender or nation of students. As Rosier (1990) states TIMSS items were set in everyday life situations which are familiar to students of participating countries, moreover reading difficulty of items was reduced by using possible simplest language in order to eliminate the effect of reading comprehension on understanding of science.

2.2.2. TIMSS Conceptual Framework

Two frameworks were found in literature to explain TIMSS conceptual framework. Both of these two frameworks which are namely 'curriculum framework' and 'educational experience opportunity framework' were published in 1996. The curriculum framework was described first by Robitaille and others (1993) in TIMSS monograph 1. The second framework explaining the TIMSS conceptual framework was 'educational experience opportunity framework' was described first by Schmidt and Cogan (1996) in TIMSS technical report. Both of these two frameworks are discussed below.

2.2.2.1. TIMSS conceptual framework of curriculum

TIMSS chose curriculum as an explanatory factor focusing on student achievement (Martin, 1996). Since the implementation of this curriculum model, TIMSS still uses the same 3-level curriculum model with some small changes. TIMSS uses curriculum in order to figure out how educational opportunities are provided to students, and the factors that influence how students use these educational opportunities effectively. Curricular goals, how the education system is organized to reach these curricular goals and how these curricular goals are attained is the concern of TIMSS (Mullis, et al., 2009). As a result of this, as explained in Figure 2.1 TIMSS curriculum model has three aspects which are namely Intended Curriculum, Implemented Curriculum and Attained Curriculum. TIMSS curriculum model shown in Figure 2.1 is the model also used in TIMSS 2011.

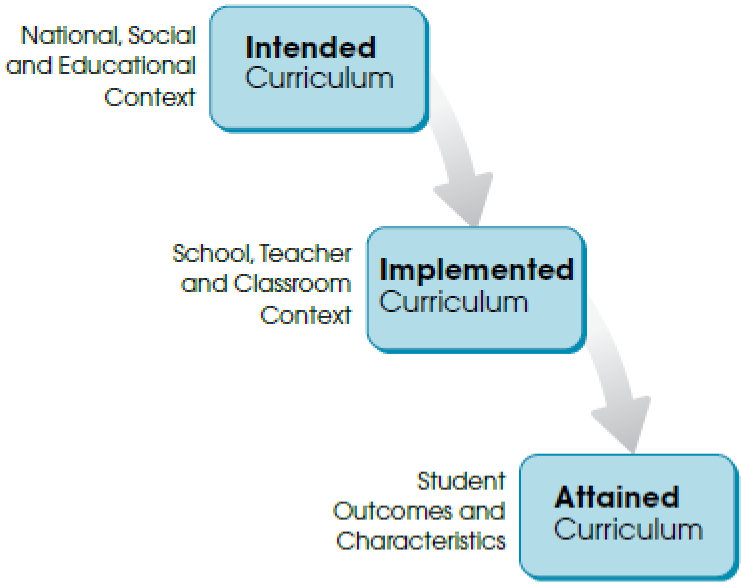


Figure 2.1 TIMSS Curriculum Model.

Retrieved from "*TIMSS 2011 assessment frameworks*" by I.V.S. Mullis, M.O. Martin, G.J. Ruddock, C.Y. O'Sullivan and C. Preuschoff, 2009, p. 10. Copyright 2009 by IEA

Based on the Figure 2.1, intended curriculum represents the science content that students are supposed to learn at school. Implemented curriculum is the actual case happening in the classroom and related with what is taught, who teaches and how it is taught. The achieved curriculum is the students' learning outcomes in science in terms of what they learnt and what they think about science (Mullis, et al., 2009).

Working from this curriculum model, TIMSS provide information about students' learning in the participating countries by using mathematics and science assessment tests, TIMSS Encyclopedia and questionnaires (Mullis, et al., 2009). While TIMSS curriculum model was constituted, researchers gathered and examined curriculums and documents related to education system from each country or each state or canton (e.g. United States and Switzerland) where there is no national curriculum but it is specified at the state or canton level. Afterwards, curriculum guides and list of objectives are formed in order to develop the analytic framework of intended curriculum according to the aspects of content (earth science, nature of science …etc.), performance expectations (understanding, analyzing ...etc.), and perspectives (e.g. attitudes, careers, participation, and increasing interest …etc.) in terms of both mathematics and science (Martin, 1996). To study the implemented curriculum, teachers and school principals questionnaires and as well as in some countries videotaped case studies were used in order to see their instructional practices (National Research Council, 1996; and Martin, 1996). Finally, to study the attained curriculum, students (chosen by random sampling) were assessed by multiple-choice and open-ended items (National Research Council, 1996). In the light of all these studies, TIMSS conceptual model is formed to provide a theoretical foundation for collecting data and to examine the relationship between variables (*Ibid*).

2.2.2.2. TIMSS conceptual framework of educational experience opportunity

Analyzing opportunities to learn and educational outcomes is also possible in terms of TIMSS design (National Research Council, 1996). Educational experience opportunity framework is an extension of curriculum framework. In Figure 2.2, it is seen that intended, implemented and attained curriculum which are the levels of curriculum framework are included into the educational experience opportunity framework. TIMSS conceptual framework of educational experience opportunity is explained in Figure 2.2.

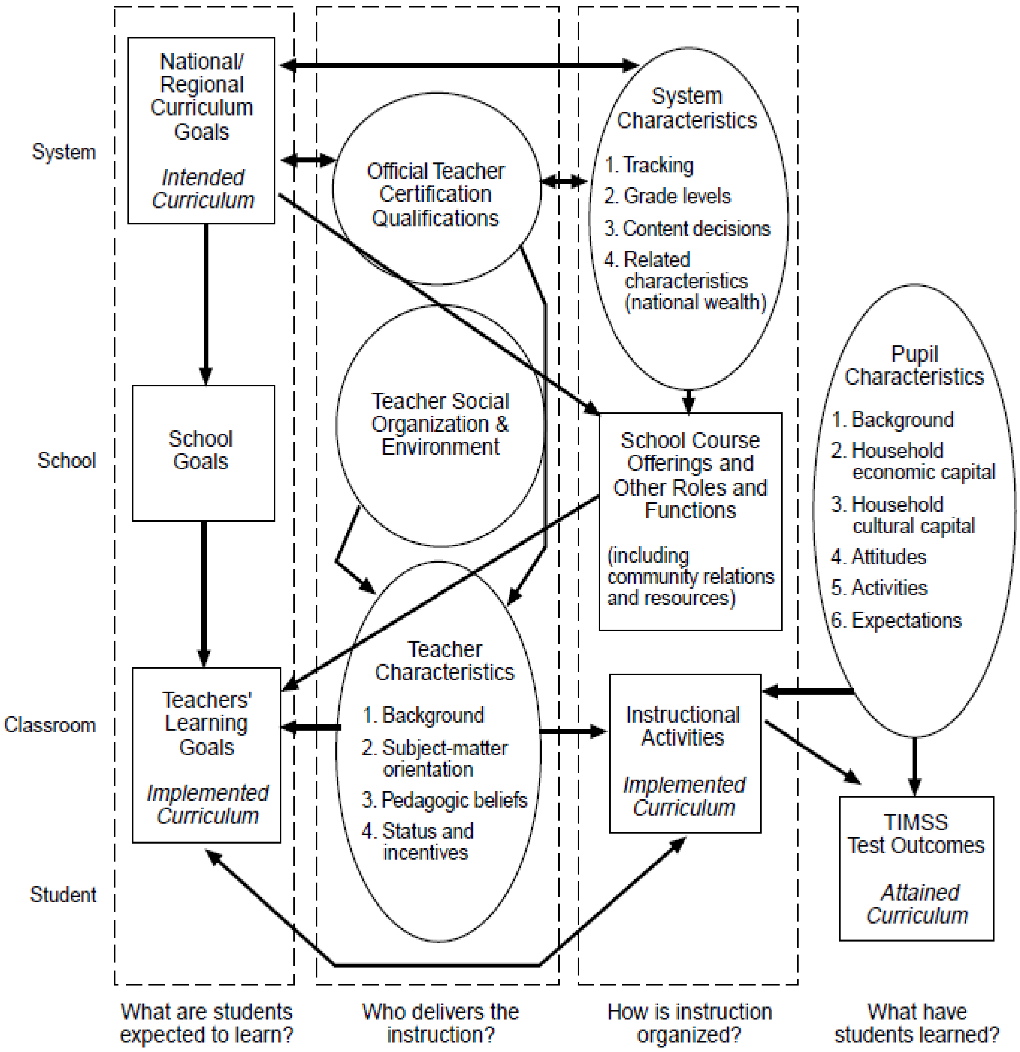


Figure 2.2 TIMSS Conceptual Framework of Educational Experience Opportunity. Retrieved from “Development of the TIMSS context questionnaires” by W.H. Schmidt & L.S. Cogan, 1996, pg. 5-8. Copyright 1996 by IEA

National Research Council (1996) evaluates TIMSS design by stating that TIMSS curriculum model answers 4 core questions. First question is “What are students expected to learn?”, which is a concern of intended curriculum. Second question, “Who delivers the instruction?” stresses the importance of teachers. Third question, “What have students learned?” is a concern of implemented curriculum. The final and the fourth question “What have students learned?” is a concern of attained curriculum (*Ibid,* pg. 3-4).

Arrows observed in the model are the hypothesized associations between clusters. For example, it is assumed that system characteristics like tracking, grade levels have an effect on school course offerings and other roles and functions, and school course offerings and other roles and functions have an effect on teachers' learning goals. Therefore, although system characteristics do not have a direct effect on teachers' learning goals, it indirectly affect in the final model. Yet another example from the model is pupil characteristics and as well as instructional activities have an effect on TIMSS test outcomes.

This conceptual framework explains the content related educational experiences as a part of TIMSS measures and analysis (Wang & Schmidt, 2001). In the development of this educational experience opportunity framework, school, classroom and students levels were taken into account. For each level, factors at the level were investigated from the literature separately and then finally integrated to constitute the final model having 3 levels. Accordingly, this framework constitutes the backbones of student, teacher and school-principal questionnaires (Schmidt & Cogan, 1996). Schmidt and Cogan (1996) stated that educational experience opportunity model is useful to investigate the cross-nation education systems.

In addition to these conceptual frameworks which are namely TIMSS conceptual framework of curriculum and TIMSS conceptual framework of educational experience opportunity, TIMSS 2011 uses science framework and contextual framework. Science framework focuses on science achievement assessment, and contextual framework focuses on the factors affecting teaching and learning processes in science. TIMSS 2011 Contextual Framework contains 4 broad areas which are national community contexts, school contexts, classroom contexts and student characteristics and attitude. TIMSS uses curriculum, principal, teacher and student questionnaires to collect data about these 4 contexts (Mullis, et al., 2009). These science framework and contextual framework is explained in detail in Chapter 3 as these two frameworks are essential in data collection procedure.

2.2.3. The Impact and use of TIMSS results in Turkey, England and Finland

International studies like TIMSS and PISA, which measures students' scientific literacy and science learning outcomes, influence the countries' science education reforms (Chui & Chen, 2012). The impact and use of TIMSS results are observable in all these three countries, namely Turkey, England and Finland. TIMSS results play a non-negligible role in Turkish education system as the results are also used to monitor Turkish education. Therefore, it can be said that international studies like TIMSS affect curriculum development and educational reforms indirectly (Tasar, Aztekin, & Arifoglu, 2012). The impact and use of TIMSS results are also clear in England than Turkey. England has participated all TIMSS cycles at both 4th and 8th grades. TIMSS results gain importance in studies held in England. Moreover, Department for Education used TIMSS 2007 results with additional analysis while performing curriculum review in 2011. In addition to these, summaries of national reports, attitudinal feedbacks and scores for students are sent to each school participating to TIMSS (Rowe, 2012). Finally, the impact and use of TIMSS results on education system are also observable in Finland. Finland participated in TIMSS 1999 and 2011, and researchers held studies about mathematics and science through TIMSS, based on these studies they participated meetings, conferences and symposia organized by the Finnish National Board of Education. Furthermore, several articles and reports about the Finnish education system were written based on the TIMSS results (Kuppari & Vettenranta, 2012).

2.2.4. Related TIMSS Studies in Science Education

Since the start of the TIMSS studies, so many researchers used TIMSS data with different purposes like focusing on mathematics achievement (Ceron-Acevedo, 2013; Akyüz, 2006, 2014; Ker, 2015; Lamb & Fullarton, 2001; Sandoval-Hernandez, Jaschinski, Fraser & Ikoma, 2015), and/or science achievement (Bietenbeck, 2011; Jen, Lee, Chien, Hsu & Chen, 2013; Kaya, 2008; Korkmaz, 2012; Macintyre, 2014; Martin, 2010; Mohammadpour, Shekarchizadeh & Kalantarrashidi, 2015, Özdemir, 2003; Yaman, 2004), and also benefits and limitations of large scale international assessments (Bos, 2002; Murphy, 1996; and Riley & Torrance, 2003). Some of these studies made cross-country comparisons, some showed the trends in specific education system, or performed cross-sectional analysis within a specific country. In this part of the thesis, the focus will be on the recent studies focusing on science achievement and attitude toward science. Below, most recent TIMSS studies focusing on science achievement and attitude toward science were reviewed.

Kaya (2008) performed a cross country comparison study among Singapore, Japan, the United States, Australia, and Scotland, and investigated the effects of student- and classroom-level factors on 4^{th} grade students' science achievement through the use of TIMSS 2003 data. Gender, science self-confidence and home resources were the student-level factors investigated in that study. Teacher's experience, education, major, teacher support (teacher characteristics factor), science inquiry, science instruction time, class size (instructional variables factor), average of home educational resources in class and average of self-confidence in class (classroom composition factor) were the classroom-level variables used in that study. 2-level hierarchical linear modeling was performed for the analysis part due to the nested structure of the data. The results of the analysis showed that variance explained by level-2 variables were greater than variance explained by level-1 variables in either country. Variance in science achievement explained by level-1 variables ranged from 4.3 % (Scotland) to 7.0 % (Singapore), moreover, variance in science achievement explained by level-2 variables ranged from 30 % (Japan) and 72 % (Singapore). Total variance explained by the best model was greatest in Singapore and lowest in Japan. HLM analysis results showed that at the student level, both self-confidence and home resources has a significant effect on 4^{th} grade students' science achievement in all these five countries. The higher self-confidence the students have, the higher science achievement they perform. Similarly, the higher home educational resources the students have the higher science achievement they perform. Moreover, gender was found significant in Singapore and Scotland models whereas it was non-significant in Japan, United States and Australia. Male students outperformed female students in Singapore and Scotland. Furthermore, HLM results showed that at the classroom level, there was no clear pattern among these five countries in terms of teacher effects and instructional variables. In general, classroom mean home resources had a positive effect on students' science achievement. Furthermore, teacher support was found significant in Singapore and United States that the more supportive the teachers, the higher science achievement the students perform. Finally, science inquiry instruction of teachers was found significant in Singapore, United States and Australia. A negative relationship between teachers' emphasis on science inquiry and students' science achievement was found in the U.S. and Australia.

Yet another recent study was performed a cross country comparison among 29 countries including England and Turkey through the use of 8th grade TIMSS 2007 data by Mohammadpour, Shekarchizadeh and Kalantarrashidi (2015). 3-level HLM analysis was performed in the analysis part in order to investigate the variability in science achievement as a function of three levels which are student, school and country. Student level factors included science self-concept, attitude toward science, valuing science, educational aspiration, gender, socio economic status (SES), academic activity time, non-academic activity time, time on chores, language spoken at home and attitude toward science. School level factors included teacher quality, school climate, class size, attendance at school, school location, school resources, grouping by ability, enrichment course, remedial course, teacher emphasis on homework. Furthermore, country-level factors included per capita income, gross domestic product (GDP) on education, purchasing power and net enrollment secondary school. 3-level HLM analysis results showed that total variance in science achievement explained by student level factors was greater than the total variance explained by school and country-level factors. 43.33 % variance in science achievement was explained by student level factors, moreover, 19.78 %, and 36.90 % variance were explained by school- and country level factors, respectively (Ibid, pg.5). In terms of student-level factors, science self-concept, SES, gender, time on chores, academic activities time, nonacademic activities time, and valuing science showed a significant relationship with 8^{th} grade students' science achievement; whereas, attitude toward science, attitude toward school, educational aspiration, and the language spoken at home showed non-significant relationship with 8th grade students' science achievement. Moreover, in terms of school level factors, school climate, school location, attendance at school and school resources showed significant relationship with science achievement of 8th grade students, whereas, teacher quality, class size, enrichment courses and grouping by ability showed non-significant relationship with science achievement of 8th grade students. Finally, in term of country-level factors, net enrollment secondary school and GDP on education showed significant relationship with science achievement; whereas, per capita income and purchasing power showed no significant relationship with science achievement of 8th grade students. Apart from this 3-level HLM analysis, 2-level HLM analysis was also performed to make cross country comparisons among these 29 countries. 2-level HLM analysis results showed that the greatest between-school variance was in Malaysia (62.07 %) and the lowest between-school variance was in South Korea (4.55 %). Variance in science achievement explained by student level factors was greatest in South Korea (32.52 %), and lowest in Thailand (6.11 %). Furthermore, variance in science achievement explained by school level variables was greatest in Jordan (65.42 %), and lowest in Italy (12.37 %).

Above the studies focusing on science education through the use of TIMSS data by performing HLM analysis were reviewed. Due to the nested data structure of TIMSS, HLM analyses are appropriate. In literature, there are several studies focusing on science achievement through the use of TIMSS data but by performing SEM or multiple linear regressions; which were reviewed below.

Korkmaz (2012) aimed to investigate the relationship between science achievement of 8th grade Turkish students and some selected factors like student centered activities (student responses), teacher centered activities (student responses), students' attitude toward science and students' need of science through the use of TIMSS 2007 data by using multiple regression analysis. The results of multiple regression analysis showed that all these predictors namely attitude toward science, student centered activities, teacher centered activities and need for science showed significant relationship with 8th grade Turkish students' science achievement.

Özdemir (2003) performed a study to reveal the selected factors related to science achievement of Turkish students through the use of TIMSS-R data by performing SEM (by LISREL Program). The factors investigated were namely student-centered classroom activities, teacher-centered classroom activities, SES, students' perceptions of success/failure in science, students' perception of enjoyment of science and students' perfection of importance of science success. SEM analysis results showed that the strongest relationship existed between SES and science achievement. Student-centered classroom activities showed a negative relationship with science achievement of Turkish students whereas, teacher-centered classroom activities showed a positive relationship. Moreover, a strong relationship between students' perception of success/failure in science and science achievement was found. Finally, non-significant relationship between students' enjoyment of science and science achievement of Turkish students was found.

One of the recent studies using TIMSS data (2007) and focusing on science education was performed to investigate the influences of Taiwanese students' perceived social relationship (PSR) on their affective (including positive attitude toward science and self-confidence in learning science) and cognitive (science achievement) learning outcomes by SEM using LISREL Program (Jen, Lee, Chien, Hsu & Chen, 2013). The analysis results of that study showed that PSR in science classes have positive effects on students' positive attitude toward science and self-confidence in learning science which are the affective learning outcomes. Moreover, further analysis showed that these two affective learning outcomes namely, positive attitude toward science and self-confidence in learning science also predicted science achievement of students; more specifically, these two affective components accounted for 17.0 % of the variance on science achievement of 8th grade Taiwanese students.

Bietenbeck (2011) investigated the relationship between teaching practices and student achievement through TIMSS 2007 4th and 8th grade United States data. Teaching practices are categorized as traditional teaching and modern teaching in that study. Traditional teaching variable was formed based on the student questionnaire items like memorizing science facts and principles, listening to the teacher's lecture style presentation and reading science textbooks. Moreover, modern teaching variable was formed based on the student questionnaire items like working in small groups on experiment and investigation, relating to daily life, giving explanations, designing or planning an experiment, making observations. While investigating the relationship between teaching practices and student achievement several student-level (gender, age, ethnicity related variables and number of books at home), teacher-level (gender, age, teaching experience and major field), and school-level (parental involvement, free lunch, and total student enrollment) variables were controlled. The results of the analysis showed that traditional teaching had a large positive effect on 4th and 8th grade students' achievement in United States whereas, modern teaching was found non-significant on student achievement.

Martin (2010) investigated the relationship between 8th grade students' science achievement and teacher preparedness and inquiry based instructional practices through TIMSS 2007 United State data. This study performed correlation analysis in order to investigate the relationship. Results showed that there is a positive relationship between students' science achievement and teachers' preparedness to teach science content and implementing inquiry-based instruction. Teacher questionnaire results were used for the teachers' preparedness to teach science content and teachers' implementing inquiry-based instruction. In this study in order to create inquiry-based instruction variable, nine experienced secondary science teachers participated in the study to identify items of TIMSS teacher questionnaire as inquiry-based and didactic. This study focused on two teacher level predictors which are teacher preparedness and inquiry-based instructions; which were not used in the present study as teacher level predictors. This study does not perform hierarchical linear modeling, which program was used to perform correlation analysis was not stated explicitly, but it is assumed that SPSS program was used to perform correlation analysis. Not using hierarchical linear modeling gives rise to omitting the nested nature of TIMSS data, which is a deficiency in statistical analysis.

Yaman (2004) performed a study to investigate the relationship between teacher characteristics and science achievement through the use of TIMSS 1999 8th grade Turkey data. Structural equation modeling (SEM) by LISREL Program was used in the analysis of the data. The latent variables used in that study were extent of the limitations in science class (disruptive students, uninterested students, and uninterested parents), assessment of the student work1 (multiple choice, standard test, and reasoning test), questions asked in science lessons (work on problems, relationship analyze, real world use, reasoning), assessment of the student work2 (observation, responses in class, project performance), and time spent on outside activities (parent meeting, student record update, student meeting, professional reading, and administrative tasks). SEM analysis results showed that there was a negative relationship between teacher beliefs about uninterested and distributive students and students' science achievement. Questions asked in science lessons like analyzing relationship, explaining reasoning and working on problems were found positively related to science achievement of Turkish students. Finally, students performed less science achievement if their teachers preferred student-centered learning activities.

2.3. Hierarchical Linear Modeling (HLM)

Hierarchical Linear Model (HLM) is also known as 'random coefficient model', 'variance component model', 'mixed models' or 'multilevel model' (Hox, 2010; and Snijder & Bosker, 2012). When the research focuses on the relationships between the variables characterizing individuals and the variables characterizing groups, it is generally called as multilevel research. In multilevel research, the data structure in population is hierarchical; therefore sample is drawn from a hierarchical population. In the same way, in educational research, the population includes schools and pupils in these schools (Hox, 2010); students are nested within classes and classes are nested within schools and even schools nested within districts (Mullis & Martin, 2013). In this situation, students within a cluster like class and/or school would share some similarities as they are in the same cluster. Various statistical techniques are used in analyzing TIMSS data, but due to its data structure, HLM is the most recommended and appropriate one to have accurate results (*Ibid*). In an educational research, levels might be pupil, class, teacher, school, and district. Although HLM can be used with more than two levels, 2-level models are the most common (Raudenbush, & Bryk, 2002).

2.4. Learning Outcomes in Science Education

The requirement to make the teaching and learning process more transparent and more explicit directs us to focus on the learning outcomes (Kennedy, 2012; and Bernholt, Eggert & Kulgemeyer, 2012). Learning outcomes can provide valid evidence about the effectiveness of science instruction and science education policies if they are concretized and clearly understood by teachers, students, school administrators, textbook writers and policy makers (Chiu, & Chen, 2012). Learning outcomes can be interpreted as a common tool that explains the curriculum at cantonal, national and international levels (Kennedy, 2012). The importance of learning outcomes is clear; which increases the importance of comprehending the framework of learning outcomes, correspondingly in the following part of this section, definition and purposes of learning outcomes were discussed before explaining learning outcomes in science education in different countries worldwide.

There are various learning outcome definitions in literature (Moon, 2002; Adam, 2004; Morss & Murray, 2005; and Kennedy, 2012), but these definitions do not differ deeply (Chiu & Chen, 2012). Although Adam (2004) states that it is originally based on Pavlov's conditioning of dogs, some researchers state that the development of learning outcome concept is linked to term "objective" through the mastery learning theory of Bloom; in which three domains of learning (cognitive, affective, and psychomotor) are identified (Kennedy, 2012; and Proitz, 2010). Yet, objectives, aims and learning outcomes are not same and should be distinguished. The aim is a general intention of a teacher in terms of the course, programme or module, whereas the objective is a specific intention of teacher. Aims clarify the general content and direction of the course, instruction or programme from the point view of teacher, whereas objectives clarify the specific areas that teacher intends to teach in the lesson. Moon (2004) and Adam (2004) explain the difference between aim and learning outcome by stating that aims focus on teaching and management of learning whereas learning outcomes focus on learning.

In literature, different definitions of learning outcomes exist. Otter (1992) states that learning outcome is "what a learner knows and/or can do as a result of learning" (pg. i). In a very similar way, some researchers define learning outcomes as "statements of what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning.", where the 'process of learning' could be lecture, lesson or a programme (Kennedy, Hayland, & Ryan, 2006, pg 5). Kennedy (2012) simply defines learning outcomes as clear statements of the expectations what students should achieve. On the contrary, some researchers state that learning outcomes are the achievements of the learner no matter what teacher intends to teach or expect from students or what the aim of module or course is (Adam, 2004; and Vlasceanu, Grunberg & Parlea, 2004).

Some researchers classify learning outcomes as cognitive and non-cognitive outcomes. Cognitive outcomes are knowledge outcomes and skills outcomes. Skills outcomes are based on "complex processes of thinking, such as verbal and quantitative reasoning, information processing, comprehension, analytic operations, critical thinking, problem-solving and evaluation of new ideas" (pg. 9), whereas knowledge outcomes involve remembering ideas, phenomena or materials (Nusche, 2008). Furthermore, non-cognitive outcomes include psychological development, attitudes, values and occupational competence (*Ibid*). Moreover, recent studies define learning outcomes in cognitive domain, affective domain and psychomotor domain (Kennedy, 2012). Cognitive domain includes demonstration of knowledge, comprehension, application, analysis, synthesis and evaluation. Affective domain includes integration of beliefs, ideas and attitudes. Finally psychomotor domain includes acquisition of physical skills. From a different perspective, knowledge perspective, the practice perspective and cognitive components are the three dimensions of learning outcomes. As a fundamental competence, knowledge perspective includes basic rote memory, recalling and drilling information. As an application competence, the practice perspective includes application of knowledge to the contexts related to science learning. Cognitive components includes both knowledge and practice, in which reasoning, argumentation, inquiry and modeling abilities are used to develop meaningful learning (Chiu & Chen, 2012). In the light of this review, learning outcomes can be interpreted as indicators for learning progress, efficiency in teaching, and policy making. Learning outcomes clarify whether there is a gap between idealism and reality (*Ibid*).

In addition to the differences in definition of learning outcomes, the aims of having learning outcomes at the system level also show variation amongst countries.

Learning outcomes are included into two main groups in terms of their purposes: tool for instructional planning and curriculum development and also tool for measurement of effectiveness and accountability (Proitz, 2010). Similarly, Ewell (2005) states that now learning outcomes are used as a measure of effectiveness of institution. Furthermore, improving competency model, developing standards of education and preparation for the nationwide examinations are the three common purposes of having learning outcomes amongst countries (Chiu & Chen, 2012). The purpose of the learning outcome can affect education system. With regard to preparation of nationwide examination purpose, in Austria, England, United States of America (Linn, 2000; McNeil, 2000; and Panizzon, 2012) and Turkey, teaching-to the test mentality as a result of high stakes assessment highly affects teacher and the classroom environment. Past questions can operationalize the learning rather than the learning outcomes stated in the curriculum (Millar, Whitehouse & Abrahams, 2012); which is a negative effect of preparation for the nationwide examination purpose.

There has been intensive research about learning outcomes specifically in science education. Australian Council for Educational Research (ACER, 2006, pg. 136) states that learning outcomes in science education includes

> scientific attitudes and habits of mind, skills of investigation, an understanding of the nature of science and its role in society, the capacity to use the literacies of science in learning and communicating about science, and the ability to apply understandings of science for decision making in their everyday lives taking account of the likely impact of those decisions on others and the environment.

National Research Council (2007, pg. 36) describes the four intertwined strands of learning outcomes in science; which are respectively (1) “to know, use, and interpret scientific explanations of the natural world”, (2) “to generate and evaluate scientific evidence and explanations”, (3) “to understand the nature and development of scientific knowledge” and (4) “to participate productively in scientific practices and discourse”. Definitions and functions of learning outcomes show variation amongst countries (Ayas, 2012) as a result of differences between cultures and societal expectations (Chiu & Chen, 2012), still scientific literacy is the common aim of science education in many countries (DeBoer, 2000; Roberts, 2007; Bernholt, Neumann, & Nentwig, 2012; Chiu & Chen, 2012; and Neuman, Bernholt & Nentwig, 2012). Some basic information about learning outcomes of different countries is stated below. Yet, learning outcomes in science domain in Turkey, England and Finland are explained in detail in this chapter in the following sections namely section 2.6 after explaining education systems of these three countries.

Countries' learning outcomes are different and yet similar at some points. In Germany, competencies including content and performance to develop deep understanding emphasized by long-term learning are learning outcomes (Bernholt, Neumann & Nentwig, 2012; Chui & Chen, 2012; Koller & Parchmann, 2012; and Neumann, Bernholt & Nentwig, 2012). There are no predefined learning outcomes in Finland in the national-level curriculum (Chui & Chen, 2012). Some researchers state that predefined learning outcomes can limit teachers' autonomy in teaching and learning process (Chui & Chen, 2012; and Lavonen, Krzywacki & Koistinen, 2012) and also learning outcomes cannot alone fully explain the qualities of the learner and the learning process (European Union, 2011); which might be the reason of no pre-defined learning outcomes in Finland at the national level. Contrary to no-pre-defined learning outcomes at the national level, the aims and goals of science education for teaching and learning are stated at the school-level education in Finland (Lavonen, Krzywacki & Koistinen, 2012; and Neumann, Bernholt, & Nentwig, 2012). Moreover, the Finnish National Board of Education's goals are very similar to the notion of competencies used by PISA (Neumann, Bernholt, & Nentwig, 2012). Acquisition term is used to state learning outcome in science education of Turkey in order to emphasize the student-centered nature of Turkish science curriculum (ERG, 2005). These acquisitions in science education in Turkey focus on knowledge, skills, affective components and science-technology-society environment (MoNE, 2013). Learning outcomes are framed by knowledge, abilities and attitudes in France (Chui & Chen, 2012; and Venturini & Tiberghien, 2012) moreover; Neumann, Bernholt, and Nentwig, (2012) state that expected learning outcomes are explained as competencies in France. Learning outcomes include knowledge, skills and understanding of how science works in England (Millar, Whitehouuse & Abrahams, 2012; and Neumann, Bernholt, & Nentwig, 2012). Learning outcomes are concerned mainly with skills, domains and levels in Switzerland (Chui & Chen, 2012; and Labudde, Nidegger, Adamina, & Gingins, 2012). Learning outcomes focus on scientific literacy in Holland (Bertona, 2012;

and Neumann, Bernholt & Nentwig, 2012). Scientific literacy and notion of competencies in terms of knowledge, practice and cognitive dimensions (specifically eight competencies) are emphasized in Taiwan's science education as learning outcomes (Chiu & Chen, 2012; and Neumann, Bernholt, & Nentwig, 2012). In Australia, learning outcomes are defined as students' cognitive, attitudinal and behavioral demonstrations (Australian Curriculum, Assessment and Certification Authorities (ACACA), 2008; and Chiu & Chen, 2012). To sum up, definitions and functions of learning outcomes in science education vary from country to country. Most of the countries clearly define science learning outcomes except Finland. In many countries scientific literacy is on the main focus.

This study made cross country comparisons between Turkey, Finland and England, therefore, in the next sections education systems and science education in these three countries were discussed in detail.

2.5. Education Systems in Turkey, Finland and England

This study performs a cross-country comparative study between Turkey, Finland and England. Therefore, it is better to understand the vital similarities and differences between these three countries. This section summarized the basic features of education systems in Turkey, Finland and England, moreover, next section specifically focused on science education in these three countries.

At system level, educational outcomes may differ due to the resources (e.g. economy) and structure of education systems (e.g. curriculum development and educational policies) (Martin, et al., 2012). In this section, brief information about economic resources among these three countries is stated in Table 2.1. Table 2.1 is created according to the UNESCO statistics (2014). As there is no separate data for England, the following information is given for United Kingdom.

Table 2.1 Educational Statistics for Turkey, Finland and United Kingdom

Statistics	**Turkey**	**Finland**	**United Kingdom**
Population (thousand)	73,997	5,408	62,783
Youth Literacy (%)	98,7	100	99
Primary School Enrolment (%)	94	98,8	99,8
Secondary School Enrolment (%)	82,1	92,4	94,6
Tertiary School Enrolment (%)	69,4	93,7	61,9
Budget in Education	$13,4 billion	€ 11.1 billion	£62.2 billion
Education Expenditure as % of Total Government Expenditure[a]	8,6 (2006)	12,2 (2011)	13,3 (2010)

Note. [a] Update data for Turkey is the year 2006, for Finland the year 2011 and for United Kingdom the year 2010

Economic resources provides countries the opportunity of having better educational facilities and higher number of well-trained teachers and school principals (Mullis, et al., 2009). Although there is a huge population difference between Turkey and Finland, the budget for education in these two countries is similar. In this respect, the above table states us that Turkish students most probably have less educational facilities than their counterparts in Finland and England as a result of low percentage of education expenditures.

2.5.1.Education System in Turkey

Turkish education system; which has highly centralized governance structure, is headed by Ministry of National Education (MoNE). In education system, the decision maker is MoNE hence schools and teachers and schools have little autonomy (Öztürk, 2011); which limit the immediate changes when required (OECD, 2013b). Below school days and lessons, class size, compulsory education, primary and lower-secondary education, and upper-secondary education in Turkey were explained in detail.

School days and lessons: Schools start in the mid of September and end in the mid of June. A school year must contain at least 180 days. Schools are open five days in a week from Monday to Friday. School day is commonly consisted of morning and afternoon sessions with a lunch break. Schools commonly start at 8.15 and end at 15.00. However, in crowded schools, school day may split into two bodies. Moreover, students need to wear the school uniform from primary school till the end of upper-secondary school.

Class Size: At primary and lower-secondary level, number of students per class on average is 29 in Turkey, however, there is a variation in between the regions in Turkey in terms of class size; for example, the average class size in Istanbul and Southeast Anatolia Region is 39 (the highest value) and in West Black Sea Region is 21 (the lowest value) according to the educational year of 2013/14 statistics (MoNE, 2014, pg. 20).

Compulsory Education: Compulsory education is free of charge in public schools. The length of compulsory education is increased from 8 years to 12 years in 2012 (OECD, 2013b). Compulsory education system is defined into 3 levels of education, which are primary, lower and upper secondary levels, of 4 years each. Therefore, this new system is called 4+4+4 System. Pre-primary or kinder garden education is not compulsory but on an optional basis, students in the age group of 3-5 can attend to pre-primary school education. State schools are free of charge. 13 % of pre-school students, 3.5 % of primary and lower-secondary school students attend to private schools (MoNE, 2014, pg. 77, 92, & 93).

Primary and Lower-Secondary Education: 5.5 years old students start with primary education which lasts in 4 years. Primary school curriculum includes life sciences, mathematics, Turkish and physical education, and lower-secondary education curriculum includes science and technology, mathematics, language, visual arts (MoNE, 2014). Constructivism is emphasized in the curriculum of all levels. Language of instruction is Turkish, and foreign language is taught from 2nd grade. At primary school level, there is one teacher for all subjects in the class, whereas, at secondary school level, there are separate subject teachers. According to 2013/14 school year statistics, there are around 5, 5 million students in each primary and also lower-secondary education (MoNE, 2014, pg. 13).

Upper-Secondary Education: In the upper-secondary level, which lasts in 4 years, there are different types of upper secondary schools; although there is no differentiation in primary and lower-secondary level schools. General Secondary Education and Vocational and Technical Secondary Education are the two different types of upper secondary schools. After completing lower-secondary school, students take upper secondary school entrance exam called TEOG in order to determine their upper secondary school. Students are academically selected and assigned into upper secondary schools based not only TEOG exam results but also pupils' previous achievement in lower-secondary school. TEOG exam result counts for 70 % and previous achievement in 6th, 7th and 8th grades counts for 30 % of the academic selection for the upper secondary education. According to 2013/14 school year statistics, there are around around 6 million students in upper secondary education (MoNE, 2014, pg. 13).

2.5.2.Education System in Finland

National school system in Finland began in 1866, and a Supervisory Board of Education was founded under Ministry of Education in 1869 in order to monitor and govern the school system in Finland. In this day and time, the Finnish National Board of Education (FNBE) is responsible for both general education and vocational education and training; moreover, the Ministry of Education is responsible for higher education (FNBE, nd). From pre-primary to higher education, education is free of charge; moreover, teaching materials, a warm meal every day, pupil health service and transportation are provided by education providers (e.g. municipalities). Quality, equity, efficiency, and internationalization are the key words in Finnish education policy. Finland uses international comparative studies like PISA, PIRLS, TIMSS, PIAAC, and TALIS to monitor its education system outcomes (FNBE, nd). Teaching is a popular occupation in Finland as teaching profession has a high status in Finland and also teachers have a high autonomy (FNBE, 2014c) due to decentralized system in Finland. Approximately 63500 teachers work in basic education, upper-secondary schools and also in adult education in Finland (FNBE, 2014b, pg. 1). Below school days and lessons, class size, compulsory education, primary and lower-secondary education, and upper-secondary education in Finland were explained in detail.

School days and lessons: Schools start in the mid of August and end in the beginning of June. A school year must contain 190 days. Schools are open five days in a week, and 19 to 30 lessons per week are instructed at schools based on level of education and number of elective subjects taken (FNBE, 2015). Finland is the third lowest country among OECD countries in terms of number of instruction hours in basic education (Kyrö, 2011). Moreover, teaching methods, as well as teaching materials e.g. course books are chosen by teachers often in cooperation with other teachers in Finland (FNBE, 2014c).

Class Size: No regulation for class size exists in Finland (FNBE, 2015). OECD (2011a) reports that average class size is lower than 20 pupils in basic education in Finland. Normally, classes are formed by the pupils at the same age, but in some cases when schools have small student population, then students with different ages may have education altogether (FNBE, 2015).

Compulsory Education: Compulsory education in Finland encompasses 10 years for students between 6-16 years old. Compulsory education starts with pre-primary education for 6 years-olds. Pre-primary education is free and compulsory from 2015, although it was still free but voluntary before August 2015 (FNBE, nd). After pre-primary education, basic education starts for 7 years-olds. Every student is allocated a nearby school depending on the home location but another school can be chosen with some restrictions. All schools introduce their own curricula within the framework of national core curriculum. There is no school selectivity at compulsory education level (*Ibid*).

Primary and Lower-Secondary Education: Basic education is a general name for primary and lower-secondary education in Finland. Basic education takes 9 years and first 6 years are taught by class teachers and last 3 years are taught by different subject teachers. Students at the age of 6 should start to basic education, but student can start one year later if only provided a certificate about students' readiness to start to school (FNBE, 2015). Students can attend public schools or private schools. Only 2 % of students in basic education attend to private education (FNBE, 2014a, pg.1).

Upper Secondary Education: Upper secondary school starts after 10 years-long compulsory education. Upper secondary education can be in two forms namely general or vocational upper secondary education, which takes 3 years. More than 40 % of students start vocational education which has technology, communications and transport as main fields. Grade point average in compulsory education is used to determine the selection of students for upper secondary schools. Ability in addition to awarded points for hobbies and relevant activities may also be used for school selection (FNBE, nd).

2.5.3.Education System in England

Department for Education (DfE) and Department for Business, Innovation and Skills (BIS) are responsible for education in England. Planning and monitoring education in schools are performed by DfE, on the other hand, science, innovation, skills, further and higher education are BIS's responsibility areas. Assessment is the area of responsibility of both teachers and Standards of Testing Agency (STA) (EURYDICE, 2011a). Below school days and lessons, class size, compulsory education, primary and lower-secondary education, and upper-secondary education in England were explained in detail.

School days and lessons: Schools generally start in early September and end in of July. A school year must contain 190 days. Schools are open five days in a week from Monday to Friday. Schools commonly start at around 09.00 and end at 15.00 or 16.00 based on the decision of the school. Minimum recommended lesson times per week range between 21 and 25 in a way that the older the pupils, the higher lesson times per week they have (EURYDICE, 2011a, pg. 4). Furthermore, many British schools have a uniform rule that students need to wear based on the schools' decisions.

Class Size: Class size for five to seven years old students can be maximum 30 (EURYDICE, 2011a, pg. 4). OECD (2011a) reports that average class size in United Kingdom is around 25 (pg.402).

Compulsory Education: Compulsory education starts with primary education when the pupils are 5 years old and continues till the end of secondary school. Students can attend to public or private schools. Public schools are free of charge.

Pre-primary education is not compulsory in England, but families can send their children a full-time or part-time pre-primary education till the age of 5 if they want to. Pre-primary education is free of charge for 3 and 4 years old pupils (EURYDICE, 2011a).

Primary Education: Primary education lasts 6 years, starting at the age of 5 and ends at the age of 11. Most of the primary schools are mix gender. There is no school selectivity for pupils at the primary education level; students can attend to primary school without any ability assessment. Generalist teachers teach at primary schools (EURYDICE, 2011a).

Secondary Education: Secondary education lasts 5 years, starting at the age of 11 and ending at the age of 16. Most of the secondary schools do not select students based on academic ability; still some grammar schools are selective. Specialist teachers teach at secondary schools. Many secondary schools also provide education for the students aged 16 to 18 as a part of post-compulsory education; which can also be called upper-secondary education (EURYDICE, 2011a).

2.6. Science Education in Turkey, Finland and England

Science affects our world, daily work and everyday experiences (Neuman, Bernholt, & Nentwig, 2012). Therefore, preparing individuals to develop a certain level of understanding of science is the mission of science education as a part of formal education (Wang & Schmidt, 2001) and also an education goal of countries around the world (Mullis, et al., 2009). Understanding science as well as mathematics set ground for participation in society effectively and also for taking informed decisions for personal health, future educational endeavors and workforce (*Ibid*). Science education is required because it provides a basis for the world's future welfare (Department for Education, 2014b) and especially in the early grades it is required because students at young ages have a natural curiosity about the world and their place in it (Mullis, et al., 2009). Science education should continue in years in a systematic way hence individuals can understand the power of rational explanation (Department for Education, 2013), distinguish facts from fiction and can make appropriate decisions when they face with situations related to treatment of diseases, global warming, and applications of technology (Mullis, et al., 2009).

Based upon these explanations, it is clear that science education plays a vital role in individual's life, moreover, we should not underestimate the importance of school science which has the responsibility and aim to educate scientists of next generation (Tytler & Osborne, 2012).

Before comparing and contrasting Turkey, Finland and England in terms of the student- and teacher-characteristics associated with their science achievement and attitude toward science, some general information about their science education is summarized in Table 2.2 to have a general picture about the Turkey's, Finland's, and England's science education at the system level. Table 2.2 is created according to the information retrieved from curriculums of these three countries (Department for Education, 2014b; FNBE, 2004a; Ministry of Education, 2006; MoNE, 2013) and also according to the TIMSS reports written by the authorities in Turkey, Finland and England (Kuppari & Vettenranta, 2012; Rowe, 2012; Tasar, Aztekin, Arifoglu, 2012).

Table 2.2 Structures of Science Education Systems in Turkey, England and Finland

Characteristics	Turkey	Finland	England
Science Curriculum	National	National Core + Local curriculum	National + School curriculum
Vision/aims of Science Education	developing scientifically literate citizens regardless of their individual differences	ensuring quality, efficiency and equality in education	-developing scientific knowledge and conceptual understanding, -understanding of the nature, processes and methods of science -understanding of the uses and implications of science today and for the future
Learning Outcomes	-Scientific Knowledge -Skills -Affective Components -Science- Technology-Society-Environment	No predefined learning outcomes at national level	-Knowledge, -Skills and -Understanding of how science works (NOS) -Attitude
Emphasized in Curriculum	-Scientific Literacy -Constructivism	-Equity -Safety at school and home	Scientific Inquiry
Science Course at 8th Grade	Single subject	Separate subjects	Single subject
Minumum Teacher Education	Bachelor	Master	Bachelor

Before giving detailed information about each countries' science education system, it would be better to give an overview about goals and objectives, instructional methods and processes, materials and assessment methods and activities in 8th grade science curricula of Turkey, England and Finland. In science curricula, goals and objectives are prescribed for all three countries, whereas instructional methods and processes as well as materials for science lessons are not prescribed in England and Finland but prescribed in Turkey curriculum. Assessment methods and activities are prescribed in Finland and Turkey curriculums unlike England curriculum (Mullis et al., 2012a, 2012b).

In the following part, science education curriculums of Turkey, Finland and England are summarized in terms of aims and/or visions, learning outcomes, content and latest revisions.

2.6.1.Science Education in Turkey

In Turkey, the Ministry of National Education (MoNE) is responsible for all steps of educational and training services and activities (Tasar, Aztekin, Arifoglu, 2012). The compulsory education is 12 years including primary, lower and upper secondary education since 2012 (OECD, 2013b).

Starting from the early days of foundation of Republic of Turkey, the basic framework of education, which consists of three main components namely basic education, secondary education and tertiary education (Ayas, 2012), and the general structure of education (Ayas, 2012; MoNE, 2005; and OECD, 2007) have remained basically same even though there has occurred several changes in education system. After 2000s, the curriculum is revised after needs analysis according to the innovations in technology, subject field, educational sciences, and European standards; moreover, the Turkish science curriculum has been under renovation science 2004 in terms of curricula's philosophy and methods of assessment (Ayas, 2012). In the new science curriculum, constructivist approach is emphasized rather than behaviorist approach by emphasizing student centered learning (MoNE, 2005).

When science curriculum in primary and lower secondary grades is examined, it is clearly observed that in Grades 1-3 "Knowledge of Life" is taught by general classroom teachers, whereas in Grades 4-8 "Science and Technology" course is taught by science specialist teachers. The vision of Science and Technology course is to develop scientifically literate citizens regardless of their individual differences (MoNE, 2005, 2013). Furthermore, learning outcomes are emphasized in the science curriculum of Turkey. Learning outcomes are defined as acquisitions in science education in Turkey (ERG, 2005). Table 2.3 summarizes the acquisitions in science education.

Table 2.3 Learning Outcomes in Turkey

Knowledge	Skills	Affective Components	Science- Technology-Society-Environment
Biology	Scientific Process Skills	Attitude	Socio-Scientific Issues
Chemistry	Life Skills	Motivation	Nature of Science
Physics		Values	Relationship between science and technology
Earth Science		Responsibilities	Social contribution of science
			Sustainable development consciousness
			Science and career consciousness

Note. Retrieved from "Fen bilimleri dersi öğretim programı (3, 4, 5, 6, 7, ve 8. sınıflar)" by MoNE, 2013, pg. 1

Acquisitions in science education are designed taking account of the relationship between scientific knowledge, skills (scientific process skills and life skills), affective components (attitude, motivation, values and responsibilities), and science-technology-society-environment (MoNE, 2013). As clear these learning areas include cognitive and affective dimensions.

Skills include scientific process skills and life skills. Scientific process skills are the skills that scientists use during their studies like observing, measuring, classifying, data recording, hypothesizing, data using, setting a model, controlling and changing variables, and performing an experience. Life skills are the basic skills required while reaching and using scientific knowledge like analytical thinking, decision making, creativity, entrepreneurship, communication and group work (MoNE, 2013).

Affective components are attitude, motivation, values and responsibility. Attitude includes developing positive attitude toward science and liking to learn science. Motivation includes being enthusiastic about science studies and showing voluntary participation to science studies. Value includes giving value to the researches in science and to the contributions of these science researches on the relationship between technology-society-environment and daily life. Responsibility includes feeling responsible to develop scientific knowledge by realizing how important to develop scientific knowledge for him/her and other individuals in society (MoNE, 2013).

Science- Technology-Society-Environment includes socio-scientific issues, nature of science, relationship between science and technology, social contribution of science, sustainable development consciousness, and science and career consciousness. Socio-scientific issues include scientific and moral reasoning skills about solving socio-scientific problems related to science and technology. Nature of science includes understanding what science is, how and why scientific knowledge is constituted, scientific processes, scientific knowledge can change in time, and how scientific knowledge can be used in new studies/researches. Relationship between science and technology includes understanding the interaction of science and technology, and contributions of this interaction. Social contribution of science includes understanding the contributions of scientific knowledge on society development and solving social problems. Sustainable development consciousness includes raising the consciousness on using natural resources economically to enable next generations to meet their needs and on advantages of using natural resources economically on individual, economic and social aspects. Science and career consciousness includes raising consciousness about the science related careers and the contribution of these science related careers on developing scientific knowledge (MoNE, 2013).

Science teachers should hold minimum bachelor degree to teach science in Turkey.

2.6.2.Science Education in Finland

Quality, efficiency, and equality are the building stones of Finnish education and science policy (Ministry of Education, 2006). Offering equal education to all citizens regardless of their nationality, mother tongue and socio-economic situation is the main objective of Finnish education policy. National core curriculum which includes basic objectives and contents on instruction is prepared by The National Board of Education and then local curricula based on this national core curriculum are prepared by municipalities (Kuppari & Vettenranta, 2012; and Mullis, et al., 2012a). There are no predefined learning outcomes in Finland in the national-level curriculum (Chui & Chen, 2012) as some researchers state that predefined learning outcomes can limit teachers' autonomy in teaching and learning process (Chui & Chen, 2012; and Lavonen, Krzywacki & Koistinen, 2012). Although learning outcomes are not predefined, the aims and goals of science education for teaching and learning are stated clearly at the school-level education (Lavonen, Krzywacki & Koistinen, 2012; and Neumann, Bernholt, & Nentwig). Moreover, the Finnish National Board of Education goals are very similar to the notion of competencies used by PISA (Neumann, Bernholt, & Nentwig, 2012).

In the primary school (1-4 Grade levels), 'Environmental and Natural Studies' course is taught to students as a science course. Safety at school and home (e.g. preventing bullying and violence, accidents at home …etc.) is specifically emphasized in the science curriculum of Finland. In the lower secondary school, science is taught as separate subjects of biology, geography, physics, chemistry and health (Mullis, et al., 2012a). In addition to these science courses in primary and lower secondary school, there are also cross-curricular themes. Growth as a person, cultural identity and internationalism, media skills and communication, participatory citizenship and entrepreneurship, responsibility for the environment, well-being, and a sustainable future, safety and traffic and finally technology and the individual are the cross-curricular themes stated in the national core curricula (FNBE, 2004a). Both cognitive and affective dimensions e.g. attitude and motivation are emphasized in the science curriculum of Finland (FNBE, 2004b). Moreover, LUMA program was carried out in order to develop mathematics and science education and improve the motivation of teachers and students through the integration of mathematics, science and information technology in between the years 1996 and 2002 (LUMA, 2004).

In Finland, science education teachers must have minimum master degree (Lavonen, 2013) unlike Turkey and England where only bachelor degree is enough for teachers to teach science.

2.6.3.Science Education in England

The Department for Education is responsible for development and implementation of science curriculum which is a national curriculum at all grades (Rowe, 2012), moreover, based on this national curriculum every state-funded school must offer a school curriculum (Department for Education, 2013). The aim of science education in England is to "develop scientific knowledge and conceptual understanding … understanding of the nature, processes and methods of science to answer scientific questions about the world around them … understanding of the uses and implications of science today and for the future" (*Ibid*, pg. 56). In science curriculum, scientific inquiry is the attainment target and the main content includes life processes and living things, materials and their properties and also physical processes. In 2007, review of curriculum is performed and new curriculum is introduced to grade 7 students with the beginning of 2008 school year. Key concepts, key processes, range and content of the curriculum and finally curriculum opportunities are stated clearly in the new science curriculum. "Scientific thinking, applications and implications of science, cultural understanding and collaboration" are emphasized as key concepts, "practical and inquiry skills, critical understanding of evidence and communication" are emphasized as key processes, "energy, electricity and forces, chemical and material behavior, organisms, behavior and health, the environment, earth and the universe" are emphasized as range and content and finally students opportunities to enhance their learning with concepts, processes and content are the curriculum opportunities stated in the new science curriculum (Rowe, 2012, pg. 280).

Knowledge, skills and understanding of how science works are the learning outcomes which are stated in science curriculum in England (Millar, Whitehouse & Abrahams, 2012; and Neumann, Bernholt, & Nentwig, 2012). Furthermore, in the science curriculum of England, it is stated that scientific attitudes, experimental skills and investigations, analysis and evaluation and finally measurement should be taught to pupils as a part of working scientifically (Department for Education, 2013).

Science teachers should have minimum bachelor degree to teach science in England.

Although either country has different science education, three of them emphasize developing students' science achievement and attitude toward science. This study focuses on science achievement and attitude toward science as learning outcomes. Therefore, in the next sections, the student and teacher characteristics affecting students' science achievement and also attitude toward science were explained.

2.7.Student- and Teacher-Level Characteristics on Students' Science Achievement and Attitude toward Science

2.7.1. Student-Level Characteristics

In the present study, gender, home educational resources, parental involvement, time spent on homework, and students bullied at school were investigated under student level characteristics. This section described these student level variables' relationship with science achievement and attitude toward science. Moreover, other student level variables which were found to have an effect on student learning outcomes in literature but were not included to the conceptual model of the present study were also discussed in other variables section. The student-level variables explained in other variables section were not included to the conceptual model of this study as TIMSS 2011 did not collect any data about these variables or it is thought these variables are not appropriate for the theoretical framework of the study.

2.7.1.1. Gender

Studies started to focus on gender (or sex which is the term used in previous studies) in the mid-1970s (Gill, 2013). Some studies state that there is no gender difference in terms of science achievement (Greenfield, 1996). On the contrary to the studies stating no impact of gender on achievement, some researchers indicate that gender has a relationship with achievement. Gender significantly correlates with academic performance (Furnham, Chamorro-Premuzic & McDougall, 2002) and relates to science as well as mathematics achievement (Mullis, et al., 2009). Similarly, Rosier (1990) states that abilities and interests related to science outcomes are often influenced by students' gender, yet, studies investigating the relationship between gender and science learning outcomes show varying results. Commonly, it is stated that boys outperform girls in science domain (DeBacker, & Nelson, 2000, Dimitrov, 1999; Jovanovich & King, 1998; and Kahle, 2004). According to DeBacker and Nelson (2000), boys outperform girls on perceived ability and stereotyped views of science in the study focusing on gender differences with 242 high school students. Yet another study, Dimitrov (1999) focused on the gender differences specifically between high, medium and low achievers in science. In this study, researcher found that although there is no gender difference in science achievement for low achiever and medium achiever students, gender difference occurs between high achievers, to make it clear, high achiever boys perform better science performance than high achiever girls. Similarly, studies focused on very high performers in Olympiads and competitions of specific prizes show that boys are more likely to be the winners (Ellison & Swanson, 2009). Some researchers state that gender differences in science achievement differs from country to country (Martin, et al., 2012).

Some studies state that results in terms of gender differences may vary depending on the grade level (Greenfield, 1996 and Kahle, 2004) or on the area of interest. For example, male students may outperform girls in science or mathematics area but when the area is reading, this pattern may change. PIRLS studies consistently found the result that 4th grade female students have a higher reading achievement than male students in most of the countries (Mullis, Martin, Foy & Drucker, 2012).

Current studies focusing on gender differences in performance state that the performance difference between male and female students is small and also less than the performance difference related to home background factors (Coley, 2001; Hattie, 2012; and McGraw, Lubienski, & Strutchens, 2006). Furthermore, the similarity in terms of science and mathematics capabilities between male and female students is higher than the difference of capabilities between male and female students (Hyde & Linn, 2006). Recent meta-analysis studies show that the effect of gender on students' academic achievement is low (0.12 effect size) (Hattie, 2012, p. 256).

In addition to achievement, gender is one of the most significant variables affecting students' attitude toward science (Brotman & Moore, 2008; Dawson, 2000; Gardner, 1975; Murphy & Whitelegg, 2006; and Schibeci, 1984). Recent studies emphasize the gender difference in attitude toward science although there are some studies stating that there is few gender differences in terms of attitude toward science (Greenfield, 1996) or no gender differences in terms of attitude toward science (Morrell & Lederman, 1998). Recent studies focusing on gender differences in attitude toward science show different results. There are some studies stating that boys have more positive attitude toward science than girls (Haste, 2004; and Jones, Howe & Rua, 2000); whereas, there are some studies stating that, overall, girls have more positive towards science than boys (Kerr & Murphy, 2012; and Murphy & Beggs, 2003). It is clear that there is no consensus about the relationship between gender and attitude toward science as well as science achievement.

Based on the above literature review, it is clear that there is no consensus about the relationship between gender and attitude toward science as well as science achievement. It is also important to investigate the possible reasons behind gender differences in science achievement and attitude toward science. The reasons of performance differences between girls and boys arise from teachers as a result of gender biases (Greenfield, 1996; and Kahle, Parker, Rennie & Riley, 1993), society as a result of cultural stereotypes (DeBacker & Nelson, 2000), students as a result of different cognitive abilities (Spelke, 2005). Moreover, Jacobi, Wittreich and Houge

(2003) state that parents' beliefs on gender roles in science also influence students' attitudes towards science in addition to their science achievement.

2.7.1.2. Home Educational Resources

Students come to learning environment from different home backgrounds. In literature there is a wide research emphasizing the importance of home background factors (e.g. socioeconomic status, parents' education level, migration background and language spoken at home) on students' achievement both in science and mathematics domain. Important home background factors are number of books in the home, availability of a computer and internet connection as well as study desk which can enhance students' learning opportunity at home (Mullis, et al., 2012). Majority of home background or SES studies have focused only on the economic factors however in addition to economic factors, parental occupation and education are also important dimensions of home educational resources and good predictors of academic achievement (Brooks-Gunn, Han, & Waldfogel, 2010; and Magnuson, 2007).

The effect of home educational resources is assessed under different names like economic, social, and cultural status (ESCS) in PISA studies and socio-economic status (SES) in many different studies. Many of the studies state that SES of students correlates with the academic achievement of students (Bradley & Corwyn, 2002; Duncan, Ziol-Guest, & Kalil, 2010; Farooq, Chaudhry, Shafiq & Berhanu, 2011; Sirin, 2005; and Willms, 2006) and correlates with the educational attainment of students (Haveman & Wolfe, 2008). Across OECD countries, there is a high performance difference between socio-economically advantaged students and less-advantaged students and also between the students who are attending to socio economically advantaged schools and socio-economically disadvantaged schools (OECD, 2013a). SES of schools and students seem like having a strong influence on students' learning outcomes (OECD, 2013a; Dincer & Uysal, 2009; and World Bank, 2011) as schools generally tend to nurture existing patterns of socio-economic status rather than creating more equitable environment for students having both socio economically advantaged or disadvantaged backgrounds (OECD, 2013a). Recent meta-analysis studies focusing on home background factors and students' achievement show that the effect size of socio-economic status is 0.52, which means that home educational resources has a medium influence on students' academic achievement (Hattie, 2012, pg. 252). Furthermore, apart from academic achievement, having home backgrounds supportive of learning enhance students' attitudes toward learning (Mullis, et al., 2012).

2.7.1.3. Parental Involvement

Parental involvement is a broad topic that can be divided into several different types like providing supportive learning environment for children including health, safety and well-being at home, school-home communication, getting involved in school events, visiting the child's classroom, supporting children's learning activities like helping with homework, involvement in schools' decision making, advocate and governance procedures, and involvement in family collaboration for supporting children's further learning (Epstein, 1986; and LaRocque, Kleiman & Darling, 2011).

Parental involvement is one of the key factors affecting students' learning outcomes (Lee & Bowen, 2006). Parents play teacher, supporter, advocate and decision-maker role in their children's learning process and school lives, therefore, parents' effect on students' learning outcomes is non-ignorable. Lyons (2006) states that there is a positive relationship between students' participation in science (for example choosing science for further education) and the supportive nature of their parents toward science education. Some studies state that parents and teachers influence students' school subject selection decision (which is related to students' attitude toward science) (Haeusler & Kay, 1997). The cooperation between school principals, teachers and parents influence the success of a school and also the academic achievement of students (National Education Association, 2008). Furthermore, parents affect children's academic achievement by being involved in the education process like helping with the homework (LaRocque, Kleiman & Darling, 2011).

One of the characteristics of high achievement gain schools is to provide strong parental involvement programs (Brophy, 1988). Parental involvement positively affects students' academic achievement by helping them to attain academic skills, developing their motivation (Grolnick & Slowiaczek, 1994) and by improving students' academic self-concepts and school behaviors (Sanders, 1998). Moreover, there are more studies revealing the positive relationship between parental involvement and students' motivation (Fan & Williams, 2010). Parental involvement increases students' academic performance (Dearing, Kreider, & Weiss, 2008; LaRocque, Kleiman & Darling, 2011; and Mullis, Martin, Foy & Drucker, 2012) and overall attitude toward school (Dearing, Kreider & Weiss, 2008). Meta-analysis studies show that parental involvement has a positive effect on students' achievement both in elementary school (Jeynes, 2005) and middle school levels (Hill & Tyson, 2009; Jeynes, 2007). Moreover, Hattie (2012) makes a broad meta-analysis study by using pre-meta-analysis studies. Recent meta-analysis study of Hattie (2012) states that effect size of parental involvement on students' academic achievement is 0.49; which means that parental involvement has a medium effect on students' academic achievement.

2.7.1.4. Time Spent on Homework

Homework is an important factor investigated by researchers to see the effect on students' learning outcomes. Homework can be perceived as a tool that teachers use to extend instruction and also to assess students' learning (Martin, et al., 2012). Some studies indicate a positive relationship between time spent on homework and academic achievement of students. Holmes and Croll (1989) states that more time spent on homework is associated with higher examination scores based on their study performed in a single-sex grammer school with 79 male students. Similarly, McMullen (2010) states that increasing the homework time will positively affect students' achievement and also the performance of low-achieving students in low-performing schools. Furthermore, Maltese, Tai, and Fan (2012) performed more detailed study to reveal the relationship between time spent on homework and final course grades as well as standardized test scores in science and mathematics domain by using a longitudinal data. This study results indicates a strong positive relationship between time spent on homework and standardized test scores whereas no consistent relationship between time spent on homework and final course grades is found (*Ibid*). Moreover, Cooper, Robinson and Patall (2006) performed a meta-analysis study about the research conducted in United States from 1987 till 2003. The results of this meta-analysis study show that most of the studies focusing on the relationship between homework and student achievement indicate a positive correlation although still some of the studies indicate a negative correlation (*Ibid*). Recent meta-analysis studies show that the effect of homework on students' academic achievement is medium (0.29 effect size) (Hattie, 2012, pg. 253). In the meta-analysis study of Hattie, it should be understood that this study does not specifically focus on time spent on homework. Although there are a number of studies stating that the time spent on homework significantly affects academic achievement; a recent study having a representative sample of 9^{th} and 10^{th} grade 3,483 students in Germany states that time spent on homework is not related to school achievement after gender, prior achievement and cognitive abilities are controlled (Dettmers, Trautwein, Lüdtke, Kunter & Baumert, 2010).

Literature review on the relationship between the time spent on homework and academic achievement suggests that there is no strong consensus with regard to the study findings. Some studies state that the relationship between students' achievement and time spent on homework is unclear (Martin, et al., 2012; Mullis, et al., 2009; and Trautwein & Köller, 2003). There might be two reasons for this unclear relationship. Firstly, some teachers give homework only to the low-performing students (Martin, et al., 2012; and Trautwein, 2007) to keep the balance between higher achieving and lower achieving students. Secondly, higher performing students may have higher motivation to do homework and finish it in a shorter time compared to lower achieving students. Furthermore, prior knowledge can play an important role in homework finishing time as well as motivation. Therefore, only assessing the effect of homework time may not be a good indicator of students' science achievement and attitude toward science (Trautwein, Luedtke, Kastens, & Koeller, 2006; and Trautwein, 2007).

2.7.1.5. Students Bullied at School

One of the characteristics of strong achievement gain schools is having safe and orderly school climate (Brophy, 1988). When pupils start to school, they start to spend less time with their family members, but start to spend more time with nonfamily members like school friends and teachers. Therefore, the influence of family seems to decrease and the influences of environment and school seem to increase (Liljeberg, Eklund, Fritz & Klinteberg, 2011); which can increase the probability of the fact that friendships can affect students' academic and social outcomes (Veronneau & Dishion, 2011).

The sense of security in terms of both student and teacher safety can ensure a stable learning environment for students. A safe school environment is essential in students' academic achievement (Mullis, et al., 2012), hence bullying has a negative impact on students' academic achievement (Martin, et al., 2012 and Mullis, et al., 2012).

Bullying is an intentionally hurting behavior either physically or emotionally, repeated over time, by an individual or group. Bullying mainly occurs because of prejudice against particular groups of different race, religion, gender, and sexual orientation (Department for Education, 2014a).

PIRLS results show that students reporting more frequent bullying had lower reading achievement than students in safe and orderly schools (Mullis, Martin, Foy & Drucker, 2012). Yet, another study held in Jamaica, aiming to show the relationship between academic achievement and violence experience shows that students who faced the high levels of violence performed the lowest achievement (Baker-Henningham, Meeks-Gardner, Chang, & Walker, 2009). In addition to facing violence problems, whether students face rejection-related actions at school is another important dimension of bullying at school. Peer rejection is how disliked a student by group members (other students) (Ladd, 2005). Peer rejection can lead to externalizing (e.g. classroom disruptiveness, hyperactivity, and delinquent behavior) or/and internalizing problems (e.g. anxiety and depression) (Ladd, 2006) and also school avoidance of students (Ladd, Kochenderfer, & Coleman, 1997) as well as dropping out of school, truancy, and underachievement (Ladd, 2005), deprived involvement in learning activities, and reduced classroom participation (Buhs & Ladd, 2001), and negative self-perception (Boivin & Begin, 1989); which in turn related with students' engagement to learning process and achievement (Ladd, 2013). Therefore, peer rejection, violence (from peers) can play an important role in students' learning process. Peer rejection shows relationship with underachievement

(Buhs & Ladd, 2001; and Buhs, Ladd, & Herald, 2006). Hattie (2012) states that peer influence has a medium influence (0.53 effect size) on students' achievement (pg. 256) according to his meta-analysis study. Furthermore, results of one of the recent studies, in which TIMSS 2011 4th and 8th grade data and PIRLS 2011 4th grade data were used, show that students who are frequently bullied at school are more likely to demonstrate poor science, mathematics and reading achievement in most of the participating countries (Kaur et al., 2014). Moreover, in literature it is also stated that, students are more likely to have negative attitudes when they face higher levels of discord with their classroom mates (Ladd, Kochenderfer & Coleman, 1997).

2.7.1.6. Other Student-Level Characteristics

In this section, other student-level variables affecting students' science achievement and attitude toward science are explained in detail. However, these variables explained as other student-level characteristics were not included to the model of the present study, as TIMSS 2011 did not collect any data about these variables or it is thought these variables are not appropriate for the theoretical framework of the study.

Immigrant background is one of the student-level factors affecting students' learning outcomes. In terms of equity concerns, immigrant background plays an important role in individuals' education life as cultural, ethnic and especially language differences may create differences between immigrant and non-immigrant students. Immigrant students face the problems occurring due to having instruction in a language different from the language spoken at home, and getting involved in a new environment, new culture which thereby affect students' learning outcomes (Schmid, 2001). Students having immigrant background show significantly lower performance than students having non-immigrant background in science and mathematics even after accounting socio-economic status (Guldemond, Hofman & Hofman, 2004; and OECD, 2013a).

Entry to the school is one of the student-level factors studied by researchers to investigate whether it has an effect on students' learning outcomes or not. Entry to the school includes whether students had early parenting practices, preprimary education and/or preschool preparation (Tayler, 2013). Preprimary education is one of the essentials in countries' education policies. In some countries like Austria, Holland, and Hungary, the preprimary education is mandatory. In some countries like Australia, Crotia, and Singapore, the preprimary school enrolment is almost 100 % although the preprimary school enrollment is not mandatory. Moreover, the other countries are working on to increase the enrollment in preprimary school (Mullis, Martin, Foy & Drucker, 2012). Early entry to the school has a long-term positive influence on students' cognitive and as well as social development (Tayler, 2013). Across OECD countries, students attended to pre-primary school for more than one year performed significantly higher than the students who had not attended pre-primary education (OECD, 2014c) before and after socio-economic status of the students are controlled (OECD, 2010). Especially for disadvantaged students, attending preschool education is expected to increase educational opportunities as students are able to spent longer period in educational programs (Deming & Dynarski, 2008; Havnes & Mogstad, 2010; and SCCRE, 2014). Similarly, studies show that students having intensive preschool experience show higher achievement performance on standardized tests as well as higher graduation rates, and high levels of employment (Campbell & Ramey, 1995; and Reynolds & Temple, 2008). PIRLS 2006 analysis results show that there was a positive relationship between the years of preprimary education and 4th grade students reading performance (Mullis, Martin, Foy & Drucker, 2012). Moreover, some meta-analysis studies show that preschool education has a positive and long-term effect on school readiness (Reynolds & Temple, 2008) and cognitive development (Camilli, Vargas, Ryan & Barnett, 2010; and Reynolds & Temple, 2008). Recent meta-analysis studies focusing on the effect of preschool programs on students' learning show that the effect size of preschool programs is 0.45, which means that preschool programs has a medium effect on students' learning (Hattie, 2012, pg. 252).

Yet another factor studied by researchers to reveal the possible effects on students' learning outcomes is student engagement. Studies related to student engagement have started to appear in literature since 1980s. Student engagement is the students' participation in learning activities offered as a part of school program (Mosher & MacGowan, 1985). Recent studies state that student engagement refers to the students' motivation to learn, students' efforts, interests, making homework, attitudes toward the school experiences and/or attending extracurricular activities (Ackerman, 2013). Therefore, student engagement can be used in understanding school dropouts and school graduation with sufficient academic background (Reschly & Christenson, 2006). Student engagement is a complex variable which is affected by teacher behaviors, family characteristics, school and curricular characteristics (Ackerman, 2013; and Mosher & MacGowan, 1985).

Engagement affects students' academic achievement, social and emotional learning outcomes (Klem & Connell, 2004; and Mosher & MacGowan, 1985). Moreover, the relationship between student engagement and academic achievement appear to be reciprocal (Skinner & Belmont, 1993), so it is more appropriate to improve students' engagement and achievement simultaneously rather than focusing only on achievement or engagement (Ackerman, 2013). Furthermore, high levels of student engagement are associated with higher attendance to lessons and higher levels of academic performance (Klem & Connell, 2004).

In literature there are some studies investigating the relationship between parents' educational expectations and students' learning outcomes. There is a positive relationship between parents' educational expectations and students' academic achievement (Hong & Ho, 2005; Martin, et al., 2012; and Mullis, Martin, Foy & Drucker, 2012). PIRLS 2011 results state that there is 80 score points difference in reading between the students whose parents expected a postgraduate degree and upper secondary school graduation (Mullis, Martin, Foy & Drucker, 2012). According to longitudinal study performed by Hong & Ho (2005) in United States, more communication between parents and students as well as higher aspirations of parents give rise to higher student performance. Same study also compares 4 ethnic groups and results show that across these four ethnic groups, parents' educational aspiration is the most powerful predictor on students' own educational expectations which ultimately increase the student achievement (*Ibid*).

In addition to parents' educational expectations, students' educational expectation is one of the factors which is in the focus of researchers to reveal its effect on students' learning outcomes. Students' educational expectations are associated with education outcomes including academic achievement (Zhang, 2012).

Eccles and Wigfield (2002) state that students' expectations are closely related to students' academic performance. In the study performed in Taiwan with the longitudinal nationwide data, the results show that students with high educational expectations and efforts show higher performance than the students with low educational expectations and efforts. Students' educational expectations accounted for a moderate variance in students' academic achievement (Liu, Cheng, Chen & Wu, 2009). Some studies state that the relationship between achievement and students' educational expectations is reciprocal (Bui, 2007; and Sanders, Field & Diego, 2001). In this reciprocal relationship, the impact of school achievement on students' educational expectations is stronger than the opposite direction (Bui, 2007). Recent meta-analysis study results show that students' expectation is the variable having the highest influence on students' academic achievement among student-, teacher-, school-, and curriculum- level variables. Hattie (2012) makes a meta-analysis study in which he focuses on more than 60 thousand studies and 913 meta-analysis studies in student-, teacher-, home-, school-, curricula- and teaching-levels. According to this meta-analysis study, findings show that student expectation has the highest effect size on students' achievement among all other variables from student-, teacher-, school-, home-, teaching-, and curriculum-level variables. In this study, the effect size of student expectation on student achievement is 1.44; which means that student expectation has a very high influence on student achievement (*Ibid*).

Personality is another factor studied by researchers to reveal the effects on students' learning outcomes. Personality is an important predictor variable in students' academic achievement like exam scores, course grades and college GPA (O'Connor & Paunonen, 2007). Personality traits affect students' academic achievement through motivation, self-regulation, classroom behaviors (Komarraju, 2013). 'Big Five' theory of personality explains the personality traits which are conscientiousness, openness, agreeableness, extraversion, and neuroticism (*Ibid*). Conscientiousness is the strongest predictor of academic achievement within the Big Five personality traits (Furnham, Chamorro-Premuzic, & McDougall, 2002; and Conard, 2006). However, in literature there are other studies emphasizing the importance of other personality traits like openness and agreeableness on students' academic achievement. Conscientiousness, openness and agreeableness were found correlated positively with academic achievement whereas neuroticism was found negatively related with academic achievement in the study performed in Estonia in many grades by Laidra, Pullmann, and Allik (2007). Moreover, Furnham, Chamorro, and McDougall (2002) states that conscientiousness positively relates to academic performance whereas extraversion negatively relates to academic performance by their study which was carried with 93 British university students. To sum up, overall effect of personality on students' academic performance is non-ignorable. Meta-analysis studies show that the effect size of personality on students' achievement is low (Hattie, 2012). Apart from the effect on academic achievement, some studies state that personality as well as gender, structural and curriculum variables influence students' attitudes toward science (Osborne, Simon & Collins, 2003).

Some researchers studied the relationship between prior achievement and students' learning outcomes. Prior achievement is an important factor affecting students' achievement (Huitt, Huitt, Monetti & Hummel, 2009). Prior knowledge of students is significantly related to the overall science achievement of students (Lawson, 1983). Moreover, Reynolds and Walberg (1992) state that prior achievement as well as home environment, exposure to home media through reading and instructional time have a significant effect on science achievement in the study which creates a structural model of science achievement and attitude. Recent meta-analysis studies show that effect size of prior achievement on students' achievement is 0.65, which states that prior achievement has a high influence on students' achievement (Hattie, 2012, pg. 251).

Yet another student level variable studied by researchers to investigate the possible effects on students' learning outcomes is physical activity of students. Physical activity and nutrition can affect pupils' brain development and functioning and thereby their ability to learn (Clinton, Rensford & Willing, 2007). Healthy children in terms of physical activities and nutrition are more open to effective learning than the students who are lack of physical activities and good nutrition (Clinton, 2013). Although there is no evidence that improved physical activity and nutrition will directly give rise to higher levels of academic achievement (Clinton, Rensford & Willing, 2007; and Keeley & Fox, 2009), many studies state that there is a positive but a small relationship between students' physical activity and academic achievement (Dwyer, Sallis, Blizzard, Lazarus & Dean, 2001; and Keeley & Fox, 2009).

Apart from the student-level factors discussed above, researchers also performed studies to reveal the effect of students' intelligence, goal setting and self-efficacy on their learning outcomes. Intelligence is a significant predictor of academic achievement (Gottfredson, 2002; Gottfredson, 2003; and Laidra, Pullmann & Allik, 2007). Laidra, Pullmann, and Allik (2007) state that intelligence is a stronger predictor of achievement than personality traits as a result of their correlational study performed in Estonia with 3618 students at 2, 4, 6, 8, 10, and 12 grades. Yet another student level variable affecting students' learning outcomes is goal setting. Goals are the reliable determinants of action (Locke & Latham, 2002). There are some studies revealing that the minimum grade expected by the students is the consistent determinant of actual grade and is related to academic performance of students (Wood & Locke, 1987; and Locke & Latham, 2002). Moreover, goal setting and self-efficacy is also related to each other. People having high self-efficacy set higher goals for themselves (Bandura, 1989). Bandura (1989) who coined the term into the literature states that self-efficacy affects almost all aspects of learning and performance of students. Students having high self-efficacy has higher academic achievement and also less anxiety and more willingness to choose challenging tasks than the students having less self-efficacy (Pintrich & DeGroot, 1990).

2.7.1.7. Summary of the Student-Level Characteristics

The effect of student-level characteristics on students' learning outcomes like science achievement and attitude toward science is still an important topic although there have been ample studies performed so far. Gender, home educational resources, parental involvement, time spent on homework, bullying at school, immigrant background of the students, entry to the school, parents' educational expectations, student engagement, students' educational expectations, personality, prior achievement, physical activity, goal setting and self-efficacy are the student level factors affecting students' science achievement and attitude toward science.

So many studies conducted to reveal the relationship between gender and students' academic achievement as well as attitude, but the results of studies vary according to findings. Some study results state that there is no gender effect on achievement (Greenfield, 1996) but some indicate for a correlation between gender and achievement (Furnham, Chamorro-Premuzic & McDougall, 2002; Hattie, 2012; and Mullis, et al., 2009). Some studies show that male students show higher performance than girls (DeBacker & Nelson, 2000; Dimitrov, 1999; Jovanovich & King, 1998; and Kahle, 2004) and some studies indicate female students show higher performance than male students (Mullis, Martin, Foy & Drucker, 2012). Apart from academic achievement, the effect of gender on students' attitude toward science is also investigated by many researchers. Some study results show that boys have more positive attitude toward science than girls (Haste, 2004; and Jones, Howe & Rua, 2000); on the contrary to these findings, some study results show that girls have more positive toward science than boys (Kerr & Murphy, 2012; and Murphy & Beggs, 2003). To sum up, there is no strong consensus reached by researchers about the effect of gender on both science achievement and attitude toward science.

Studies investigating the relationship between home resources and students' learning outcomes found consistent positive results. Each student comes to school from different home background; which can have an effect on students' learning outcomes. Home educational resources have a significant effect on students' learning outcomes (OECD, 2013a; Dincer & Uysal, 2009; Hattie, 2012; and World Bank, 2011). Number of books in home, availability of computer and internet connection, having a study desk at home and also parents' highest education level can affect students science achievement and attitude toward science as these home educational resources can enhance students' learning opportunity at home (Mullis, et al., 2012).

Studies investigating the relationship between parental involvement and students' academic achievement as well as attitude found consistent positive results. Parental involvement positively correlates with academic achievement (Dearing, Kreider, & Weiss, 2008; LaRocque, Kleiman & Darling, 2011; and Mullis, Martin, Foy & Drucker, 2012) and overall attitude toward school (Dearing, Kreider, & Weiss, 2008; and Lyons, 2006).

The effect of time spent on homework on students' academic achievement is studied by many researchers. Although some researchers state that time spent on homework positively correlates with academic achievement (Holmes & Croll, 1989; Maltese, Tai, & Fan, 2012; and McMullen, 2010), some researchers state that time spent on homework is not related to academic achievement after controlling gender, prior achievement and cognitive abilities of students (Dettmers, Trautwein, Lüdtke, Kunter & Baumert, 2010). As clear, the relationship between time spent on homework with academic achievement is unclear (Martin, et al., 2012; Mullis, et al., 2009; and Trautwein & Köller, 2003) due to homework assignment approaches of the teacher (Martin, et al., 2012; and Trautwein, 2007) and motivation and prior knowledge of the students (Trautwein, Luedtke, Kastens & Koeller, 2006; and Trautwein, 2007).

Safe and orderly school climate plays an important role in teaching learning process (Brophy, 1988, and Martin, et al., 2012). Bullying, which also includes violence or peer rejection, has a negative impact on students' learning outcomes like science achievement and attitude (Baker-Henningham, Meeks-Gardner, Chang, & Walker, 2009; Kaur et al., 2014; Ladd, 2005; Martin, et al., 2012; Mullis, et al., 2012; and Mullis, Martin, Foy & Drucker, 2012).

Apart from the factors discussed above there are other student level variables affecting students' learning outcomes namely science achievement and attitude toward science. These student level variables affecting students' learning outcomes are immigrant background of the students (Guldemond, Hofman & Hofman, 2004; OECD, 2013a; and Schmid, 2001), entry to the school (Hattie, 2012; Mullis, Martin, Foy & Drucker, 2012; and Tayler, 2013), student engagement (Ackerman, 2013; Klem & Connell, 2004; and Mosher & MacGowan, 1985), parents' educational expectations (Hong & Ho, 2005; Martin, et al., 2012; and Mullis, Martin, Foy & Drucker, 2012), students' educational expectations (Bui, 2007; Eccles, & Wigfield, 2002; Hattie, 2012; Liu, Cheng, Chen, & Wu, 2009: Sanders, Field, & Diego, 2001; and Zhang, 2012), personality (Hattie, 2012; Komarraju, 2013; and O'Connor & Paunonen, 2007), prior achievement (Hattie, 2012; Huitt, Huitt, Monetti, &

Hummel, 2009; Lawson, 1983; and Reynolds & Walberg, 1992), physical activity (Dwyer et al., 2001; Keeley & Fox, 2009), intelligence (Gottfredson, 2002, 2003; and Laidra, Pullmann & Allik, 2007), goal setting (Wood & Locke, 1987; and Locke & Latham, 2002), and self-efficacy (Bandura, 1989; and Pintrich & DeGroot, 1990). However, these variables were not included into the present study as there is no information available in TIMSS 2011 data or they are not applicable to the conceptual framework of the present study.

2.7.2. Teacher-Level Characteristics

Teacher quality plays an essential role in effective education; therefore, there is a growing interest in research in teacher and teacher policy areas in recent years especially by IEA, OECD, and UNESCO (Sandoval-Hernandez, Jaschinski, Fraser, & Ikoma, 2015). The quality of the teacher plays a vital role in student engagement with science (Osborne & Dillon, 2008), and in the student achievement (Lamb & Fullarton, 2001) hence affects students' learning outcomes. Importance of classroom and teacher characteristics as predictors of student outcomes is emphasized especially in educational effectiveness (Muijs, Kyriakides, van der Werf, Creemers, Timperley & Earl, 2014). Teacher is perceived as key component of students' learning (Druva & Anderson, 1983) as it is teacher's responsibility to implement the curriculum and determine the classroom environment (Rivkin, Hanushek & Kain, 2005).

The effect of classroom level factors is higher than the effect of school level factors on students' learning outcomes like student achievement (Kyriakides, Campbell & Gagatsis, 2000; and Muijs & Reynolds, 2010). Therefore, we can state that instructional approaches and teacher characteristics play a vital role in students' learning and achievement (Mullis, et al, 2009). Teacher-level characteristics are important for the studies aiming to reveal which factors affect students' science learning outcomes. In literature there are so many studies examining the relationship between teacher characteristics and student achievement by aiming to identify effective teacher characteristics improving student learning outcomes (Ma, 2013). Furthermore, Chidolue (1996) states that students' increased science achievement and attitude toward science should be investigated as a result of teacher effectiveness as these two outcomes are indicators of successful teaching.

In the present study, confidence in teaching science, teacher career satisfaction, collaborate to improve teaching, teachers' emphasize in science investigations, teacher experience and teachers' professional development were investigated under teacher level characteristics. This section described these teacher level variables' relationship with science achievement and attitude toward science; moreover, other teacher level variables which were found to have an effect on student learning outcomes in literature but were not included to the conceptual model of the present study were also discussed under other teacher characteristics section. The teacher-level variables explained in other variables section were not included to the conceptual model of this study as TIMSS 2011 did not collect any data about these variables or it is thought these variables are not appropriate for the theoretical framework of the study.

2.7.2.1. Confidence in Teaching Science

Teachers' confidence in teaching refers to the teacher efficacy (Ross, 2013). Teachers' with high level of confidence in teaching believe that they can be successful, hence do not avoid challenging goals for both themselves and their students, and are not afraid of failure (Woolfolk Hoy & Spero, 2005). Teachers' confidence is strongly related to several educational outcomes at both teacher level (e.g. instructional behavior, enthusiasm, and teachers' persistent) and student level (e.g. achievement, motivation and self-efficacy) (Tschannen-Moran & Woolfolk Hoy, 2001).

Self-efficacy is one of the most important factors affecting student achievement (Pajares, 1996) accordingly; the impact of teacher confidence on students' academic achievement has been a hot topic since 30 years (Mahmoee & Pirkamali, 2013). Several studies conducted to investigate the relationship between teachers' confidence and students' learning outcomes state that teachers' self-confidence in teaching is associated with their students' motivation and also students' achievement (Bandura, 1997; Henson, 2002; and Mojavezi & Tamiz, 2012). Similarly, Ross (2013) states that teacher efficacy is strongly related to students' achievement as teachers with high confidence in teaching are more open to acquiring new instructional skills; which makes teachers more effective in the classroom and hence give rise to better student learning. Moreover, teachers' higher confidence affects their students' confidence in a positive way. Caprara, Barbarabelli, Steca and Malone (2006) state that teachers' confidence in teaching affects their job satisfaction and their students' academic performance as a result of the study performed with over 2000 teachers in 75 Italian junior high schools. Yet, another study performed in 23 Jordanian schools with 1820 students and 679 teachers shows that teachers' efficacy is a significant predictor of students' attitude toward school (Al-Alwan & Mahasneh, 2014). One of the reasons behind this significant relationship between teachers' confidence and students' learning outcomes might be that teachers having high confidence can better motivate their students and enhance cognitive development of their students (Mahmoee & Pirkamali, 2013).

2.7.2.2. Teacher Career Satisfaction

Career satisfaction simply explains that whether teachers like their job or not (Michaelowa, 2002). The more teachers are satisfied with their career, the more they are motivated to teach and get prepared for their lessons (Martin, et al., 2012; and Mullis, Martin, Foy & Drucker, 2012). Teachers should have a minimum level of career satisfaction to continue teaching. Job satisfaction is an important factor affecting individuals' productivity. Although there is a growing literature on the student achievement and the factors affecting it, teacher career satisfaction seems like it is neglected to research (Michaelowa, 2002).

Classroom environment, school facilities, teachers' own characteristics like family status, job experience, teachers' contract conditions would be the indicators of teachers' career satisfaction (Michaelowa, 2002). More specifically, most common factors negatively affecting teachers' career satisfaction in United States are lack of planning time, too heavy workload, low salary, problematic student behaviors and lack of influence over school policy (UNESCO, 2006). Especially in some countries in Africa, teacher career satisfaction levels are very low. Almost 50 % of the teachers working in Africa would prefer another job (Michaelowa, 2002), which is a strong implication of career dissatisfaction. Teacher attritions are observed due to the low levels of career satisfaction. There are some policies emphasized to reduce the teacher attrition in order to increase student achievement (Boyd, Grossman, Lankford, Loeb & Wyckoff, 2009); however, whether these policies are effective or not is questionable.

There is a significant relationship between teacher's career satisfaction and their self-efficacy, teaching performance and working conditions. Ololube (2006) stated that teachers' job satisfaction has an influence on teaching performance in the study with a sample of 680 teaching staff from 18 randomly selected secondary schools in Nigeria. Recent study performed by TIMSS 2011 Turkey data which specifically focuses on Turkish science teachers' career satisfaction states that teachers' self-efficacy and working conditions accounted for 15% variance in science teachers' career satisfaction (Kahraman, 2014).

Recent studies investigating the relationship between teachers' career satisfaction and students' learning outcomes reach a consensus. Higher teacher career satisfaction positively affects student learning (Michaelowa, 2002; and Mullis, Martin, Foy & Drucker, 2012).

2.7.2.3. Collaborate to Improve Teaching

Teacher collaboration with colleagues can be perceived as a foundation in profession community building like improving teaching (Martin, et al., 2012; and Mullis, Martin, Foy & Drucker, 2012) hence it can play a vital role in students' outcomes. Collaboration and interaction may improve educational effectiveness, teachers' own professional development and students' learning (Creemers & Kyriakides, 2008). Teachers collaborating in planning and implementing lessons usually feel less isolated and less likely to leave teaching profession (Johnson, Berg & Donaldson, 2005).

Teachers' collaboration affects students' learning outcomes. Collaboration among teachers can increase student learning and performance (Wheelan & Kesselring, 2005). Similar to Wheelan and Kesselring (2005), Pil and Leana (2009) state that pupils whose teachers work closely with other teachers show better academic performance. Professional communities like collaboration among teachers show a small but a positive effect on students' achievement (Lomos, Roelande & Bosker, 2011). Wimberley (2011) conducted a study to reveal the relationship between teacher collaboration and student achievement in 100 public schools districts with 8th grade students, and the study results suggest a significant relationship between teacher collaboration and student achievement. Furthermore, yet in another study performed in 47 elementary schools with 452 teachers and 2536 4th grade students concluded that teacher collaboration related to curriculum, instruction and professional development was a significant positive predictor of students' achievement (Goddard, Goddard & Tschannen-Moran, 2007). Apart from the studies focusing on the relationship between teacher collaboration and students' learning outcomes, recent studies also state that collaboration among teachers is also related to higher levels of teacher confidence in teaching and career satisfaction (OECD, 2014g).

2.7.2.4. Teachers Emphasize on Science Investigations

In order to carry out science investigations successfully, teachers should make sure that students have both the substantive knowledge which is the understanding of science concepts and also the skills (Abrahams & Millar, 2008; Roberts & Gott, 2003). In order to develop students' science investigations, teachers can help students to understand science by scientific inquiry processes (Martin, et al., 2012). Focusing on science investigation by developing conceptual understanding helps students to do science, learn science concepts and also understand the nature of science (Hodson, 1990, 2009). Conducting discussions before, during and after performing activities is essential in increasing the gains of students from science investigation (Patrick & Yoon, 2004).

Scientific inquiry includes science process skills which are observing, inferring, classifying, predicting, measuring, questioning, interpreting, and analyzing data and also includes scientific reasoning and critical thinking to reach scientific knowledge. In a similar way but with other words, scientific inquiry can be defined as the systematic approaches used by scientists while searching answers to specific questions (Lederman & Lederman, 2012). Scientific inquiry activities are emphasized for an effective teaching learning process (National Research Council, 2011; and Martin, et al., 2012). Scientific inquiry is emphasized in many of the countries science curriculum, and is a way to encourage students to build their knowledge and understanding of science (Martin, et al., 2012). Therefore, scientific inquiry activities are inevitable part of science investigations.

Some studies state that emphasis of science investigations has a positive effect on students' academic achievement. House (2009) performed a study to reveal the relationship between the emphasis of science investigations and science achievement through TIMSS 2003 Korean data. According to the results of his study, House (2009) states that 8th grade students performed higher levels of science achievement who reported that they conducted their own research activities and watched their teachers while performing science experiments than the students who reported that they only listened to their teachers during lectures. Moreover, a recent meta-analysis study, which focused on master thesis, doctoral thesis and articles published between 2003 and 2014, concluded that constructivist learning approach has positive effects on students' academic achievement (Ayaz & Sekerci, 2015).

2.7.2.5. Teacher Experience

Teacher experience is one of the teacher-level characteristics that can affect students' learning outcomes. Teacher experience is an important characteristic as it is directly associated with the teacher compensation (Hanushek, Kain, O'Brien & Rivkin, 2005). Depending on the Bandura's theory of self-efficacy, the first years of teaching experience plays a vital role in the development of teacher efficacy (Woolfolk Hoy & Spero, 2005) and teacher efficacy affects students' academic performance (Bandura, 1997; Henson, 2002; and Ross, 2013). Furthermore, several studies state that teacher experience has a positive effect on teacher effectiveness (Rice, 2003) which is highly related to students' learning outcomes like achievement and attitude. In addition to indirect effect of teacher experience on students' academic performance through development of teacher efficacy and effectiveness, some studies reveal a direct relationship between teacher experience and students' learning outcomes by stating that more experienced teachers are more effective in teaching in mathematics and reading domain (Harris & Sass, 2008). Teacher experience has a positive but a small effect on student achievement in reading and mathematics domains (Buddin & Zamarro, 2009; and Rivkin, Hanushek & Kain, 2005). Furthermore, Chidolue (1996) performed a study to reveal the relationship between teacher characteristics and students' achievement and attitude, and found that teacher experience shows a high correlation with students' achievement and also attitude. Apart from these studies, IEA performed a detailed study focusing on teacher experience. IEA's study made a cross country comparison within all TIMSS countries in order to reveal if teacher experience is associated with 4th grade students' mathematics achievement and how this relationship changes with regard to other teacher characteristics. The results of this study show that there is no unique pattern of the relationship between teacher experience and student achievement, in other words, it varies among all TIMSS countries. Yet, on average, there is a pattern stating that students with more experienced teachers tend to have higher achievement. This pattern is so strong in Turkey that there is 84 score points difference between the students having teachers with less than 5 years' experience and with at least 20 years' experience; moreover, it is also significant in England (Sandoval-Hernandez et al., 2015). Moreover, teacher experience is associated with students' socio-economic status, school location (rural or urban), and teachers' career satisfaction and this relationship differs in different countries (*Ibid*).

There are many studies performed to reveal the relationship between teachers' experience and students' achievement, most of these studies state that there is a positive relationship, however, findings regarding to teachers' experience should be interpreted carefully due to many reasons. Firstly, teachers can be hired during a shortage or a surplus (Wayne & Youngs, 2003) therefore experience duration should be calculated carefully. Secondly, some teachers starting to the teaching profession realize or decide that they are not well matched for teaching and leave the teaching profession in first few years (Hanushek, Kain & Rivkin, 2004). Especially in the early years of teaching, teacher experience makes a difference (Clotfelter, Ladd & Vigdor, 2006; and Hanushek, Kain, O'Brien & Rivkin, 2005). Third reason why the results of studies related to teacher experience should be interpreted carefully is related to characteristics of education systems and/or schools. The relationship between student achievement and teacher experience would be difficult to examine as in some schools or education systems more experienced teachers may be assigned to students with lower ability in need of more help and high discipline problems, but in other schools or education systems, the opposite would be the case (Mullis, Martin, Foy & Drucker, 2012).

2.7.2.6. Teachers' Professional Development

Professional development is a long process starting from the pre-service teaching years and continuing through teaching career (Simon & Campbell, 2012). Teachers attending to seminars, workshops, and/or conferences and following professional journals have the opportunity to improve their knowledge and effectiveness (Yoon et al., 2007). OECD (2005) reported that professional development of teachers is a key policy in the education system.

Professional development is recognized as an important issue by many of the countries. In general, curriculum materials, collaborative structures, action research, immersion activities, practicing, courses, and workshops are the key components of designing an effective professional development for science and mathematics teachers (Loucks-Horsley, Love, Stiles, Mundry & Hewson, 2003). How professional development is implemented varies from country to country. Consultants in Finland and United Kingdom report that lack of professionalism or competence is not the problematic case but there is a need for re-training of teachers towards inquiry, reasoning and problem solving in science and mathematics area due to the changes in pedagogical approaches (Marginson, Tytler, Freeman & Roberts, 2013). According to reports, teachers' professional development differs in organization and autonomy from country to country. Teacher collaboration and school based autonomy are the key aspects of professional development in many European countries including Finland. Moreover, in terms of subject-based professional development, China obliges teachers to attend subject-based professional development to be promoted to have a higher salary. In Singapore, there is emphasis on professional development. In Australia, The Australian Professional Standards for Teachers provides continuous and discipline based professional learning for teachers (Marginson et al., 2013). In a similar way, in England, The Institute of Education in London hosts Science Learning Centers which offer continuing professional development courses for science teachers in each region of the country (Simon & Campbell, 2012).

Teachers' professional development has a significant positive influence on students' academic achievement (Blank, de las Alas & Smith, 2008). Similarly, Myrberg (2007) states that teachers' having adequate knowledge of learners and also pedagogy has a positive effect on students' achievement. Therefore it is important that teachers have professional development in pedagogy and knowledge of learners. Similarly, Jarrett, Evans, Dai, Williams and Rogers (2010) found that teachers' high level of professional development has a positive effect on students' achievement. Wenglinsky (2001) states that professional development of teachers especially focusing on higher order thinking skills and special populations of students can lead to higher student achievement in his study with NAEP data of 7,146 8th graders. Moreover, this study results show that the amount of the time that teachers receive professional development does not give a significant contribution to the student achievement. Recent meta-analysis studies show that science teachers' professional development on student outcomes (Yoon et al., 2007; and Timperley, Wilson, Barrar & Fung, 2007) and on science (Tinoca, 2004) has a medium influence on students' science achievement. In a similar way, Hattie (2012) finds that teachers' professional development has a medium influence (0.51 effect size) on students' learning (pg. 252). Furthermore, apart from the studies focusing on the relationship between teachers' professional development and students' learning outcomes, some studies focus on the relationship between professional development and teaching practices and classroom culture. Increasing the quantity of professional development is statistically associated with both greater use of inquiry-based teaching practices and higher levels of investigative classroom culture (Supovitz & Turner, 2000).

2.7.2.7. Instruction to Engage Students

Student engagement in academic contexts is a new area to study on as it started to appear in literature since 1980s (Ackerman, 2013). Mosher and McGowan's article published in 1985 can be perceived as the first active research on student engagement area (Christenson, Reschly & Wylie, 2012). Student engagement is known as a key component for effective teaching and learning science process (Anderson, 1981) among teachers, education researchers and policy makers (Olitsky & Milne, 2012). Engagement is the first component of 5E instructional model (engagement, exploration, explanation, elaboration and evaluation) to teach science in a constructivist approach (BSCS, 2006), therefore, instruction to engage students play an important role in learning-teaching process.

Student engagement can occur in behavioral, emotional and cognitive domains (Fredricks, Blumenfeld & Paris, 2004) anyhow cognitive interaction between the student and the instructional content is the focus of students' engagement to learning. Engagement can occur in different forms like listening to the teacher, reading loud and/or giving an explanation (Mullis, Martin, Foy & Drucker, 2012). Core concept of student engagement in academic contexts is clear however there are some differences in the frame of the student engagement between researchers (Appleton, Christenson & Furlong, 2008). Some researchers only focus on students' motivation for further learning or students' efforts in classroom in terms of student engagement, however, some researchers investigate students' interest, attitude, doing homework habits and even extracurricular activities in terms of student engagement (Ackerman, 2013).

Students can be "more engaged in schools where there is strong disciplinary climate, positive teacher-student relations, and high expectations for student success" (Willms, 2003, pg. 57). Similar to Willms (2003) statement, Akey (2006) states that student engagement is affected by student-teacher relations and classroom climate. Moreover, some researchers specifically focused on the relationship between teacher support and students' engagement. Teacher support associates with student engagement and academic achievement (Klem & Connell, 2004) especially in elementary school level (Marks, 2000). Teachers, who care more and structure the learning environments in a fair and clear way, are more likely to have more engaged students to the lessons (Klem & Connell, 2004). Therefore, we can conclude that teacher- and school-level characteristics may affect student engagement based on the studies of Akey (2006), Klem and Connell (2004), and Willms (2003).

The relationship between instruction to engage students and students' learning outcomes is also examined by a number of researchers. There is a positive relationship between instruction to engage students and students' achievement (Martin, et al., 2012). Students showing high levels of engagement show higher academic performance (Akey, 2006; and Singh, Granville & Dika, 2002). Furthermore, Willms (2003) performed a study by PISA data, and concluded that students having higher engagement show higher academic performance than the students having less engagement.

Instruction to engage students variable was available in TIMSS 2011 data, however, this variable was not included to the conceptual model of this study, as the reliability values were low (0.45 in Turkey, 0.49 in Finland and 0.50 in England) (Martin & Mullis, 2012, pg. 2-3).

2.7.2.8. Other Teacher-Level Characteristics

In this section, other teacher-level variables affecting students' science achievement and attitude toward science are explained in detail. However, these variables explained as other teacher-level characteristics were not included to the model of the present study, as TIMSS 2011 did not collect any data about these variables or it was thought the variable is not appropriate for the theoretical framework of the study.

Teacher-student relationship is one of the factors assessed to reveal the effects on student learning outcomes. Teacher-student relationships have been conceptualized in several ways (Davis, 2003; and Wentzel, 2009). Teachers' parenting styles (Reeve, 2006; and Walker, 2008), and beliefs (Woolfolk Hoy & Davis, 2005) may be the main domains of teacher-student relationships. Closeness, warmth and absence of conflict are the signs of a positive teacher-student relationship (O'Connor, Dearing & Collins, 2011). Ensuring positive teacher-student relationships is essential because positive teacher-student relationships can buffer the effects of poor home background factors (Hattie & Yates, 2014). When teachers get in touch with students in an emotionally warm and positive way and respond to students' needs, then students tend to show higher performance and feel more motivated during the courses (Davis, 2013). Moreover, research state that students' prior teacher-student relationships can have an effect on further relationships; more specifically students who had positive teacher-student relationships are more open to have positive relationships (Davis, 2006). Teacher-student relationships play an important role in improving students' achievement, and attitude (Wubbels, Levy & Brekelmans, 1997). In a similar way, other studies state that teacher-student relationships have a significant and long-lasting effect on students' achievement and social development. Positive, close and supportive teacher-student relationships give rise to higher levels of academic achievement than conflictual teacher-student relationships (Rimm-Kaufmann, 2014). Recent meta-analysis studies focusing on the effect of student-teacher relationship on students' achievement show that teacher-student relationship has a high influence (0.72 effect size) on student achievement (Hattie, 2012, pg. 256).

Gender of teacher may be one of the teacher level characteristics affecting students' learning outcomes. Some researchers focused on the relationship between gender of the teacher and students' academic performance as well as attitude. Some studies stated that female teachers have better student outcomes than male teachers both in reading and mathematics domain (Buddin & Zamarro, 2009). Further studies stated that teachers' gender influence may vary according to the students' some characteristics like gender, socio-economic status and ethnicity (Dee, 2006; Mulis, et al., 2009; and UNESCO, 2006).

Another teacher-level character affecting students' learning outcomes is teacher's subject specific degrees. Students whose teachers have standard credential show higher performance than the students whose teachers are certified out of the field (Goldhaber & Brewer, 2000). Teachers' subject-specific advanced degrees positively correlate with students' achievement in mathematics or science domain (Rice, 2003).

Whether teachers have advanced degrees like master of PhD is another teacher level variable assessed to investigate the possible effects on students learning outcomes. There are so many studies performed to reveal whether students having teachers with advanced degrees (e.g. master or PhD) learn better than the students having teachers without advanced degree. Some studies state that teachers with a master degree or PhD degree do not give rise to higher student outcomes when compared to teachers without advanced degrees (Buddin & Zamarro, 2009), whereas, some studies reveal that there is a positive relationship between teachers' advanced degrees and student achievement (Rice, 2003). As clear, the results of studies focusing on the relationship between teachers' advanced studies and students' learning outcomes show ambiguity about the relationship by stating that there is no relationship, or positive relationship (Wayne & Youngs, 2003).

In literature, there are many studies performed to reveal the effects of classroom management on students' learning outcomes. Classroom management is related to student behavior and discipline. Classroom management can be assessed by rule clarity, efficient time use (Lüdtke, Trautwein, Kunter & Baumert, 2007), instructional planning and delivery, reward system, and physical setting (Horner, Sugai & Todd, 2014). TIMSS data give information about whether disruptive students and/or uninterested students limit teachers or not, which can be related to classroom management but it is clear that it not a direct assessment of classroom management. Classroom management may influence student achievement as an effective classroom management enables effective teaching learning process (Freiberg, 2013). Quality of classroom management can affect the opportunity of students to learn (Lipowsky, Rakoczy, Vetter, Klieme, Reusser & Pauli, 2009). Classroom management was positively associated with students' academic performance in Lipowsky et al.'s (2009) study performed in 19 German and 19 Swiss mathematics classes. Furthermore, some studies state that there is a positive relationship between student-centered classroom management and students' academic and social achievement (Freiberg, 2013).

Apart from the teacher level characteristics discussed above, researchers also performed studies to reveal the effect of instructional activities, pedagogical content knowledge (PCK), teachers' epistemological beliefs, and teachers' expectations on students' learning outcomes. Setting goals, relating the topic with daily life, using interesting materials can increase students' motivation (Mulis, et al., 2009). Wenglinsky (2000) states that students performing hands-on learning activities show a higher performance than the students who have individualized instruction as a results of his study with the sample of 7,146 eight graders. Moreover, PCK also has an effect on students learning outcomes. PCK includes content knowledge, pedagogical knowledge and contextual knowledge and understanding of how student differences affect instructional decisions (Gess-Newsome, 2013). Recent studies show that teachers with strong PCK give rise to higher student achievement (Hill, Rowan & Ball, 2005; and Baumert et al., 2010). As stated above, yet another teacher level factor affecting students' learning outcomes is teachers' epistemological beliefs. How teachers think about knowledge and knowing influences their classroom practices (Brownlee & Berthelsen, 2005; Olafson & Schraw, 2006; and Schraw, Brownlee & Olafson, 2013) and students' learning outcomes (Lidar, Lundqvist & Ostman, 2005; and Marra, 2005). Moreover, constructivist learning environment design may give rise to epistemological growth (Marra, 2005). Finally, teacher expectations play an important role in teaching-learning process and have an effect on students' learning outcomes. High teacher expectations can increase student achievement when teacher gives required support and resources (Jussim, 2013). Recent meta-analysis studies focusing on the effect of teacher expectations on student achievement shows that teacher expectations has a medium effect (0.43 effect size) on students' learning (Hattie, 2012, pg. 252).

2.7.2.9. Summary of the Teacher-Level Characteristics

The effect of teacher level factors on students' learning outcomes like science achievement and attitude toward science is still an important topic although there have been ample studies performed so far. Teachers' confidence in teaching science, career satisfaction, collaborate to improve teaching, teachers' emphasize on science investigations, experience, professional development, instruction to engage students, teacher-student relationships, gender, teachers' with subject-specific degrees, teachers' with advanced degrees, classroom management, instructional activities, pedagogical content knowledge, teachers' epistemological beliefs, and teachers' expectations are the teacher level characteristics affecting students' science achievement and attitude toward science.

Teachers' confidence in teaching positively correlates with students' learning outcomes like achievement (Bandura, 1997; Caprara, Barbarabelli, Steca & Malone, 2006; Henson, 2002; Mojavezi & Tamiz, 2012; and Ross, 2013) and attitude toward school (Al-Alwan, & Mahasneh, 2014). Teachers' with high confidence in teaching do not avoid challenging goals for themselves or for students (Woolfolk Hoy & Spero, 2005), and are more open to acquiring new instructional skills (Ross, 2013), hence they can better motivate their students and improve their students' cognitive development (Mahmoee & Pirkamali, 2013).

Another teacher level characteristic affecting students' learning outcomes is teacher career satisfaction as teachers are more motivated to teach and get prepared for their lessons when they have higher carrier satisfaction (Martin, et al., 2012; and Mullis, Martin, Foy & Drucker, 2012). The relationship between teacher career satisfaction and students' learning outcomes is clear. Literature review about this relationship indicates that higher teacher career satisfaction positively affects students learning (Michaelowa, 2002; and Mullis, Martin, Foy & Drucker, 2012).

Teacher collaboration to improve teaching is another teacher level characteristic affecting student learning outcomes. Collaboration play an important role in learning-teaching process as it may improve educational effectiveness, teachers' own professional development and students' learning (Creemers & Kyriakides, 2008). Studies performed to investigate the relationship between teachers collaboration and student achievement indicates a significant positive relationship (Goddard, Goddard & Tschannen-Moran, 2007; Lomos, Roelande & Bosker, 2011; Pil and Leana, 2009; Wheelan & Kesselring, 2005; and Wimberley, 2011).

Emphasis of science investigations is another factor affecting students' learning outcomes. Emphasis on science investigations by developing conceptual understanding helps students to do science, learn science concepts and also understand the nature of science (Hodson, 1990, 2009). Previous study results show that emphasis of science investigations has a positive effect on students' academic achievement (Ayaz & Sekerci, 2015; House, 2009; and Martin, et al., 2012).

Teacher experience is a teacher-level character studied by many researchers to reveal the possible effects on students' learning outcomes like academic achievement and attitude. Teacher experience has a positive effect on students' academic achievement (Buddin & Zamarro, 2009; Chidolue, 1996; Harris & Sass, 2008; and Rivkin, Hanushek & Kain, 2005) and students' attitude (Chidolue, 1996). There are many studies revealing a positive relationship between teacher experience and students' learning outcomes; however, teacher experience should be interpreted with caution due several reasons like teacher hiring for a shortage (Wayne & Youngs, 2003), teachers' job quits in the first years of teaching (Hanushek, Kain, and Rivkin, 2004), and the assignment policy of teachers by schools or education systems (Mullis, Martin, Foy, & Drucker, 2012).

Professional development of teachers is a key policy in the education system (OECD, 2005). Teachers attending to seminars, workshops, and/or conferences and following professional journals have the opportunity improve their knowledge and effectiveness (Yoon et al., 2007). Teachers' professional development plays an important role in students' learning outcomes. Previous study results show that teachers' professional development has a significant and positive impact on students' academic achievement (Blank, de las Alas & Smith, 2008; Hattie, 2012; Jarrett et al., 2010; Myrberg, 2007, Wenglinsky, 2001; Yoon et al., 2007; Timperley et al., 2007; and Tinoca, 2004).

Instruction to engage students is another factor studied by researchers to reveal its influence on students learning outcomes. Student engagement is known as a key component of effective teaching and learning science process (Anderson, 1981; and Olitsky & Milne, 2012). The results of the previous studies showed that there is a positive relationship between students' engagement to the instruction and academic achievement (Akey, 2006; Singh, Granville & Dika, 2002; Martin, et al., 2012; and Willms, 2003).

Apart from the teacher level factors discussed above, there are other teacher level variables affecting students' learning outcomes like science achievement and attitude toward science. These teacher level variables affecting students' learning outcomes are namely teacher-student relationships (Davis, 2013; Hattie, 2012; Rimm-Kaufmann, 2014; and Wubbels, Levy & Brekelmans, 1997), gender (Buddin & Zamarro, 2009; Dee, 2006; Mulis, et al., 2009; and UNESCO, 2006), teachers' with subject-specific degrees (Goldhaber & Brewer, 2000; and Rice, 2013), teachers' with advanced degrees (Rice, 2003), classroom management (Freiberg, 2013; and Lipowsky et al., 2009), instructional activities (Mulis, et al., 2009; and Wenglinsky, 2000), pedagogical content knowledge (Hill, Rowan & Ball, 2005; and Baumert et al., 2010), teachers' epistemological beliefs (Lidar, Lundqvist &

Ostman, 2005; and Marra, 2005), and teachers' expectations (Jussim, 2013; and Hattie, 2012). However, these variables were not included into the present study as there is no information available in TIMSS 2011 data, or as it is thought these variables are not applicable to the conceptual framework of the present study.

2.7.3. Dependent Variables of the Study

In the present study, students' science achievement and attitude toward science were assigned as the dependent variables in the conceptual model and the reasons of choosing these two variables are clearly explained in Chapter 1. In this part, the relationship between science achievement and attitude toward science is reviewed after defining these two variables.

Student achievement is in the center of nearly all aspects of education. In the Education Resources Information Center (ERIC) system, there are more than 2000 research studies and also in google scholar database; there are nearly 5000 published resources within the last ten years with "student achievement" in title (Guskey, 2013). Definition of student achievement differs and there is no common definition used by policy makers, school leaders, teachers, students, parents or researchers (Guskey, 2007) but in the simplest term achievement refers to 'accomplishment' (Guskey, 2013). It is clear that achievement in any domain like science or mathematics must include knowing some important concepts and facts in the domain but of course science achievement should go beyond only knowing (Shavelson & Ruiz-Primo, 1998). Bates, Shifflet and Lin (2013) define achievement as determination of students' academic competencies and abilities related to school content and daily life.

Students' attitude toward science is an important topic taking attention in science education field more than 40 years (Tytler & Osborne, 2012). Attitude toward science was defined as favorable or unfavorable reaction to an object like science, or scientist by Gardner (1975), and as "general or enduring positive or negative feeling about science" by Koballa and Crawley (1985, pg. 223). Recent studies show that, attitude toward science is not a single unitary construct on the contrary it consists of a number of sub-constructs (Kerr & Murphy, 2012; and Osborne, Simon & Collins, 2003). Similarly, Tytler and Osborne (2012) defines attitude toward science as a construct consisting a number of sub-constructs and states that attitude toward science is a complex concept which includes attitude towards science and scientists, attitude towards school science, interest in science and science related activities as well as a career in science and science related work, and finally enjoyment of science learning experiences.

The relationship between students' science achievement and attitude toward science was revealed in many studies. There is a consensus about this relationship in literature that there is a positive significant relationship between achievement and attitude. However, there is no consensus about the strength of this relationship; some studies state that it is a strong relationship and some state it is a weak relationship. Renaud (2013) states that there is a weak relationship between attitude and academic achievement and it is also clear that students in some highest performing countries in TIMSS like Chinese Taipei, Japan, and Korea report very low positive attitude toward science, and this low positive attitude toward science in East Asian countries is consistent with previous TIMSS results (Martin, et al., 2012). That showing high science achievement but having low positive attitude toward science may occur due to the fact that the high level of difficulty in science may decrease students' liking learning science but having a cultural tradition of serious attitudes toward learning may increase the science achievement of students in these Far East countries (*Ibid*). Some researchers state that there is a strong positive relationship between attitude toward science and science achievement (Chidolue, 1996; Hattie, 2009; Martin, et al., 2012; and Mullis, Martin, Foy &, Drucker, 2012) and also it is clear that this relationship is bidirectional which means that attitude and achievement influence each other mutually (Hattie & Anderman, 2013; Martin, et al., 2012; Mullis, Martin, Foy & Drucker, 2012; and Renaud, 2013). Recent meta-analysis studies show that students' attitude toward science has a medium effect (0.35 effect size) on students' science achievement (Hattie, 2012, pg. 252).

CHAPTER 3

METHODOLOGY

In this chapter of the dissertation, design of the study, data source, population and sampling, instruments, validity and reliability, data analysis in addition to assumptions and limitations of the present study were explained.

This study examined the relationship between student- and teacher-level characteristics and students' science achievement and attitude toward science of 8th grade students in Turkey, Finland and England. Multilevel analysis was used due to the nested data structure of TIMMS 2011. HLM 7 Program was used in analyzing the data. The results were reported for Turkey, Finland and England. The research questions of the present study are stated below:

1. Which student characteristics are significantly related to 8th grade students' science achievement in Turkey, Finland and England after home educations resources (HER) is controlled?

2. Which teacher characteristics are significantly related to 8th grade students' science achievement in Turkey, Finland and England?

3. How much of the variance in 8th grade students' science achievement is explained by teacher- and student-level characteristics in Turkey, Finland and England?

4. Which student characteristics are significantly related to 8th grade students' attitude toward science in Turkey, Finland and England after HER is controlled?

5. Which teacher characteristics are significantly related to 8th grade students' attitude toward science in Turkey, Finland and England?

6. How much of the variance in 8th grade students' attitude toward science is explained by teacher- and student-level characteristics in Turkey, Finland and England?

Science achievement (five plausible values on science scores) and the attitude toward science were the outcome variables of interest in the present study. Attitude toward science indices was created based on the theoretical framework created by IEA which explains the sub-dimensions of attitude as variables namely students' confidence with science, students' like learning science and students' value science (Martin, et al., 2012). Student-level variables were gender, home educational resources, parental involvement, time spent on homework, and bullied at school. Teacher-level variables were teachers' confidence in teaching science, teacher career satisfaction, teachers' collaboration to improve teaching, teachers' emphasize science investigations, teacher experience and teachers' professional development. The detailed descriptions of these variables are available in Chapter 1, section 1.4.

3.1.Design of the Study

The present study was a quantitative research with non-experimental study. Hierarchical linear modeling techniques were used to investigate the relationship between student- and teacher-level characteristics and 8th grade Turkish, Finnish and English students' science achievement and attitude toward science. Therefore, the present study was a correlational study as it was performed with no-causal concern between student and teacher variables and students' science achievement and attitude toward science. Due to the nature of the TIMSS 2011 data, this study was cross-sectional study.

3.2.Data Source

The Trends in International Mathematics and Science Study (TIMSS) 2011, eighth grade data of Turkey, England and Finland was the main data source for this study. TIMSS data is used for the analysis, as international comparisons (especially gathering information altogether) requires international co-operation of professionals in each participating country; which is only possible through large-scale studies (Rosier, 1990). TIMSS 2011 was performed with the efforts of hundreds of people around the world. 63 countries and 14 benchmarking participants attended to TIMSS 2011. Across 4th and 8th grade students, the TIMSS

2011 database comprised data from 608,641 students, 49,429 teachers and 19,612 school principals as well as the National Research Coordinators of the each participating country (Foy, et al., 2013a). Each participating country assigns a TIMSS National Research Coordinator (NTC) for implementing TIMSS in their country.

TIMSS studies are directed and managed by the TIMSS & PIRLS International Study Center at Boston College. There are standard guidelines and procedures for the participating countries to follow carefully (Foy, et al., 2013a). Due to TIMSS 2011 representative sample data collection procedures, the results of this study can be generalized to the attending countries' students. TIMSS 2011 provided information about student, teacher and school characteristics. In this dissertation student- and teacher-level characteristics were in the focus due to the purposes of the present study. Furthermore, due to the nested data structure, this data source was appropriate for performing multilevel analysis in student and teacher levels.

3.3.Population and Sampling

TIMSS 2011 targeted students at 4th grade and 8th grade. For the purpose of the present study, 8th grade students' data was used in this dissertation. TIMSS 8th grade target population is "All students enrolled at the 8th grade of formal schooling and providing the mean age at the time of testing is at least 13.5 years" (Joncas & Foy, 2012, pg.4).

Two-stage random sampling design was employed in TIMSS 2011 study. In the first stage, a sample of schools are drawn and in the second stage one or more intact classes are chosen from the schools sampled in the first stage (Joncas & Foy, 2012). Equivalence of the target population and sample is an important issue in comparative studies in education systems hence the definitions of the target populations should be same and the samples should be equivalent as much as possible with similar standard errors of sampling (Rosier, 1990). In order to have a nationally representative sample of schools and students, each country taking place in TIMSS needs to develop and implement a national sampling plan which is a collaborative exercise between each country's National Research Coordinator and TIMSS sampling experts (Joncas & Foy, 2012).

In the present study, the data from three European countries namely Turkey, Finland and England were analyzed separately by using two-level hierarchical linear modeling. Table 3.1 gives information about population and sample of the present study.

Table 3.1 Population and Sample of the Present Study

Countries	Population		Sample	
	Schools	Students	Schools	Students
England	3,742	599,447	118	3,842
Finland	715	64,026	145	4,266
Turkey	17,621	1,198,697	239	6,928

Note: Retrieved from "*TIMSS 2011 international results in science*" by M.O. Martin, I.V.S. Mullis, P. Foy, G.M. Stanco, 2012, pg. 457. Copyright 2012 by IEA.

3.4.Instruments

TIMSS 2011 international assessment of student achievement at 8th and 4th grade contains written tests both in science and mathematics domain with different questionnaires to have detailed information on educational and social contexts for achievement (Mullis, et al., 2009). TIMSS 2011 assessment instruments were originally prepared in English and then translated into 45 different languages (Martin & Mullis, 2012). TIMSS 2011 uses two frameworks to assess science; which are namely science framework and context framework. Science framework includes content and cognitive domains to assess science achievement; which was explained in section 3.4.1 in detail. Moreover, contextual framework, which was explained in section 3.4.2 and section 3.4.3, focuses on factors associated with students' science learning by using student, teacher and school questionnaires. These student, teacher and school questionnaires which focus on the practices and procedures performed in school, classroom and home environment (Mullis, et al., 2009). IEA renews the frameworks in each assessment (4-years cycle). Although the TIMSS 2011 framework shows a great deal of similarities with the previous assessment, there are observable changes both in science framework and context framework. For example, in TIMSS 2003 science framework' content domain at 8^{th} grade includes life science, chemistry, physics, earth science and environmental science (Mullis, et al., 2003) whereas TIMSS 2011 science framework content domain at 8^{th} grade includes chemistry, physics, biology and earth science (Mullis, et al., 2009). Moreover, in terms of science frameworks' cognitive domain, again some differences are observed, for example, in 2003 science cognitive domain includes factual knowledge, conceptual reasoning, and reasoning and analysis (Mullis, et al., 2003), whereas in 2011 science cognitive domain includes knowing, applying and reasoning (Mullis, et al., 2009).

In this section, information about TIMSS 2011 science achievement assessment as well as student and teacher questionnaires is presented below. TIMSS 2011 collected data about school level characteristics by implementing school questionnaires and also about educational policies and the national contexts shaping the content and the implementation of mathematics and science curricula across countries by implementing curriculum questionnaires; however, in this part information about school questionnaire or curriculum questionnaire were not available as the present study did not focus on school level characteristics.

3.4.1. Science Achievement Assessment

A range of questions in each subject were used in order to assess students' knowledge and understanding in science (Mullis et al., 2009). While developing items to assess students' science achievement both at the 4^{th} and 8^{th} grade, the first step to focus on is the content topic. It is also very important that items also reflect a measure of proficiency in a cognitive domain. TIMSS focus on "what should the student know?" and "what should the student be able to do?" while assessing students' learning in particular content topics (Mullis & Martin, 2011, pg. 6). 8^{th} grade science sample items of TIMSS 2011 are available in Appendix C.

Two question-formats namely multiple choice and constructed responses were used in TIMSS 2011 assessment. Multiple choice questions provide four response items to students, and only one of these four options is the correct answer. Moreover, for constructed response questions, students are required to construct a written response with their own words contrary to selecting a response from four options. Both item types have different features in assessing students' learning. Multiple choice questions can be used to assess any of the behaviors in the content domain, but cannot be used to assess students' abilities in more complex interpretations or evaluations as multiple choice item type does not allow students' explanations and/or supporting statements. Constructed-response questions are more suitable for assessing knowledge and skills requiring explanations and interpretations based on pre-knowledge and experience because constructed-response item type gives opportunity to students to provide explanations by answering with reasons and even by drawing diagrams. Due to these different features of multiple choice items and constructed response items, the choice of item format plays an important role in assessing students' learning outcomes. TIMSS 2011 selected best item format which enables students to demonstrate their proficiency while developing assessment questions. Actual responses to multiple choice items and also the codes assigned to constructed response items according to the scoring guides are available in student achievement data files (Mullis & Martin, 2011).

14 assessment booklets with a series of mathematics and science questions were used in TIMSS 2011 to assess students' learning (Mullis & Martin, 2011). Table 3.2 gives detailed information about the distribution of 8th grade science assessment items by content domain, cognitive domain, and item format.

Table 3.2 Distribution of assessment items by content domain, cognitive domain and item format

TIMSS Assessment Items	Multiple Choice Items	Constructed Response Items	Total Items	Percentage of Score Points
Content Domain				
Biology	38 (38)	41 (49)	79 (87)	37%
Chemistry	22 (22)	22 (25)	44 (47)	20%
Physics	29 (29)	26 (29)	55 (58)	25%
Earth Science	21 (21)	18 (21)	39 (42)	18%
Total	110 (110)	107 (124)	217 (234)	100%
Percentage of Score Points	47%	53%		
Cognitive Domain				
Knowing	58 (58)	15 (18)	73 (76)	32%
Applying	40 (40)	52 (63)	92 (103)	44%
Reasoning	12 (12)	40 (43)	52 (55)	24%
Total	110 (110)	107 (124)	217 (234)	100%
Percentage of Score Points	47%	53%		

Notes: [1] Score points are shown in parenthesis, [2] Retrieved from "*TIMSS 2011 international results in science*" by M.O. Martin, I.V.S. Mullis, P. Foy, G.M. Stanco, 2012, pg. 457. Copyright 2012 by IEA.

3.4.2. Student Questionnaire

All of the students who were attending to TIMSS 2011 completed a student questionnaire which asks about aspects of home and school lives, home environment, school climate, and also self-perception and attitude toward science as well as mathematics. Some items in student questionnaires were identical both at 4th and 8th grade, but in some cases, language was simplified at 4th grade and content was altered to be more appropriate for the respective grade level. Completing student questionnaire took 15-30 minutes (Mullis et al., 2009). The data collected through the use of student questionnaires about 8th grade students' gender, home educational resources, parental involvement, time spent on homework, bullied at school, and attitude toward science were used in the present study.

3.4.3. Teacher Questionnaire

Science and also mathematics teachers of sampled students completed teacher questionnaire in TIMSS 2011. The main focus of teacher questionnaire was on teacher characteristics, classroom contexts for teaching and learning science and mathematics, and also the topics taught in science and mathematics lessons. More specifically, teachers answered about their backgrounds, views on collaboration with other teacher opportunities, career satisfaction, professional development, assessment practices, homework practices, enhancing students' interest in science, classroom characteristics, instructional time, materials and also activities for teaching science through teacher questionnaire. Completing teacher questionnaire took 30 minutes (Mullis et al., 2009). The data collected through the use of teacher questionnaires about 8th grade science teachers' confidence in teaching science, career satisfaction, collaborate to improve teaching, teachers emphasize science investigations, teacher experience and professional development were used in the present study.

3.5.Validity and Reliability

Reliability and validity are the first concerns of developing a test; moreover, in addition to validity and reliability, TIMSS also needs to have comparative validity as it is an international study comparing students' learning outcomes among countries (Martin & Mullis, 2008). TIMSS 2011 items were developed in such a way that they can measure science achievement reliably and also enhance the validity of TIMSS test (Mullis & Martin, 2011). IEA performed a field test in March-April 2010 in each country in approximately 30 schools in order to evaluate the validity and reliability of the various questionnaire scales. Before the implementation of TIMSS 2011, TIMSS Questionnaire Item Review Committee (QIRC), and the TIMSS National Research Coordinators reviewed the results of the field test analysis of the student, teacher and school questionnaire items. Items lack of reliability and validity were eliminated and not included in the final questionnaires used in TIMSS 2011 administration (Martin & Mullis, 2012).

3.5.1. Uni-dimensionality

Uni-dimensionality refers to the obtaining a single large factor for most of the covariance among items (Martin & Mullis, 2012). In other words, uni-dimensionality can be described as one latent variable or phenomena (Slocum-Gori, & Zumbo, 2010). All of the questionnaire items in TIMSS 2011 assessment were analyzed in terms of their measurement properties and these items were controlled whether they are suitable for scaling with the 1-Parameter IRT (Rasch) measurement. Therefore, the assumption of an underlying uni-dimensional construct is checked and the reliability of resulting scale is estimated. Principal components analysis was used to check the dimensionality of the items in each scale in TIMSS. According to the rule of thumb, items having less factor loading than 0.3 were eliminated from the scale if these items do not have a critical importance in the conceptual model (Martin & Mullis, 2012).

3.5.2. Validity

Validity is the extent of evidence based supported inferences drawn from results, in other words, whether a student showing high performance in science really knows a lot in science or not and what evidence we have about it relate to validity (Martin & Mullis, 2008). A positive relationship between the scale and student achievement is used as an aspect of validity in TIMSS 2011. There were teacher, school and student questionnaires and hence the TIMSS 2011 data was constructed by teachers', students', and school principals' responses. All the responses were related to student records and learning environments which are thereby related to student achievement. Preliminary score was calculated for each of the scale in order to reveal the relationship between the scale and student achievement. The scales not showing the expected relationships were eliminated, and most of the scales were valid as they had a positive relationship between achievement within and across the TIMSS 2011 participating countries (Martin & Mullis, 2012).

TIMSS also focuses on comparative validity as it is an international study making cross country comparisons on achievement. Different science curriculum, languages and school systems of countries creates comparative validity concerns in international studies. TIMSS ensures comparative validity by assessment framework, test development, verifications of translation, target population, constructed response scoring and achievement scaling (Martin & Mullis, 2008).

3.5.3. Reliability

Reliability is the extent of consistent measures of an instrument. Reliability is a must for a good measurement but it is not sufficient if the test is not valid (Martin & Mullis, 2008). For each of the scales, Cronbach Alpha values were computed to reveal the internal validity. To observe sufficiently reliable scale, Cronbach's Alpha value should be minimum 0.7. The analysis showed that most of the TIMSS 2011 scales had a Cronbach's Alpha value higher than 0.7 (Martin & Mullis, 2012). Table 3.3 gives information about the reliability values of some of the latent variables used in this study among Turkey, Finland and England.

Table 3.3 Reliability Values of Latent Values

Variable	Reliability* Turkey	Reliability* England	Reliability* Finland
Students Bullied at School	0.69	0.77	0.76
Home Educational Resources	0.63	0.40	0.35
Parental Involvement	0.70	0.80	0.76
Students' Attitude toward Science	0.78	0.90	0.82
Confidence in Teaching Science	0.62	0.72	0.73
Teacher Career Satisfaction	0.72	0.76	0.79
Collaborate to Improve Teaching	0.82	0.82	0.81
Instruction to Engage Students in Learning	0.45	0.50	0.49
Teachers Emphasize Science Investigation	0.71	0.70	0.72
Professional Development	0.81	0.72	0.65

Note. *Cronbach's Alpha, Retrieved from "TIMSS 2011 Science Context Questionnaire Scales, Eight Grade" in *Methods and procedures in TIMSS and PIRLS 2011* by Martin & Mullis, 2012, pg.2-3.

As clear in the above table, teacher level variable namely instruction to engage students in learning has low reliability values which ranged from 0.45 to 0.50 in Turkey, England and Finland. Therefore instruction to engage student variable was removed from the conceptual model of the study and not included to the analysis.

3.6.Data Analysis

In education research, students are nested within classes, classes are nested within schools and even schools are nested within districts. This nested structure of the data should be taken into account carefully in the analysis part, as students within classes, classes within schools or schools within districts can have some similarities due to being in the same cluster (Hox, 2010). TIMSS data is a nested data; therefore due to the nested nature of the data, hierarchical linear modeling (HLM) was used to analyze the data. HLM can be explained as a hierarchical system of regression equations. There are some differences between multilevel regression model and single-level multiple regression model. Multilevel regression model is more complicated as it has larger number of parameters; contain cross-level interactions and several different residual variances (*Ibid*). Therefore, researchers should be careful in performing the multilevel analysis and interpreting the output.

There are two models used in model building which are namely top-down model and bottom-up model. Top-down model includes two steps, firstly maximum number of the fixed and random effects are considered and then insignificant effects are removed from the model, secondly rich random structure is introduced and then again insignificant effects are removed. In the bottom-up model parameters are added one by one and tested for the significance when they are added to the model. It is better to start with the lower level while building up the model as lower level has larger sample size (Hox, 2010).

In the present study, data analysis was performed by HLM 7 program. Before starting the data analysis, data should have been edited in a way that it can be introduced to the HLM software. SPSS 22 was used in the data preparation step. HLM analysis was carried out separately for each of the dependent variables of the study and for each of the countries which are namely Turkey, Finland and England. Missing data was handled by listwise deletion. Moreover, apart from the HLM data analyses, descriptive statistics of data were reported to have an overview about the variables among countries.

Centering, the use of plausible values, sampling weights, handling missing data and building the explanatory model play an essential role in data analysis step. These features are explained below in detail in the next sections.

3.6.1. Centering

Centering is an important issue in multilevel analysis. If all explanatory variables have a zero value, then in multiple linear regression analysis no matter it is multiple or single-level, the intercept of the regression gives the expected value of the outcome variable. However, in some cases it is not possible to have a zero value of an explanatory variable. For example, we can focus on an explanatory variable namely gender, as males are coded as '1' and females are coded as '2', then zero is not a possible score range. In order to handle this problem, transformation of the variables making a 'zero' legitimate is useful. This linear transformation is called centering (Hox, 2010).

Centering around grand mean and centering around group mean are the two methods of centering. Centering around grand mean or in other words grand mean centering is applied by subtracting the grand mean from all values of an explanatory variable. In order to obtain interpretable results of the intercept in the regression equation as expected value of the outcome value, grand mean centering can be applied. Yet another centering approach is centering around group mean or in other words group mean centering. In group mean centering, the group's mean is subtracted from the corresponding individual scores. Group mean centering gives very explicit results when the individual scores should be interpreted relative to their groups' mean (Hox, 2010). Moreover, mixing the centering at different levels is also possible and does not create a problem because the centering approach for level-2 variables only influences the interpretation but does not influence the preciseness of parameter estimation (Stancel-Piatak & Sandoval-Hernandez, 2015).

Using centering in multilevel analysis has some advantages and solves some possible problems that can occur. For example, cross-level interactions are observed in many multilevel regression models; which is a problem. Centering is also important for interactions because many multilevel regression models include cross-level interactions. Centering the variables in the interaction solves the interpretation of results problem. Yet another reason to use centering in multilevel analysis is that variances of intercepts and slopes can have a clear interpretation (Hox, 2010). In this study centering around grand mean was used in HLM analysis.

3.6.2. The Use of Plausible Variables

International large scale assessments use large number of items in a limited time by the aim of having a representative sample of students to provide comparable information of students both in knowledge and skills in several content domains like reading, mathematics and science (Davier, Gonzalez & Mislevy, 2009). As the domains e.g. science, mathematics, or reading are too broad, it is not possible that all students respond to the whole items of the domains due to some time and financial limitations. Therefore, students attending to large scale assessments response to sample of items providing that the scores are comparable. Students do not answer all of the items, hence some information is missing. Plausible value implementation performed in a way that this missing information is estimated and imputed so the score of the each student is based on the whole test. In other words, by using plausible values, it is possible to know how students would have performed if they had answered all of the items instead of answering a sample of items (Stancel-Piatak & Sandoval-Hernandez, 2015).

International surveys like TIMSS, PIRLS and PISA use plausible values to report student performance because in educational studies measurement errors can occur due to the several reasons like broader concept of the measurement, mental and physical situation of students on the assessment day, occurrence of the possible conditions affecting the measurement results. The range of abilities that a student can have, constitute the plausible values (OECD, 2009b). More specifically, “the plausible values are not test scores … but are random numbers drawn from the distribution of scores that could be reasonably assigned to each individual”

(Monseur & Adams, 2009, pg. 6). Plausible values are not imputed scores for an individual student, but rather “imputed scores for like students with similar response patterns and background characteristics in the sampled population” in order to have correct population estimates (Martin & Mullis, 2012, pg. 6). Therefore, plausible values can provide unbiased estimation of proficiency levels (Davier, Gonzalez & Mislevy, 2009).

TIMSS 2011 drew 5 plausible values in science domain as well as mathematics domain. One common misconception about using plausible values is that mean of plausible values can be used (Davier, Gonzalez & Mislevy, 2009). While performing analysis with plausible values to estimate the population, each plausible value should be used separately and then the average over five calculations of the each plausible value should be reported as the population statistic (Davier, Gonzalez, & Mislevy, 2009; and OECD, 2009c), yet in many multilevel analysis programs like HLM and MPlus, the software program can make appropriate plausible value analysis when researchers introduce plausible values to the program (Muthen, & Muthen, 2010; and Raudenbush, Bryk, Cheong, Congdon, & Toit, 2011).

In the present study, 5 plausible values for science achievement were used. These 5 plausible values were introduced to HLM software in order to have appropriate plausible value analysis.

3.6.3. Sampling Weights

Means and percentages of student characteristics were computed as weighted estimates of the population parameters after TIMSS 2011 data was collected. The inverse of student’s probability of selection with the required adjustments for nonresponse is a student’s sampling weight (Joncas & Foy, 2012). Sampling weights should be used in analysing the data in order to assure that the number of students represented in the population is proportional to the contribution of each student to the statistical estimate. Therefore, the proportional contribution of components on the total estimate is adjusted (Gonzalez, 2012).

In TIMSS 2011, the weighting component at each level of school, class, and student includes basic weight which is the inverse of the probability of selection at that level with the required nonparticipation adjustment. For each student's overall sampling weight, three weighting components which are namely student (within class), class (within school) and school were taken into account (Joncas & Foy, 2012).

In this study, sampling weights for the student level was used. Weight at student level is created by multiplying "student weight adjustment" by "student weight factor". More specifically, the weights are created in this way:

Level 1: [STUDENT WEIGHT ADJUSTMENT] * [STUDENT WEIGHT FACTOR]

3.6.4. Handling the Missing Data

HLM 7 programme does not allow any missing data at level-2, hence does not run the model to perform analysis unless the missing data at level-2 is handled. If there is missing data at level-2, the HLM programme performs listwise deletion of cases when the MDM file is made or again listwise deletion of cases when running the analysis (Raudenbush, Bryk, Cheong, Congdon & Toit, 2011). TIMSS 2011 data can include some missing data, as it is a survey study. In this study, there was some missing data both at student-level and teacher-level. Listwise deletion was performed to handle the missing data.

3.6.5. Building Explanatory Models

The variables identified in literature, which significantly affect students' science achievement and attitude toward science were included in this study if they were available in TIMSS 2011 data and if they were applicable to the theoretical framework of the study. Five explanatory variables were introduced to model as student-level variables and six explanatory variables were introduced to the model as teacher-level variables. Both student- and teacher-level variables were introduced to the program one by one. Moreover, random slope and cross-level interactions were also investigated while building explanatory models up.

Bottom-up model was used in the present study, in other words, parameters were added one by one and significance test was performed when each of the parameter was added to the model. When a predictor was found non-significant then it was removed from the model. Finally, best models were created based on bottom-up modeling.

3.7.Variables of the Study

Present study investigated the effects of student level and teacher level characteristics on 8th grade students' science achievement and attitude toward science in Turkey, Finland and England. Extensive liteature review about these variables were explained in section 2.7 and how these variables were assessed in terms of scale items were explained in section 1.4.

3.7.1. Student-Level Characteristics (Level-1 Variables)

Gender, home educational resources, parental involvement, time spent on homework, and bullying at school were the independent teacher level variables of the present study.

3.7.2. Teacher-Level Characteristics (Level-2 Variables)

Teachers' confidence in teaching science, teacher career satisfaction, collaborate to improve teaching, teachers' emphasis on science investigations, teacher experience and professional development were the independent teacher-level variables of the present study.

3.7.3. Control Variables

Additional analysises were performed to see the effect of student-level variables on science achievement and attitude toward science after the effect of home educational resources was controlled. Firstly, HER was analysed at student-level as a part of the whole model, and then it was controlled to see its effect alone, and the effects of other student-level variables on science achievement and attitude toward science after HER was controlled.

3.7.4. Outcome Variables

There were two outcome variables in the present study, which were namely students' science achievement and students' attitude toward science. How these two outcome variables were assessed was explained in section 1.4.3, and extensive literature review about these two outcome variables was explained in section 2.7.3.

3.8.Assumptions of the Study

The present study assumed some assumptions which were explained in this section. Assumpations of this study were explained below:

1. This study assumed sample of Turkey, England and Finland in TIMSS 2011 were representative population in each country.
2. The present study assumed that all participants of TIMSS 2011 answered the questionnaires by giving correct information about themselves and reflecting their true feelings and real situations.
3. For the analysis step, several HLM assumptions were held which are about linearity, normality, homoscedasticity, and independence. These assumptions are that (a) at each level, function forms are linear (linearity assumption), (b) level-1 residuals are normally distributed and a multivariate normal distribution occurs for level-2 random effects (normality assumption), (c) level-1 residual variance does not vary but constant (homoscedasticity assumption), (d) level-1 and level-2 residuals does not correlate with each other, in other words they are uncorrelated (independence assumption), (e) observations at the highest level are independent of each other (independence assumption).
4. Both student and teacher questionnaires as well as cognitive items were originally written in English and then translated into Finnish and Turkish. Present study assumed that the translations from English to Finnish and Turkish were correctly performed.

3.9.Limitations of the Study

There were some limitations in the present study which were explained below:

1. This is a correlational study and due to the cross sectional nature of the data, cause and effect relationship between student- and teacher-level factors and students' learning outcomes could not be discussed. Exploring the teacher effects on students' learning outcomes would be more appropriate in a longitudinal study.
2. Previous achievement is one of the significant factors affecting students' learning outcomes (Hattie, 2012; and Huitt, Huitt, Monetti & Hummel, 2009). In order to reveal the student- and teacher-level factors on students' learning outcomes, controlling previous science achievement would give more precious results. The same situation is also valid for students' previous attitude toward science. Therefore, the effect of students' previous science achievement and students' previous attitude toward science should have been investigated. However, TIMSS does not provide information about students' previous science achievement or previous attitude toward science. The effect of previous science achievement and attitude toward science could not be investigated in this study; which was another limitation of the present study.
3. Some limitations due to the HLM 7 program occurred. The outcome variables of the present study which are namely science achievement and attitude toward science have a bidirectional relationship as clearly stated in literature (Hattie & Anderman, 2013; Martin, et al., 2012; Mullis, Martin, Foy & Drucker, 2012; and Renaud, 2013). However, this bidirectional relationship between attitude and achievement was omitted as it is not possible to test this model in one step in HLM 7 program. Therefore, the effect of student- and teacher-level factors on student achievement and attitude was investigated separately. In other words, separate HLM analyses were performed for each of the dependent variables.

CHAPTER 4

RESULTS

In this chapter, results of hierarchical linear modeling (HLM) based on the research questions were presented. In the first section of this chapter, descriptive statistics of the variables were presented. In the following sections, variance components, fixed effects, and explained variances both at 1st and 2nd level were presented in Turkey, Finland and England by building HLM models to reveal the relationship between selected student-, and teacher-level variables and 8th grade students' science achievement and attitude toward science. Moreover, cross level interactions were also examined and explained by graphs. In overall, analysis results for research questions were explained in detail in this chapter. Finally, the summary of the results was given at the end of this chapter.

4.1.Descriptive Statistics

This study examined the relationship between selected student- and teacher-level variables and 8th grade students' science achievement and attitude toward science in Turkey, Finland and England. The descriptive statistics for each country namely Turkey, Finland and England were presented in the Table 4.1 if the variables are continuous and in Table 4.2 if the variables are categorical.

Table 4.1 Descriptive Statistics of Continuous Student- and Teacher-Level Variables

Variables	Turkey		Finland		England	
	Mean	SD	Mean	SD	Mean	SD
Student-Level						
Science Achievement	484.30	98.49	555.38	65.12	539.57	80.94
Attitude Toward Science	10.33	1.59	9.12	1.28	10.05	1.66
Parental Involvement	8.59	2.92	4.96	2.94	8.29	3.05
Home Educational Resources	8.39	2.05	11.25	1.48	10.85	1.59
Teacher-Level						
Career Satisfaction	10.37	2.02	9.86	1.78	9.55	2.28
Emphasize Science Investigations	10.50	1.98	9.77	1.57	9.39	1.55
Professional Development	2.07	1.99	0.88	1.12	3.57	1.87

Notes. SD: Standard Deviation

Table 4.2 Descriptive Statistics of Categorical Student- and Teacher-Level Variables

Variables		Turkey	Finland	England
Student-Level				
Gender	Female	49.3 %	48.3 %	48.3 %
	Male	50.7 %	50.8 %	51.2 %
Bullying at School	Almost Never	51.0 %	71.1 %	67.4 %
	Weekly or Monthly	47.9 %	27.9 %	31.6 %
Weekly Time Spent on Science Homework	Minimum 45 Minutes	51.5 %	79.2 %	71.9 %
	At least 45 Minutes	45.7 %	7.3 %	24.2 %
Teacher-Level				
Confidence in Teaching Science	Somewhat Confident	31.3 %	41.8 %	13.7 %
	Very Confident	67.5 %	47.5 %	59.9 %
Collaboration to Improve Teaching	Collaborative	68.3 %	78.2 %	57.8 %
	Very Collaborative	30.4 %	16.4 %	22.1 %
Years of Experience	Less than 10 Years	54.6 %	30.1 %	45.1 %
	More than 10 Years	43.3 %	64.2 %	34.1 %

4.2.Analysis Results on Science Achievement in Turkey, England and Finland

Science achievement is one of the dependent variables of the present study. This section explained the relationship between student- and teacher-level variables and 8th grade students' science achievement in Turkey, England and Finland. Research questions related to science achievement were answered with relevant HLM analysis in this section. Analysis results on attitude toward science and related research questions were explained in section 4.3.

4.2.1. Variation in Science Achievement within and between Classrooms

Empty model in other words null model or one-way ANOVA model was run by HLM 7 program to determine the variation in science achievement in Turkey, Finland and England. Neither student-level nor teacher-level variables were introduced to this empty model. Model equations for level 1 which is student level and level 2 which is teacher level are below:

Level 1 (Student Level):

$SCIENCE\_ACHIEVEMENT_{ij} = \beta_{0j} + r_{ij}$

In the level 1 model equation, r_{ij} is the error variance for student i in the classroom j.

Level 2 (Teacher Level):

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

In the level 2 model equation, u_{0j} is the error variance for class j.

Mixed Model:

$SCIENCE\_ACHIEVEMENT_{ij} = \gamma_{00} + u_{0j} + r_{ij}$

Table 4.3 explains the variation in science achievement at both within- and between-classrooms for Turkey, England and Finland.

Table 4.3 Maximum Likelihood Estimates of the Variance Components of Science Achievement at the Student- and Teacher-Level

Random Effect	Variance Component	SD	df	Chi-square	p-value
Turkey					
INTRCPT1, u_0	2807.34	52.98	226	2640.42	<0.001
level-1, r	6978.38	83.54			
Finland					
INTRCPT1, u_0	510.21	22.59	144	658.44	<0.001
level-1, r	3725.59	61.04			
England					
INTRCPT1, u_0	3889.56	62.37	112	3712.60	<0.001
level-1, r	3318.34	57. 61			

Notes. SD: Standard Deviation; df: degrees of freedom

Moreover, variance components table (Table 4.3) also gives us important information about whether we should perform a multilevel analysis or not. In order to be able to perform an HLM analysis, the individuals in the same group should be more alike than the individuals in the different groups. Chi^2-test was performed to see whether an HLM analysis is required or not for Turkey, Finland and England.

Chi^2-test for Turkey data:

The result of this chi^2-test showed that science achievement scores of students in the same class are more alike than the students in different classes in Turkey. It is clear that HLM analysis is required for Turkey data.

Chi^2 test results for Turkey: $\chi 2$ (226): 2640.42, $p<0.001$

Chi^2-test for Finland data:

The result of this chi^2-test showed that science achievement scores of students in the same class are more alike than the students in different classes in Finland. It is clear that HLM analysis is required for Finland data.

Chi^2 test results for Finland: $\chi 2$ (144): 658.44, $p<0.001$

Chi^2-test for England data:

The result of this chi^2-test showed that science achievement scores of students in the same class are more alike than the students in different classes in England. It is clear that HLM analysis is required for England data.

Chi^2 test results for England: $\chi 2$ (112): 3712.60, $p<0.001$

Intra-class correlation (ICC) values for students' science achievement:

Before performing the multilevel analysis, it is important to analyze the extent of the students differed between classes with respect to the dependent variables. In this aspect intra-class correlation values should be calculated. Intra-class correlation formula is below:

Intra-class Correlation (ICC) = $\rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_{e})$

By using ICC values, the percentage of between-classroom variance and within-classroom variance in science achievement can be calculated. Between-classroom variance and within-classroom variance in science achievement play an important role in interpreting HLM model results.

ICC in Turkey:

Intra-class Correlation (ICC) = $\rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_{e})$

ICC = ρ = 2807.34 / (2807.34 + 6978.38) x 100 % = 28.69 %

This value is interpreted as the percentage of variance in science achievement at the second level. Therefore, we can conclude that 28.69 % variance in science achievement was explained by teacher-level variables. Furthermore, based on the following calculations, we can calculate the percentage of between-classroom variance and within-classroom variance in students' science achievement in Turkey.

ρ (between-class) = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_{e})$

ρ (between-class) = 2807.34 / (2807.34 + 6978.38) x 100 % = 28.69 %

For Turkey, 28.69 % variance in 8th grade students' science achievement was explained by teacher-level variables (between-class variance).

ρ (within-class) = $\sigma^2_{e} / (\sigma^2_{u0} + \sigma^2_{e})$

ρ (within-class) = 6978.38 / (2807.34 + 6978.38) x 100 % = 71.31 %

For Turkey, 71.31 % variance in 8th grade students' science achievement was explained by student-level variables (within-class variance).

ICC in Finland:

Intra-class Correlation (ICC) = $\rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ICC = ρ = 510.21 / (3725.59 + 510.21) x 100 % = 12.05 %

This value is interpreted as the percentage of variance in science achievement at the second level. Therefore, we can conclude that 12.05 % variance in science achievement was explained by teacher-level variables. Furthermore, based on the following calculations, we can calculate the percentage of between-classroom variance and within-classroom variance in students' science achievement in Finland.

ρ (between-class) = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ρ (between-class) = 510.21 / (3725.59 + 510.21) x 100 % = 12.05 %

For Finland, 12.05 % variance in 8th grade students' science achievement was explained by teacher-level variables (between-class variance).

ρ (within-class) = $\sigma^2_e / (\sigma^2_{u0} + \sigma^2_e)$

ρ (within-class) = 3725.59 / (510.21+ 3725.59) x 100 % = 87.95 %

For Finland, 87.95 % variance in 8th grade students' science achievement was explained by student-level variables (within-class variance).

ICC in England:

Intra-class Correlation (ICC) = $\rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ICC = ρ = 3889.56 / (3889.56 + 3318.34) x 100 % = 53.96 %

This value is interpreted as the percentage of variance in science achievement at the second level. Therefore, we can conclude that 53.96 % variance in science achievement was explained by teacher-level variables. Furthermore, based on the following calculations, we can calculate the percentage of between-classroom variance and within-classroom variance in students' science achievement in England.

ρ (between-class) = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ρ (between-class) = 3889.56 / (3889.56 + 3318.34) x 100 % = 53.96 %

For England, 53.96 % variance in 8th grade students' science achievement was explained by teacher-level variables (between-class variance).

ρ (within-class) = $\sigma^2_e / (\sigma^2_{u0} + \sigma^2_e)$

ρ (within-class) = 3318.34 / (3889.56 + 3318.34) x 100 % = 46.04 %

For England, 46.04 % variance in 8th grade students' science achievement was explained by student-level variables (within-class variance).

To sum up, based on ICC values, 28.69 % of the variance was located at the class level in Turkey, 12.05 % in Finland and 53.96 % in England. Percentage of between-classroom variance and within-classroom variance in students' science achievement in Turkey, Finland and England was summarized in the Table 4.4.

Table 4.4 Percentage of Between-Classroom and Within-Classroom Variance in Science Achievement

Percentage of Variance	Turkey	Finland	England
ρ (between-class)	28.69 %	12.05 %	53.96 %
ρ (within-class)	71.31 %	87.95 %	46.04 %

As clear in Table 4.4, for Turkey and Finland within-class variation was higher than between-class variation, whereas, in England between-class variation was slightly higher than within-class variation. The next section describes the effects of student-level variables on science achievement in Turkey, Finland and England.

4.2.2. Relationship between Student-Level Variables and Science Achievement: 1st Research Question

The first research question examined which student characteristics are significantly related to 8th grade students' science achievement in Turkey, Finland and England after home educations resources (HER) is controlled. The student-level variables were gender, parental involvement, time-spent on science homework, bullied at school and home education resources. At this step, all of the student level variables were introduced to the model based on build-up model, whereas none of the teacher-level variables were used at this step of the analysis. The relationship between student-level variables and students' science achievement was analyzed separately for Turkey, Finland and England. The following model was used at this step:

Level-1 Model:

$SCIENCE\_ACHIEVEMENT_{ij} = \beta_{0j} + \beta_{1j}*(GENDER_{ij}) +$
$\beta_{2j}*(HOMEWORK\_TIME_{ij}) + \beta_{3j}*(BULLY_{ij}) +$
$\beta_{4j}*(PARENTAL\_INVOLVEMENT_{ij}) +$
$\beta_{5j}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + r_{ij}$

Level-2 Model:

$\beta_{0j} = \gamma_{00} + u_{0j}$
$\beta_{1j} = \gamma_{10}$
$\beta_{2j} = \gamma_{20}$
$\beta_{3j} = \gamma_{30}$
$\beta_{4j} = \gamma_{40}$
$\beta_{5j} = \gamma_{50}$

Mixed Model:

$SCIENCE\_ACHIEVEMENT_{ij} = \gamma_{00} + \gamma_{10}*(GENDER_{ij}) +$
$\gamma_{20}*(HOMEWORK\_TIME_{ij}) + \gamma_{30}*(BULLY_{ij}) +$
$\gamma_{40}*(PARENTAL\_INVOLVEMENT_{ij}) +$
$\gamma_{50}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + U_{0j} + r_{ij}$

Table 4.5 explains the relationship between student-level variables and science achievement in all three countries namely Turkey, Finland and England.

Table 4.5 The Effects of Student-Level Variables on Science Achievement in Turkey, Finland and England

Type of Effect	**Turkey**		**Finland**		**England**	
	Unstandardized Coefficient (SE)	Standardized Coefficient	Unstandardized Coefficient (SE)	Standardized Coefficient	Unstandardized Coefficient (SE)	Standardized Coefficient
Fixed Effects						
Intercept	480.02***(3.64)		555.87***(1.99)		528.77***(5.46)	
Student-Level						
Gender	8.51*** (2.17)	0.04***	3.51, ns (2.44)	0.03, ns	-5.85* (2.43)	-0.04*
Homework Time	-6.31** (2.34)	-0.03**	-21.80*** (4.02)	-0.09***	5.24* (2.61)	0.03*
Bullying at School	- 6.60** (2.27)	-0.03***	3.13, ns (3.13)	0.02, ns	3.04, ns (2.90)	0.02, ns
Parental Involvement	-0.12, ns (0.43)	-0.004, ns	-1.22*** (0.36)	-0.06***	0.21, ns (0.35)	0.01, ns
Home Educational Resources	13.96*** (0.70)	0.29***	15.22*** (0.81)	0.35***	13.96***(0.74)	0.27***
Random Effects	Variance Component	SD	Variance Component	SD	Variance Component	SD
Between Class, u_0	1713.63***	41.40	383.66***	19.59	2858.82***	53.47
Within Class, r	6517.93	80.73	3227.20	56.81	2947.27	54.29

Notes: ns: non-significant; SD: Standard Deviation; SE: Standard Error; *p<0.05 level, **p<0.01, ***p<0.001

As clear in Table 4.5, some of the student-level variables were found non-significant on science achievement in Turkey, Finland and England. When a non-significant variable was found in the model, this variable was removed from the model, and the model was run again until the best model was found. The unstandardized coefficient and standard error values as well as standardized coefficient values for significant variables shown in Table 4.5 are the values found in the best model after non-significant student-level variables were removed from the model.

Results of the HLM models after adding student-level variables showed that home educational resources variable and time spent on science homework were the variables showing significant relationship with science achievement in all three countries namely Turkey, England and Finland. Standardized coefficient value of home educational resources was the highest value in the model of all three countries. The relationship between home educational resources and science achievement was found positive in all three countries; Turkey, England and Finland. In other words, the higher the home educational resources of students, the higher science achievement scores they performed in Turkey, Finland and England. On average, one point increase in home educational resources gave rise to around 14 points increase in science achievement in Turkey, 15 points increase in science achievement in Finland and 14 points increase in science achievement in England.

Time spent on science homework showed a positive significant relationship with students’ science achievement in England whereas a negative significant relationship was found in Turkey and Finland models. The standardized coefficient values showed that science achievement score difference related with time spent on homework was less than the science achievement score difference related with one point increase in home educational resources in all these three countries. Moreover, spending more than 45 minutes (weekly) on science homework was associated with decrease of approximately 6 science points in Turkey and decrease of 21 science points in Finland and increase of approximately 5 science points in England.

Gender showed a significant relationship with science achievement in Turkey and England, whereas non-significant relationship was found in Finland. In other words, being a female or a male created a difference in science achievement in Turkey and England. More specifically, on average female students scored approximately 9 points higher than male students in Turkey, and male students scored approximately 6 points higher than female students in England. In Turkey, on average female students are more successful than male students whereas, in England male students are more successful than female students in science. Standardized coefficient values showed that the science achievement score difference associated with gender is less than the science achievement score difference associated with one point increase in home educational resources and greater than the science achievement score difference associated with bullying and time spent on homework in Turkey. Moreover, standardized coefficient values showed that the science score difference related with gender was less than science score related with one point increase in home educational resources but greater than the science score difference related with time spent of homework in England.

Bullying at school showed a significant relationship with science achievement in Turkey, whereas non-significant relationship was found in England and Finland. Being bullied at school affects students' science achievement negatively in Turkey. On average, decrease in science achievement associated with weekly or monthly being bullied at school was approximately 7 points in Turkey.

Parental involvement was yet another variable showing significant relationship with science achievement in Finland. One point increase in parental involvement associated with approximately 1 point decrease in Finnish students' science scores. Science score difference related with one point increase in parental involvement was lowest compared to effects of other student-level variables on science achievement in Finland. Relationship between parental involvement and science achievement was found non-significant in England and Turkey.

Explained variance at level 1 by level-1 predictors

In addition to the information given above in the Table 4.5, in order to deeply explain the relationship between student-level variables and 8th grade students' science achievement, explained variances at level-1 were also calculated. Explained variance at level 1 can be calculated as follows:

Explained variance at level 1: $R_1^2 = (\sigma^2_{eIb} - \sigma^2_{eIm}) / \sigma^2_{eIb}$ where σ^2_{eIb} is total error variance in the intercept only model; and σ^2_{eIm} is error variance left in the model with predictors.

Explained variance at level 1 was calculated below for Turkey, England and Finland.

Turkey Data:

Explained variance at level-1 by 1st level variables for Turkey data when science achievement was the outcome variable:

$R_1^2 = (6978.38 – 6517.93) / 6978.38 = 0.066$

Conclusion: 6.6 % of variance in 1st level is explained by 1st level (student-level) variables which are gender, homework time, bullying at school and home educational resources when science achievement of 8th grade Turkish students was the outcome variable.

1st research question of the present study focused on the relationship between student-level variables and 8th grade students' science achievement in Turkey (and also in England and Finland) after home educational resources (HER) is controlled. Below, the unique variance explained by student-level variables in Turkish students' science achievement was calculated after home educational resources variable was controlled.

Explained variance at level 1 ONLY by home educational resources variable:

$R_1^2 = (6978.38 – 6557.78) / 6978.38 = 0.060$

Conclusion: 6.0 % of variance at 1st level was explained only by home educational resources when science achievement of 8th grade Turkish students was the outcome variable. Therefore, unique variance explained by student level variables after home educational resources variable is controlled: 6.6 % - 6.0 % = 0.6 %. To sum up, whole model explained 6.6 % variance in 8th grade Turkish students' science achievement. Moreover, students' gender, homework time, and bullying at school explained 0.6 % of variance in science achievement of 8th grade Turkish students in 1st level after home educational resources variable was controlled for Turkey data.

Finland Data:

Explained variance at level-1 by 1st level variables for Finland data when science achievement was the outcome variable:

$R_1^2 = (3725.59 – 3227.20) / 3725.59 = 0.133$

Conclusion: 13.3 % variance at 1st level was explained by 1st level (student-level) variables which are home educational resources, time spent on science homework and parental involvement when science achievement of 8th grade Finnish students was the outcome variable.

1st research question of the present thesis focused on the relationship between student-level variables and 8th grade students' science achievement in Finland (and also in Turkey and England) after home educational resources (HER) is controlled. Below, the unique variance explained by student level variables in Finnish students' science achievement was calculated after home educational resources variable was controlled.

Explained variance at level 1 ONLY by home educational resources variable:

$R_1^2 = (3725.59 – 3284.93) / 3725.59 = 0.118$

Conclusion: 11.8 % of variance at 1st level was explained only by home educational resources when science achievement of 8th grade Finnish students was the outcome variable. Therefore, unique variance explained by student-level variables after home educational resources variable was controlled: 13.3 % - 11.8 % = 1.5 %. To sum up, this whole model explained 13.3 % variance in Finnish students' science achievement. Moreover, time spent on science homework and parental involvement explained 1.5 % of variance at 1st level after home educational resources variable is controlled when science achievement of 8th grade Finnish students was the outcome variable.

England Data:

Explained variance at level-1 for England data when science achievement was the outcome variable: $R_1^2 = (3318.34 – 2947.27) / 3318.34 = 0.111$

Conclusion: 11.1 % variance at 1st level was explained by 1st level (student-level) variables which are gender, time spent on homework and home educational resources when science achievement of 8th grade English students was the outcome variable.

1st research question of the present study focused on the relationship between student level variables and 8th grade students' science achievement in England (and also in Turkey and Finland) after home educational resources (HER) is controlled.

Below, the unique variance explained by student-level variables in English students' science achievement was calculated after home educational resources variable is controlled.

Explained variance at level-1 ONLY by home educational resources variable:

R_1^2 = (3318.34 – 2959.43) / 3318.34 = 0.108

Conclusion: 10.8 % of variance at 1st level was explained by home educational resources when science achievement of 8th grade Turkish students was the outcome variable. Therefore, unique variance explained by student-level variables, which are gender and time spent on homework after home educational resources variable was controlled: 11.1 % - 10.8 % = 0.3 %. To sum up, this whole model explained 11.1 % variance in 8th grade English students' science achievement. Moreover, gender and time spent on science homework explained 0.3 % of variance at 1st level after home educational resources variable was controlled for England data when science achievement was the outcome variable.

Below table, namely Table 4.6 summarized explained variance in 8th grade Turkish, Finnish and English students' science achievement by only home educational resources variable and level-1 predictors after controlling home educational resources.

Table 4.6 Explained Variance in 8th Grade Students' Science Achievement by Student-Level Predictors

Explained Variance %	**TURKEY**	**FINLAND**	**ENGLAND**
Science Achievement			
Level-1 Predictors	6.6 %	13.3 %	11.1 %
Only HER	6.0 %	11.8 %	10.8 %
Level-1 Predictors after controlling HER	0.6 %	1.5 %	0.3 %

As clear in Table 4.6 explained variance in science achievement by student-level (level-1) variables range from 6.6 % (in Turkey) to 13.3 % (in Finland). More variance in science achievement explained in Finland by student-level variables compared to Turkey and England. Furthermore, explained variance in science achievement only by home educational resources range from 6.0 % (in Turkey) to 11.8 % (in Finland). Based on these findings, explained variance by level-1 predictors after controlling HER was calculated in Turkey, Finland and England. Explained variance in science achievement by student-level variables after controlling home educational resources was ranged from 0.3 % (in England) to 1.5 % (in Finland). Explained variance in science achievement by student-level variables after controlling home educational resources was quite less than explained variance in science achievement only by home educational resources in all three countries. These findings also picturized that only home education resources variable explained a great deal of variance in science achievement compared to other student-level variables in each country.

4.2.3. Relationship between Teacher-Level Variables and Science Achievement: 2nd Research Question

The second research question examined which teacher characteristics are significantly related to 8th grade students' science achievement in Turkey, Finland and England. In order to answer this research question two-level model was run with HLM 7 Programe. Multi-collinearity plays an important role in HLM analysis. Multi-collinearity tests should be performed before running the HLM analyses and if there are some variables showing high VIF values in multi-collinearity test, then these variables should be removed from the model. In the present study, multi-collinearity tests were performed before running the HLM models, and there was no multi-collinearity effect. The multi-collinearity test results with VIF values for Turkey, England and Finland were presented in Appendix A.

The teacher-level variables were teachers' confidence in teaching science, teacher career satisfaction, collaborate to improve teaching, teachers emphasize science investigations, teachers' professional development and teacher experience. The relationship between student- and teacher-level variables and students' science achievement were analyzed separately for Turkey, Finland and England. Table 4.7 summarizes the HLM analysis results of best models for Turkey, Finland and England; moreover HLM models of each country were presented separately in Appendix B

The Relationship between Student- and Teacher-Level Variables and Science Achievement

At this step of the analysis, all of the teacher level variables were added to the model which was created in the previous step. Build-up modeling was used and then non-significant teacher-level variables removed from the model one by one until obtaining the best-fit model. Following model used in this step:

Level-1 Model

$SCIENCE\_ACHIEVEMENT_{ij} = \beta_{0j} + \beta_{1j}*(GENDER_{ij}) +$

$\beta_{2j}*(HOMEWORK\_TIME) + \beta_{3j}*(BULLY_{ij}) +$

$\beta_{4j}*(PARENTAL\_INVOLVEMENT) +$

$\beta_{5j}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + r_{ij}$

Level-2 Model

$\beta_{0j} = \gamma_{00} + \gamma_{01}*(CONFIDENCE_{j}) + \gamma_{02}*(CAREER) + \gamma_{03}*(COLLABORATE_{j}) +$

$\gamma_{04}*(SCIENCE\_INVESTIGATIONS_{j}) + \gamma_{05}*(EXPERIENCE_{j}) +$

$\gamma_{06}*(PROFESSIONAL\_DEVELOPMENT_{j}) + u_{0j}$

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

$\beta_{3j} = \gamma_{30}$

$\beta_{4j} = \gamma_{40}$

$\beta_{5j} = \gamma_{50}$

$\beta_{6j} = \gamma_{60}$

Mixed model:

$SCIENCE\_ACHIEVEMENT_{ij} = \gamma_{00} + \gamma_{01}*(CONFIDENCE_{ij}) + \gamma_{02}*(CAREER_{ij}) + \gamma_{03}*(COLLABORATE_{j}) + \gamma_{04}*(SCIENCE\_INVESTIGATIONS_{ij}) + \gamma_{05}*(EXPERIENCE_{ij}) + \gamma_{06}*(PROFESSIONAL\_DEVELOPMENT_{ij}) + \gamma_{10}*(GENDER_{ij}) + \gamma_{20}*(HOMEWORK\_TIME_{ij}) + \gamma_{30}*(BULLY_{ij}) + \gamma_{40}*(PARENTAL\_INVOLVEMENT_{ij}) + \gamma_{50}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + U_{0j} + r_{ij}$

Table 4.7 summarizes the relationship between student- and teacher-level variables and 8^{th} grade students' science achievement in all three countries, namely Turkey, England and Finland.

Table 4.7 The Effects of Student- and Teacher-Level Variables on Science Achievement in Turkey, Finland and England

Type of Effect	**Turkey**		**Finland**		**England**	
	Unstandardized Coefficient(SE)	Standardized Coefficient	Unstandardized Coefficient(SE)	Standardized Coefficient	Unstandardized Coefficient(SE)	Standardized Coefficient
Fixed Effects						
Intercept	480.09***(3.60)		555.87***(1.99)		506.73***(12.97)	
Teacher-Level						
Confidence in Teaching Science	11.04, ns (6.45)	0.05, ns	1.32, ns (3.88)	0.01, ns	27.79* (14.05)	0.12*
Career Satisfaction	4.17** (1.48)	0.09**	1.55, ns (1.07)	0.04, ns	2.56, ns (2.24)	0.02, ns
Collaboration to Improve	0.81 (6.48)	0.003, ns	2.31, ns (5.21)	0.01, ns	-14.54, ns (11.06)	-0.08, ns
Emphasize Science	0.03, ns (1.51)	0.001, ns	1.27, ns (1.23)	0.03, ns	1.38, ns (3.34)	0.03, ns
Years of Experience	8.67, ns (5.98)	0.04, ns	-0.23, ns (4.16)	-0.001, ns	11.00, ns (10.63)	0.07, ns
Professional Development	1.64, ns (1.49)	0.03, ns	-0.27, ns (1.74)	-0.004, ns	-4.54, ns (2.76)	-0.10, ns
Student-Level						
Gender	8.49*** (2.17)	0.04***	3.51, ns (2.44)	0.03, ns	-5.86* (2.43)	-0.04*
Homework Time	-6.28** (2.35)	-0.03**	-21.80*** (4.02)	-0.09***	5.15, ns (2.61)	0.03, ns
Bullying at School	-6.59** (2.26)	-0.03***	3.13, ns (3.13)	0.02, ns	3.04, ns (2.90)	0.02, ns
Parental Involvement	-0.12, ns (0.43)	-0.003, ns	-1.23*** (0.36)	-0.06***	0.21, ns (0.35)	0.01, ns
Home Educational Resources	13.92***(0.70)	0.29***	15.22***(0.81)	0.35***	14.05***(0.74)	0.27***
Random Effects	Variance Component	SD	Variance Component	SD	Variance Component	SD
Between Class, u_0	1641.49***	40.52	383.66***	19.59	2778.25***	52.71
Within Class, r	6518.15	80.74	3227.19	56.81	2951.00	54.32

Notes: ns: Non-significant; SD: Standard deviation; SE: Standard Error; * p < 0.05 level, **p < 0.01, *** p < 0.001

As clear in Table 4.7, some of the student- and teacher-level variables were found non-significant on science achievement in Turkey, Finland and England. When a non-significant variable is found in the model, this variable was removed from the model, and the model was run again until the best model was found. The unstandardized coefficient and standard error values as well as standardized coefficient values shown in Table 4.7 were the values found in the best model.

In general, relationship between some teacherllevel variables (namely teachers' collaboration to improve teaching, emphasis on science investigations, professional development, experience) and students' science achievement was found non-significant in Turkey, England and Finland. There was a positive relationship between teachers' confidence in teaching science and students' science achievement only in England. One point increase in teachers' confidence in teaching science was associated with approximately 28 points increase in students' science achievement in England. Teachers' career satisfaction was found significant in the model explaining students' science achievement in Turkey. One point increase in teachers' career satisfaction was associated with approximately 4 points increase in students' science achievement in Turkey. None of the teacher-level variables selected in this study was found significant in the model explaining science achievement in Finland. As clearly explained in the following section named explained variances in science achievement, this finding does not necessarily mean teacher-level variables do not affect students' science achievement in Finland. This finding may be caused by the fact that teacher-level variables like teacher experience, career satisfaction, professional development … etc does not highly vary from classroom to classroom in Finland. To sum up, teacher-level variables found significant in the models varied from country to country. Teachers' career satisfaction was found positively significant in Turkey model, moreover, confidence in teaching science variable was found positively significant in England model. None of the teacher-level variables was found significant in Finland model when science achievement is the outcome variable.

Based on the HLM analysis results, following figures namely Figure 4.1 for Turkey, Figure 4.2 for Finland and Figure 4.3 for England were created for clearly explaining research questions 1 and 2.

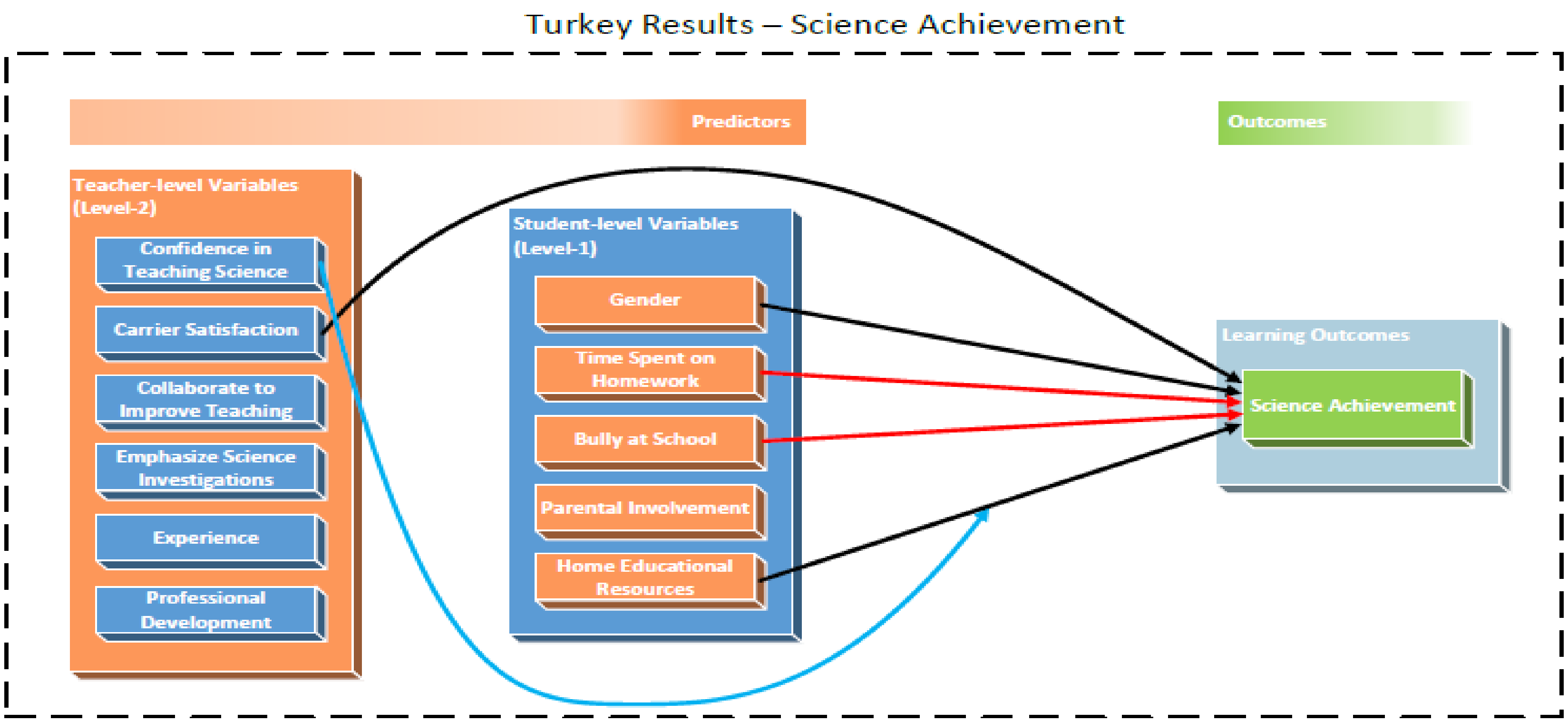


Figure 4.1 The Best Model of Turkey on Science Achievement

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on the relationship between level-1 predictors and outcome variable.

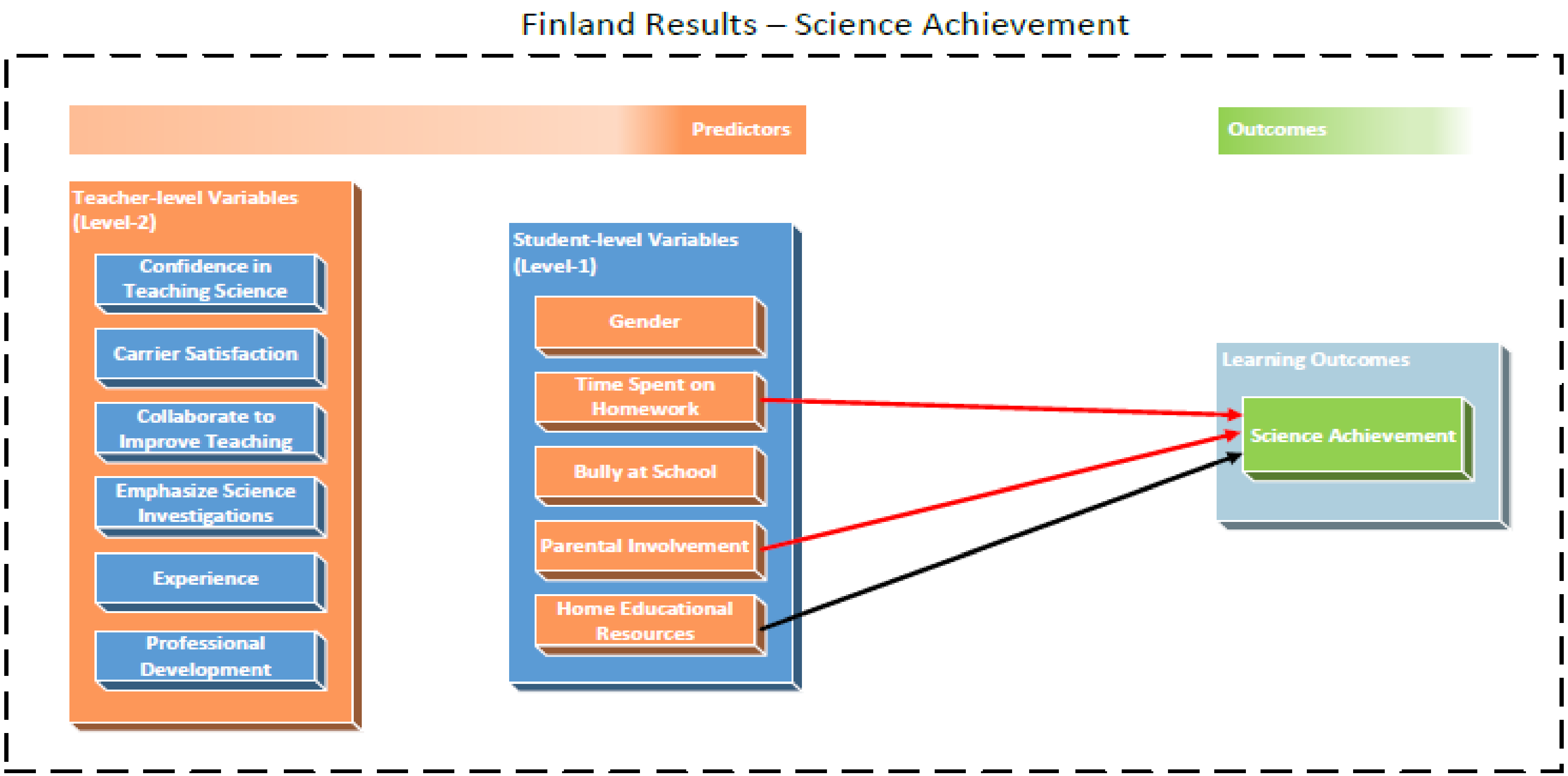


Figure 4.2 The Best Model of Finland on Science Achievement

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement.

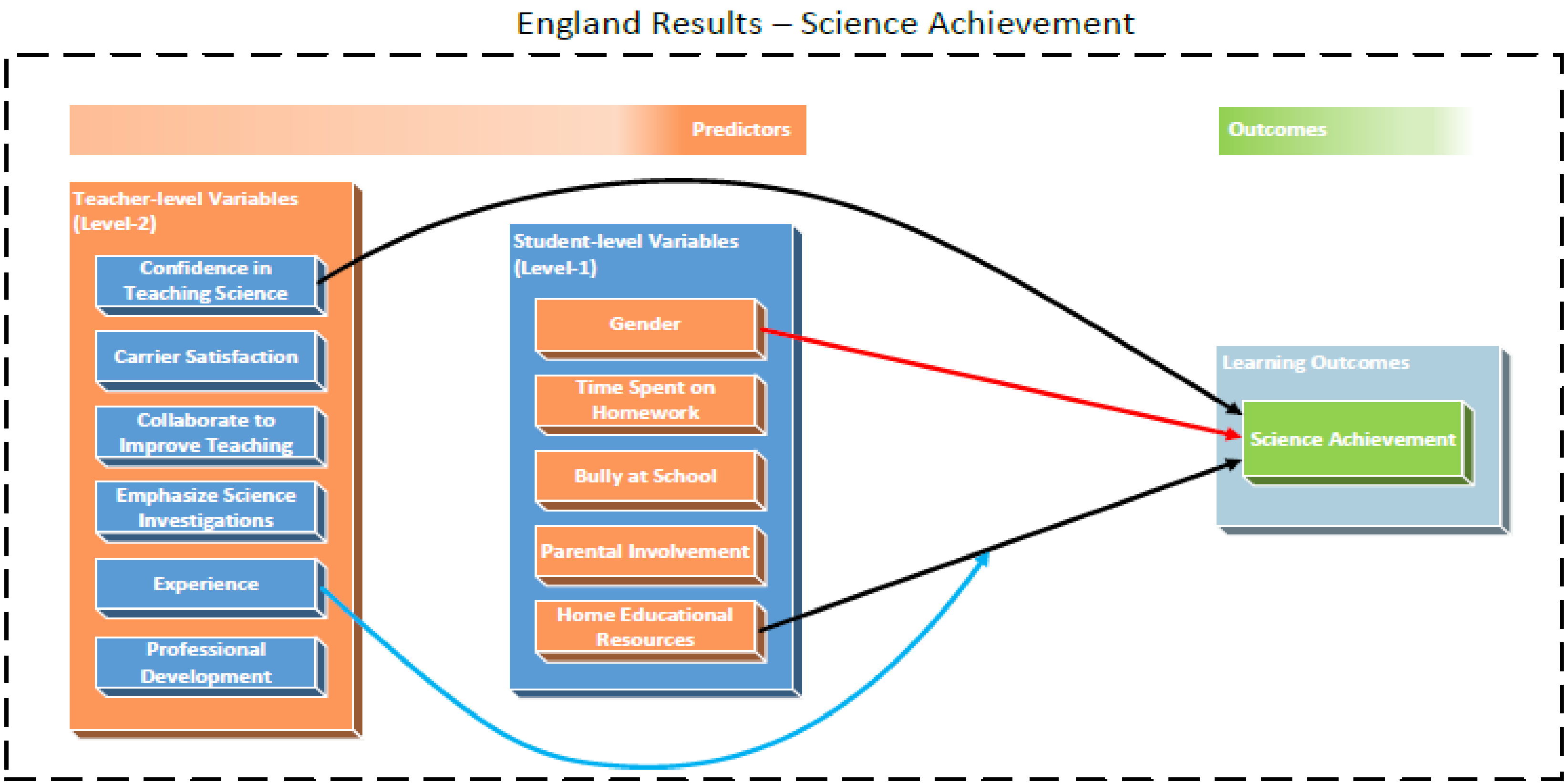


Figure 4.3 The Best Model of England on Science Achievement

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on the relationship between level-1 predictors and outcome variable

Based on the explanations above with the information in Table 4.7, regression equations of the final models for Turkey, England and Finland were calculated below:

For Turkey:

SCIENCE_ACHIEVEMENT = 480.09 + 4.17*CAREER + 8.49*GENDER – 6.28*HOMEWORK_TIME – 6.59*BULLY + 13.92*HOMEEDUCATIONAL_RESOURCES

For Finland:

SCIENCE_ACHIEVEMENT = 555.87 + 15.22*HOMEEDUCATIONAL_RESOURCES – 1.23*PARENTAL_INVOLVEMENT - 21.80*HOMEWORK_TIME

For England:

SCIENCE_ACHIEVEMENT = 506.73 + 27.79*CONFIDENCE_TEACHING_SCIENCE + 14.05*HOMEEDUCATIONAL_RESOURCES – 5.86*GENDER

4.2.4. Explained Variances in Science Achievement: 3rd Research Question

The third research question examined how much of the variance in 8th grade students' science achievement was explained by teacher- and student-level characteristics in Turkey, Finland and England. Explained variance at level-2 was calculated for Turkey, England and Finland as clearly stated below and then summarized in Table 4.8.

Turkey Results:

Explained variance at level 2: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$, where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level 2 for Turkey data when science achievement is outcome variable: $R_2^2 = (2807.34 - 1641.49) / 2807.34 = 0.415$

Conclusion: 41.5 % variance at 2nd level was explained by teachers' career satisfaction, students' gender, homework time, bullying at school and home educational resources when science achievement of 8th grade Turkish students was the outcome variable.

Variables of the lower level; which are the student level variables for the present study, can also explain some of the variance at 2nd level. Therefore, explained variances by student level predictors at level-2 were also calculated to see the effect of teacher-level variables after student-level variables were controlled. Explained variance at level 2 by student-level variables was calculated below.

Explained variance at level 2 by level-1 predictors: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$ where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level-2 by 1st level variables for Turkey data when science achievement is outcome variable: $R_2^2 = (2807.34 – 1713.63) / 2807.34 = 0.389$

Conclusion: 38.9 % variance at 2nd level was explained by gender, homework time, bullying at school and home educational resources when science achievement of 8th grade Turkish students was the outcome variable.

As calculated above, 38.9 % variance in 2nd level is explained by gender, homework time, bullying at school and home educational resources when science achievement of 8th grade Turkish students is the outcome variable. Therefore, unique variance explained by 2nd level variables: 41.5 % - 38.9 % = 2.6 %, in other words, 2.6 % of variance in 8th grade Turkish students' science achievement is explained by teachers' career satisfaction after all student level variables are controlled.

Total explained variance by the best model of Turkey:

Total explained variance by the model can be calculated as follows:

Total explained variance = (ICC at 1st Level of Explained Variance at 1st Level) + (ICC at 2st Level of Explained Variance at 2st Level)

Total explained variance by the best model:

(71.31 % of 6.6 %) + (28.69 % of 41.5 %) = 4.7 % + 11.91 %= 16.6 %

To sum up, this model explains 4.7 % variance in 8th grade Turkish students' science achievement at student-level, and 11.91 % variance at teacher level. Total explained variance in Turkish students' science achievement is 16.6 %.

Finland Results:

At level-2, the teacher level variables which are namely confidence in teaching science, teachers' career satisfaction, teachers' collaboration to improve teaching, teachers' emphasis on science investigations, years of experience and professional development were found non-significant in the model. This finding should be interpreted with caution. This finding does not necessarily mean that teacher-level variables do not affect students' science achievement in Finland, but it may mean that teacher characteristics do not vary in a large amount from classroom to classroom in Finland hence cannot explain variation in science achievement. Teachers in Finland may be similar in terms of their confidence in science, career satisfaction, emphasis in science investigations … etc., hence their characteristics affect students' science achievement in a same way. This finding may imply that teachers are raised in a similar way all over Finland, and they are all great as there is no difference between teachers in terms of their characteristics taken into account in this study. Related literature review about this assumption was explained in the discussion part.

Total explained variance by the best model of Finland:

Total explained variance by the model can be calculated as follows:

Total explained variance: (ICC at 1st Level of Explained Variance at 1st Level) + (ICC at 2st Level of Explained Variance at 2st Level)

Total explained variance by best model:

(87.95 % of 13.3 %) + (12.05 % of 0 %) = 11.7 % + 0 %= 11.7 %

To sum up, this model explains 11.7 % variance in 8th grade Finnish students' science achievement.

England Results:

Explained variance at level 2: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$, where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level-2 for England data when science achievement was outcome variable: $R_2^2 = (3889.56 - 2778.25) / 3889.56 = 0.286$

Conclusion: 28.6 % variance at 2nd level was explained by teachers' confidence in science, students' gender and home educational resources when science achievement of 8th grade English students was the outcome variable.

Variables of the lower level; which are the student level variables for the present study, can also explain some of the variance at 2nd level. Therefore, explained variances by student-level predictors at level-2 were also calculated to see the effect of teacher-level variables after student-level variables were controlled. Explained variance at level-2 by student-level variables was calculated below.

Explained variance at level-2 by level 1 variables for England data when science achievement was outcome variable: R_2^2 = (3889.56 – 2858.83 / 3889.56) = 0.264

Conclusion: 26.4 % variance at 2nd level was explained by gender, and home educational resources when science achievement of 8th grade English students was the outcome variable.

As calculated above, 26.4 % variance in 2nd level was explained by gender, and home educational resources when science achievement of 8th grade English students was the outcome variable. Therefore, unique variance explained by 2nd level variables: 28.6 % - 26.4 % = 2.2 %, in other words, 2.2 % of variance in 8th grade English students' science achievement was explained by only teachers' confidence in science after all student-level variables were controlled.

Total explained variance by the best model of England:

Total explained variance by the model can be calculated as follows:

Total explained variance: (ICC at 1st Level of Explained Variance at 1st Level) + (ICC at 2st Level of Explained Variance at 2st Level)

Total explained variance by the best model:

(46.04 % of 11.1 %) + (53.96 % of 28.6 %) = 5.1 % + 15.4 % = 20.5 %

To sum up, this model explains 5.1 % variance in 8th grade English students' science achievement at student-level, and 15.4 % variance at teacher level. Total explained variance in English students' science achievement is 20.5 %.

Table 4.8 gives information about explained variance at 1st level (student level), 2nd level (teacher level) and also total variance explained by the final model in Turkey, England and Finland.

Table 4.8 Explained Variances in 8th Grade Students' Science Achievement in Turkey, Finland and England

Explained Variance (%)	Turkey	Finland	England
Student-Level	4.7 %	11.7 %	5.1 %
Teacher-Level	11.91 %	-	15.4 %
Total	16.6 %	11.7 %	20.5 %

4.2.5. Adding Random Slopes

The slope coefficients between student-level variables and science achievement were also tested to figure out whether it is the same in every class or not. Hypothesis testing results stated that the relationships between homework time, home educational resources and students' science achievement differs between classrooms in Turkey. Hypothesis resting results suggested that relationship between parental involvement and students' science achievement differs between classes in Finland. Finally, hypothesis testing results suggested that the relationship between home educational resources and students' science achievement differs between classes in England. Hypothesis testing results were clearly explained below for each of the countries, namely Turkey, England and Finland.

For Turkey:

Hypothesis testing results indicated that the relationship between homework time, home educational resources and students' science achievement varied between classes in Turkey.

Relationship between Time spent on Homework and Students' Science Achievement:

The relationship between time spent on homework and students' science achievement is not the same in every class in Turkey. In other words, there is a variation in terms of the relationship between time spent on homework and science achievement between classes in Turkey (χ^2 (224): 295.31, $p<0.001$).

Relationship between Home Educational Resources and Students' Science Achievement:

The relationship between home educational resources and students' science achievement is not the same in every class in Turkey. In other words, there is a variation in terms of the relationship between home educational resources and science achievement between classes in Turkey (χ^2 (225): 281.04, $p<0.01$).

For Finland:

Hypothesis testing results indicated that the relationship between parental involvement and students' science achievement varies between classes in Finland.

Relationship between Parental Involvement and Students' Science Achievement:

The relationship between parental involvement and students' science achievement is not the same in every class in Finland. In other words, there is variation in terms of the relationship between parental involvement and science achievement between classes in Finland ($\chi 2$ (144): 181.36, $p<0.05$).

For England:

Hypothesis testing results indicated that the relationship between home educational resources and students' science achievement varies between classes in England.

Relationship between Home Educational Resources and Students' Science Achievement:

The relationship between home educational resources and students' science achievement is not the same in every class in England. In other words, there is variation in terms of the relationship between home educational resources and science achievement between classes in England ($\chi 2$ (111): 200.13, $p<0.001$).

4.2.6. Cross-Level Interactions

HLM allows researchers to investigate if relationship between lower-level variables and science achievement change as a function of higher level variables. Several models were run to reveal if there were possible interaction effects for each country. For Turkey cross-level interaction on science achievement between students' home educational resources and teachers' confidence in teaching science was found. For Finland, no significant cross-level interaction in the model was found. For England, cross-level interaction on science achievement between students' home educational resources and teachers' year of experience was found. These cross level interactions are explained below.

Cross level interaction between students' home educational resources and teachers' confidence in teaching science when 8th grade Turkish students' science achievement is the outcome variable:

Teachers' confidence in teaching science can explain (part of) the different relations between students' home educational resources and science achievement (t (225) = -2.03, p<0.05). Figure 4.4 shows the cross-level interaction between teacher confidence in teaching science and students' home educational resources on science achievement in Turkey.

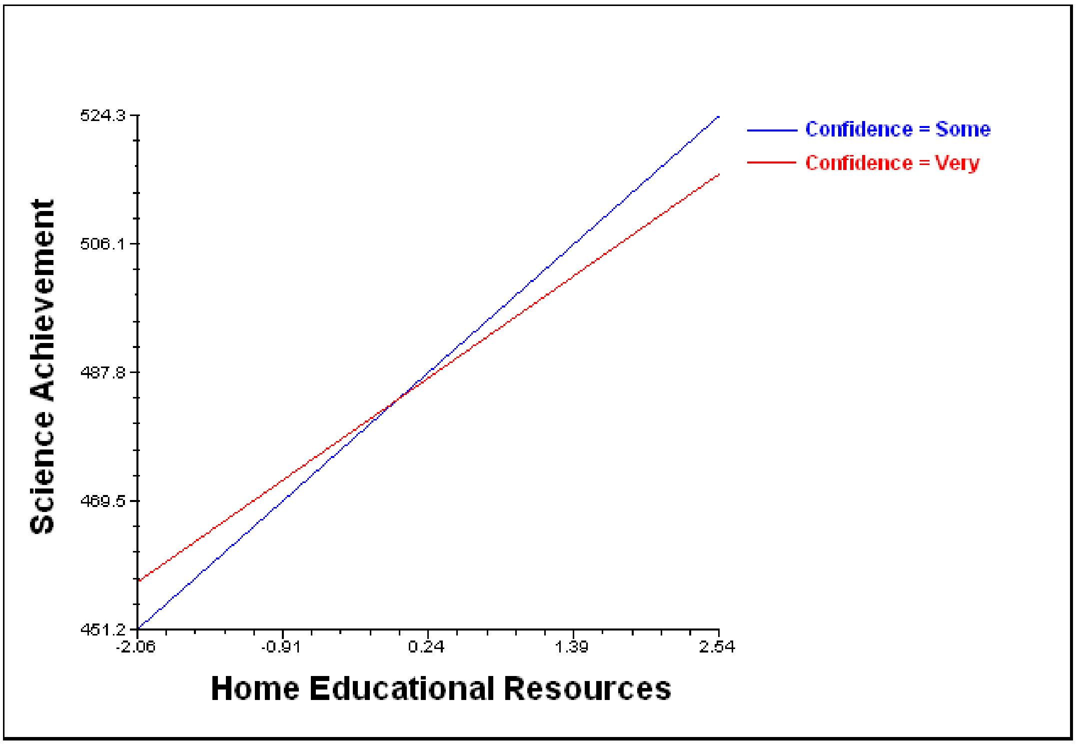


Figure 4.4 Students' Home-Educational Resources by Teacher Confidence in Teaching Science Interaction Predicting Students' Science Achievement in Turkey

As clear in Figure 4.4 in classes with less experienced teachers (worked less than 10 years), the effect of home educational resources is greater than in classes with more experienced teachers (worked more than 10 years).

Cross level interaction between students' home educational resources and teachers' year of experience when 8th grade English students' science achievement is the outcome variable:

Teachers' years of experience can explain (part of) the different relations between students' home educational resources and science achievement (t (111) = -2.45, $p<0.05$). Figure 4.5 shows the cross-level interaction between teacher experience and students' home educational resources on science achievement in Turkey.

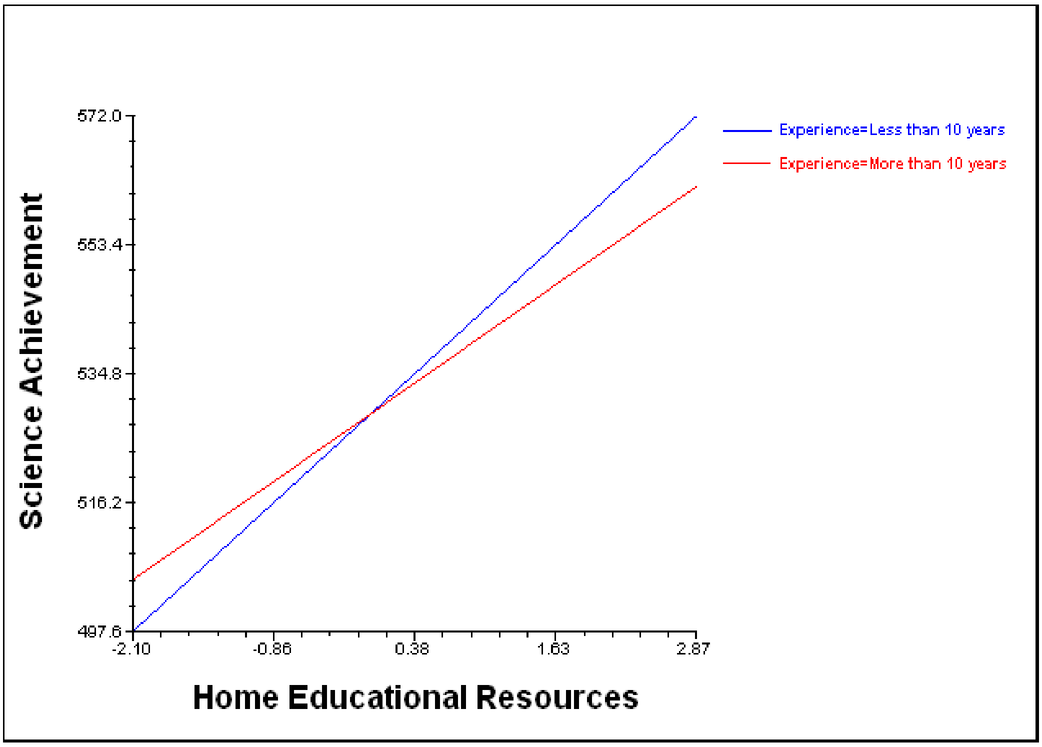


Figure 4.5 Students' Home-Educational Resources by Teacher Experience Interaction Predicting Students' Science Achievement in England

As clear in Figure 4.5 the relationship between science achievement and home educational resources varies according to teacher experience. In classes with less experienced teachers (worked less than 10 years), the effect of home educational resources is greater than in classes with more experienced teachers (worked more than 10 years).

4.3. Analysis Results on Attitude toward Science in Turkey, Finland and England

Attitude toward science is the second dependent variable of the present study. This section explained the relationship between student- and teacher-level variables and 8^{th} grade students' attitude toward science in Turkey, England and Finland. Research questions related to attitude toward science were answered with relevant HLM analysis in this section.

4.3.1. Variation in Attitude toward Science within and between Classrooms

Empty model was run by HLM 7 Program to determine the variation in 8^{th} grade students' attitude toward science within and between classrooms in Turkey, Finland and England. Neither student-level nor teacher-level variables were introduced to this empty model. Model equations for level-1 which is student level and level-2 which is teacher level are below:

Level-1 (Student Level):

$ATTITUDE_{ij} = \beta_{0j} + r_{ij}$

In the level-1 model equation, r_{ij} is the error variance for student i in the classroom j.

Level-2 (Teacher Level):

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

In the level-2 model equation, u_{0j} is the error variance for class j.

Mixed Model:

$ATTITUDE_{ij} = \gamma_{00} + u_{0j} + r_{ij}$

Table 4.9 explains the variation in attitude toward science at both student and teacher level for Turkey, England and Finland.

Table 4.9 Maximum Likelihood Estimates of the Variance Components of Attitude toward Science at the Student- and Classroom-Level

Random Effect	Variance Component	SD	df	Chi-square	p-value
Turkey					
INTRCPT1, *u0*	0.29	0.54	226	1030.68	<0.001
level-1, *r*	2.24	1.50			
Finland					
INTRCPT1, u_0	0.13	0.36	139	368.98	<0.001
level-1, *r*	1.51	1.23			
England					
INTRCPT1, u_0	0.20	0.45	112	392.48	<0.001
level-1, *r*	2.53	1.59			

Notes: SD: Standard Deviation; df: Degrees of freedom

Variance components table (Table 4.9) also gives us important information about whether we should perform a multilevel analysis or not. In order to be able to perform an HLM analysis, the individuals in the same group should be more alike in terms of their attitude toward science than the individuals in the different groups. Chi^2-test was performed to see whether an HLM analysis is required or not.

Chi^2-test for Turkey data;

Students in the same class are more alike than the students in different classes in terms of attitude toward science in Turkey. This chi^2-test result suggested that HLM analysis is required for Turkey data.

Chi^2-test results: $\chi 2$ (226): 1030.68 , $p<0.001$

Chi^2-test for Finland data;

Students in the same class are more alike than the students in different classes in terms of attitude toward science in Finland. This chi^2-test result suggested that HLM analysis is required for Finland data.

Chi^2-test results: $\chi 2$ (139): 368.98, $p<0.001$

Chi^2-test for England data;

Students in the same class are more alike than the students in different classes in terms of attitude toward science in England. This chi^2-test result suggested that HLM analysis is required for England data.

Chi^2-test results: $\chi 2$ (112): 392.48, $p<0.001$

Intra-class correlation values for students' attitude toward science:

Before performing the multilevel analysis, it is important to analyze the extent of the students differed between classes with respect to the dependent variables. In this aspect intra-class correlation (ICC) values are calculated. ICC formula is below:

$ICC = \rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

By using ICC values, the percentage of between-classroom variance and within-classroom variance in students' attitude toward science can be calculated. Between-classroom variance and within-classroom variance in attitude toward science play an important role in interpreting HLM model results.

Intra-class correlation values for students' attitude toward science in Turkey:

$ICC = \rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

$ICC = \rho = 0.29 / (0.29 + 2.24) \times 100\ \% = 11.5\ \%$

This value is interpreted as the percentage variance at the second level. Therefore, we can conclude that 11.5 % variance of attitude toward science was explained by teacher level variables in Turkey. Furthermore, based on the following calculations, we can calculate the percentage of between-classroom variance and within-classroom variance in attitude toward science in Turkey.

ρ (between-class) = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ρ (between-class) = 0.29 / (0.29 + 2.24) x 100 % = 11.5 %

For Turkey, 11.5 % variance in attitude toward science was explained by teacher-level variables.

ρ (within-class) = $\sigma^2_e / (\sigma^2_{u0} + \sigma^2_e)$

ρ (within-class) = 2.24 / (0.29 + 2.24) x 100 % = 88.5 %

For Turkey, 88.5 % variance in attitude toward science was explained by student-level variables.

Intra-class correlation values for students' attitude toward science in Finland:

ICC= ρ = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ICC = ρ = 0.13 / (0.13 + 1.51) x 100 % = 7.9 %

This value is interpreted as the percentage variance at the second level. Therefore, we can conclude that 7.9 % variance of attitude toward science was explained by teacher level variables in Finland. Furthermore, based on the following calculations, we can calculate the percentage of between-classroom variance and within-classroom variance in attitude toward science in Finland.

ρ (between-class) = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ρ (between-class) = 0.13 / (0.13 + 1.51) x 100 % = 7.9 %

For Finland, 8th grade classrooms, 7.9 % variance in attitude toward science was explained by teacher-level variables.

ρ (within-class) = $\sigma^2_e / (\sigma^2_{u0} + \sigma^2_e)$

ρ (within-class) = 1.51 / (0.13 + 1.51) x 100 % = 92.1 %

For Finland, 8th grade classrooms, 92.1 % variance in attitude toward science was explained by student-level variables.

Intra-class correlation values for students' attitude toward science in England:

ICC = $\rho = \sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ICC = ρ = 0.20 / (0.20 + 2.54) x 100 % = 7.3 %

This value is interpreted as the percentage variance at the second level. Therefore, we can conclude that 7.3 % variance of attitude toward science was explained by teacher level variables in England. Furthermore, based on the following calculations, we can calculate the percentage of between-classroom variance and within-classroom variance in attitude toward science in England.

ρ (between-class) = $\sigma^2_{u0} / (\sigma^2_{u0} + \sigma^2_e)$

ρ (between-class) = .20 / (0.20 + 2.54) x 100 % = 7.3 %

For England, 8th grade classrooms, 7.3 % variance in attitude toward science was explained by teacher-level variables.

ρ (within-class) = $\sigma^2{}_e / (\sigma^2_{u0} + \sigma^2_e)$

ρ (within-class) = 2.54 / (0.20 + 2.54) x 100 % = 92.7 %

For England, 8th grade classrooms, 92.7 % variance in attitude toward science was explained by student-level variables.

Table 4.10 explains the percentages of variance in students' attitude toward science within- and between-classrooms in Turkey, England and Finland.

Table 4.10 Percentage of Between-Classroom Variance and Within-Classroom Variance in Attitude toward Science

Percentage of Variance	Turkey	Finland	England
ρ (between-class)	11.5 %	7.9 %	7.3 %
ρ (within-class)	88.5 %	92.1 %	92.7%

4.3.2. Relationship between Student-Level Variables and Students' Attitude toward Science: 4th Research Question

The fourth research question examined which student characteristics are significantly related to 8th grade students' attitude toward science in Turkey, Finland and England after home educations resources (HER) is controlled. The student-level variables were gender, parental involvement, time-spent on science homework, bullied at school and home education resources. At this step, all of the student-level variables were introduced to the model, whereas none of the teacher-level variables were used. The relationship between student-level variables and students' attitude toward science was analyzed separately for Turkey, Finland and England.
The following model was used at this step:

Level-1 Model:

$ATTITUDE_{ij} = \beta_{0j} + \beta_{1j}*(GENDER_{ij}) + \beta_{2j}*(HOMEWORK\_TIME_{ij}) +$
$\beta_{3j}*(BULLY_{ij}) + \beta_{4j}*(PARENTAL\_INVOLVEMENT_{ij}) +$
$\beta_{5j}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + r_{ij}$

Level-2 Model:

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

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

$\beta_{3j} = \gamma_{30}$

$\beta_{4j} = \gamma_{40}$

$\beta_{5j} = \gamma_{50}$

Mixed Model:

$ATTITUDE_{ij} = \gamma_{00} + \gamma_{10}*(GENDER_{ij}) + \gamma_{20}*(HOMEWORK\_TIME_{ij}) +$
$\gamma_{30}*(BULLY_{ij}) + \gamma_{40}*(PARENTAL\_INVOLVEMENT_{ij}) +$
$\gamma_{50}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + U_{0j} + r_{ij}$

Table 4.11 explains the effects of student-level variables on attitude toward science in all three countries namely Turkey, Finland and England.

Table 4.11 The Effects of Student-Level Variables on Attitude toward Science in Turkey, Finland and England

Type of Effect	**Turkey**		**Finland**		**England**	
	Unstandardized Coefficient (SE)	Standardized Coefficient	Unstandardized Coefficient (SE)	Standardized Coefficient	Unstandardized Coefficient (SE)	Standardized Coefficient
Fixed Effects						
Intercept	10.21*** (0.05)		9.22*** (0.04)		10.14*** (0.07)	
Student-Level						
Gender	0.12** (0.04)	0.04**	-0.26*** (0.05)	-0.10***	-0.59*** (0.05)	-0.18***
Homework Time	0.08, ns (0.04)	0.03, ns	0.21*** (0.08)	0.05***	0.42*** (0.06)	0.11***
Bullying at School	- 0.16*** (0.04)	-0.05***	0.05, ns (0.05)	0.02, ns	- 0.13* (0.06)	-0.04*
Parental Involvement	0.11*** (0.01)	0.20***	0.07*** (0.01)	0.16***	0.10*** (0.01)	0.18***
Home Educational Resources	0.08*** (0.01)	0.10***	0.19*** (0.02)	0.22***	0.17*** (0.02)	0.16***
Random Effects	Variance Component	SD	Variance Component	SD	Variance Component	SD
Between Class, u_0	0.31***	0.56	0.09***	0.30	0.17***	0.42
Within Class, r	2.10	1.45	1.38	1.18	2.25	1.50

Notes: NS: Non-significant; SD : Standard deviation; SE: Standard Error; * p<0.05 level, **p<0.01, ***p<0.001

As clear, in Table 4.11, some of the student-level variables were found non-significant on students' attitude toward science in Turkey, Finland and England. When a non-significant variable was found in the model, this variable was removed from the model, and the model was run again until the best model was found. The unstandardized coefficient and standard error values as well as standardized values shown in Table 4.11 are the values found in the best model after non-significant student-level variables were removed from the model.

All of the student-level variables were found significantly related to the 8th grade English students' attitude toward science. In Turkey, gender, bullying at school, parental involvement and home educational resources were found significant whereas time spent on homework was found non-significant in the best model explaining students' attitude toward science. In Finland, gender, time spent on science homework, parental involvement and home educational resources were found significant whereas bullying at school was found non-significant in the best model explaining students' attitude towards science.

Results of the HLM model after adding student-level variables showed that home educational resources, gender, and parental involvement have a significant relationship with attitude toward science in all three countries namely Turkey, Finland and England. Gender was found significant in models explaining 8th grade students' attitude toward science in Turkey, England and Finland. In other words, being a female or a male student created a difference in attitude toward science in Turkey, England and Finland. More specifically, on average female students had attitude toward science approximately 0.12 points higher than male students in Turkey, and male students had attitude toward science approximately 0.26 points higher than female students in Finland and 0.59 points higher than female students in England. In Turkey, on average female students had more attitude toward science than male students whereas, in England and Finland male students had more attitude toward science than female students in science.

Home educational resources variable showed significant relationship between students' attitude toward science in all three countries namely Turkey, England and Finland. The relationship between home educational resources and students' attitude toward science was found positive in all these three countries. In other words, the higher the home educational resources of students, the higher attitude toward science students have. On average, one point increase in home educational resources was associated with 0.08 points increase in Turkish students' attitude toward science, 0.19 points increase in Finnish students' attitude toward science and 0.17 points increase in English students' attitude toward science.

Time spent on science homework showed positive significant relationship with students' attitude toward science in England and Finland, whereas, a non-significant relationship was found in Turkey model. Spending at least 45 minutes in a week for science homework was related with 0.21 points increase in 8th grade Finnish students' attitude toward science, and 0.42 points increase in 8th grade English students' attitude toward science.

Bullying at school showed a significant relationship with students' attitude toward science in Turkey and England, whereas non-significant relationship was found in Finland. Being bullied at school has a negative relationship with attitude toward science both in Turkey and England. On average, being bullyied at school weekly or monthly was associated with 0.16 point decrease in students' attitude toward science in Turkey and 0.13 point decrease in students' attitude toward science in England. Attitude toward science score difference related with being bullied at school is lowest compared to effects of other student-level variables in England.

Parental involvement was yet another variable showing significant relationship with attitude toward science in all these three countries. Parental involvement and students' attitude toward science showed a positive relationship in Turkey, Finland and England. On average, one point increase in parental involvement was associated with 0.11 point increase in Turkish students', 0.07 point increase in Finnish students' and 0.10 point increase in English students' attitude toward science. Standardized coefficient values show that attitude toward science score difference related with one point increase in parental involvement was greater than one point increase in home educational resources in Turkey and England, whereas, it is less in Finland model.

Explained variance at level 1 by level 1 predictors

In addition to the information given above in the Table 4.11, explained variances at level-1 were also calculated in order to deeply explain the relationship between student-level variables and 8th grade students' attitude toward science. Explained variance at level-1: R12 = (σ2eIb – σ2eIm) / σ2eIb where σ2eIb is total error variance in the intercept only model; and σ2eIm is error variance left in the model with predictors. Explained variance at level 1 was calculated below for Turkey, England and Finland.

Turkey Data:

Explained variance at level-1 for Turkey data when attitude toward science is the outcome variable: $R_1^2 = (2.24 – 2.10) / 2.24 = 0.063$

Conclusion: 6.3 % of variance in 1st level was explained by 1st level (student-level) variables which are gender, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade Turkish students was the outcome variable.

4th research question of the present thesis focused on the relationship between student level variables and 8th grade students' attitude toward science in Turkey (and also in England and Finland) after home educational resources (HER) was controlled. Below, the explained variance by student-level variables in Turkish students' attitude toward science was calculated after home educational resources variable was controlled.

Explained variance at level-1 ONLY by home educational resources variable:

$R_1^2 = (2.24 – 2.20) / 2.24 = 0.018$

Conclusion: 1.8 % of variance at 1st level was explained only by home educational resources when attitude toward science of 8th grade Turkish students was the outcome variable. Therefore, unique variance explained by student-level variables after home educational resources variable was controlled: 6.3 % - 1.8 % = 4.5 %. To sum up, whole model explained 6.3 % variance in 8th grade Turkish students' attitude toward science. Moreover, students' gender, bullying at school and parental involvement explained 4.5 % of variance at 1st level after home educational resources variable was controlled for Turkey data when attitude toward science was the outcome variable.

Finland Data:

Explained variance at level-1 for Finland data when attitude toward science is the outcome variable: R_1^2 = (1.51– 1.38) / 1.51 = 0.086

Conclusion: 8.6 % of variance at 1st level was explained by 1st level (student-level) variables which are gender, parental involvement, homework time, and home educational resources when attitude toward science of 8th grade Finnish students was the outcome variable.

1st research question of the present thesis focused on the relationship between student level variables and 8th grade students' attitude toward science in Finland (and also in England and Turkey) after home educational resources (HER) was controlled. Below, the explained variance by student-level variables in Finnish students' attitude toward science was calculated after home educational resources variable was controlled.

Explained variance at level-1 ONLY by home educational resources variable:

R_1^2 = (1.51 – 1.45) / 1.51 = 0.040

Conclusion: 4.0 % of variance in 1st level was explained only by home educational resources when attitude toward science of 8th grade Finnish students was the outcome variable. Therefore, unique variance explained by student-level variables after home educational resources variable was controlled: 8.6 % - 4.0 % = 4.6 %. To sum up, whole model explained 8.6 % variance in 8th grade Finnish students' attitude toward science. Moreover, students' gender, parental involvement and homework time explained 4.6 % of variance in 1st level after home educational resources variable was controlled for Finland data when attitude toward science was the outcome variable.

England Data:

Explained variance at level-1 for England data when attitude toward science is the outcome variable: R_1^2 = (2.53 – 2.24) / 2.53 = 0.114

Conclusion: 11.4 % of variance at 1st level was explained by 1st level (student-level) variables which are gender, homework time, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade English students is the outcome variable.

1st research question of the present thesis focused on the relationship between student level variables and 8th grade students' attitude toward science in England (and also in Turkey and Finland) after home educational resources (HER) is controlled. Below, the explained variance by student level variables in English students' attitude toward science was calculated after home educational resources variable was controlled.

Explained variance at level-1 ONLY by home educational resources variable:

$R_1^2 = (2.53 – 2.46) / 2.53 = 0.028$

Conclusion: 2.8 % of variance at 1st level was explained only by home educational resources when attitude toward science of 8th grade English students was the outcome variable. Therefore, unique variance explained by student-level variables after home educational resources variable was controlled: 11.4 % - 2.8 % = 8.6 %. To sum up, whole model explained 11.4 % variance in 8th grade English students' attitude toward science. Moreover, students' gender, homework time, bullying at school and parental involvement explained 8.6 % of variance in 1st level after home educational resources variable was controlled for England data when attitude toward science was the outcome variable.

Below table, namely Table 4.12 summarized explained variance in 8th grade Turkish, Finnish and English students' attitude toward science by only home educational resources variable and level-1 predictors after controlling home educational resources.

Table 4.12 Explained Variance in 8th Grade Students' Attitude toward Science by Student-Level Predictors

Explained Variance %	**TURKEY**	**FINLAND**	**ENGLAND**
Attitude toward Science			
Level-1 Predictors	6.3 %	8.6 %	11.4 %
Only HER	1.8	4.0 %	2.8 %
Level-1 Predictors after controlling HER	4.5 %	4.6 %	8.6 %

As clear in Table 4.12 explained variance in attitude toward science by student-level (level-1) variables range from 6.3 % (in Turkey) to 11.4 % (in England). More variance in attitude toward science was explained by Level-1 predictors in England compared to Turkey and Finland. Furthermore, explained variance in attitude toward science only by home educational resources range from 1.8 % (in Turkey) to 4.0 % (in Finland). Based on these findings, explained variance by level-1 predictors after controlling HER was calculated in Turkey, Finland and England. Explained variance in attitude toward science by student-level variables after controlling home educational resources was ranged from 4.5 % (in Turkey) to 8.6 % (in England). Explained variance in attitude toward science by student-level variables after controlling home educational resources was greater than explained variance in attitude toward science only by home educational resources in all three countries. These findings also picturized that not only home educational resources but also other student-level variables explained great deal of variance in attitude toward science in all these three countries.

4.3.3. Relationship between Teacher-Level Variables and Students' Attitude toward Science: 5th Research Question

The fifth research question examined which teacher characteristics are significantly related to 8th grade students' attitude toward science in Turkey, Finland and England. In order to answer this research question two-level model was run with HLM 7 Programe. Multi-collinearity plays an important role in HLM analysis. Multi-collinearity tests should be performed before running the HLM analyses and if there are some variables showing high VIF values in multi-collinearity test, then these variables should be removed from the model. In the present study, multi-collinearity tests were performed before running the HLM models, and there was no multi-collinearity effect. The multi-collinearity test results with VIF values for Turkey, England and Finland were presented in Appendix A.

The teacher-level variables were teachers' confidence in teaching science, teacher career satisfaction, collaborate to improve teaching, teachers emphasize science investigations, teachers' professional development and teacher experience. The relationship between student- and teacher-level variables and students' science achievement were analyzed separately for Turkey, Finland and England. Table 4.13 summarizes the HLM analysis results of best models for Turkey, England and Finland; moreover HLM models of each country were presented separately in Appendix B.

The Relationship between Student- and Teacher-Level Variables and Students' Attitude toward Science

At this step of the analysis, all of the teacher-level variables were added to the model, and then non-significant teacher-level variables were removed from the model one by one until obtaining the best-fit model. Following model used in this step:

Level-1 Model

$ATTITUDE_{ij} = \beta_{0j} + \beta_{1j}*(GENDER_{ij}) + \beta_{2j}*(HOMEWORK\_TIME_{ij}) +$

$\beta_{3j}*(BULLY_{ij}) + \beta_{4j}*(PARENTAL\_INVOLVEMENT_{ij}) +$

$\beta_{5j}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + r_{ij}$

Level-2 Model

$\beta_{0j} = \gamma_{00} + \gamma_{01}*(CONFIDENCE_{j}) + \gamma_{02}*(CAREER_{j}) + \gamma_{03}*(COLLABORATE_{j}) +$

$\gamma_{04}*(SCIENCE\_INVESTIGATIONS_{j}) + \gamma_{05}*(EXPERIENCE_{j}) +$

$\gamma_{06}*(PROFESSIONAL\_DEVELOPMENT_{j}) + u_{0j}$

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

$\beta_{3j} = \gamma_{30}$

$\beta_{4j} = \gamma_{40}$

$\beta_{5j} = \gamma_{50}$

$\beta_{6j} = \gamma_{60}$

Mixed model:

$ATTITUDE_{ij} = \gamma_{00} + \gamma_{01}*(CONFIDENCE_{ij}) + \gamma_{02}*(CAREER_{ij}) +$
$\gamma_{03}*(COLLABORATE_{j}) + \gamma_{04}*(SCIENCE\_INVESTIGATIONS_{ij}) +$
$\gamma_{05}*(EXPERIENCE_{ij}) + \gamma_{06}*(PROFESSIONAL\_DEVELOPMENT_{ij}) +$
$\gamma_{10}*(GENDER_{ij}) + \gamma_{20}*(HOMEWORK\_TIME_{ij}) + \gamma_{30}*(BULLY_{ij}) +$
$\gamma_{40}*(PARENTAL\_INVOLVEMENT_{ij}) +$
$\gamma_{50}*(HOMEEDUCATIONAL\_RESOURCES_{ij}) + U_{0j} + r_{ij}$

Table 4.13 summarized the relationship between student- and teacher-level variables and 8th grade students' attitude toward science in all three countries, namely Turkey, England and Finland.

Table 4.13 The Effects of Student- and Teacher-Level Variables on Attitude toward Science in Turkey, Finland and England

Type of Effect	**Turkey**		**Finland**		**England**	
	Unstandardized Coefficient(SE)	Standardized Coefficient	Unstandardized Coefficient(SE)	Standardized Coefficient	Unstandardized Coefficient(SE)	Standardized Coefficient
Fixed Effects						
Intercept	10.38*** (06)		9.31*** (0.06)		10.14*** (0.08)	
Teacher-Level						
Confidence in Teaching Science	0.16 (0.09)	0.05, ns	-0.07, ns (0.08)	-0.03, ns	-0.07, ns (0.13)	-0.02, ns
Career Satisfaction	0.03, ns (0.02)	0.04, ns	0.00, ns (0.02)	0.00, ns	0.01, ns (0.02)	0.01, ns
Collaboration to Improve	-0.05, ns (0.09)	-0.01, ns	-0.08, ns (0.09)	-0.02, ns	-0.02, ns (0.10)	-0.01, ns
Emphasize Science	0.04* (0.02)	0.05*	0.05* (0.02)	0.06*	-0.01, ns (0.03)	0.01, ns
Years of Experience	-0.40*** (0.08)	-0.13***	-0.15* (0.07)	-0.06*	0.26** (0.09)	0.08**
Professional Development	-0.02, ns (0.02)	-0.03, ns	-0.01, ns (0.03)	-0.001, ns	0.04, ns (0.02)	0.05, ns
Student-Level						
Gender	0.12** (0.04)	0.04**	-0.26*** (0.05)	-0.10***	-0.59*** (0.05)	-0.18***
Homework Time	0.08, ns (0.04)	0.03, ns	0.21*** (0.08)	0.05***	0.42*** (0.06)	0.11***
Bullying at School	-0.17*** (0.04)	-0.05***	-0.05, ns (0.05)	-0.02, ns	-0.13* (0.06)	-0.04*
Parental Involvement	0.11*** (0.01)	0.20***	0.07*** (0.01)	0.16***	0.11*** (0.01)	0.20***
Home Educational Resources	0.09*** (0.01)	0.12***	0.21*** (0.08)	0.24***	0.17*** (0.02)	0.16***
Random Effects	Variance Component	SD	Variance Component	SD	Variance Component	SD
Between Class, u_0	0.27***	0.52	0.08***	0.28	0.14***	0.37
Within Class, r	2.09	1.45	1.38	1.18	2.28	1.51

Notes. ns: Non-significant; SD: Standard deviation; SE: Standard Error; * p < 0.05 level, **p < 0.01, *** p < 0.001

In general, the relationship between teachers' confidence in teaching science, career satisfaction, collaboration to improve teaching science, professional development and students' attitude toward science was found non-significant in Turkey, England and Finland. The relationship between teacher experience and 8th grade students' attitude toward science was found significant in all three countries. Moreover, teachers' emphasis on science investigations was found significant in Turkey and Finland models.

Both the magnitude and direction of the relationship between teacher experience and 8th grade students' attitude toward science differed from country to country. There is a negative relationship in Turkey and Finland models, whereas a positive relationship is found in England model. In other words, in Turkey and Finland students with less than 10 years experienced teachers were more favored in terms of attitude toward science compared to students with more than 10 years experienced teachers, and the opposite situation was valid in England model. Having a teacher worked less than 10 years was associated with approximately 0.40 point increase in Turkish students' attitude toward science, 0.15 point increase in Finnish students' attitude toward science, and 0.26 point decrease in English students' attitude toward science.

Teachers' emphasis on science investigations was found significant in Turkey and Finland models. A positive relationship between teachers' emphasis on science investigations and students' attitude toward science was found in either model. In other words, the more science investigations teachers emphasize, the more attitude toward science 8th grade Turkish and Finnish students have. One point increase in emphasis in science investigations was associated with 0.04 point increase in Turkish students' attitude toward science and 0.05 point increase in Finnish students' attitude toward science. Standardized coefficients show that the attitude toward science score difference related with one point increase in teachers' emphasis on science investigations was lower than attitude toward science score difference related with teacher experience in Turkey.

Based on the HLM analysis results, following figures namely Figure 4.6 for Turkey, Figure 4.7 for Finland and Figure 4.8 for England were created for clearly explaining research questions 4 and 5.

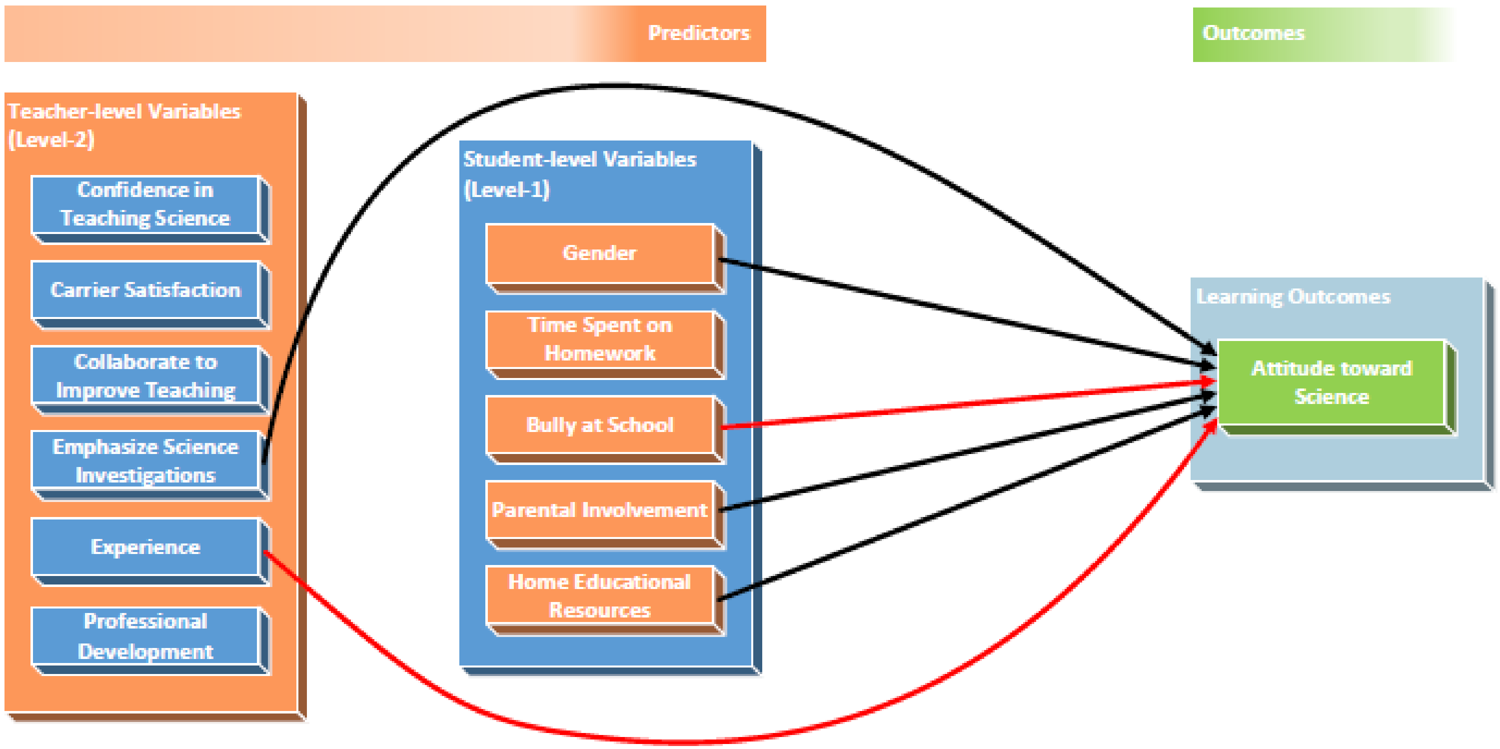


Figure 4.6 The Best Model of Turkey on Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement.

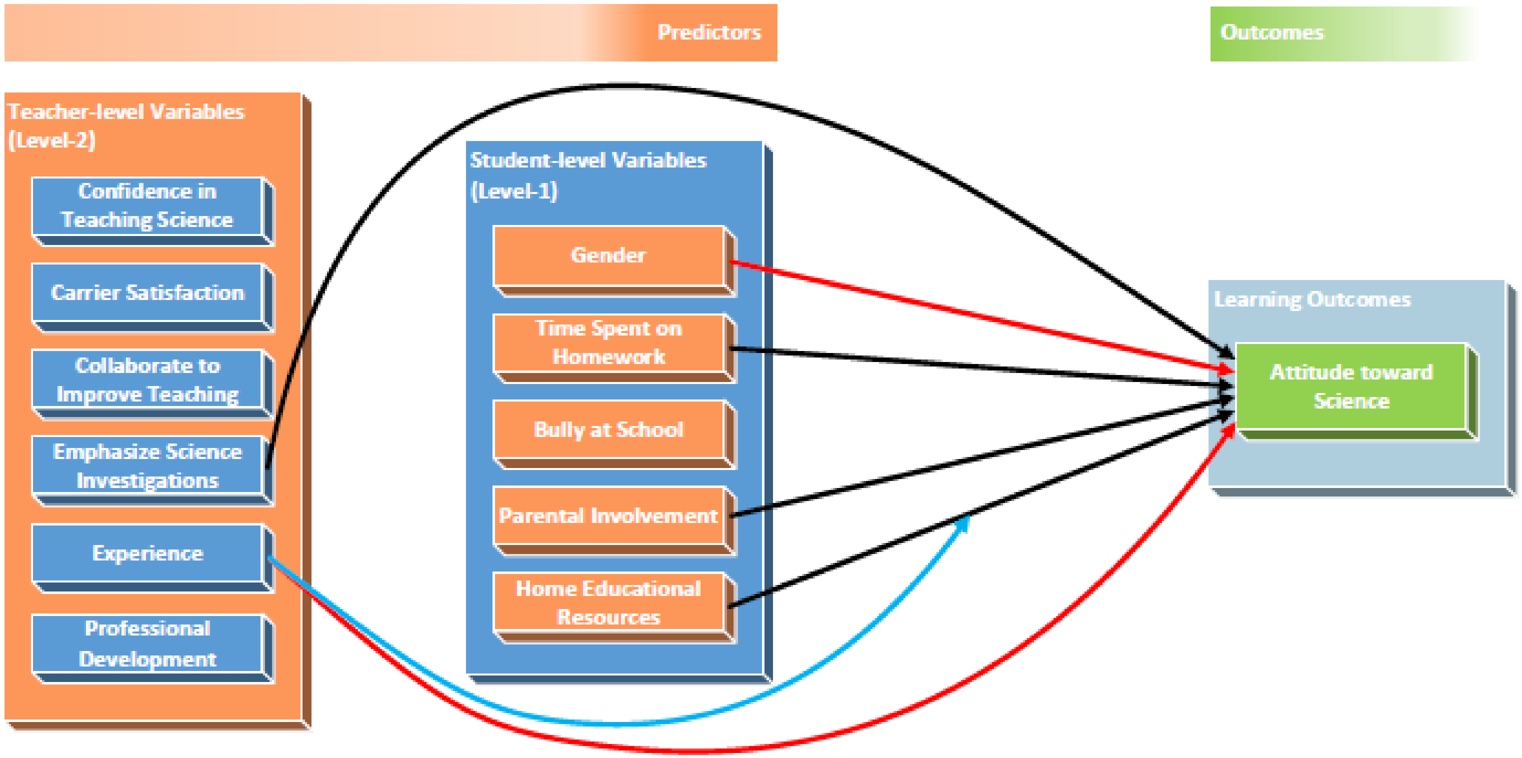


Figure 4.7 The Best Model of Finland on Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on the relationship between level-1 predictors and outcome variable.

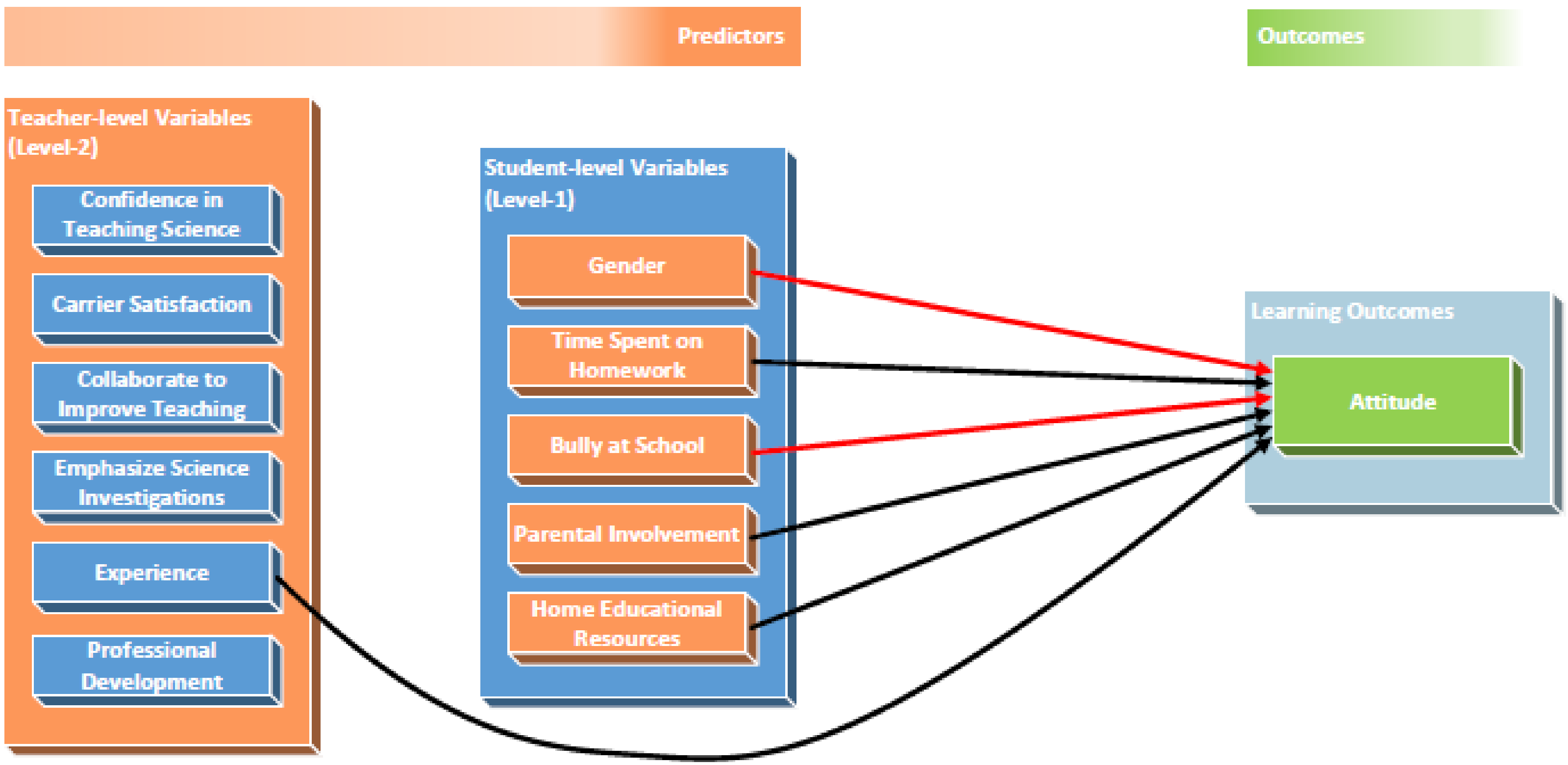


Figure 4.8 The Best Model of England on Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement.

Based on the explanations above with the information in Table 4.13, regression equations of the final models for Turkey, England and Finland were calculated below:

For Turkey:

ATTITUDE = 10.38 - 0.40*EXPERIENCE + 0.04*SCIENCE_INVESTIGATIONS + 0.09*HOMEEDUCATIONAL_RESOURCES - 0.17*BULLY + 0.12*GENDER + 0.11*PARENTAL_INVOLVEMENT

For Finland:

ATTITUDE = 9.31 - 0.15*EXPERIENCE + 0.05*SCIENCE_INVESTIGATIONS - 0.26*GENDER + 0.21*HOMEWORK_TIME + 0.07*PARENTAL_INVOLVEMENT + 0.21*HOMEEDUCATIONAL_RESOURCES

For England:

ATTITUDE = 10.14 + 0.26*EXPERIENCE + 0.17*HOMEEDUCATIONAL_RESOURCES - 0.59*GENDER + 0.42*HOMEWORK_TIME + 0.11*PARENTAL_INVOLVEMENT - 0.13*BULLY

4.3.4. Explained Variances in Attitude toward Science: 6th Research Question

The sixth research question examined how much of the variance in 8th grade students' attitude toward science was explained by teacher- and student-level variables in Turkey, Finland and England. Explained variance at level-2 when attitude toward science is outcome variable is calculated for Turkey, England and Finland as clearly explained below and summarized in Table 4.14.

Turkey Results:

Explained variance at level 2: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$, where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level 2 for Turkey data when attitude toward science is outcome variable: $R_2^2 = (0.29 - 0.27) / 0.29 = 0.069$.

Conclusion: 6.9 % variance at 2nd level was explained by teacher experience, teachers' emphasize science investigations, students' gender, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade Turkish students was the outcome variable.

Variables of the lower level; which are the student level variables for the present study, can also explain some of the variance at 2nd level. Therefore, explained variances by student level predictors at level-2 were also calculated to see the effect of teacher-level variables after student-level variables were controlled. Explained variance at level 2 by student.level variables was calculated below.

Explained variance at level-2 by 1st level predictors: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$ where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level-2 by 1st level predictors for Turkey data when attitude toward science is outcome variable: $R_2^2 = (0.29 - 0.31) / 0.29 = - 0.069$, sometimes negative values can be obtained as calculations are based on random samples, however, this negative value should be omitted while interpreting the results.

Conclusion: 6.9 % variance in 2nd level was explained by gender, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade Turkish students is the outcome variable.

Above calculations showed that the variance explained by teacher experience and teachers' emphasize science investigations was almost negligible when 1st level predictors are controlled.

Total explained variance by the best model of Turkey:

Total explained variance by the model can be calculated as follows:

Total explained variance: (ICC at 1st Level of Explained Variance at 1st Level) + (ICC at 2st Level of Explained Variance at 2st Level)

Total explained variance by best model:

(88.5 % of 6.3 %) + (11.5 % of 6.9 %) = 5.6 % + 0.8 % = 6.4 %

To sum up, this model explained 5.6 % variance in 8th grade Turkish students' attitude toward science at student-level, and 0.8 % variance at teacher-level. Total explained variance in 8th Turkish students' attitude toward science was 6.4 %.

Finland Results:

Explained variance at level 2: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$, where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level-2 for Finland data when attitude toward science is outcome variable: $R_2^2 = (0.13 – 0.08) / 0.13 = 0.385$

Conclusion: 38.5 % variance at 2nd level was explained by teachers' emphasis on science investigations, experience of teachers, students' home educational resources, gender, parental involvement and time spent on science homework when attitude toward science of 8th grade Finnish students is the outcome variable.

Variables of the lower level; which are the student level variables for the present study, can also explain some of the variance at 2nd level. Therefore, explained variances by student level predictors at level-2 were also calculated to see the effect of teacher level variables after student level variables were controlled. Explained variance at level-2 by 1st level predictors was calculated below.

Explained variance at level-2 by 1st level predictors: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$ where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level-2 for Finland data when attitude toward science is outcome variable: $R_2^2 = (0.13 – 0.09) / 0.13 = 0.308$

Conclusion: 30.8 % variance in 2nd level was explained by gender, parental involvement, homework time, and home educational resources when attitude toward science of 8th grade Finnish students is the outcome variable.

As calculated above, 30.8 % variance in 2nd level was explained by 1st level predictors which are gender, homework time, parental involvement and home educational resources when attitude toward science of 8th grade Finnish students is the outcome variable. Therefore, we can conclude that the variance in Finnish students' attitude toward science explained only by teachers' emphasize science investigations and teacher experience was 38.5 % - 30.8 % = 7.7 % when all 1st level variables were controlled.

Total explained variance by the best model of Finland:

Total explained variance by the model can be calculated as follows:

Total explained variance: (ICC at 1st Level of Explained Variance at 1st Level) + (ICC at 2st Level of Explained Variance at 2st Level)

Total explained variance by best model:

(92.1 % of 8.6 %) + (7.9 % of 38.5 %) = 7.9 % + 3.0 % = 10.9 %

To sum up, this model explained 7.9 % variance in 8th grade Finnish students' attitude toward science at student-level, and 3.0 % variance at teacher-level. Total explained variance in variance in 8th Finnish students' attitude toward science was 10.9 %.

England Results:

Explained variance at level 2: $R_2^2 = (\sigma^2_{u0Ib} - \sigma^2_{u0Im}) / \sigma^2_{u0Ib}$, where σ^2_{u0Ib} is total intercept variance in the intercept only model; and σ^2_{u0Im} is intercept variance left in the model with predictors.

Explained variance at level 2 for England data when attitude toward science is outcome variable: $R_2^2 = (0.20 - 0.14) / 0.20 = 0.30$

Conclusion: 30 % variance at 2nd level was explained by teacher experience, students' gender, homework time, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade English students is the outcome variable.

Variables of the lower level; which are the student level variables for the present study, can also explain some of the variance at 2nd level. Therefore, explained variances by student level predictors at level-2 were also calculated to see the effect of teacher level variables after student level variables were controlled. Explained variance at level 2 by student level variables was calculated below.

Explained variance at level 2 for England data when attitude toward science is outcome variable: $R_2^2 = (0.20 - 0.17) / 0.20 = 0.15$

Conclusion: 15 % variance at 2nd level was explained by gender, homework time, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade English students is the outcome variable.

As calculated above, 15 % variance at 2nd level was explained by 1st level predictors which are gender, homework time, bullying at school, parental involvement and home educational resources when attitude toward science of 8th grade English students is the outcome variable. Therefore, unique variance explained by 2nd level variable: 30 % - 15 % = 15 %, in other words, 15 % of variance in 8th grade English students' attitude toward science was explained only by teacher experience after student level variables were controlled.

Total explained variance by the best model of England:

Total explained variance by the model can be calculated as follows:

Total explained variance: (ICC at 1st Level of Explained Variance at 1st Level) + (ICC at 2st Level of Explained Variance at 2st Level)

Total explained variance by best model:

(92.7 % of 11.4 %) + (7.3 % of 30 %) = 10.6 % + 2.2 % = 12.8 %

To sum up, this model explained 10.6 % variance in 8th grade English students' science achievement at student-level, and 2.2 % variance at teacher level. Total explained variance in English students' science achievement is 12.8 %.

Table 4.14 summarized the explained variance at student-level and teacher-level in Turkey, England and Finland when students' attitude toward science is the outcome variable.

Table 4.14 Explained Variances in 8th Grade Students' Attitude toward Science in Turkey, England and Finland

Explained Variance (%)	**Turkey**	**Finland**	**England**
Student-Level	5.6 %	7.9 %	10.6 %
Teacher-Level	0.8 %	3.0 %	2.2 %
Total	6.4 %	10.9 %	12.8 %

As clear in Table 4.14, variance in attitude toward science explained by student-level predictors was higher than explained variance by teacher-level predictors in all three countries; Turkey, Finland and England. England model explained the greatest variance in attitude toward science among all these 3 countries.

4.3.5. Adding Random Slopes

The slope coefficients between student-level variables and students' attitude toward science were also tested to figure out whether the relationship is the same in every class or not. Hypothesis testing results indicated that the relationship between gender and students' attitude toward science varies between classes in Turkey. No random slope effect was obtained in England data. Finally, hypothesis resting results showed that relationship between students' home educational resources, time-spent on science homework, parental involvement and attitude toward science vary between classes in Finland. Hypothesis testing results were clearly explained below for each of the countries, namely Turkey, England and Finland.

For Turkey:

Hypothesis testing results indicated that the relationship between gender and students' attitude toward science varies between classes in Turkey.

Relationship between gender of students and attitude toward science of 8th grade students in Turkey:

The relationship between gender and students' attitude toward science is not the same in every class in Turkey. In other words, the relationship between gender and attitude toward science varies between classes in Turkey (χ^2 (226): 312.13, $p<0.001$).

For England:

Random slope effect between student-level variables and attitude toward science of 8th grade English students was not found.

For Finland:

Hypothesis testing results indicated that the relationship between students' home educational resources, time-spent on science homework, parental involvement and attitude toward science vary between classes in Finland.

Relationship between home educational resources of students and attitude toward science of 8th grade students in Finland:

The relationship between students' home educational resources and attitude toward science is not the same in every class in Finland. In other words, the relationship between students' home educational resources and attitude toward science varies between classes in Finland (χ^2 (135): 168.01, $p<0.05$).

Relationship between time-spent on science homework and attitude toward science of 8th grade students in Finland:

The relationship between time-spent on science homework and attitude toward science is not the same in every class in Finland. In other words, the relationship between time-spent on science homework and attitude toward science varies between classes in Finland (χ^2 (91) = 116.38, $p<0.05$).

Relationship between parental involvement of students and attitude toward science of 8th grade students in Finland:

The relationship between students' parental involvement and attitude toward science is not the same in every class in Finland. In other words, the relationship between students' parental involvement and attitude toward science varies between classes in Finland (χ^2 (136): 166.16, $p<0.05$).

4.3.6. Cross-level Interactions

Several models were run to reveal if there were possible interaction effects for each country. For Turkey, no significant cross-level interaction was found when the outcome variable is 8th grade students' attitude toward science. For England, no significant cross level interaction was found. For Finland, a significant cross level interaction between students' home educational resources and teachers' year of experience was found when the outcome variable is 8th grade students' attitude toward science. This cross level interaction was explained below.

Cross level interaction between students' home educational resources and teachers' year of experience when 8th grade Finnish students attitude toward science is the outcome variable:

Teachers' years of experience can explain (part of) the different relations between students' home educational resources and attitude toward science in

Finland (t (138) = -2.7, p<0.01). Figure 4.9 shows the cross-level interaction between teacher experience and students' home educational resources on attitude toward science.

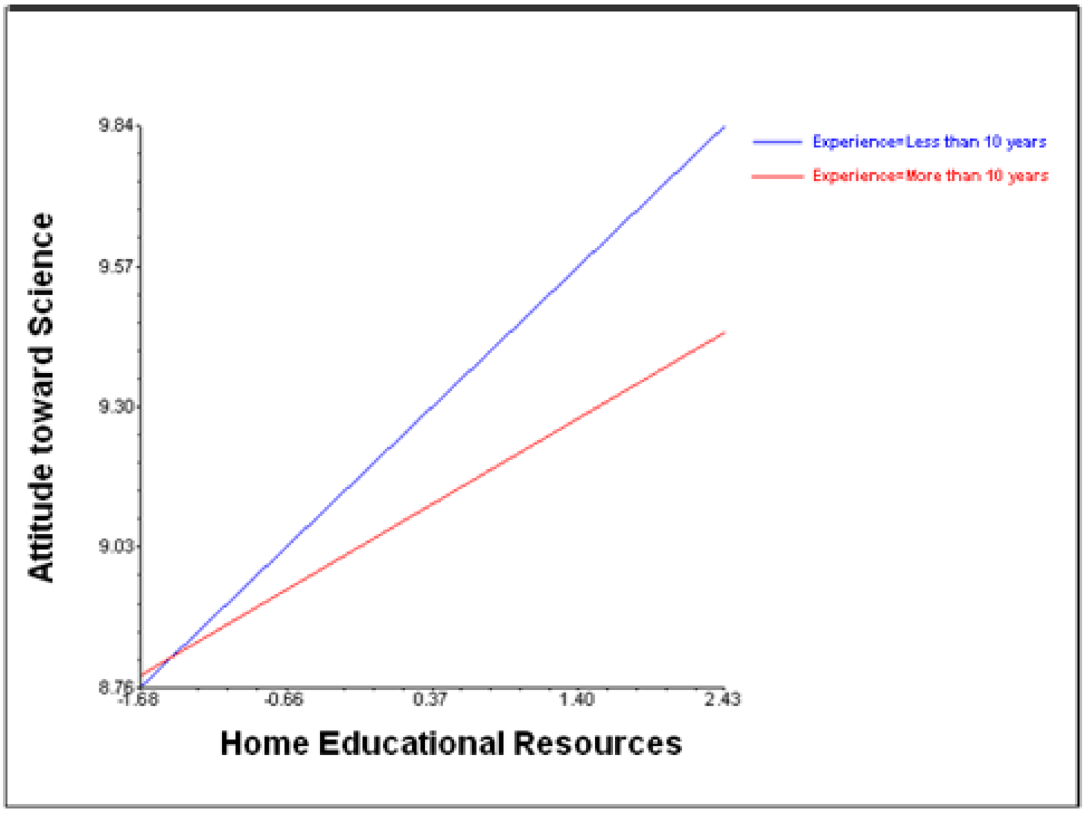


Figure 4.9 Students' Home Educational Resources by Teacher Experience Interaction Predicting Students' Attitude toward Science in Finland

As clear in Figure 4.9, the relationship between home educational resources and students' attitude toward science varies according to teacher experience. In classes with less experienced teachers (worked less than 10 years), the effect of home educational resources on students' attitude toward science is greater than in classes with more experienced teachers (worked more than 10 years) in Finland.

4.4. Summary

In the present study, 2-level HLM analysis was performed to investigate the relationship between student- and teacher-level characteristics and 8th grade students' science achievement and attitude toward science in Turkey, Finland and England. The results of the county specific analyses both for science achievement and attitude toward science were summarized in Table 4.15.

Table 4.15 Significant Student- and Teacher-Level Variables within Countries on Science Achievement and Attitude toward Science

Variables	Turkey		Finland		England	
	SA	ATS	SA	ATS	SA	ATS
Student-Level						
Gender	***	**		***	*	***
Home Educational Resources	***	***	***	***	***	***
Homework Time	**		***	***		***
Bullying at School	**	***				*
Parental Involvement		***	***	***		***
Level-1 Variance Explained (%)	4.7	5.6	11.7	7.9	5.1	10.6
Teacher-Level						
Confidence in Teaching Science					*	
Career Satisfaction	**					
Teachers' Emphasize Science Investigations		*		*		
Collaboration to Improve Teaching						
Years of Experience		***		*		**
Professional Development						
Level-2 Variance Explained (%)	11.9	0.8	-	3.0	15.4	2.2
Total Variance Explained (%)	16.6	6.4	11.7	10.9	20.5	12.8

Notes. SA: Science Achievement; ATS: Attitude toward Science; *p<0.05 level, **p<0.01, ***p<0.001

Six research questions were addressed in order to investigate the relationship between student- and teacher-level characteristics and 8th grade students' science achievement and attitude toward science in Turkey, England and Finland. HLM analysis performed separately for each of the countries. Empty model was performed to investigate whether HLM analysis could be performed for these three countries. Analysis results suggested that HLM analysis should be performed as there was enough between-class variance both in science achievement and attitude toward science in Turkey, England and Finland. After running empty model, student-level and teacher-level variables introduced to the model in each country by build-up model strategy to obtain best models for each of these three countries. Below figures namely Figure 4.10 for Turkey, Figure 4.11 for Finland and Figure 4.12 for England summarized the best model results.

Turkey Results – Summary

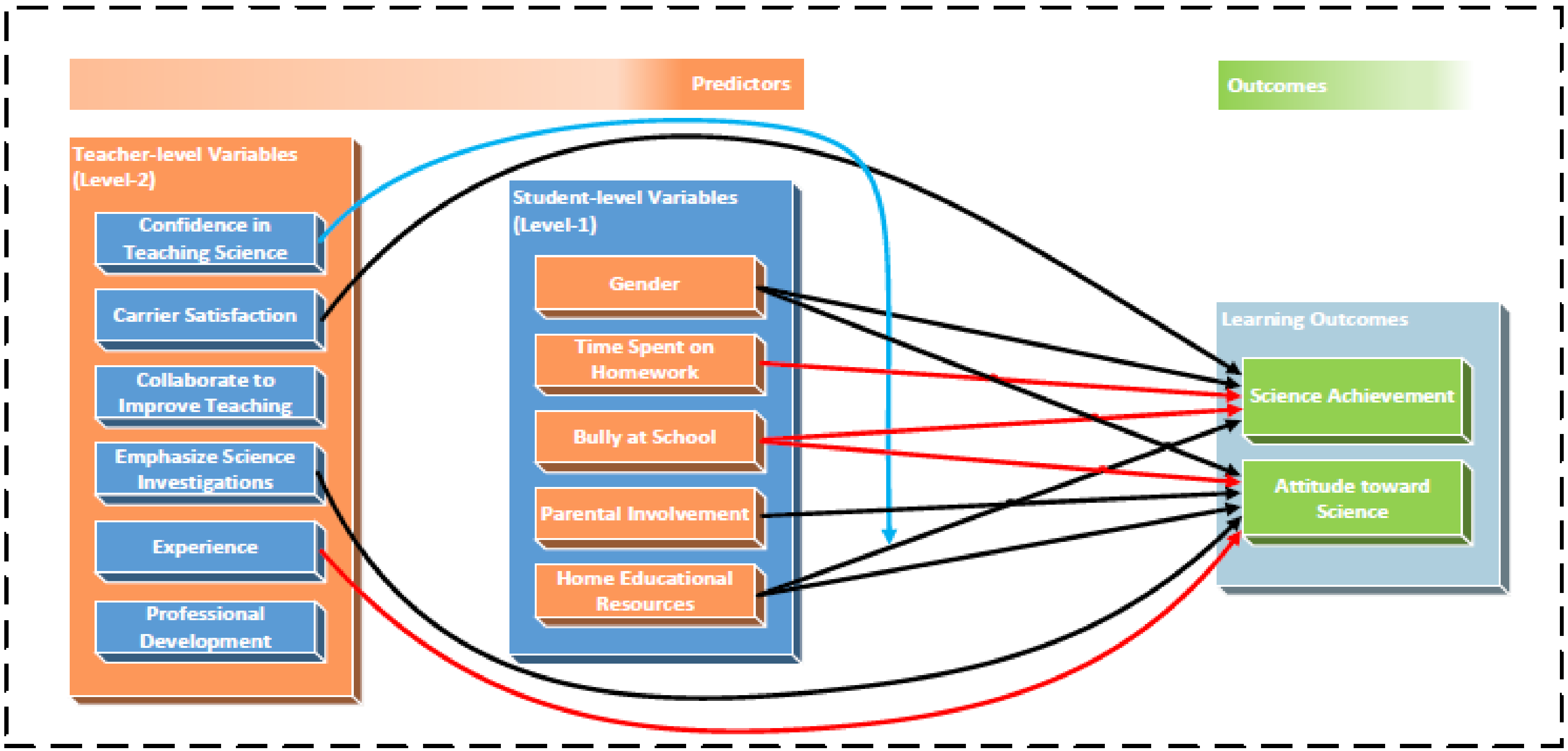


Figure 4.10 Best Model of Turkey on Science Achievement and Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on the relationship between level-1 predictors and outcome variable.

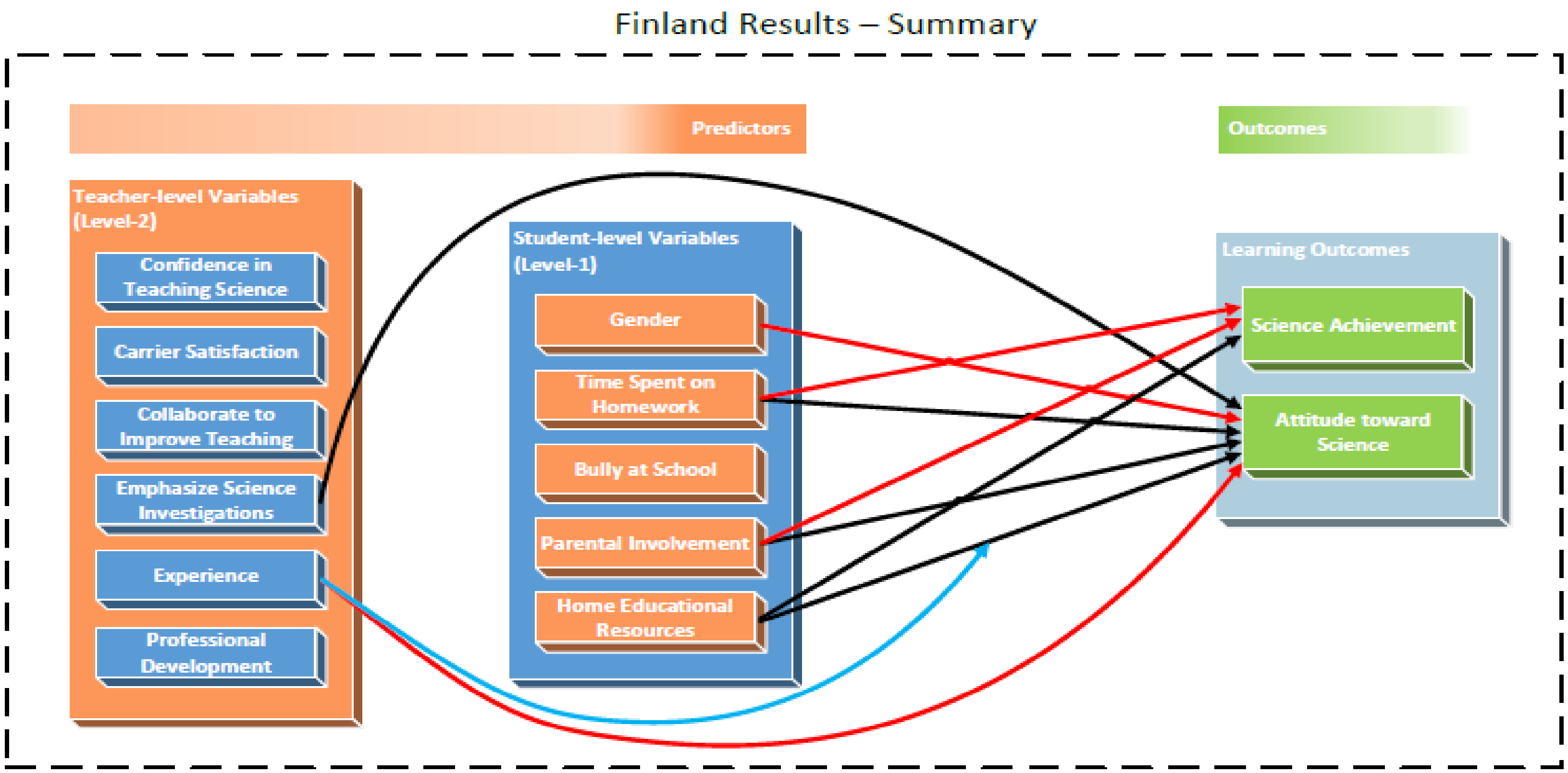


Figure 4.11 Best Model of Finland on Science Achievement and Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on the relationship between level-1 predictors and outcome variable.

England Results – Summary

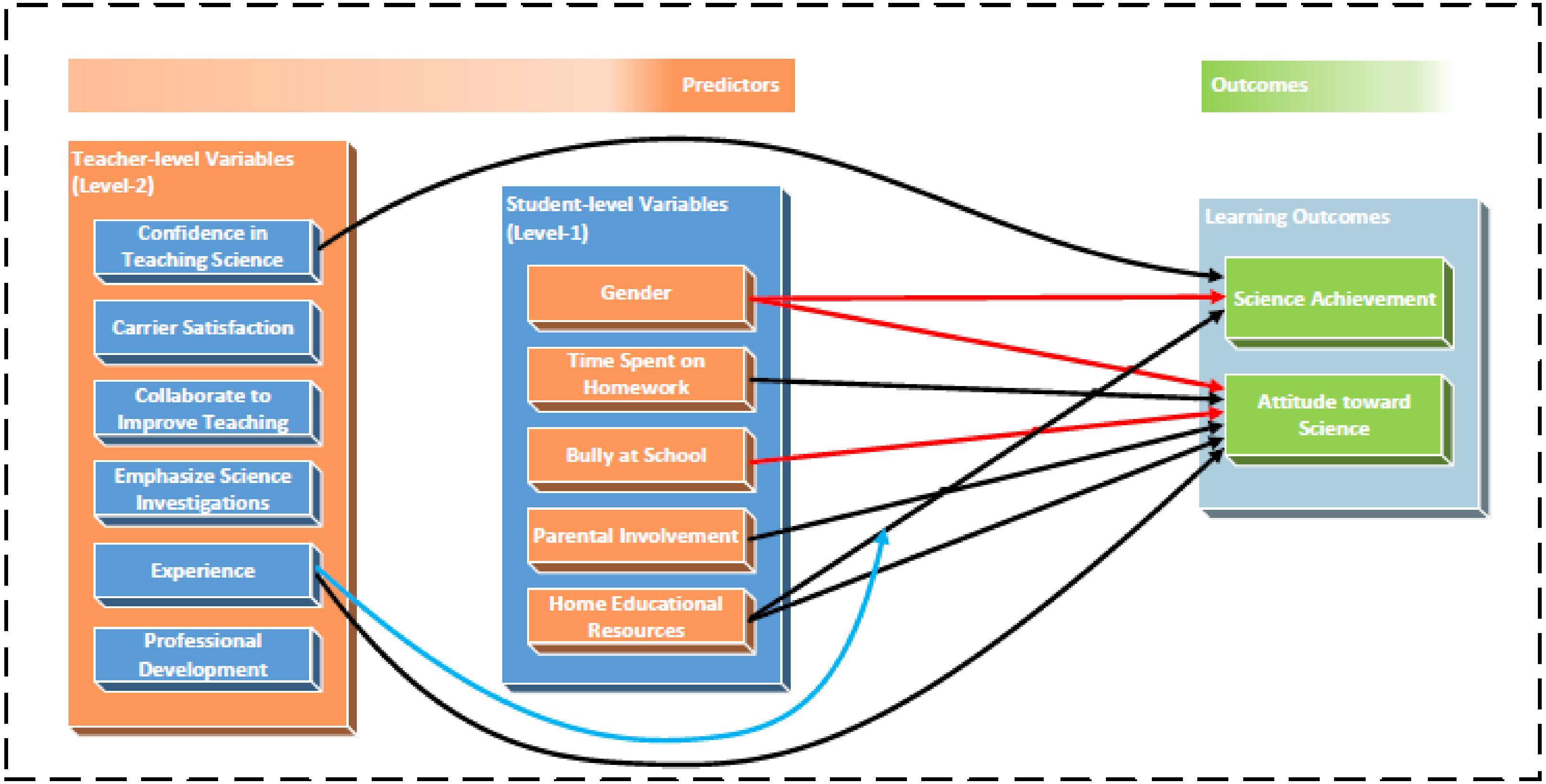


Figure 4.12 Best Model of England on Science Achievement and Attitude toward Science

Notes. Black arrows refer to positive relationship between predictors and students' science achievement. Red arrows refer to negative relationship between predictors and students' science achievement. Blue arrows refer to mediator effects of level-2 predictors on the relationship between level-1 predictors and outcome variable.

First and fourth research questions focused on the relationship between student-level variables and 8^{th} grade students' science achievement and attitude toward science in Turkey, Finland and England. The analysis results revealed that the student-level variables that showed significant relationship with students' science achievement and/or attitude toward science differed from country to country. Home educational resources variable was the unique student-level variable showed a positive significant relationship with both students' science achievement and attitude toward science in all three countries namely Turkey, England and Finland. Apart from home educational resources, gender and parental involvement related to 8^{th} grade students' attitude toward science in these all three countries. In Turkey model explaining science achievement and also attitude toward science of 8^{th} graders, the analysis results showed that female students are more favored than male students and bullying at school negatively correlates with these two learning outcomes (namely science achievement and attitude toward science). Time spent on homework negatively correlated with students' science achievement in Turkey, and it is found non-significant in Turkey model explaining attitude toward science. Parental involvement was found significant in Turkey model explaining attitude toward science, but non-significant in Turkey model explaining science achievement. Furthermore, Turkey model analysis results showed that one point increase in home educational resources was related with highest score difference in science achievement, and highest score difference in attitude toward science was obtained by one point increase in parental involvement among all student level variables. For Finland, home educational resources variable was found significant and bullying at school was found non-significant in all of the models explaining science achievement and attitude toward science. The relationship between other student-level variables namely gender, time spent on homework, and parental involvement and students' learning outcomes namely science achievement and attitude toward science differed in Finland models. Gender found non-significant in model explaining science achievement and found significant in model explaining attitude toward science in Finland. Analysis results showed that male Finnish students were favored in terms of attitude toward science. Time spent on homework found negatively correlating with science achievement and positively correlating with attitude toward science in Finland. Furthermore, parental involvement was found negatively correlating with science achievement and positively correlating with attitude toward science in Finland. Finally, Finland model analysis results show that one point increase in home educational resources was related with highest score difference in both science achievement, and attitude toward science among all student-level variables. For England, gender and home educational resources found significant in all models explaining science achievement and attitude toward science. Male students were more favored in terms of science achievement and attitude toward science than female students in England. In the model explaining science achievement, other student level variables namely time spent on homework, bullying at school and parental involvement were found non-significant in England. Moreover, time spent on homework and parental involvement positively correlated and bullying at school negatively correlated with 8th grade English students' attitude toward science. Finally, England model analysis results show that one point increase in home educational resources was related with highest score difference in science achievement, and highest score difference in attitude toward science was obtained by one point increase in parental involvement among all student-level variables similar to Turkey model findings.

Second and fifth research questions focused on the relationship between teacher-level characteristics and students' science achievement and attitude toward science in Turkey, England, and Finland. The analysis results revealed that the teacher level variables that showed significant relationship with students' science achievement and/or attitude toward science differed from country to country. Overall, collaboration to improve teaching and professional development of teachers were the only variables which were found non-significant on both science achievement and attitude toward science in all three countries; Turkey, England and Finland. Furthermore, teacher experience was found significant in all models explaining attitude toward science in Turkey, Finland and England. In Turkey models, career satisfaction of teachers positively correlated with 8th grade students' science achievement, moreover, teachers' emphasis on science investigations positively correlated with attitude toward science. In Turkey model explaining attitude toward science, teacher experience was found negatively related to students' attitude toward science. In other words, students with less experienced teachers were more favored in terms of attitude toward science than students with high experienced teachers. Finally, career satisfaction was the unique significant teacher-level variable on science achievement and teachers emphasize on science investigations and experience were the two significant teacher-level variables on attitude toward science. Teacher experience was related with more score difference in 8^{th} grade Turkish students attitude toward science compared to the score difference related with one point increase in teachers' emphasize on science investigations. In Finland models, none of the teacher-level predictors were found significant in explaining variance in science achievement. This finding does not necessarily mean that teacher-level variables like teachers' confidence in teaching science, career satisfaction, experience, collaboration to improve teaching … etc. do not have an effect on students' science achievement. This finding may be explained by solid teacher education (pre-service and in-service) in Finland which is explained in discussion part of this thesis. Similar to Turkey model findings, science investigations and teacher experience were found significant in Finland model explaining attitude toward science. In the Finland model explaining attitude toward science, positive relationship with teachers' emphasis on science investigations and negative relationship with teacher experience were obtained. Moreover, in England models, teacher-level variable found significant on science achievement was teachers' confidence in teaching science, and it was teacher experience on attitude toward science. A positive relationship between teacher confidence and students' science achievement as well as teacher experience and students' attitude toward science was obtained in best models of England.

Third and sixth research questions focused on how much of the variance in 8^{th} grade students' science achievement and attitude toward science was explained by teacher- and student-level characteristics in Turkey, Finland and England. Below tables namely Table 4.16 and Table 4.17 summarized the explained variance in science achievement and attitude toward science by student- and teacher-level predictors.

Table 4.16 Summary of Explained Variance in Science Achievement and Attitude toward Science by Student-Level Predictors

Explained Variance %	**TURKEY**	**FINLAND**	**ENGLAND**
Science Achievement			
Level-1 Predictors	6.6 %	13.3 %	11.1 %
Only HER	6.0 %	11.8 %	10.8 %
Level-1 Predictors after controlling HER	0.6 %	1.5 %	0.3 %
Attitude toward Science			
Level-1 Predictors	6.3 %	8.6 %	11.4 %
Only HER	1.8	4.0 %	2.8 %
Level-1 Predictors after controlling HER	4.5 %	4.6 %	8.6 %

Table 4.16 was created based on the analysis performed only at student-level. This table is beneficial in understanding the effect of home educational resources on students' science achievement and attitude toward science. It is clear that home educational resources variable was dominant in explaining the variance in science achievement, as only 0.6 %, 1.5 % and 0.3 % variance in science achievement is explained by level-1 predictors after controlling home educational resources respectively in Turkey, Finland and England. Here, it is clear that explained variance in science achievement only by home educational resources is greater than the explained variance in attitude toward science only by home educational resources in all these three countries namely Turkey, Finland and England.

Table 4.17 Summary of Explained Variance in Science Achievement and Attitude toward Science by Student- and Teacher-Level Predictors

Explained Variance %	**TURKEY**	**FINLAND**	**ENGLAND**
Science Achievement			
Student-Level	4.7 %	11.7 %	5.1 %
Teacher-Level	11.9 %	-	15.4 %
Total	16.6 %	11.7 %	20.5 %
Attitude toward Science			
Student-Level	5.6 %	7.9 %	10.6 %
Teacher-Level	0.8 %	3.0 %	2.2 %
Total	6.4 %	10.9 %	12.8 %

Referring to the previous summary table, analysis results showed that percentage of explained variance in science achievement by teacher-level variables was greater than the percentage of variance explained by student-level variables in Turkey, England. No variance in science achievement was explained by teacher-level variables in Finland, as none of the teacher-level variables were found significant in Finland model explaining science achievement. Explained variance in science achievement by student-level variables ranged from 4.7 % (in Turkey) to 11.7 %, (in Finland) moreover, explained variance in science achievement by teacher-level variables ranged from 11.9 % (in Turkey) to 15.4 % (in England). In overall, highest percentage of variance in science achievement was explained by England by 20.5 % variance in science achievement compared to Turkey and Finland models. Moreover, analysis results also showed that percentage of explained variance in attitude toward science by student-level variables was greater than percentage of variance explained by teacher-level variables in all three countries; Turkey, Finland and England. Explained variance in attitude toward science by student-level variables ranged from 5.6 % (in Turkey) to 10.6 % (in England), moreover, explained variance in attitude toward science by teacher-level variables ranged from 0.8 % (in Turkey) to 3.0 % (in Finland). In overall, highest percentage of variance in attitude toward science was explained by England by 12.8 % variance in attitude toward science compared to Turkey and Finland models. To sum up, generally teacher-level variables explained more variance in science achievement and student-level variables explained more variance in attitude toward science. In overall, highest percentage of variance both in science achievement and attitude toward science was explained by England model.

CHAPTER 5

DISCUSSION, RECOMMENDATIONS AND CONCLUSION

In this chapter of the thesis, analysis results were firstly discussed in compatible with the literature. Then recommendations for practice and policy as well as suggestions for further research were presented in the following sections. Finally, conclusion was presented in this chapter.

The results of TIMSS 2011 assessment revealed the gap between Turkish students and the students' from other developed countries. Science learning outcomes of 8th grade Turkish students were far below the desired level. Moreover, students' attitude toward science was not high in Turkey. In order to understand what should be done to improve science achivement and also attitude toward science in Turkey, firstly the factors affecting these two learning outcomes should be determined. Making cross-country comparisons in terms of factors affecting science learning outcomes could be more enlightening. In this study, the relationship between selected student- and teacher-level variables and 8th grade students' science achievement and attitude toward science in Turkey, Finland and England were examined. Guided by several models for international comparisons of science education, the present study conceptualized a model (Figure 1.2) explaining student- and teacher-level variables' effects on 8th grade students' science achievement and attitude toward science. Science achievement and attitude toward science were the outcome variables of the present study. This study made a difference by not only focusing on science achievement as an outcome variable but also on attitude toward science. Science achievement is not the unique outcome of science education (Creemers & Kyriakides, 2008; and Lipowsky, 2006), as researchers we should also focus on cognitive beyond outcomes like attitude toward science as a part of effective teaching process in science education (Chidolue, 1996), however, the main focus is on the student achievement (Akyüz, 2006; and Neumann, Kauertz &

Fischer, 2012). Moreover, in the science curriculums of Turkey, England and Finland, attitude toward science is highly emphasized to be developed in science education (Department for Education, 2014b; FNBE, 2004b; MoNE, 2013). Therefore, present study focused on both science achievement and attitude toward science as outcome variables.

Cross-country comparisons were performed between Turkey, England and Finland. More than 60 countries attended to TIMSS 2011 assessment, among these 60 countries, Finland and England were chosen on purpose. One of the vital reasons behind this choice was that Turkey's European Union membership process. In education area Turkey has been developed education system to improve alignment with European Standards (OECD, 2013b) and to reach Europe 2020 targets (European Commission, 2013). Therefore, instead of focusing on Far East top performing countries like Singapore, Japan, or South Korea, European countries was on focus. Yet, another reason for choosing England and Finland was that these two countries have been showing higher science performance than TIMSS scale center-point of 500 consistently since 1995 in TIMSS assessments. Both England and Finland are well known countries with their successful science education. Therefore, this study focused on making cross-country comparisons between Turkey, England and Finland.

The findings of the study differed from country to country. The possible reasons behind these differences were discussed below.

5.1. Discussion of the Results

What can we learn from TIMSS 2011 data about differences in 8th grade students' science achievement and attitude toward science? First thing we learn is that within-classes and between-classes differences in both science achievement and attitude toward science matter in Turkey, England and Finland. In other words, there is a great variance in science achievement and also in attitude toward science at both student-level and teacher-level. However, it is known that less variance in science achievement and attitude toward science is expected in more equiable systems.

Recent meta-analysis studies showed that teacher-level factors have greater effect on students' learning outcomes than student-level factors when student-, teacher-, home-, teaching-, curricula-, and school-level variables are used to see the possible effects on students' learning (Hattie, 2012). Consistent with recent studies, the results of this study show that explained variance by teacher-level factors (between-class) was greater than explained variances by student-level factors (within-class) in 8th grade students' science achievement in Turkey and England, and none of the teacher-level variables was found significant in Finland model. However, this consistency is not valid in explaining variances in attitude toward science. Explained variances in attitude toward science by student-level variables were greater than the explained variances in attitude toward science by teacher-level factors in Turkey, Finland and England. Here, it is better to note that the effects are linked to selected student- and teacher-level variables and also the results of analysis on both science achievement and attitude toward science varied from country to country, yet vital similarities were found in models.

The findings of the present study did not support the hypothesized conceptual model explained in Figure 1.2 for Turkey, Finland and England. The conceptual model suggested that selected student-level variables including gender, home educational resources, time spent on homework, bullying at school and parental involvement, and teacher-level variables including confidence in teaching science, career satisfaction, collaboration to improve teaching, teachers' emphasize science investigations, years of experience and professional development would predict both science achievement and attitude toward science at 8th grade in Turkey, Finland and England. The results varied from country to country, still with some similarities among all models of Turkey, Finland and England explaining science achievement and attitude toward science. The results showed that only home educational resources variable, which is a student-level predictor, was consistent predictor of science achievement in all three countries investigated. Other student-level variables were found significant in some of the models explaining science achievement but not in all three countries' models. Moreover, home educational resources, gender, and homework time, which are student-level predictors, were consistent predictors of attitude toward science in all three countries investigated.

Other student-level variables were found significant in some of the models explaining attitude toward science but not in all three counries' models. None of the teacher-level variables was found consistent to predict science achievement in all countries namely Turkey, Finland and England. Teacher-level variables found significant in models explaining science achievement varied from country to country. Furthermore, only teacher experience, which is a teacher-level predictor, was consistent to predict attitude toward science in all three countries. Other teacher-level variables were found significant in some of the models explaining attitude toward science but not in all three countries' models.

In Finland none of the teacher-level variables were found significant in the model explaining the variance in science achievement. This finding may be occurred due to the between-class variance differences in countries investigated. For example, Finland had the smallest between-class variance in science achievement (12.05 %) compared to Turkey (28.69 %) and England (53.96 %) (see Table 4.4). Moreover, England had smaller between-class variance in attitude toward science than Turkey and Finland (see Table 4.10). Lower levels of between-class variance imply homogeneity between classrooms, therefore, in countries with smaller between-class variance like Finland for science achievement and also England for attitude toward science, it was less likely to find significant effects of teacher-level variables on outcome variables. Reasons behind Finland's low between-class variance may be related to two facts: Finland's solid teacher education in pre-service and inservice, and also decentralized education system. Firstly, teacher education in Finland emphasizes teachers' pedagogical thinking. Research-based approach is the main feature of Finnish teacher education, which help teachers how to teach in an innovative way (Ahtee, Lavonen & Pehkonen, 2008). Secondly, decentralized education system in Finland gives a lot freedom and responsibility to Finnish teachers. Developing the curriculum based on national core curriculum, selecting the learning materials and also teaching and evaluation methods are the responsibilities of teachers. Teachers are free at the same time as there are no inspectors, no national assessment and no national evaluation of learning materials. Therefore, Finnish teachers are educated to be autonomus and reflective academic experts (Ibid).

Findings related to student-level and teacher-level predictors on science achievement and attitude toward science were discussed below.

5.1.1. Discussion of Student-Level Predictors

5.1.1.1. Gender

In all countries, gender differences in science in terms of achievement, attitude toward science, interest, choice of careers has been a hot topic (Science Education for Diversity, 2010). IEA study results show that gender differences in students' learning outcomes differ from country to country (Martin, et al., 2012) because societies' cultural stereotypes (DeBacker & Nelson, 2000) and parents' beliefs on gender roles (Jacobi, Wittreich & Houge, 2003) can influence students' science achievement and attitude toward science. The findings of the present study were consistent with these previous studies. This study showed that effect of gender on both students' science achievement and attitude toward science differed across Turkey, Finland and England. The results of this study showed that female students performed higher science achievement than male students in Turkey, whereas, opposite situation was found in England model. Moreover, in Finland model, gender was found non-significant on science achievement. Furthermore, gender was found significant in Turkey, Finland and England models explaining variance in attitude toward science, in other words, being a female or male created attitude difference. In Turkey, female students showed higher attitude toward science than male students, whereas, the opposite situation was found in England and Finland models. Furthermore, similar to meta-analysis study of Hattie (2012) stating that gender has a low influence on students' learning outcomes, the results of the present study showed that gender does not have a strong effect on both science achievement and attitude toward science in all three countries; Turkey, England and Finland.

The performance difference between male and female students is small and also less than the performance difference related to home backgrounds (Coley, 2001; and McGraw, Lubienski & Strutchens, 2006). Referring to these studies, it could be expected that the effect of home educational resources on students' science achievement is higher than the effect of gender in Turkey, England and Finland. The results of the present study found partially consistent results with the findings of

Coley (2001) and McGraw, Lubienski and Strutchens (2006). The effect of gender on science achievement was smaller than the effect of home educational resources in Turkey and England. Gender found non-significant in Finland model explaining the variance in science achievement. Moreover, the effect of gender on students' attitude toward science was smaller than the effect of home educational resources in Turkey and Finland, however, the same effect was not found in England. More specifically, the effect of gender on attitude toward science was slightly higher than the effect of home educational resources in England.

Gender was found non-significant in Finland model explaining science achievement but found significant in Turkey and England models explaining both science achievement and attitude toward science. Gender equality projects run by countries may have an effect on this finding. Turkey, England, and Finland run several projects to improve gender equality. In Turkey, the picture of gender equality is different than Finland and England. For example, school enrollment rate for females is still a problem in Turkey. In Turkey female students have a strong disadvantage in secondary enrollment rate, whereas no substantial gender gap is found among other OECD countries (OECD, 2011b). Several projects like 'Hey Girls, Let's Go to School – Haydi Kizlar Okula!' are performed in Turkey to increase female students' school enrollment rates. A recent study examined the effectieveness of this 'Haydi Kizlar Okula!' project showed that implementation of the program increased both girls' enrollment and total enrollment rate, but the magnitude of its impact was lower than expected (Ergün, 2012). In England, the Equality of Human Rights Commission gives advices to schools about gender equality duty like actions to challenge stereotyping for improving gender sensitivity (EURYDICE, 2010). Moreover, in United-Kingdom, WISE campaign namely 'Women into Science, Emgineering and Construction' aims to encourage girls of school age to pursue science in school or college (EURYDICE, 2011b). Finally in Finland, the National Board of Education (2004) states that gender equality is mentioned in the national core curriculum of basic education. Therefore, many attempts took place in Finland for improving gender-sensitive teaching, girls' attitudes toward science, and gender awareness in teacher education. For example, guide books were prepared for upper secondary schools which advice how to develop teaching methods and learning environments for the benefit of both genders (EURYDICE, 2010). GISEL Project which is namely 'Gender Issues, Science Education and Learning' being carried out in Finland in order to improve girls' attitudes toward science and technology when choosing an advanced science course in upper secondary school and a career in future (EURYDICE, 2011b). Finally, TASUKO Project namely 'Equality and Gender-Sensitivity in Teacher Education' was started in 2008 with 600.000 € budget at nine universities in Finland (Lahelma & Hynninen, 2012) which aims to provide more theoretical and practical information on gender equality and gender sensitivity to future teachers (Bohan, 2011). As clear, Finland makes great attempts and expends energy for gender equality. Finland's large number of projects to improve equality may be the reason behind the finding that gender was found non-significant in Finland model explaining science achievement.

The findings of this study showed that gender was a consistent predictor of both science achievement and attitude toward science in Turkey and England unlike Finland. The reason behind this finding may be related to gender bias in science curriculum materials of Turkey and England. In the project performed by Science Education for Diversity (2010), several countries including Turkey and England analysed their science curriculum materials like curriculum frameworks, textbooks and teacher manuels to control gender bias. Both in Turkish and English science curriculums, males tend to be depicted having more active roles and females having more passive roles. Moreover, in Turkish science curriculum, although there were some exceptions in illustrations like females having careers like astronaut and researcher, the tendency for females was towards stereotypical depictions. Both Turkish and English science curriculums still have gender bias problems which may be the reason behind gender was a consistent predictor of science achievement and attitude toward science both in Turkey and England.

The findings of this study showed that direction of the relationship between gender and learning outcomes (science achievement and attitude toward science) differed between Turkey and England in a way that female students were favored in Turkey; whereas, male students were favored in England. One of the possible explanations behind this finding may be the higher percentage of female resilient students in Turkey compared to the percentage in United Kingdom. Moreover, percentage of female resilient students is higher than the percentage of male resilient students in Turkey, but it is totally the opposite in United Kingdom (OECD, 2013a).

5.1.1.2. Home Educational Resources

At student-level, home-educational resources created greatest variation in science achievement in all three countries, namely Turkey, England and Finland. Positive relationship between home-educational resources and 8th grade students' science achievement was found in all three countries investigated. The more home educational resources students have, the more successful they are in science domain. Moreover, home-educational resources factor was found positively significant on 8th graders' attitude toward science in all three countries investigated. In general, the more educational resources students have at home, the higher attitude toward science they have in all these three countries. This findings are consistent with the previous studies stating that home educational resources correlate with students learning outcomes e.g. science achievement and attitude toward science (Bradley & Corwyn, 2002; Brooks-Gunn, Han, & Waldfogel, 2010; Duncan, Ziol-Guest & Kalil, 2010; Farooq, Chaudhry, Shafiq & Berhanu, 2011; Hattie, 2012; OECD, 2013a; Magnuson, 2007; Mullis, et al., 2012; Sirin, 2005; and Willms, 2006). Home educational resources can have strong effect on students' learning outcomes (Dincer & Uysal, 2009; and World Bank, 2011) because home educational resources contribute to students' learning opportunity at home (Mullis, et al., 2012).

The findings of this study showed that although home educational resources variable was the strongest student-level variable in all of the models explaining science achievement, it is not the unique strong student-level variable in models explaining attitude toward science. Only HER explained great deal of variance in science achievement and therefore, percentage of variance explained by other Level-1 predictors after controlling HER is very low (see Table 4.6). However, only HER explained smaller variance in attitude toward science compared to science achievement, therefore, explained variance in attitude toward science by other Level-1 predictors after controlling HER was greater in all three countries (see Table 4.12). This finding indicates that HER variable could not dominate explained variance in attitude toward science, and there are other student-level variable/s explaining a great deal of variance in attitude toward science as well as HER. In Turkey and England, the effect of parental involvement on attitude toward science was greater than the effect of HER on attitude toward science. Moreover, in Finland, although effect of parental involvement on attitude toward science was lower than the effect of HER, there was no huge difference. Therefore, we can conclude that HER is not the unique strongest student-level variable explaining variance in attitude toward science. Parental involevement played a significant role in explaining variance in attitude toward science as well as HER and HER dominated the explained variance in science achievement.

Present study found that percentage of explained variance in science achievement only by HER variable was highest in Finland (11.8 %), lower in England (10.8 %) and was lowest in Turkey (6.0 %) (See Table 4.6). Similarly, percentage explained in attitude toward science was highest in Finland (4.0 %), lower in England (2.8 %) and was lowest in Turkey (1.8 %) (See Table 4.12). This pattern may be related to the the distribution of home educational resources among students in Turkey, Finland and England. The percent of students having few resources is very low in Finland (2 %), and in England (5 %), however, it is quite high in Turkey (54 %). Moreover, the percentage of the students having some/many resources is quite higher than students with few resources in Finland (98 %) and England (95 %), whereas, it is quite similar to percentage of students having few resources at home in Turkey (46 %) (Martin et al., 2012, pg. 186).

5.1.1.3. Parental Involvement

Parental involvement was found non-significant in the models of Turkey and England, yet low effect of parental involvement on students' science achievement was found in Finland. Among all student-level variables, the effect of parental involvement on science achievement was the smallest in Finland model (see Table 4.5). Parental involvement was found to show a significant relationship between attitude toward science in Turkey, Finland and England. The results of this study show that effect of parental involvement on science achievement or attitude toward science differs from country to country. Recent studies state that parental involvement increases students' academic performance (Dearing, Kreider & Weiss, 2008; LaRocque, Kleiman & Darling, 2011; and Mullis, Martin, Foy & Drucker, 2012) and overall attitude toward school (Dearing, Kreider & Weiss, 2008). However, the results of the present study are partially consistent with previous study results because non-significant relationship between parental involvement and students' science achievement in Turkey and England was found.

Parental involvement was a powerful predictor of attitude toward science in all three countries namely Turkey, Finland and England. As explained in home educational resources part, parental involvelement played a significant role in explaining variance in attitude toward science as well as HER.

5.1.1.4. Bullying at School

Being bullied negatively affects students learning outcomes including achievement and attitude (Baker-Henningham, Meeks-Gardner, Chang, & Walker, 2009; Ladd, Kochenderfer & Coleman, 1997 and Mullis, Martin, Foy & Drucker, 2012). The results of this study were consistent with previous research. Bullying at school negatively correlated with Turkish students' science achievement, whereas, non-significant relationship was found in the models of Finland and England. Bullying at school negatively correlated with attitude toward science in Turkey and England, whereas non-significant relationship was found in Finland. In overall, the results of this study showed that Turkey is the country facing bullying problem more than England and Finland based on both descriptive statistics (see Table 4.2) and HLM results. The reason behind this finding may be related to countries' efforts and focus on decreasing bullying at schools. Strategies followed by Finland, England and Turkey to solve the bullying problem at school were explained below one by one.

Safety at school and home which specifically includes preventing bullying and violence and accidents at school and home is clearly emphasized in the science curriculum of Finland (Kuppari & Vettenranta, 2012). Moreover, In Finland, teacher education involving pedagogical studies and guided teaching practice specifically focus on discussions and getting familiar with various issues arising in everyday school life (FNBE, 2014b). In addition to special emphasis on science curriculum and teacher education about bullying, Finland performs valuable programs for anti-bullying. For example, anti-bullying programme called KiVa-koulu (cool school) is being applied by 2500 comprehensive schools in order to decrease bullying and racist discrimination and to improve well-being, safety and respect at schools (Ministry of Education and Culture, 2012). In England, Department of Education also pays attention to bullying at school, and publishes reports specifically about bullying issue at schools in which the Government's approach to bullying and also most effective anti-bullying strategies in schools are clearly explained (Department for Education, 2014a). In England, bullying is perceived as an important topic to study both by researchers and government itself. However, in Turkey, studies focusing on bullying at school do not have a long history. In Turkey school bullying studies have started to appear since 2001 (Atik, 2011). Moreover, Turkey government does not perform specific studies to overcome bullying unlike Finland and England. It is just stated in Turkish curriculum by only one sentence like 'bullying at school problem should be solved by the cooperation of school and parents' (MoNE, 2005, pg. 75). The reason behind why bullying at school found to have a negative relationship with science achievement and attitude toward science in Turkey model but a non-significant relationship was found in Finland may be related to the great governmental emphasis and efforts to solve bullying at school by teacher education and long-term anti-bullying programmes in Finland whereas studies in this area are weak in Turkey.

5.1.1.5. Time Spent on Homework

Findings of the present study showed that there was a negative relationship between time-spent on homework and 8th grade students' science achievement in Turkey and Finland, but non-significant in England. Moreover, there was a positive relationship with time spent on homework and 8th grade students' attitude toward science in Finland and England. The relationship between time spent on homework and attitude toward science is positive unlike the relationship with science achievement. These findings may be interpreted as an unclear relationship. In a similar way, some studies state that there is an unclear relationship between students' achievement and time spent on homework (Martin et al., 2012; Mullis et al., 2009; and Trautwein & Köller, 2003). There might be two reasons for this unclear relationship. Firstly, teachers may have different approaches of giving homework. Some teachers may give homework to all of the students in the class, whereas, some teachers may give homework only to the students who show lower performance than their classmates (Martin et al., 2012; and Trautwein, 2007). Secondly, higher achieving students may be more motivated to do homework and finish it in a short time, whereas lower achieving students may complete their homework in a longer time, moreover, prior knowledge also plays an important role in time spent to complete homework as well as motivation. Therefore the amount of time to spend on homework may not be a good indicator of academic success (Trautwein, Luedtke, Kastens & Koeller, 2006; and Trautwein, 2007) as well as attitude toward science. Therefore, it would be more precious to focus on the aims of giving homework, or how students do their homework to investigate the relationship between homework and students' learning outcomes e.g. science achievement and attitude toward science instead of focusing on time spent on homework.

5.1.2. Discussion of Teacher-Level Predictors

5.1.2.1. Confidence in Teaching Science

Recent studies show that confidence in teaching science is positively associated with several student learning outcomes including achievement and attitude toward science (Al-Alwan & Mahasneh, 2014; Mojavezi & Tamiz, 2012; Ross, 2013; and Tschannen-Moran & Woolfolk Hoy, 2001). Therefore, positive effect of confidence in teaching science on both science achievement and attitude toward science was expected in all three countries investigated. However, the results of the present study did not support previous findings. Teachers' confidence in teaching science was found significantly related to science achievement only in England, whereas it was found non-significant in the models of Turkey and Finland. Moreover, confidence in teaching science did not show significant relationship with attitude toward science in all three countries: Turkey, Finland and England.

The distribution of teachers very confident in teaching science and somewhat confident in teaching science may be helpful in understanding the finding of the study that confidence in teaching science was only significant in England model explaining science achievement. Recent studies show that the distribution of students with teachers very confident in science and somewhat confident in science varied from country to country. There was a huge difference between the percentage of students with teachers very confident in teaching science (84 %) and the percentage of students with teachers somewhat confident in teaching science (16 %) in England unlike Turkey and Finland (Martin et al., 2012, pg. 318). TALIS study showed that teachers' confidence in teaching is not very high but at the TALIS average in Turkey (OECD, 2009a, pg, 244).

5.1.2.2. Career Satisfaction

The studies performed to reveal the relationship between career satisfaction and student learning outcomes are limited (Michaelova, 2002). Recent studies focusing on the relationship between teachers' career satisfaction and student achievement state that there is positive correlation in between (Michaelowa, 2002; and Mullis, Martin, Foy & Drucker, 2012). The results of the present study showed that career satisfaction was found significant only in Turkey model explaining science achievement and was significant in none of the models explaining attitude toward science. More specifically, teachers with higher career satisfaction promote higher levels of science achievement in Turkey. Among teacher-level variables, teachers' career satisfaction was found to create the greatest effect on science achievement in Turkey model. The possible reason behind the finding that career satisfaction was only significant in Turkey model explaining science achievement might be related by system differences in these three countries, which is explained below.

Recent studies show that 82 % lower secondary teachers feel career satisfaction in England (OECD, 2014g). Moreover, teaching is a very popular profession in Finland because it is seen as a high status profession; teachers are autonomous in their work in a way that they decide on teaching methods, learning materials including lesson books; and also the system is trust-based rather than control as teachers in Finland are not evaluated by high stake exams (FNBE, 2014c). Recent studies show that 95 % of lower secondary teachers feel career satisfaction because of higher salaries, lower teaching hours, lower student-teacher ratio (OECD, 2014b, 2014h) and higher status due to the competition to enter teaching profession (OECD, 2014b; and Osborne & Dillon, 2008). The reasons behind popularity of teaching in Finland may yield to homogeneous career satisfaction in Finland between teachers. This may be the reason why teacher career satisfaction in Finland is non-significant in Finland model. However, the picture in Turkey is far different than the Finland case. Recent TALIS studies focusing on working conditions of teachers and the learning environment in schools show that career satisfaction of Turkish teachers are far below the TALIS average (OECD, 2009c). Not surprisingly, carrier satisfaction of teachers created difference in Turkey model. Carrier satisfaction was found significant in Turkey model explaining science achievement of 8th graders.

5.1.2.3. Teacher Collaboration to Improve Teaching

Collaboration among teachers can increase student learning and performance (Creemers & Kyriakides, 2008; Goddard, Goddard & Tschannen-Moran, 2007; Lomos, Roelande & Bosker, 2011; Martin, et al., 2012; Mullis, Martin, Foy & Drucker, 2012; Pil & Leana, 2009; Wheelan & Kesselring, 2005; and Wimberley, 2011). The findings of the present study did not show consistent results with previous studies. In the present study, teacher collaboration to improve teaching was found non-significant in all models explaining science achievement and attitude toward science in all three countries Turkey, Finland and England.

5.1.2.4. Teacher Experience

The average experience of teachers differs from country to country. Recent studies show that teachers have an average of 12 years teaching experience in England (OECD, 2014f) and 15 years teaching experience in Finland (OECD, 2014h). In literature, there are several studies investigating whether teacher experience has an effect on students' learning outcomes. Some researchers state that teacher experience has a small effect on student achievement (Buddin & Zamarro, 2009; and Rivkin, Hanushek & Kain, 2005). Recent studies on this topic state that there is no unique pattern of the relationship between teacher experience and science achievement, still the general pattern shows a positive relationship (Sandoval-Hernandez et al., 2015). The findings of the present study showed that teacher experience was found non-significant in models explaining science achievement and found significant in models explaining attitude toward science in Turkey, Finland and England. More specifically, there was a positive relationship between teacher experience and attitude toward science in England, whereas, a negative relationship was found in Turkey and Finland models. There may be 3 reasons behind this finding which were explained below.

Some researchers state that the relationship between teacher experience and student learning outcomes should be interpreted with caution because (1) teachers can be hired during a shortage or a surplus (Wayne & Youngs, 2003), which can cause calculation mistakes in teacher experience; (2) some teachers leave teaching profession in the early years of teaching because they are not well matched with teaching (Hanushek, Kain & Rivkin, 2004); which can increase the number of demotivated teachers loaded in low experience level; and finally (3) some education systems assign experienced teachers to lower ability groups or schools with higher disciplinary problems whereas opposite situation would be valid in other education systems (Mullis, Martin, Foy & Drucker, 2012). These reasons may be possible reasond behind the findings that the direction of the relationship between teacher experience and attitude toward science differed from country to country.

5.1.2.5. Teachers' Emphasize Science Investigations

Scientific inquiry is vital in effective teaching learning process (National Research Council, 2011; and Martin, et al., 2012) and some studies state that emphasis of science investigations has a positive effect on students' academic achievement (Ayaz & Sekerci, 2015; and House, 2009). However, the finding of the present study does not show consistency with previous study results. Teachers' emphasize science investigations did not show significant relationship with science achievement in all three countries namely Turkey, England and Finland. Moreover, teachers emphasize science investigations was found significant in Turkey and Finland and non-significant in England when attitude toward science was the outcome variable. Teachers' emphasize science investigations positively correlated with attitude toward science in Turkey and Finland.

Recent studies show that 96.3 % of teachers in England and 97.3 % of teachers in Finland believe that their role as a teacher is to facilitate students' own inquiry (OECD, 2014g). In Turkey, two approaches namely constructivist approach and direct transmission of knowledge approach are quite integrated to learning (OECD, 2009a). More specifically, equal endorsement of both constructivism and direct transmission is valid in Turkey. Turkish teachers' beliefs about constructivist approaches are not very high and they still utilize direct transmission (*Ibid*). Recent studies focusing on educational approaches of Turkish teachers showed that teachers approve constructivist approaches but tend to use traditional approaches. Doruk (2014) performed a study with pre-service mathematics teachers and concluded that although teachers' beliefs are largely in line with constructivism, they tend to use traditional approaches due to several reasons like impact of previous education experiences, their negative opinions about constructivism, limitations of their university education, lack of experience, and choosing the easier option. Similarly, based on the study performed with pre-service science teachers, Seker (2011) concluded that although pre-service teachers have strong beliefs favoring constructivist approach, they mostly utilize behaviourist approach application. That teachers' use of traditional approaches instead of constructivist approaches may be explained by the fact that constructivism is somehow a new issue in Turkey. Major reform in science curriculum was performed in Turkey in 2004 in line with constructivism and behaviorist approach was left behind (MoNE, 2005). However, as teachers of today were educated through behaviorist approaches, they cannot break their old habits and utilize constructivist approaches although they favor constructivism (Seker, 2011). This might be a reason why teachers' emphasis on science investigations matter in Turkey. However, emphasis of constructivism in England began in 1960s by the emphasis of student-centered pedagogy at primary schools (Westbrook, Durrani, Brown, Orr, Pryor, Boddy & Salvi, 2013). England has a long history in constructivism and hence teachers working in England had enough time to understand and implement constructivism. To sum up, system based differences between countries in when constructivist approach emphasized in science teaching and how governments linked constructivism with teacher education may be the possible explanations behind the finding that teachers' emphasis on science investigations was found significant in Turkey and Finland model explaining attitude toward science, whereas it was non-significant in England model in the present study.

5.1.2.6. Professional Development

Hattie (2012) finds that the effect of professional development on students' academic achievement is medium (0.51 effect size). Referring to Hattie (2012), medium effect of professional development on students' achievement and attitude in Turkey, Finland and England was expected. However, the results of this study showed inconsistent results with Hattie's (2012) findings. Teachers' professional development was found non-significant in Turkey, Finland and England models explaining both science achievement and attitude toward science.

TALIS collects data about teachers' professional development. According to most recent TALIS study, percentage of teachers participating in courses and/or workshops is greater in England (91.7 %) than Finland (79.3 %) in a year time (OECD, 2014g, pg.336). Furthermore, TALIS results for Turkey showed that the percentage of teachers participating into professional development in the last 18 months was lowest in Turkey by 74.8 % among all participating countries to TALIS (OECD, 2009a, pg. 80), although 43 % of teachers in Turkey state that they have a high level of need for professional development (*Ibid*, pg. 84). Recent studies showed that teachers in Turkey state low satisfaction in professional development activities, as a result, they prefer not to participate any more (Bayar & Kösterelioglu, 2014). In England and Finland, there is a great effort to improve teachers' professional development unlike Turkey. In England, the Institute of Education in London hosts Science Learning Centers offer continuing professional development courses for science teachers in each region of the country (Osborne & Dillon, 2008; and Simon & Campbell, 2012). In Finland, a national teacher education programme was launced in 2010 in order to provide systematic development of teachers' competencies, activate teachers who participate less frequently in staff-development training and therefore improve equal access to continuing professional education (Ministry of Education and Culture, 2012). Based on the empirical study results and efforts made by countries to improve professional development of teachers, it was expected to find differences in the effect of professional development on students' learning outcomes among Turkey, Finland and England. However, professional development was found non-significant in all models explaining science achievement and attitude toward science in Turkey, Finland and England. The reason behind this finding may be the way that IEA collects data about professional development. IEA assesses only whether teachers attend to professional development or not, but does not collect any data about how frequently they attend or how qualified are the seminars, workshops, and meetings they are attending. Both teachers attending to professional development just once per year and teachers regularly attending to professional development like several times per year state yes to the questionnaire.

5.2. Recommendations for Practice and Policy

5.2.1. Recommendations for Student-Level

5.2.1.1. Gender

The results of this study showed that gender was found significant in all models explaining science achievement and attitude toward science in Turkey and England. Therefore, Turkey as well as England should show more attention to buffer the effect of gender on students learning outcomes. Gender is an important characteristic in education field as performance differences between genders is also related to equity (OECD, 2013a). Gender equality at school can be promoted by "giving girls and boys the capabilities to act on the basis of equal rights and responsibilities in society, working life and family life" (The National Board of Education, 2004, pg.22). As a result of comparative studies in education, Keeves (2001) draws attention to the importance of building schools and enhancing teacher education in order to achieve greater equity between male and female students.

Studies show that the gender differences are more often developed due to the social context than inborn properties of individuals, therefore teachers should encourage their students to learn in a way that gender roles do not exist (Gill, 2013). Teachers' awareness and knowledge about gender neutral instructional techniques, and non-threatening, rich and supportive environment for both female and male students in classrooms should be increased. Teachers can encourage students to break the gender stereotypes by making relevant connections between schoolwork and future occupations (Greene & DeBacker, 2004). In order to decrease the gender differences in academic achievement, teachers should control whether curriculum content reflects gender diversity of their students and also the society they are living in (Bates, Shifflet & Lin, 2013).

Studies in curricula, teaching material and training policies to combat gender stereotyping and also encouraging both parents and teachers to motivate girls to pursue interests in science and mathematics would improve gender equality in developed countries (OECD, 2011b). Furthermore, reducing user fees, providing school materials, meals, and safe travel to schools would improve gender equality in developing countries (*Ibid*).

The number of the projects aiming to improve gender equality, gender awareness in teacher education and girls' attitudes toward science should be increased in Turkey, Finland and England. Finland's projects like GISEL Project, which aims to improve girls' attitudes toward science and technology when choosing an advanced science course in upper secondary school and a career in future (EURYDICE, 2011b), and also TASUKO Project, which aims to provide more theoretical and practical information on gender equality and gender sensitivity to future teachers (Bohan, 2011) may be good examples to follow in Turkey.

5.2.1.2. Home Educational Resources

Home educational resources can create high differences in learning outcomes. The results of present study stated that home educational resources factor is one of the most dominant factors affecting students' science achievement and attitude toward science. Home educational resources factor was found significant in all of the models explaining both science achievement and attitude toward science in all three countries namely Turkey, Finland and England. In order to eliminate this effect some precautions should be taken. Compensation of the lack of home resources should be done by schools in disadvantaged areas (Muijs et al., 2004). Teachers should be aware of the home educational resources of their students and then direct the learning environment in a way that students having low educational home resources are not in a disadvantaged position. For example, if some students in the classroom do not have a computer at home, then teacher should not give a research homework requiring computer and internet.

Students' having low educational resources accepted as disadvantaged students. Teachers can be frustrated while working with highly disadvantaged students. At this point, Darling-Hammond and Sykes (2003) suggest mentoring during pre-service education. Mentoring during pre-service education can reduce pre-service teachers' attritions in working with disadvantaged students (*Ibid*). In Turkey, mentoring during preservice education takes place, but while selecting the mentoring schools, schools having disadvantaged students can also be considered instead of only focusing on high performing successful schools. Visits to village schools can be performed with preservice teachers; hence preservice teachers get familiar with the learning environment with students having less home educational resources, and get more experienced before becoming a teacher.

OECD suggests making some arrangements especially in schools where most of the students coming from lower socio-economic status. OECD (2012b) suggests several reforms in disadvantaged schools by strengthening school leadership, supportive school climate, high-quality teachers, and effective classroom teaching strategies. School leaders should be well selected for these disadvantaged schools, and required leadership preparation programs should provide both general and specialized knowledge to handle the problems in these schools. To be able to develop positive classroom climates, enhancing teacher-student and also peer relationships is important (OECD, 2012c). Moreover, required policies should be implemented to raise teacher quality in disadvantaged schools by developing teacher education programs to develop both the skills and the knowledge for working at disadvantaged schools and also to attract the attention of qualified teachers to prefer disadvantaged schools by adequate financial and career incentives (OECD, 2012b).

5.2.1.3. Parental Involvement

According to the results of this study, the relationship between parental involvement and students' science achievement and attitude toward science vary from country to country. In general, in order to improve parental involvement, schools can follow some strategies. Teachers should explain the importance and effects of parental involvement to education process on students' academic achievement and should courage parents to involve in their children's learning process (Bates, Shifflet & Lin, 2013). Parents and teachers should communicate frequently and work together to develop students' achievement and expectations. Parents should relate school contents to daily life and help their children while they are making future plans, if parents are not able to help the pupils with their homework and study habits then these parents can get involved in their children's education by showing positive attitude toward their children's school and education and interest in their educational activities (Haines & Mueller, 2013).

Students tend to have low achievement when their parents show low levels of desire for their children's success, do not explain the education goals clearly, or do not explain the value of education (Hill & Tyson, 2009). Therefore, the effect of parents' behaviors and attitude toward their children's education on their children's educational outcomes is non-negligible. Parents should develop positive behaviors and attitude toward their children's education and give some courage and enthusiasm to their children for further success and developing the educational outcomes.

Educators and parents should work together and form well-organized, goal-linked school-learning communities to involve families into their children's education in order to boost students' achievement (Epstein & Salinas, 2004). Communication strategies should be aligned by schools to enhance parental involvement in teaching-learning process (OECD, 2012b). Family science nights, interactive science projects and interactive homework might take families' attention and enhance parental involvement in students' science learning.

5.2.1.4. Bullying at School

The results of this study showed that Turkey is the country having negative bullying effect on science achievement and attitude toward science, whereas, no effect was observed in Finland models. Therefore, Turkey should pay more attention to buffer the effect of bullying at school on students learning outcomes. More effort should be performed on this specific topic about revealing the possible reasons of bullying in Turkish schools, and understanding in which areas of cities and country bullying is more observed, what can be done to help teachers in such disadvantaged schools, how bullying in school problem can be solved.

In order to prevent bullying, schools need to identify and clarify the possible conflicts and differences between pupils through directly talks with pupils, dedicated events and/or projects and also through assemblies before bullying takes place (Department for Education, 2014a). In order to intervene bullying, schools need to involve both parents and pupils in order to make clear that school does not tolerate bullying and which procedure to follow when a pupil is being bullied. Open discussions about religion, ethnicity, gender, sexuality differences between people could motivate bullying. If there is serious and persistent bullying at schools, then school staff should work with police and children's services. Furthermore, schools should create a safe environment where students being bullied can easily find a person in charge to report bullying and discuss the cause of bullying, without fear or discrimination (*Ibid*).

Finland runs an effective anti-bullying programme called KiVa-koulu (cool school) which is being applied by 2500 comprehensive schools to decrease bullying and racist discirimination (Ministry of Education and Culture, 2012). Such anti-bullying programmes can be a good model for Turkey as there is not enough study in preventing bullying at schools in Turkey.

5.2.2. Recommendations for Teacher-Level

5.2.2.1. Confidence in Teaching Science

Confidence in teaching science was found to be significant in England model explaining variation in science achievement. Some suggestions were given to improve teachers' confidence in teaching science. School improvement plans should include professional learning and organizational enhancement in order to improve teachers' confidence in teaching (Ross, 2013). Moreover, school principals should help teachers to increase their confidence in teaching by motivating them and also forging a link between student learning outcomes and teachers' professional abilities (Ross & Bruce, 2007); which may raise awareness on teachers' about their professional skills affecting students' learning outcomes. Furthermore, school principals should create a collaborative environment that teachers can learn from one another and also facilitate skill development in service trainings (*Ibid*).

5.2.2.2. Career Dissatisfaction

Career satisfaction of teachers play an important role in teaching-learning process as career satisfaction can directly affect the motivation of teacher, get prepared for the lessons (Martin et al., 2012; and Mullis, Martin, Foy & Drucker, 2012) and productivity (Michaelowa, 2002). Much of the teacher turnover is due to teacher career dissatisfaction (Smith & Ingersoll, 2004).

The findings of the present study stated that career satisfaction has a positive relationship with 8^{th} grade students' science achievement in Turkey. Therefore, required precautions should be performed in Turkey in order to develop teachers' career satisfaction. Literature review shows that there are many factors affecting teachers' career satisfaction. Classroom environment, school facilities, teachers' own characteristics like family status, job experience, teachers' contract conditions would be the indicators of teachers' career satisfaction (Michaelowa, 2002). Furthermore, too heavy workload, low salary, problematic student behaviors and lack of influence over school policy influence teachers' career satisfaction in a negative way (UNESCO, 2006). To this respect, reforms especially about classroom environment, school facilities, teachers' contract conditions, workload, and salary may improve career satisfaction of teachers in Turkey.

5.2.2.3. Teachers' Collaboration to Improve Teaching

Administrators should courage teachers and give incentives and time to increase the collaboration between teachers and colleagues regarding instructional practices (Bates, Shifflet & Lin, 2013). School leaders should foster a climate in which teachers collaborate to learn about their own practice (OECD, 2014a). Common strategies based in collaborative practices are instructional rounds, peer observations, instructional coaching, learning walls and professional learning communities (Australian Institue for Teaching and School Leadership, nd). Moreover, best practices for collaboration are (1) scheduling adequate time for collaboration, (2) ensuring both horizontal and vertical collaboration, (3) setting collaboration meetings formally and (4) creating an atmosphere of mutual trust (Berry, Daughtrey & Wieder, 2009). Firstly, instead of letting collaboration among teachers just happen, schedules should be created which may increase the effectiveness of collaboration. Secondly, teachers traditionally collaborate horizontally, which is collaboration among same grade level and same subject area. Vertical collaboration across grade levels and different subject areas is at least as important as horizontal collaborations. Thirdly, structuring collaboration meetings formally may result in more effective collaboration as it helps teachers to focus on. Finally, mutual trust atmosphere may improve collaboration, as collaborations include reflections and critiques.

5.2.2.4. Teacher Experience

The effect of teacher experience on student achievement can show variation depending on the countries' teacher policy characteristics. For example, some systems assign their experienced teachers to lower ability students with high discipline problems, whereas other systems can do the opposite approach (Mullis, Martin, Foy & Drucker, 2012). Characteristics of education system should be taken into account when the policies about teacher education are implemented, as there is no unique solution applicable to all education systems (Sandoval-Hernandez et al., 2015). Education systems should analyze their characteristics carefully and then assign teachers with higher and lower experience to the schools and classes in a way that the highest overall gain in student outcomes would be obtained.

5.2.2.5. Professional Development

In recent years, several innovations in science teaching have taken place. Results show that teachers do not change their practice or how they see themselves if they do not really want to change, or understand the importance of the change on teaching-learning process. External courses can be beneficial and develop some aspects of learning however, fundamental changes in teachers' practices and how teachers view teaching do not occur by external courses. Professional development needs to be conceptualized in a way that where teachers have to meet teaching standards and professional developers are subject to external demands (Simon & Campbell, 2012). Effective school principals are more creative in finding opportunities to teachers for their professional development (Mullis et al., 2009); however, we should note the importance of teachers' willingness to attend to professional development otherwise it may be dictated from senior management (Simon & Campbell, 2012). Teachers should seek professional development which aims to improve content knowledge and also instructional strategies (Bates, Shifflet & Lin, 2013).

Turkey gives importance to professional development, however; these professional development opportunities may not be effective enough referring to the findings of OECD (2009a) and Bayar and Köstereliogl u (2014). Required initiatives should be performed by the Turkish government. England performed visible initiatives for professional development. The Institute of Education in London hosts Science Learning Centers which offer continuing professional development courses for science teachers in each region of the country (Simon & Campbell, 2012). Similar centers can be also established in Turkey based on good models running all over the world. Such centers in different regions of Turkey can be a home for researchers who specifically work on professional development of teachers and these researchers can consult to teachers by offering workshops, seminars or even by phone or skype meetings during the whole year whenever a teacher thinks s/he needs a help. Moreover, in Finland effective teacher education programmes like Osaava, being run by the government in order to ensure systematic development of teachers' competencies, activate teachers who less frequently attends to professional development activities and hence to improve equal access to professional development for all teachers (Ministry of Education and Culture, 2012). This Osaava programme may be a good model for Turkey to follow as recent studies show that the percentage of Turkish teachers participating to professional development in the last 18 months was lowest among all TALIS member countries (OECD, 2009a).

5.3. Suggestions for Further Research

This study examined the relationship between student- and teacher-level characteristics and 8th grade students' science achievement and attitude toward science in Turkey, Finland and England. Suggestions for further research were stated below:

First, how the impact of student- and teacher-level variables differ between low and high achieving students would be interesting to study. Instead of focusing on science achievement, comparisons between low achievers and high achievers can be performed. Therefore, future research may extend the current analysis by examining factors affecting separately for low and high achieving students across different subject domains and/or different countries. Furthermore, particular countries may focus on comparing particular subgroups like low-achievers in urban areas and low-achievers in rural areas or native low achievers vs. non-native low achievers depending on the main concern of the study.

Secondly, due to the cross-sectional nature of the TIMSS data, this study was correlational and only explained the relationship between student and teacher level characteristics and students' learning outcomes in science e.g. science achievement and attitude toward science. However, in order to investigate the causal relationship which can directly focus on the effects of science teaching on students' learning processes and outcomes, longitudinal data may be used in future studies.

Thirdly, home educational resources factor was found as one of the most important factors for both science achievement and attitude toward science in the present study. This finding is also consistent with previous studies. Now, it is known that there is a gap between students' having low home educational resources and high home educational resources. Therefore, further research can focus on how to reduce the effect of home educational resources on students' science learning outcomes to give strong recommendations and enable more equitable education for every child. Further studies focusing on home educational resources can focus on different areas like school locations where the majority of the students having low home educational resources may give more clear-cut recommendations for educational policy makers.

Fourthly, time spent on homework showed ambiguous results for both science achievement and attitude toward science. As clearly explained in the discussion part, there can be several reasons behind this unclear relationship like teachers' different approaches in giving homework (Martin et al., 2012; and Trautwein, 2007) and students' different motivation and prior knowledge between high achieving and low achieving students (Trautwein, Luedtke, Kastens & Koeller, 2006; and Trautwein, 2007). Therefore, instead of focusing on time, future research can focus on teachers' approaches in giving homework, and the effects of these approaches on students' science achievement and attitude toward science. Such an analysis may yield clearer results.

Fifthly, previous achievement is one of the significant factors affecting students' learning outcomes (Hattie, 2012; and Huitt, Huitt, Monetti & Hummel, 2009). In order to reveal the student- and teacher-level factors on students' learning outcomes, controlling previous science achievement would give more precious results. This study could not include previous achievement or attitude as a control variable, as TIMSS data does not include such information. Future research can yield more precious results if researchers perform studies with previous achievement and attitude as control variables.

Sixthly, the effect of teacher characteristics on students' achievement is investigated by researchers, and there are a great number of studies about this relationship. Further research would be beneficial to reveal whether teacher effect differentiate among students' background characteristics like ability and socio-economic status, among school subjects like mathematics, science, reading, among different school level characteristics like average socio-economic status, and type of school, and finally among different regions like cantons, states, and countries (Ma, 2013).

Finally, this study examined the effects of student and teacher level factors. TIMSS also collects information about school characteristics by using school questionnaires from school leaders. Further research can be done with three-level HLM analysis which takes student-, teacher-, and school-level factors into account. Apart from this, TIMSS also collects data with video studies. Future studies can combine video analysis with student and teacher questionnaires in order to perform international comparisons in science teaching and learning.

Turkey will participate in TIMSS 2015. Relevant studies with the new data can provide us the opportunity to examine the trends in science education in Turkey.

5.4. Conclusion

In conclusion, besides limitations, this study contributed to the literature by giving information about relationship between student- and teacher-level variables and 8th grade students' science achievement and attitude toward science in Turkey, Finland and England. Although this study did not provide cause-effect relationship between selected student- and teacher-level variables and science achievement and attitude toward science, it is helpful to picturize the general situation in science education in Turkey, high performing European countries namely Finland and England.

When the science curriculum of Turkey, England and Finland were examined, it was observed that developing science performance and attitude toward science were at the forefront. Therefore, dependent variables of the present study were assigned as science achievement and attitude toward science.

Two-level HLM analysis with student factors at level-1 and teacher factors at level-2 was performed through the use of TIMSS 2011 8th grade data from Turkey, England and Finland. Both for science achievement and attitude toward science, substantial differences were observed between Turkey, Finland and England.

The findings showed that within-class variation in science achievement is higher than between-class variation in Turkey and Finland, whereas between-class variation in science achievement is higher than within-class variation in England. Classrooms in Finland were more homogeneous with less between-class variance in science achievement than Turkey and England. The analysis results focusing on attitude toward science as an outcome variable showed that within-class variation in attitude toward science is higher than between-class variation in Turkey, England and Finland. Home educational resources factor was found significant in all models of Turkey, Finland and England; furthermore, it was found to be the most powerful predictor of science achievement and one of the most powerful predictors of attitude toward science of 8th grade students in Turkey, Finland and England. Yet, another student level variable, gender was a significant predictor of science achievement in Turkey and England, and again a significant predictor of attitude toward science in all three countries. Time spent on homework was found significant in Turkey and Finland models explaining science achievement and Finland and England models explaining attitude toward science. Bullying at school was found significant only in Turkey model explaining both science achievement and attitude toward science, and also found significant predictor of attitude toward science in England model. Parental involevement was found significant significant predictor of science achievement only in Finland model. Moroever, parental involvement was found one of the most powerful predictors of attitude toward science like HER variable in all three countries namely Turkey, Finland and England. Teache-level variables which are namely professional development and collaboration to improve teaching were found non-significant in all of the models explaining science achievement and attitude toward science in these three countries. Confidence in teaching science was found significant predictor of science achievement only in England model. Teacher experience was found significant predictor of attitude toward science in Turkey and Finland, and found non-significant in all of the models explaining science achievement. Finally, career satisfaction was found to be significant only in Turkey model explaining science achievement. Teachers' emphasis on science investigations were found significant in none of the models explaining science achievement and in all of the models explaining attitude toward science in Turkey, Finland and England. Finally,

The effort of this study to explain science achievement and attitude toward science of 8th grade students among selected countries was not adequate. There could be various student-, teacher- and also school-level factors explaining achievement and also attitude gap among countries. System level differences like education system properties, curriculum, teacher education, efforts of governments to reduce education differences within country would be the main reasons of gap between achievement and attitude levels among countries. Finland science curriculum includes only basic objectives and content (Kuppari & Vettenranta, 2012), hence it is wider especially compared Turkey science curriculum. Finland has a decentralized education system which leads to higher teacher autonomy in education (FNBE, 2014c) unlike Turkey. Moreover, teacher education in Finland is crucial and government is selective in accepting applications of people who wants to be a teacher (FNBE, 2014b). Moreover, each country runs different projects like Hey Girls, Let's Go to School Project to improve gender equality in Turkey, WISE Project to improve gender equality, and hosting Science Learning Centers to improve professional development in England, moreover, GISEL Project to improve female students attitude toward science, TASUKO Project to improve gender equality by improving gender sensitivity of pre-service teachers, Kiva-koulu Project to fight bullying at school, Osaava Project to improve professional development in Finland. Such system level differences may lie behind the findings of the present study.

So far, Turkey had made many attempts to improve learning outcomes and equalize the educational opportunities across different regions by several projects like the Movement of Enhancing Opportunities and Improving Technology (FATIH), Hey Girls, Let's Go to School, and Master of Implementation Plan with UNICEF (OECD, 2013d). However, the picture seen in international and national studies show that further attempts are required to improve education outcomes in Turkey.

REFERENCES

Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education*, 30(14), 1945–1969.

Al-Alwan, A.F., & Mahasneh, A.M. (2014). Teachers' self-efficacy as determinant of students' attitudes toward school: A study at the school level. *Review of European Studies*, *6*(1), 171-179.

Australian Council for Educational Research (ACER), (2006). *Teaching science in Australia: Results from the TIMSS 1999 video study*. TIMSS Australia Monograph No. 8, Victoria: ACER.

Ackerman, P. L. (2013). 'Engagement and opportunity to learn'. In: J. Hattie, and E. M. Anderman (eds) *The international guide to student achievement* (pp. 39-41). New York, NY: Taylor & Francis.

Adam, S. (2004). *Using learning outcomes – A consideration of the nature, role, application and implications for European education of employing learning outcomes at local, national and international levels.* Paper presented at the United Kingdom Bologna seminar. Retrieved on July, 02, 2014 from http://www.ehea.info/Uploads/Seminars/040620LEARNING_OUTCOMES-Adams.pdf

Ahtee, M., Lavonen, J., & Pehkonen, E. (2008). Reasons behind the Finnish success in science and mathematics in PISA tests. *Programs of Education in the 21st Century*, 6, 18-26.

Akey, T. M. (2006). *School context, student attitudes and behavior, and academic achievement: An exploratory analysis*. New York: MDRC.

Aktas, I. (2011). Examining the relationship between students' science achievement and teachers' characteristics in TIMSS 2007. Unpublished Master Dissertation. Hacettepe University.

Akyüz, G. (2006). *Teacher and classroom characteristics: Their relationship with mathematics education in Turkey, European Union countries and candidate countries*. Unpublished PhD Thesis. Middle East Technical University.

Akyüz, G. (2014). The effects of student and school factors on mathematics achievement in TIMSS 2011. *Education and Science: Large Scale Assessment Special Issue*, *39*(172), 150-162.

Anderson, L. W. (1981). Instruction and time-on-task: A review. *Journal of Curriculum Studies*, *13*, 289–303.

Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school : Critical conceptual and methodological issues of the construct. *Psychology in the Schools*, *45*(5), 369-386.

Atik, G. (2011). Assessment of school bullying in Turkey: A critical review of self-report instruments. *Procedia Social and Behavioral Sciences*, 15, 3232–3238.

Ayas, A. (2012). 'An examination of Turkish science curricula from a historical perspective with an emphasis on learning outcomes'. In: S. Bernholt, K. Neumann, and P. Nentwig (Eds.) M*aking it tangible: Learning outcomes in science education* (pp. 399-425). Waxmann: Münster.

Ayaz, M. F., & Sekerci, H. (2015). The effects of the constructivist learning approach on students' academic achievement: A meta-analysis study. *The Turkish Online Journal of Educational Technology*, *14*(4), 143-156.

Australasian Curriculum, Assessment and Certification Authorities. (ACACA) (2008). *Changing secondary schools in Australia Years 7 – 10 –State by State*. Retrieved on July 03, 2014 from http://acaca.bos.nsw.edu.au/

Australian Institute for Teaching and School Leadership. (nd). *The essential guide to professional learning: Collaboration*. Australian Institute for Teaching and School Leadership. Retieved on December 17, 2015 from http://www.aitsl.edu.au/docs/default-source/professional-growth-resources/professional-learning-resources/the-essential-guide-to-professional-learning---collaboration.pdf?sfvrsn=2

Baker, D., Fabrega, R., Galindo, C., & Mishook, J. (2004). Instructional time and national achievement: Cross national evidence. *Prospects*, *34*(3), 311-334.

Baker-Henningham, H., Meeks-Gardner, J., Chang, S., & Walker, S. (2009). Experiences of violence and deficits in academic achievement among urban primary school children in Jamaica. *Child Abuse & Neglect*, *33*, 296-306.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist, 44*, 1175-1184.

Bates, A., Shifflet, R., & Lin, M. (2013). 'Academic achievement: An elementary school perspective'. In: J. Hattie, and E. M. Anderman (Eds.). *The international guide to student achievement* (pp. 7-10). New York, NY: Taylor & Francis.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., … Tsai, Y. (2010). Teachers' mathematical knowledge, cognitive action in the classroom, and student progress. *American Educational Research Journal, 47*(1), 133-180.

Bayar, A., & Kösterelioglu, I. (2014). Satisfaction level of teachers in professional development activities in Turkey. *Turkish Studies – International Periodical for the Languages, Literature and History of Turkish and Turkic, 9*(2), 321-333.

Beaton, A.E., Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., Kelly, D.L., & Smith, T.A. (1996). *Mathematics achievement in the middle school years: IEA's third international mathematics and science study (TIMSS).* Chestnut Hill, MA: TIMSS & PIRLS International Study Center.

Bernholt, S., Eggert, S., & Kulgemeyer, C. (2012). 'Capturing the diversity of students' competences in science classrooms: Differences and commonalities of three complementary approaches'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds). *Making it tangible: Learning outcomes in science education* (pp. 173-201). Waxmann: Münster.

Bernholt, S., Neumann, K., & Nentwig, P. (2012). 'Making it tangible – Specifying learning outcomes in science education'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds). *Making it tangible: Learning outcomes in science education* (pp. 13-31). Waxmann: Münster.

Bertona, C. (2012). 'Defining the structure and the content of a new chemistry curriculum in Netherlands'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds). *Making it tangible: Learning outcomes in science education* (pp. 425-443). Waxmann: Münster.

Berry, B., Daughtrey, A., & Wieder, A. (2009). *Collaboration: Closing the effective teaching gap*. Center for Teaching Quality. Retrieved on December 17, 2015 from http://teachersnetwork.org/effectiveteachers/images/CTQPolicyBriefOn_COLLABORATION__021810.pdf

Bietenbeck, J.C. (2011). *Teaching practices and student achievement: Evidence from TIMSS*. Unpublished Master Dissertation. CEMFI University.

Blank, R. K., de las Alas, N., & Smith, C. (2008). *Does teacher professional development have effects on teaching and learning? Evaluation findings from programs in 14 states.* Report, The Council of Chief State School Officers, Washington, DC.

Bohan, M. (2011). *Combating gender stereotypes in education*. Steering Committee for Equality between Women and Men: Council of Europe. Retrieved on December 14, 2015 from https://www.coe.int/t/dghl/standardsetting/equality/03themes/gender-mainstreaming/CDEG_2011_16_GS_education_en.pdf

Boivin, M., & Begin, G. (1989). Peer Status and Self-Perception among Early Elementary School Children: The Case of the Rejected Children. *Child Development, 60*, 591-596.

Bos, K.T. (2002). *Benefits and limitations of large-scale international comparative achievement studies: The case of IEA's TIMSS study*. Unpublished doctoral dissertation. University of Twente.

Boyd, D., Grossman, P., Lankford, H., Loeb, S., & Wyckoff, J. (2009). *Who leaves? Teacher attrition and student achievement*. (CALDER Working Paper 23). Retrieved on November 28, 2014 from http://www.urban.org/UploadedPDF/1001270_teacher_attrition.pdf

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, *53*, 371-399.

Brooks-Gunn, J., Han, W. J. & Waldfogel, J. (2010). First-year maternal employment and child development in the first seven years. *Monographs of the Society for Research in Child Development, 75*(2), 1-19.

Brophy, J. (1988). Educating teachers about managing classrooms and students. *Teaching and Teacher Education, 4*(1), 1-18.

Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in the science education literature. *Journal of Research in Science Teaching , 45* , 971–1002.

Brownlee, J., & Berthelsen, D. (2005). Personal epistemology and relational pedagogy in early childhood teacher education programs. *Early Years*, *26*, 17-29.

BSCS (Biological Sciences Curriculum Study), (2006). *The BSCS 5E instructional model: Origins and Effectiveness*. Report for office of Science Education National Institutes of Health. BSCS, Collorado Springs. Retrieved on October 16, 2014 from http://bscs.org/sites/default/files/_legacy/BSCS_5E_Instructional_Model-Full_Report.pdf

Bybee, R. W. (2008). Scientific Literacy, Environmental Issues, and PISA 2006: The 2008 Paul F-Brandwein Lecture. *Journal of Science Education and Technology, 17*(6), 566-585.

Buddin, R., & Zamarro, G. (2009). Teacher qualifications and student achievement in urban elementary schools. Working Paper, Rand Education, retrieved on November 12, 2014 from http://www.rand.org/content/dam/rand/pubs/reprints/2010/RAND_RP1410.pdf

Buhs, E. S., & Ladd, G. W. (2001). Peer rejection as an antecedent of young children's school adjustment: an examination of mediating processes. *Developmental Psychology, 37*, 550-560.

Buhs, E. S., Ladd, G. W., & Herald, S. L. (2006). Peer Exclusion and Victimization: Processes That Mediate the Relation between Peer Group Rejection and Children's Classroom Engagement and Achievement? *Journal of Educational Psychology*, *98*, 1-13

Bui, K. (2007). Educational Expectations and Academic Achievement among Middle and High School Students. *Education, 127*(3), 328-331.

Camilli, G., Vargas, S., Ryan, S., & Barnett, W. S. (2010). Meta-analysis of the effects of early education interventions on cognitive and social development. *Teachers College Record, 112*(3), 579-620.

Campbell, F. A., & Ramey, C. T. (1995). Cognitive and school outcomes for high-risk African-American students at middle adolescence: Positive effects of early intervention. *American Educational Research Journal, 32*(4), 743-772.

Caprara, G. V., Barbaranelli, C., Steca, P., & Malone, P. S. (2006). Teachers' self-efficacy beliefs as determinants of job satisfaction and students' academic achievement: A study at the school level. *Journal of School Psychology, 44*(6), 473-490.

Ceron-Acevedo, F. (2013). *Cross national differentiation in school systems and achievement: Compositional effects and contextual factors in case of Chile*. Unpublished Master Dissertation. London School of Economics and Political Science.

Chidolue, M. E. (1996). The relationship between teacher characteristics, learning environment and student achievement and attitude. *Studies in Educational Evaluation, 22*(3), 263-274.

Chiu, M.H., & Chen, H.J. (2012). 'The challenge of alignment of students' learning outcomes with curriculum guidelines, instruction and assessment in science practice in Taiwan'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it tangible: Learning outcomes in science education* (pp. 303-341). Waxmann: Münster.

Christenson, S. L., Reschly, A. L., & Wylie, C. (2012). *Handbook of Research on Student Engagement*. Springer.

Chung, J. (2009). *An investigation of reasons for Finland's success in PISA*. Unpublished doctoral dissertation. University of Oxford.

Chung, J., & Crossley, M. (2013). 'Academic Achievement in Finland'. In: Hattie, J. (eds) *The international guide to student achievement* (pp. 462-465). Taylor & Francis.

Clinton, J. (2013). ‘Physical activity’. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 33-35). New York, NY: Taylor & Francis.

Clinton, J., Rensford, A., & Willing, E. (2007). Literature review of the relationship between physical activity, nutrition and academic achievement. Auckland Centre for Health Services, Research and Policy, University of Auckland, New Zealand.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2006). *Teacher student matching and the assessment of teacher effectiveness*. NBER Working Paper No 11936, National Bureau of Economic Research, Cambridge, MA: Authors.

Coley, R.J. (2001). *Differences in gender gap: Comparisons across racial/ethnic groups in education and* work. ETS Policy Information Report, Princeton, NJ: Educational Testing Service.

Conard, M. A. (2006). Aptitude is not enough: How personality and behavior predict academic performance. *Journal of Research in Personality*, *40*, 339-346.

Cooper, H., Robinson, J. C., & Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Review of Educational Research, 76*(1), 1-62.

Creemers, B. P. M., & Kyriakides, L. (2008). *The dynamics of educational effectiveness: A contribution to policy, practice and theory in contemporary schools.* Abingdon: Routledge.

Cronbach, L. J. (1963). Evaluation of course improvement. *Teachers College Record*, 64, 672-683.

Cronbach, L. J. (2000). ‘Course improvement through evaluation’. In: D. L. Stufflebeam, G. F. Madaus, T. Kellaghan (Eds.) *Evaluation models* (pp. 235-247). Springer Netherlands, Kluwer Academic Publishers.

Darling-Hammond, L. (2010). What we can learn from Finland’s successful reform? National Education Association (NEA). Retrived on October 02, 2014 from http://www.nea.org/home/40991.htm

Darling-Hammond, L., & Sykes, G. (2003). Wanted, A National Teacher Supply Policy for Education: The Right Way to Meet The "Highly Qualified

Teacher" Challenge. *Education Policy Archives*, 11 (33). Retrieved on July 20, 2015 from http://epaa.asu.edu/ojs/article/viewFile/261/387

Dawson, C. (2000). Upper primary boys' and girls' interests in science: Have they changed since 1980? *International Journal of Science Education* , *22*(6), 557–570.

Davier, M., Gonzalez, E., & Mislevy, R.J. (2009). *What are plausible values and why are they useful?*. IERI Monograph Series, Volume 2. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Davis, H. A. (2003). Conceptualizing the role of student-teacher relationships is effective: A meta-analysis. *Educational Psychologist*, *38*, 207-234.

Davis, H. A. (2006). Exploring the contexts of relationship quality between middle school students and teachers. *The Elementary School Journal*, *106*(3), 193-223.

Davis, H. A. (2013). 'Teacher-student relationships'. In: J. Hattie, and E. M. Anderman, *International guide to student achievement* (pp. 221-224). New York, NY: Taylor & Francis.

Dearing, E., Kreider, H., & Weiss, H. B. (2008). Increased family involvement in school predicts improved child-teacher relationships and feelings about school for low-income children. *Marriage & Family Review*, *43*(3), 226-254.

DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, *37*(6), 582-601.

DeBacker, T. K., & Nelson, R. M. (2000). Motivation to learn science: Differences related to gender, class type, and ability. *The Journal of Educational Research*, *93*(4), 245-254.

Dee, T. S. (2006). The why chromosome: How a teacher's gender affects boys and girls. *Education Next*, *6*(4), 68-75.

Deming, D., & Dynarski, S. (2008). The lengthening of childhood. *Journal of Economic Perspectives*, *22*(3), 71-92.

Department for Education, (2013). Science programmes of study: key stages 1 and 2 National curriculum in England. Retrieved on August 26, 2015 from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/425618/PRIMARY_national_curriculum_-_Science.pdf

Department for Education, (2014a). Preventing and tackling bullying: Advice for head teachers, staff and governing bodies. Retrieved on August 26, 2015 from https://www.gov.uk/government/publications

Department for Education, (2014b). The National Curriculum in England: Key stages 3 and 4 framework document. Retrieved on October 03, 2014 from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/330327/SECONDARY_national_curriculum_FINAL_140714.pdf

Dettmers, S., Trautwein, U., Ludtke, O., Kunter, M., & Baumert, J. (2010). Homework works if homework quality is high: Using multilevel modeling to predict the development of achievement in mathematics. *Journal of Educational Psychology*, *102*, 467-482.

Dimitrov, D. M. (1999). Gender differences in science achievement: Differential effect of ability, response format, and strands of learning outcomes. *School Science and Mathematics*, *99*(8), 445-450.

Dincer, M. A., & Uysal, G. (2009). Determinants of student achievement in Turkey. *International Journal of Educational Development*, *30*, 592-598.

Doruk, B. K. (2014). The Educational Approaches of Turkish Pre-Service Elementary Mathematics Teachers in Their First Teaching Practices: Traditional or Constructivist?. *Australian Journal of Teacher Education*, *39*(10), 113-134.

Druva, C. A., & Anderson, R. D. (1983). Science teacher characteristics by teacher behavior and by student outcome: A meta-analysis of research. *Journal of Research in Science Teaching*, *20*(5), 467-479.

Duncan, G. J., Ziol-Guest, K., & Kalil, A. (2010). Early childhood poverty and adult attainment, behavior and health. *Child Development*, *81*, 306-325.

Dwyer, T., Sallis, J. F., Blizzard, L., Lazarus, R., & Dean, K. (2001). Relation of academic performance to physical activity and fitness in children. *Pediatric Exercise Science*, *13*, 225-237.

Eccles, S., & Wigfield, A. (2002). Motivational beliefs, values and goals. *Annual Review of Psychology*, *53*, 109-132.

Eisner, E. W. (1993). Forms of understanding and the future of educational research. *Educational Researcher*, *22*(7), 5-11.

Ellison, G., & Swanson, A. (2009). The gender gap in secondary school mathematics at high achievement levels. *Journal of Economic Perspectives*, *24*(2), 109-128.

Epstein, J. L. (1986). Parents' reactions to teacher practices of parent involvement. *The Elementary School Journal*, *86*, 277-294.

Epstein, J. L., & Salinas, K. C. (2004). Partnering with families and communities. *Educational Leadership*, *61*(8), 12-18.

ERG, Egitim Reformu Girisimi, (2005). *Yeni Ogretim Programlarini Inceleme ve Degerlendirme Raporu I.* ERG Monitoring Report. Istanbul: Education Reform Initiative. Retrieved on April 09, 2015 from http://erg.sabanciuniv.edu/sites/erg.sabanciuniv.edu/files/ERG%20Mufredat%20Rapor.07.01.08pdf.pdf

ERG, Egitim Reformu Girisimi, (2014). *Turkiye Egitim Sisteminde Esitlik ve Akademik Basari Arastirma Raporu ve Analizi.* ERG Monitoring Report. Istanbul: Education Reform Initiative. Retrieved on 15 August, 2014 from http://erg.sabanciuniv.edu/sites/erg.sabanciuniv.edu/files/ERGe%C5%9FitlikWEB.22.05.14.pdf

Ergün, S. (2012). *UNICEF and Ministry of Education Girls' Education Project in Turkey:"Haydi Kizlar Okula!" Did it work? What is the aftermath?* Unpublished Master Dissertation. Georgia Institute of Technology.

EURYDICE (2010). *Gender differences in educational outcomes: Study on the measures taken and the current situation in Europe*. EURYDICE: Brussels. Retrieved on December 14, 2015 from http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/120en.pdf

EURYDICE (2011a). *Overview of education system in England*. EURYDICE at NFER, Unit for England, Wales and Northern Ireland. Retrieved on August 12, 2015 from https://www.nfer.ac.uk/shadomx/apps/fms/fmsdownload.cfm?file_uuid=3357E120-C29E-AD4D-0242-F5A56F80AFEE&siteName=nfer

EURYDICE (2011b). *Science education in Europe: National policies, practices and research*. EURYDICE: Brussels. Retrieved on December 14, 2015 from http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/133en.pdf

European Commission, (2013). Turkey 2013 Progress Report. *Enlargement Strategy and Main Challenges 2012-2014*. Commission staff working document, Brussels. Retrieved on October 03, 2014 from http://ec.europa.eu/enlargement/pdf/key_documents/2013/package/brochures/turkey_2013.pdf

European Union, (2011). *Using learning outcomes*, European Qualifications Framework Series: Note 4. Belgium: European Union.

Ewell, P. (2005). *Applying learning outcomes to higher education: An overview*. Paper prepared for the Hong Kong University Grants Committee. National Center for Higher Education Management Systems.

Fan, W. & Williams, C. M. (2010). The effects of parental involvement on students' academic self-efficacy, engagement and intrinsic motivation. *Educational Psychology, 30*, 53-74.

Farooq, M.S., Chaudhry, A.H., Shafiq, M., & Berhanu, G. (2011). Factors affecting students' quality of academic performance: A case of secondary school level. *Journal of Quality and Technology Management, 7*(2), 1-14.

FNBE, Finnish National Board of Education, (nd). Official web site of Finnish National Board of Education. Retrieved on June 02, 2015 from http://www.oph.fi/english

FNBE, Finnish National Board of Education, (2004a). National Core Curriculum for Basic Education 2004. Vammola, Helsinki. Retrieved on October 03, 2014 from http://www.oph.fi/download/47671_core_curricula_basic_education_1.pdf

FNBE, Finnish National Board of Education, (2004b). National Core Curriculum for Upper Secondary Schools 2003. Vammola, Helsinki. Retrieved on October 03, 2014 from http://www.oph.fi/download/47678_core_curricula_upper_secondary_education.pdf

FNBE, Finnish National Board of Education, (2014a). *Education in Finland: Funding in pre-primary and basic education supports equity and equality*. Vammola, Helsinki. Retrieved on August 12, 2015 from http://www.oph.fi/download/163140_funding_in_pre-primary_and_basic_education_supports_equity_and_equality.pdf

FNBE, Finnish National Board of Education, (2014b). *Education in Finland: Teacher education in Finland.* Vammola, Helsinki. Retrieved on August 13, 2015 from http://www.oph.fi/download/154491_Teacher_Education_in_Finland.pdf

FNBE, Finnish National Board of Education, (2014c). *Education in Finland: Teachers in Finland- trusted professionals*. Vammola, Helsinki. Retrieved on August 13, 2015 from http://www.oph.fi/download/148962_Teachers_in_Finland.pdf

FNBE, Finnish National Board of Education, (2015). *Finnish education in a nutshell*. Vammola, Helsinki. Retrieved on August 13, 2015 from http://www.oph.fi/download/171176_finnish_education_in_a_nutshell.pdf

Foy, P., Arora, A., & Stanco, G.M. (2013a). *TIMSS 2011 user guide for the international database*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Foy, P., Arora, A., & Stanco, G.M. (2013b). *TIMSS 2011 user guide for the international database*: *Supplement 1*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*, 59–109.

Freiberg, H. J. (2013). 'Classroom management and student achievement'. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 228-231). New York, NY: Taylor & Francis.

Furnham, A., Chamorro-Premuzic, T., & McDougall F. (2002). Personality, cognitive ability, and beliefs about intelligence as predictors of academic performance. *Learning and Individual Differences*, *14*(1), 47-64.

Gardner, P. L. (1975). Attitudes to science. *Studies in Science Education*, *2*, 1–41.

Gess-Newsome, J. (2013). 'Pedagogical content knowledge'. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 257-259). New York, NY: Taylor & Francis.

Gill, J. (2013). 'Gender Influences'. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 36-39). New York, NY: Taylor & Francis.

Goddard, Y.L., Goddard, R.D., & Tschannen-Moran, M. (2007). A theoretical and empirical investigation of teacher collaboration for school improvement and student achievement in public elementary schools. *Teachers College Record, 109*(4), 877-896.

Goldhaber, D., & Brewer, D. J. (2000). Does teacher certification matter? High school teacher certification status and student achievement. *Educational Evaluation and Policy Analysis*, *22*(2), 129-145.

Goldstein, H. (2004). International comparisons of student attainment: some issues arising from the PISA study. *Assessment in Education: Principles, Policy and Practice*, *11*(3), 319-330.

Gonzalez, E.J., (2012). Rescaling sampling weights and selecting mini-samples from large-scale assessment databases. *IERI Monograph Series: Issues and Methodologies in Large-Scale Assessments*: Volume 5, 117-134.

Gorard, S., & Smith, E. (2004). An international comparison of equity in educational systems. *Comparative Education*, *40*(1), 15-28.

Gottfredson, L. S. (2002). Where and why g matters: Not a mystery. *Human Performance, 15*, 25-46.

Gottfredson, L. S. (2003). Dissecting practical intelligence theory: Its claims and evidence. *Intelligence, 31*, 343-397.

Greene, B.A. & DeBacker, T.A. (2004). Gender and orientations toward the future: Links to motivation. *Educational Psychology Review*, *16*(2), 91-120.

Greenfield, T.A. (1996). Gender, ethnicity, science achievement, and attitudes. *Journal of Research in Science Teaching*, *33*(8), 901-933.

Grolnick, W. S., & Slowiaczek, M. L. (1994). Parents' involvement in children's schooling: A multidimensional conceptualization and motivational model. *Child Development, 65*, 237-252.

Guldemond, H., Hofman, W. H. A., & Hofman, R. H. (2004). ‘Quality and equity of European education’. In R. H. Hofman, W. H. A., Hofman, J. M. Gray, & P. Daly (Eds) *Institutional Context of educational Systems in Europe* (pp. 117-138). Kluwer Academic Publishers.

Guskey, T. R. (2007). Multiple sources of evidence: An analysis of stakeholders’ perceptions of various indicators of student learning. *Educational Measurement: Issues and Practice*, *26*(1), 19-27.

Guskey, T. R. (2013). ‘Defining student achievement’. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 3-6). New York, NY: Taylor & Francis.

Haeusler, C., & Kay, R. (1997). School subject selection by students in the post-compulsory years. *Australian Journal of Career Development*, *6* (1), 32–38.

Haines, R.T. & Mueller, C.E. (2013). ‘Academic achievement: An adolescent perspective’. In: J. Hattie, and E. M. Anderman (Eds.). *The international guide to student achievement* (pp. 10-14). New York, NY: Taylor & Francis.

Hanushek, E. A., Kain, J. F., O’Brien, D. M., & Rivkin, S. G. (2005). *The market for teaching quality*. NBER Working Paper No 11154, National Bureau of Economic Research, Cambridge, MA: Authors.

Hanushek, E. A., Kain, J. F., & Rivkin, S. G. (2004). Why public schools loose teachers. *Journal of Human Resources, 39*, 326-354.

Hanushek, E. A. & Wössmann, L. (2007). *The Role of Education Quality in Economic Growth*. Policy Research Working Paper 4122, World Bank, Washington, D.C.

Harris, D. N., & Sass, T. R. (2008). *Teacher training, teacher quality, and student achievement*. Working paper 3, National Center for Analysis of Longitudinal Data in Education Research.

Haste, H. (2004). *Science in my future: A study of the values and beliefs in relation to science and technology amongst 11–21 year olds*. London: Nestlé Social Research Programme.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. New York, NY: Taylor &Francis.

Hattie, J. (2012). *Visible Learning for Teachers: Maximizing Impact on Learning.* New York, NY: Taylor & Francis.

Hattie, J., & Anderman, E. M. (2013). 'Introduction'. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. xix-xxii). New York, NY: Taylor & Francis.

Hattie, J. & Yates, G. (2014). *Visible learning and the science of how we learn*. New York, NY: Taylor & Francis.

Haveman, R., & Wolfe, B. (2008). The determinants of children's attainments: A review of methods and findings. *Journal of Economic Literature, 33*(4), 1829-1878.

Havnes, T., & Mogstad, M. (2010). Is universal childcare leveling the playing field? Evidence from non-linear difference-in-differences. *IZA Discussion Paper No. 4978*. Institute for the Study of Labor: Germany.

Henson, R. K. (2002). From adolescent angst to adulthood: Substantive implications and measurement dilemmas in the development of teacher efficacy research. *Educational Psychologist, 37*(3), 137-150.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. Developmental Psychology, 45(3), 740-763.

Hodson, D. (1990). A critical look at practical work in school science. *School Science Review*, 70, 33–40.

Hodson, D. (2009). *Teaching and learning about science: Language, theories, methods, history, traditions and values*. The Netherlands: Sense.

Holmes, M., & Croll, P. (1989). Time spent on homework and academic achievement. *Educational Research, 31*(1), 36-45.

Hong, S. & Ho, H. (2005). Direct and indirect longitudinal effects of parental involvement on student achievement: Second-order latent growth modeling across ethnic groups. *Journal of Education Psychology, 97*(1), 32–42.

Horner, R. H., Sugai, G., & Todd, A. W. (2014). Classroom Management Self-Assessment. Positive Behavioral Interventions & Supports, retrieved on November 14, 2014 from https://www.pbis.org/resource/164/classroom-management-self-assessment

House, J. D. (2009). Classroom instructional strategies and science career interest for adolescent students in Korea: Results from the TIMSS 2003 Assessment. *Journal of Instructional Psychology, 36*(1), 13-19.

Hox, J. J. (2010). *Multilevel analysis: Techniques and applications*. New York, NY: Taylor & Francis.

Huitt, W., Huitt, M., Monetti, D., & Hummel, J. (2009). A systems-based synthesis of research related to improving students' academic performance. Paper presented at the 3rd International City Break Conference, October 16-19, Athens, Greece. Retrieved on November 15, 2014, from http://www.edpsycinteractive.org/papers/improving-school-achievement.pdf

Hyde, J. S., & Linn, M. (2006). Gender similarities in mathematics and science. *Science*, 314, 599-600.

IEA, (2011). Official web site of International Association for the Evaluation of Educational Achievement, Retrieved on June 02, 2015 from http://www.iea.nl/

Jacobi, E., Witteich, Y., & Hogue, I. (2003). Parental involvement for a new century. *The New England Reading Association Journal*, *39*, 11-16.

Jarrett, C., Evans, C., Dai, Y., Williams, D., & Rogers, K. (2010). Effects of specialized in-service professional development activities on elementary school students' reading achievement. *National Forum of Teacher Education Journal*, *20*(3).

Jen, T.H., Lee, C.D., Chien, C.L., Hsu, Y.S., Chen, K.M. (2013). Perceived social relationships and science learning outcomes for Taiwanese eighth graders: Structural equation modeling with a complex sampling consideration. *International Journal of Science and Mathematics Education*, *11*(3), 575-600.

Jeynes, W. H. (2005). A meta-analysis of parental involvement to urban elementary school student academic achievement. *Urban Education, 40*, 237-269.

Jeynes, W. H. (2007). The relationship between parental involvement and urban secondary school student academic achievement: A meta-analysis. *Urban Education, 42,* 82-110.

Johnson, S. M., Berg, J. H., & Donaldson, M. L. (2005). *Who stays in teaching and why: A review of the literature on teacher retention*. Cambridge: Harvard Graduate School of Education.

Joncas, M. & Foy, P. (2012). *Sample design in TIMSS and PIRLS*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Jones, G., Howe, A., & Rua, M. (2000). Gender differences in students' experiences, interests, and attitudes towards science and scientists. *Science Education , 84*(2) , 180–192.

Jovanovich, J., & King, S.S. (1998). Boys and girls in the performance-based science classroom: Who's doing the performing? *American Educational Research Journal, 35*(3), 477-496.

Jussim, L. (2013). 'Teachers'expectations'. In: J. Hattie & E. M. Anderman (Eds) *The international guide to student achievement* (pp. 243-247). New York, NY: Taylor & Francis.

Kahle, J. B. (2004). Will girls be left behind? Gender differences and accountability. *Journal of Research in Science Teaching, 41*(10), 961-969.

Kahle, J. B., Parker, L. H., Rennie, L. J., & Riley, D. (1993). Gender differences in science education: Building a model. *Educational Psychologist, 28*(4), 379-404.

Kahraman, N. (2014). Investigating the relationship between science teachers' self-efficacy, work environment and their job satisfaction based on TIMSS 2011. *Journal of Theory and Practice in Education*, *10*(4), 1091-1101.

Kaur, B., Areepattamannil, S., Lee, D., Hong, H., & Su, R. (2014). Does bullying at school predict student academic performance? Evidence from 65 countries. Paper presented at the 2014 annual meeting of the American Educational Research Association, Philadelphia, Pennsylvania, 3-7 April 2014. Retrieved on October 21, 2015, from the AERA Online Paper Repository.

Kaya, S. (2008). *The Effects of Student-Level and Classroom-Level Factors on Elementary Students' Science Achievement in Five Countries*. Unpublished Doctoral Dissertation. Florida State University.

Keeley, T. J. H., & Fox, K. R. (2009). The impact of physical activity and fitness on academic achievement and cognitive performance in children. *International Review of Sport and Exercise Psychology*, *2*(2), 198-214.

Keeves, J. P., (2001). 'Comparative research in education: IEA studies'. In N.J. Smelser and P.B. Baltes (Eds) *International Encyclopedia of the Social and Behavioral Sciences* (pp. 2421-2427). Oxford: Pergamon Press.

Kennedy,D., Hayland, A., & Ryan, N. (2006). *Writing and using learning outcomes: A practical guide*. The Bologna handbook. Retrieved on May 28, 2015 from http://www.procesbolonski.uw.edu.pl/dane/learning-outcomes.pdf

Kennedy, D. (2012). 'Learning outcomes in Ireland'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it tangible: Learning outcomes in science education* (pp. 109-129). Waxmann: Münster.

Ker, H.W. (2015). The impacts of student-, teacher-, and school-level factors on mathematics achievement: an exploratory comparative investigation of Singaporean students and the USA students. *Educational Psychology*, DOI: 10.1080/01443410.2015.1026801

Kerr, K., & Murphy, C. (2012). 'Children's Attitudes to Primary Science'. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds) *Second international handbook of science education* (pp. 627-650). Springer.

Klem , A. M., & Connell, J. P. (2004). Relationships matter: Linking teacher support to student engagement and achievement. *Journal of School Health*, *74*(7), 262–273.

Koballa, T. R., & Crawley, F. E. (1985). The influence of attitude on science teaching and learning. *School Science and Mathematics*, *85*(3), 222–232.

Koller, O., & Parchmann, I. (2012). 'Competencies: The German notion of learning outcomes'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds). *Making it tangible: Learning outcomes in science education* (pp. 151-173). Waxmann: Münster.

Komarraju, M. (2013). ‘Personality influences’. In: J. Hattie & E. M. Anderman (Eds) *The international guide to student achievement* (pp. 59-61). New York, NY: Taylor & Francis.

Korkmaz, F. (2012). *Contribution of some factors to eighth grade students science achievement in Turkey: TIMSS 2007*. Unpublished Master Dissertation. Middle East Technical University.

Kupiainen, S., Hautamaki, J. & Karjalainen, T. (2009). *The Finnish Education System and Pisa*. Ministry of Education Finland, Helsinki University Print.

Kuppari, P., & Vettenranta, J. (2012). ‘Finland: TIMSS 2011’. In: I. V. S. Mullis, M. O. Martin, C. A. Minnich, G. M. Stanco, A. Arora, V. A. S. Centurino & C. E. Castle (Eds) *TIMSS 2011 Encyclopedia: Education Policy and Curriculum in Mathematics and Science, Volume 1: A-K* (pg.283-298). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Kyriakides, L., Campbell, R.J., & Gagatsis, A. (2000). The significance of the classroom effect in primary schools: An application of Creemers' comprehensive model of educational effectiveness. *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice*, *11*(4), 501-529.

Kyrö, M. (2011). *International comparisons of some features of Finnish education system and training*. Finnish National Board of Education, Helsinki. Retrieved on August 12, 2015 from http://www.oph.fi/download/141160_international_comparisons_of_some_features_of_finnish_education_and_training_2011.pdf

Ladd, G. W. (2005). *Children’s peer relations and social competence: A century of progress*. New Haven, CT: Yale University Press.

Ladd, G. W. (2006). Peer Rejection, Aggressive or Withdrawn Behavior, and Psychological Maladjustment from Ages 5 to 12: An Examination of Four Predictive Models. *Child Development*, *77*(4), 822-846.

Ladd, G. W. (2013). ‘Peer influences in elementary school’. In: J. Hattie & E. M. Anderman (Eds) *The international guide to student achievement* (pp. 205-208). New York, NY: Taylor & Francis.

Ladd, G. W., Kochenderfer, B. J., & Coleman, C. C. (1997). Classroom peer acceptance, friendship, and victimization: Distinct relational systems that contribute uniquely to children's school adjustment? *Child Development, 68*(6), 1181-1197.

Laidra, K., Pullmann, H., & Allik, J. (2007). Personality and intelligence as predictors of academic achievement: A cross-sectional study from elementary to secondary school. *Personality and Individual Differences, 42*(3), 441-451.

Lamb, S., & Fullarton, S. (2001). Classroom and school factors affecting mathematics achievement: A comparative study of Australia and the United States using TIMSS. *Australian Journal of Education*, *46*(2), 154-171.

LaRocque, M., Kleiman, I., & Darling, S. M. (2011). Parental involvement: The missing link in school achievement. *Preventing School Failure: Alternative Education for Children and Youth*, *55*(33), 115-122.

Lawson, A. E. (1983). Predicting science achievement: The role of developmental level, disembedding ability, mental capacity, prior knowledge, and beliefs. *Journal of Research in Science Teaching, 20*(2), 117-129.

Labudde, P., Nidegger, C., Adamina, M., & Gingins, F. (2012). 'The development, validation, and implementation of standards in science education: Chances and difficulties in the Swiss project HarmoS'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds). *Making it tangible: Learning outcomes in science education* (pp. 235-261). Waxmann: Münster.

Lahelma, E., & Hynninen, P. (2012). 'Gender Equality in Finnish teacher education with reflections on Nordic and European collaborations'. In T. Strand, & M. Roos (Eds) *Education for social justice, equity and diversity* (pp. 109-131). Münster: LIT Verlag.

Lavonen, J. (2013). Building blocks for high quality science education: reflections based on Finnish experiences. *LUMAT* 1(3), 299-313.

Lavonen, J., Krzywacki, H., & Koistinen, L. (2012). 'Item construction for Finnish national level assessment in school pysics without pre-defined learning outcomes'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it* *tangible: Learning outcomes in science education* (pp. 477-501). Waxmann: Münster.

Lederman, N.G., & Lederman, J.S. (2012). 'Nature of scientific knowledge and scientific inquiry: Building instructional capacity through professional development'. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds) *Second international handbook of science education* (pp. 335-360). Springer.

Lee, J. S., & Bowen, N. K. (2006). Parent involvement, cultural capital, and the achievement gap among elementary school children. *American Educational Research Journal, 43*(2), 193-218.

Linn, R. L. (2000). Assessments and accountability. *Educational Researcher*, *29*(2), 4-16.

Lidar, M., Lundqvist, E., & Ostman, L. (2005). Teaching and learning in the science classroom: The interplay between teachers' epistemological moves and students' practical epistemologies. *Science Education*, *90*, 148-163.

Liljeberg, J. F., Eklund, J. M., Fritz, M. V., & Klinteberg, B. (2011). Poor school bonding and delinquency over time: Bidirectional effects and sex differences. *Journal of Adolescence, 34*(1), 1-9.

Linn, R. (2000). Assessments and accountability. *Educational Researcher*, *29*(2), 4-16.

Lipowsky, F. (2006). Auf den Lehrer kommt es an – Empirische Evidenzen für Zusammenhänge zwischen Lehrerkooperation, Lehrerhandeln und dem Lernen der Schüler. *Zeitschrift für Pädagogik (51). Beiheft*, 47-70.

Lipowsky, F., Rakoczy, K., Vetter, B., Klieme, E., Reusser, K., & Pauli, C. (2009). Quality of geometry instruction and its short-term impact on students' understanding of the Pythagorean Theorem, *Learning and Instruction*, *19*, 527-537.

Liu, K.S., Cheng, Y.Y., Chen, Y.L., & Wu, Y.Y. (2009). Longitudinal effects of educational expectations and achievement attributions on adolescents' academic achievements. *Adolescence, 44*(176), 911-924.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35 year odyssey. *American Psychologist*, *57*, 705-717.

Lomos, C., Roelande, H. H., & Bosker, R. J. (2011). Professional communities and student achievement–A meta-analysis. *School Effectiveness and School Improvement*, *22*(2), 121–148.

Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. (2003). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press.

LUMA (2004). *Finnish Know-how in Mathematics and Natural Sciences in 2002*, Final report of LUMA Programme, LUMA support group, retrieved on May 21, 2015 from http://www.oph.fi/download/48078_Luma_final_report.pdf

Lüdtke, O., Trautwein, U., Kunter, M., & Baumert, J. (2007). Reliability and agreement of student ratings of the classroom environment: A reanalysis of TIMSS data. *Learning Environments Research*, 9, 215-230.

Lyons, T. (2006). Different countries, same science classes: Students’ experience of school science classes in their own words. *International Journal of Science Education , 28* , 591–613.

Ma, X. (2013). ‘The relation of teacher characteristics to student achievement’. In: J. Hattie & E. M. Anderman (Eds). *The international guide to student achievement* (pp. 274-276). New York, NY: Taylor & Francis.

Macintyre, T.M. (2014). *Using and applying international survey data on mathematics and science education*. Unpublished Doctoral Thesis. The University of Edinburgh.

Magnuson, K. (2007). Maternal education and children's academic achievement during middle childhood. *Developmental Psychology, 43*, 1497-1512.

Mahmoee, H.M., & Pirkamali, M.A. (2013). Teacher self-efficacy and students’ achievement: A theoretical overview. *The Social Sciences*, *8*(2), 196-202.

Maltese, A.V., Tai, R.H., & Fan, X. (2012). When is homework worth the time? Evaluating the association between homework and achievement in high school science and math. *The High School Journal*, *96*(1), 52-72.

Marks, H. M. (2000). Student engagement in instructional activity: Patterns in the elementary, middle, and high school years. *American Educational Research Journal*, *37*(1), 153-184.

Marra, R. (2005). Teachers' beliefs: the impact of the design of constructivist learning environments on instructor epistemologies. *Learning Environments Research*, *8*, 135-155.

Martin, L.A. (2010). *Relationship between teacher preparedness and inquiry-based instructional practices to students' science achievement: Evidence from TIMSS 2007.* Unpublished Doctoral Thesis. Indiana University of Pennyslvania.

Martin, M.O. (1996) "Third International Mathematics and Science Study: An Overview". In: M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study (TIMSS) Technical Report, Volume I: Design and Development*. Chestnut Hill, MA: Boston College. Retrieved June 26, 2014 from http://timss.bc.edu/timss1995i/TIMSSPDF/TRCHP1.PDF

Martin, M.O. & Mullis, I.V.S. (2008). *Ensuring comparative validity: Quality control in IEA studies*. 49th IEA General Assembly, Berlin, 6-9 October, 2008. Retrieved on June 01, 2015 from http://www.iea.nl/fileadmin/user_upload/General_Assembly/49th_GA/GA49_ensuring_comparative_validity.pdf

Martin, M.O., Mullis, I.V.S., & Foy, P. (with Olson, J.F., Erberber, E., Preuschoff, C., & Galia, J.). (2008). *TIMSS 2007 international science report*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Martin, M.O. & Mullis, I.V.S. (Eds.). (2012). *Methods and procedures in TIMSS and PIRLS 2011*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Martin, M.O., Mullis, I.V.S., Foy, P., & Stanco, G.M. (2012). *TIMSS 2011 international results in science.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., Gregory, K.D., Smith, T.A., Chrostowski, S.J., Garden, R.A., O'Connor, K.M. (2000). *TIMSS 1999 international science report*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Marginson, S, Tytler, R, Freeman, B and Roberts, K (2013). *STEM: Country comparisons: International comparisons of science, technology, engineering and mathematics (STEM) education*. Final Report, Australian Council of Learned Academies (ACOLA), retrieved on April 07, 2015 from www.acola.org.au

McNeil, L. M. (2000). *Contradictions of reform: the educational costs of standardization*. New York: Routledge.

McGraw, R., Lubienski, S. T., & Strutchens, M. E. (2006). A closer look at gender in NAEP mathematics achievement and affect data: Intersections with achievement, race/ethnicity, and socioeconomic status. *Journal for Research in Mathematics Education*, *37*(2), 129-150.

McMullen, S. (2010). *The impact of homework time on academic achievement*. Working Paper, Michigan: Calvin College.

Millar, R., Whitehouse, M., & Abrahams, I. (2012). 'How learning outcomes in science are specified and measured in English school system'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it tangible: Learning outcomes in science education* (pp. 367-399). Waxmann: Münster.

Michaelowa, K. (2002). *Teacher job satisfaction, student achievement, and the cost of primary education in Francophone Sub-Saharan Africa*, Discussion Paper, No. 188. Hamburg Institute of International Economics.

Ministry of Education, (2006). *Education and Science in Finland*. Ministry of Education publications, Helsinki University Press. Retrieved on October 03, 2014, from http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2006/liitteet/eng_opm15.pdf?lang=en

Ministry of Education and Culture (2012). *Education and Research 2011 – 2016 A development plan*. Ministry of Education and Culture: Department for Education and Science Policy.

Mohammadpour, E., Shekarchizadeh, A., & Kalantarrashidi, S.A. (2015). Multilevel modeling of science achievement in the TIMSS participating countries. *The Journal of Educational Research*, DOI: 10.1080/00220671.2014.917254, 1-16.

Mojavezi, A., & Tamiz, M.P. (2012). The impact of teacher self-efficacy on students' motivation and achievement. *Theory and Practice in Language Studies*, *2*(3), 483-491.

MoNE, Ministry of National Education, (2005). Yeni Ögretim Programlarini Inceleme ve Degerendirme Raporu. Talim ve Terbiye Kurulu Başkanlığı, Ankara.

MoNE, Ministry of National Education, (2013). Fen bilimleri dersi öğretim programı (3, 4, 5, 6, 7, ve 8. sınıflar). Talim ve Terbiye Kurulu Başkanlığı, Ankara.

MoNE, Ministry of National Education, (2014). *National education statistics: Formal education 2013/'14*. A publication of official statistics programme. Ministry of National Education Strategy Development Presidency.

Monseur, C. & Adams, A. (2009). Plausible values: How to deal with their limitations. *Journal of Applied Measurement*, *10*(3), 320-334.

Moon, J. (2002). *The Module and Programme Development Handbook*. London: Kogan Page Limited.

Moon, J. (2004). *Linking levels, learning outcomes and assessment criteria*. Paper presented at the United Kingdom Bologna Seminar. Retrieved on July, 02, 2014 from http://www.ehea.info/Uploads/Seminars/040701-02Linking_Levels_plus_ass_crit-Moon.pdf

Morrell, P.D., & Lederman, N.G. (1998). Students' attitudes toward school and classroom science: Are they independent? *School Science and Mathematics*, *98*(2), 76-82.

Morss, K. & Murray, R. (2005). *Teaching at University*. London: Sage Publications.

Mosher, R., & MacGowan, B. (1985). *Assessing Student Engagement in Secondary Schools: Alternative Conceptions, Strategies of Assessing, and Instruments.* Report, University of Wisconsin, Research and Development Center

Muijs, D., Kyriakides, L., van der Werf, G., Creemers, B., Timperley, H., & Earl, L. (2014). State of the art – teacher effectiveness and professional learning. *School Effectiveness and School Improvement*, *25*(2), 231–256.

Muijs, D. & Reynolds, D. (2010). *Effective Teaching*. Evidence and Practise. London: Sage.

Mullis, I.V.S., & Martin, M.O. (2011). *TIMSS 2011 item writing guidelines*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I. V.S., & Martin, M. O. (2013). *TIMSS and PIRLS 2011: A cross-country analysis of relative school effectiveness of reading, mathematics, and science at the fourth grade*. Keynote presentation, 5th IEA International Research Conference, Singapore. Retrieved on November 11, 2014 from http://www.iea.nl/fileadmin/user_upload/IRC/IRC_2013/Papers/IRC-2013_Mullis_Martin.pdf

Mullis, I.V.S., Martin, M. O., Foy, P., & Drucker, K. T. (2012). *PIRLS 2011 International Results in Reading*. Chestnut Hill, M.A.: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I.V.S., Martin, M.O., Minnich, C. A., Stanco, G.M., Arora, A., Centurino, V.A.S., Castle, C.E. (2012a). *TIMSS 2011 encyclopedia education policy and curriculum in mathematics and science Volume 1: A-K*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I.V.S., Martin, M.O., Minnich, C. A., Stanco, G.M., Arora, A., Centurino, V.A.S., Castle, C.E. (2012b). *TIMSS 2011 encyclopedia education policy and curriculum in mathematics and science Volume 2: L-Z and benchmarking participants*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I.V.S., Martin, M.O., Ruddock, G.J., O'Sullivan, C.Y., Preuschoff, C. (2009). *TIMSS 2011 assessment frameworks*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Mullis, I. V. S., Martin, M. O., Smith, T.A., Gardem, R.A., Gregory, K.D., Gonzalez, E.J., Chrostowski, S.J., O'Connor, K.M. (2003). *Assessment frameworks and specifications 2003*. Chestnut Hill, M.A.: TIMSS & PIRLS International Study Center, Boston College.

Murphy, C., & Beggs, J. (2003). Children's attitudes towards school science. *School Science Review*, *84* (308), 109–116.

Murphy, P. (1996). The IEA assessment of science achievement, *Assessment in Education: Principles, Policy & Practice*, *3*(2), 213-23.

Murphy, P., & Whitelegg, E. (2006). *Girls in the physics classroom: A review of research of participation of girls in physics* . London: Institute of Physics.

Muthen, L.K., & Muthen, B.O. (2010). *MPlus user guide*. Los Angeles, CA: Muthen & Muthen.

Myrberg, E. (2007). The effect of formal teacher education on reading achievement of 3rd grade students in public and independent schools in Sweden. *Educational Studies*, *33*, 145-162.

National Education Association. (2008). *Parent, family, community involvement in education* (NEA Policy Brief No. 11). Washington, DC: Author. Retrieved on November 27, 2014 from http://www.nea.org/assets/docs/PB11_ParentInvolvement08.pdf

National Research Council (1990). *A Framework and Principles for International Comparative Studies in Education*. Washington, DC: The National Academies Press.

National Research Council. (1996). *Mathematics and science education around the world: What can we learn from the Survey of Mathematics and Science Opportunities (SMSO) and the Third International Mathematics and Science Study (TIMSS)?* Washington, DC: National Academy Press.

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8.* Committee on Science Learning, K-8. R.A. Duschl, H.A. Schweingruber, and A.W. Shouse (Eds.). Washington, DC: The National Academies Press.

National Research Council. (2011). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Washington, DC: The National Academies Press.

Neumann, K., Bernholt, S., & Nentwig, P. (2012). 'Learning outcomes in science education: A synthesis of the international views on defining, assessing and fostering science learning'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it tangible: Learning outcomes in science education* (pp. 501-520). Waxmann: Münster.

Neumann, K., Kauertz, A., & Fischer, H. E. (2012). 'Quality of instruction in science education'. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds) *Second international handbook of science education* (pp. 247-258). Springer.

Nusche, D. (2008). Assessment of learning outcomes in higher education: A comparative review of selected practices. OECD Education Working Paper No. 15. 29 February 2008, Directorate for Education.

O'Connor, E. E., Dearing, E., & Collins, B. A. (2011). Teacher-child relationship and behavior problem trajectories in elementary school. *American Educational Research Journal*, *48*(1), 120-162.

O'Connor, M. C., & Paunonen, S. V. (2007). Big five personality predictors of post-secondary academic performance. *Personality and individual Differences, 43*(5), 971-990.

OECD (2005). *Education at glance: OECD indicators 2005*. Paris, France: OECD Publications.

OECD (2007). *PISA 2006. Science competencies for tomorrow's world. Vol. 1: Analysis.* Paris: OECD.

OECD (2009a). *Creating effective teaching and learning environments: First results from TALIS*. OECD Publishing.

OECD (2009b). *PISA 2006 technical report*. Paris: OECD Publishing.

OECD (2009c). *PISA data analysis manual.*Paris: OECD Publishing.

OECD (2010). *PISA 2009 Results: What Students Know and Can Do – Student Performance in Reading, Mathematics and Science (Volume I).* Paris: OECD.

OECD (2011a). *Education at glance 2011: OECD indicators*, OECD Publishing.

OECD (2011b). *Report on the gender initiative: Gender equality in education, employment and entrepreneurship*. OECD Publishing.

OECD (2012a). *Assessment of higher education learning outcomes Volume 1 – Design and implementation*. Feasibility Study Report, OECD Publishing.

OECD (2012b). *Education Today 2013: The OECD Perspective*, OECD Publishing.

OECD (2012c). *Equity and quality in education: Supporting disadvantaged students and schools*, OECD Publishing.

OECD (2013a). *PISA 2012 Results: Excellence Through Equity: Giving Every Student the Chance to Succeed (Volume II).* PISA, OECD Publishing.

OECD (2013b). *Turkey: Education policy outlook.* Paris, France: OECD Publications.

OECD (2014a). *A teachers' guide to TALIS 2013: Teaching and learning international survey*. TALIS, OECD Publishing.

OECD (2014b). *Education at a Glance 2014: Finland*. OECD Publishing.

OECD (2014c). *Education at a Glance 2014: OECD Indicators*. OECD Publishing.

OECD (2014d). *PISA 2012 results in focus: What 15-year-olds know and what they can do with what they know*. OECD Publishing.

OECD (2014e). *PISA 2012 Results: What students know and can do – Student performance in mathematics, reading and science (Volume 1)*. PISA, OECD Publishing.

OECD (2014f). *TALIS 2013 results: An international perspective on teaching and learning, 'United Kingdom (England)'*. OECD Publishing: Paris.

OECD (2014g). *TALIS 2013 Results: An international perspective on teaching and learning*. OECD Publishing.

OECD (2014h). *TALIS 2013 results: An international perspective on teaching and learning, 'Finland'*. OECD Publishing: Paris.

Olafson, L. J., & Schraw, G. (2006). Teachers' beliefs and practices within and across domains. *International Journal of educational Research*, *45*(1), 71-84.

Olitsky, S., & Milne, C. (2012). 'Understanding engagement in science education: The psychological and the social'. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds) *Second international handbook of science education* (pp.19-34). Springer.

Ololube, N. P. (2006). *Teachers' job satisfaction and motivation for school effectiveness: An assessment*. Report, ERIC Number ED496539, retrieved on April 09, 2015 from http://files.eric.ed.gov/fulltext/ED496539.pdf

Osborne, J., & Dillon, J. (2008). *Science education in Europe: Critical reflections*. A report to the Nuffield Foundation. The Nuffield Foundation, London.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications, *International Journal of Science Education*, *25*(9), 1049-1079.

Otter, S. (1992). *Learning outcomes in higher education*, Unit for the Development of Adult and Continuing Education, London.

Öztürk, I.H. (2011). Curriculum reform and teacher autonomy in Turkey: The case of the history teaching. *International Journal of Instruction*, *4*(2), 113-128.

Öztürk, M. (2013). The value teachers add to educational systems: the case of Finland. *Hacettepe University Journal of Education, Special Issue* (1), 298-310.

Özdemir, E. (2003). *Modeling the factors affecting science achievement of eighth grade Turkish students based on the third international mathematics and science study-repeat (TIMSS-R) data*. Unpublished Master Dissertation. Middle East Technical University.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578.

Panizzon, D. (2012). 'Learning outcomes for science in Australia: How are they defined, measured and implemented?'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it tangible: Learning outcomes in science education* (pp. 341-367). Waxmann: Münster.

Patrick, H., & Yoon, C. (2004). Early adolescents' motivation during science investigation. *The Journal of Educational Research*, *97*(6), 319–330.

Pehkonen, E., Ahtee, M., & Lavonen, J. (2007). *How Finns learn mathematics and science.* Rotterdam/Taipei: Sense Publishers.

Pektaş, M. (2010). *Some of factors affecting science achievement in sampling of Turkey that trends in International Mathematics and Science Study (TIMSS)*. Unpublished Master Dissertation. Hacettepe University.

Pellegrino, J. W. (2012). 'The design of an assessment system focused on student achievement: A learning sciences perspective on issues of competence, growth and measurement'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds) *Making it tangible: Learning outcomes in science education* (pp. 79-109). Waxmann: Münster.

Phillips, D. C. (2014). *Encyclopedia of educational theory and philosophy*. SAGE Publications: United States of America.

Pil, F. K., & Leana, C. (2009). Applying organizational research to public school reform: The effects of teacher human and social capital on student performance. *Academy of Management Journal, 52*(6), 1101-1124.

Pintrich, P. R., & DeGroot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33-40.

Prenzel, M., Seidel, T., & Kobarg, M. (2012). 'Science teaching and learning: An international comparative perspective'. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds) *Second international handbook of science education* (pp. 667-678). Springer.

Proitz, T. S. (2010). Learning outcomes: What are they? Who defines them? When and where are they defined?. *Springer*, 22, 119-137. DOI 10.1007/s11092-010-9097-8

Raudenbush, S.W., & Bryk, A.S. (2002). *Hierarchical linear models: Applications and data analysis methods.* Newbury Park, CA: Sage.

Raudenbush, S.W., Bryk, A.S., Cheong, Y.F., Congdon, R.T., and Toit, M. (2011). *HLM 7 Hierarchical Linear and Nonlinear Modeling*. Lincolnwood: Scientific Software International.

Raven, J. (1991). The wider goals of education: Beyond the three R's. *Educational Forum*, *55*(4), 343-363.

Reeve, J. (2006). Teachers as facilitators: What autonomy-supportive teachers do and why their students benefit. *Elementary School Journal*, 106, 225-236.

Renaud, R. D. (2013). 'Attitudes and dispositions'. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 57-59). New York, NY: Taylor & Francis.

Reschly, A., & Christenson, S. L. (2006). 'Promoting school completion'. In G. Bear, & K. Minke (Eds.), *Children's needs III: Understanding and addressing the developmental needs of children*. Bethesda, MD: National Association of School Psychologists.

Reynolds, A. J., & Walberg, H. J. (1992). A structural model of science achievement and attitude: An extension to high school. *Journal of Educational Psychology*, *84*(3), 371-382.

Reynolds, A. J., & Temple, J. A. (2008). Cost-effective early childhood development programs from preschool to third grade. Annual Review of Clinical Psychology, *4*, 109-139.

Rice, J. K. (2003). *Teacher quality: Understanding the effectiveness of teacher attributes*. Washington, D.C.: Economic Policy Institute.

Riley, K., & Torrance, H. (2003). Big change question: As national policy-makers seek to find solutions to national education issues, do international comparisons such as TIMSS and PISA create a wider understanding, or do they serve to promote the orthodoxies of international agencies?. *Journal of Educational Change, 4*(4), 419-425.

Rimm-Kaufmann, S. (2014). Improving students' relationships with teachers to provide essential supports for learning. American Psychological Association, retrieved on November 16, 2014 from http://www.apa.org/education/k12/relationships.aspx

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, *73*(2), 417–458.

Roberts, D. A. (2007). Scientific literacy. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of Research on Science Education* (pp. 729-780). Mahwah, NJ: Lawrence Erlbaum Associations.

Roberts, R., & Gott, R. (2003). Assessment of biology investigations. *Journal of Biological Education*, 37(3), 114–121.

Robitaille, D.F., Schmidt, W.H., Raizen, S.A., McKnight, C.C., Britton, E., and Nicol, C. (1993). *TIMSS monograph no. 1: Curriculum frameworks for mathematics and science*. Vancouver, Canada: Pacific Educational Press.

Rosier, M. (1990). International Comparisons in Science Education. *Studies in Science Education*, *18*(1), 87-104.

Ross, J. A. (2013). 'Teacher efficacy'. . In: J. Hattie & E. M. Anderman (Eds) *The international guide to student achievement* (pp. 266-268). New York, NY: Taylor & Francis.

Ross, J. & Bruce, C. (2007). Professional development effects on teacher efficacy: Results of randomized field trial. *The Journal of Educational Research, 101*(1), 50-60.

Rowan, B., Correnti, R., & Miller, R. J. (2001). *What large-scale, survey research tells us about teacher effects on student achievement.* Consortium for Policy Research in Education, Study of Instructional Improvement, Research Note S-5. Ann Arbor, MI: University of Michigan. Retrieved on june 25, 2014 from http://www.sii.soe.umich.edu/documents/LargeScaleSurveyResearch.pdf

Rowe, N. (2012). 'England: TIMSS 2011'. In: I.V.S. Mullis, M.O. Martin, C.A. Minnich, G.M. Stanco, A. Arora, V.A.S. Centurino, & C.E. Castle (Eds). *TIMSS 2011 encyclopedia education policy and curriculum in mathematics and science Volume 1* (pp. 267-281). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Rutkowski, D.J. & Prusinski, E.L. (2011). *The Limits and Possibilities of International Large-Scale Assessments*. Education Policy Brief, Volume 9, Number 2. Bloomington: Center for Evaluation & Education Policy.

Sahlberg, P. (2007). Education policies for raising student learning: the Finnish approach. *Journal of Education Policy, 22*(2), 147-171.

Sandoval-Hernandez, A., Jaschinski, K., Fraser, P., & Ikoma, S. (2015). Is teacher Experience Associated with Mathematics Achievement? *IEA's Policy Brief Series, No.4*, Amsterdam, IEA, retrieved on May 04, 2015 from http://www.iea.nl/policy_briefs.html

Sanders, M. G. (1998). The effects of school, family and community support on the academic achievement of African American adolescents. *Urban Education,* 33, 385-409.

Sanders, C. E., Field, T. M., & Diego, M. A. (2001). Adolescents' academic expectations and achievement. *Adolescence, 36*(144), 795-802.

SCCRE, Swiss Coordination Centre for Research in Education, (2014). *Swiss Education Report 2014,* Education Report, Aarau: SKBF.

Schibeci, R. A. (1984). Attitudes to Science: An update. *Studies in Science Education* , *11*(1), 26–59.

Schmidt, W.H., & Cogan, L.S. (1996). ‘Development of the TIMSS context questionnaires’. In M. O. Martin, and D. L. Kelly (Eds.) *Technical report volume 1: Design and development* (pp. 5-1 – 5-13). Chestnut Hill, MA: TIMSS International Study Center, Boston College.

Schneider, M. (2009). The International PISA Test. *Education Next, 9*(4), 69-74.

Schraw, G., Brownlee, J., & Olafson, L., (2013). ‘Teachers’ epistemological beliefs and achievement’. In: J. Hattie, and E. M. Anderman (Eds.) *The international guide to student achievement* (pp. 268-270). New York, NY: Taylor & Francis.

Schmid, C. L. (2001). Educational Achievement, Language-Minority Students, and the New Second Generation. *Sociology of Education, 74*, 71-87.

Science Education for Diversity. (2010). *Exploration: Documentary Analysis, Work Package 2*, Systhesis Report. Science Education for Diversity: European Comission.

Seker, H. (2011). Reflections of teaching approach-related knowledge, beliefs and habits on teaching practice. *Problems of Education in the 21st Century*, 33, 73-82.

Shavelson, R. J., & Ruiz-Primo, M. A. (1998). On the Assessment of Science Achievement Conceptual Underpinnings for the Design of Performance Assessment: Report of Year 2 Activities. CSE Technical Report No 491, Center for the Study of Evaluation University of California, CA.

Simola, H. (2005). The Finnish miracle of PISA: Historical and sociological remarks on teaching and teacher education, *Comparative Education, 41*(4), 455-470.

Simon, S., & Campbell, S. (2012). ‘Teaching Learning and Professional Development in Science Education’. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds.) *Second international handbook of science education* (pp. 307-322). Springer.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research*, *95*(6), 323-332.

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417-453.

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology, 85*, 571-581.

Slocum-Gori, S.L., & Zumbo, B.D. (2011). Assessing the unidimensionality of psychological scales: Using multiple criteria from factor analysis. *Social Indicators Research, 102*(3), 443-461.

Smith, T.M. & Ingersoll, R.M. (2004). What are the effects of induction and mentoring on beginning teacher turnover? *American Educational Research Journal*, *41*(3), 681-714.

Snijder, T.A.B. & Bosker, R. J. (2012). *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. Sage, Los Angeles.

Spelke, E. S. (2005). Sex differences in intrinsic aptitude for mathematics and science?: A critical review. *American Psychologist, 60*(9), 950-958.

Stanat, P., & Lüdtke, O. (2013). ‘International large-scale assessment studies of student achievement’. In: J. Hattie & E. M. Anderman (Eds) *The international guide to student achievement* (pp. 481-484). New York, NY: Taylor & Francis.

Stancel-Piatak, & Sandoval-Hernandez, (2015). *Methodological deepening. Multilevel Modeling with Large Scale Assessment Data (TIMSS & PIRLS)*. Workshop, Hamburg: IEA Data Processing and Research Center, 11-13 May, 2015.

Supovitz, J., & Turner, H. (2000). The effects of Professional development on science teaching practices and classroom culture. *Journal of Research in ScienceTeaching, 37*(9), 963-980.

Tasar, M.F., Aztekin, S., & Arifoglu, A. (2012). ‘Turkey: TIMSS 2011’. In: I.V.S. Mullis, M.O. Martin, C.A. Minnich, G.M. Stanco, A. Arora, V.A.S. Centurino, & C.E. Castle (Eds). *TIMSS 2011 encyclopedia education policy and curriculum in mathematics and science Volume 2: L-Z and* *benchmarking participants* (pp. 933-945). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Tayler, C. (2013). 'Entry to school'. In: J. Hattie & E. M. Anderman (Eds) *The international guide to student achievement* (pp. 25-27). New York, NY: Taylor & Francis.

The National Board of Education (2004). *The development of education*. National report of Finland. Retrieved on November 15, 2015 from http://www.ibe.unesco.org/National_Reports/ICE_2004/finland.pdf

Timperley, H., Wilson, A., Barrar, H., & Fung, I. (2007). *Teacher professional learning and development: Best evidence synthesis iteration*. Report, New Zealand Ministry of Education.

Tinoca, L. F. (2004). *From professional development for science teachers to student learning in science*. Unpublished PhD Thesis. The University of Texas at Austin. Retrieved on April 07, 2015 from https://www.lib.utexas.edu/etd/d/2004/tinocalf042/tinocalf042.pdf

Trautwein, U. (2007). The homework-achievement relation reconsidered: Differentiating homework time, homework frequency, and homework effort. *Learning and Instruction, 17*(3), 372-388.

Trautwein, U., & Köller, O. (2003). The relationship between homework and achievement- Still much of a mystery. *Educational Psychology Review, 15*(2), 115-145.

Trautwein, U., Luedtke, O., Kastens, C., & Köller, O. (2006). Effort on homework in grades 5 through 9: Development, motivational antecedents, and the association with effort on classwork. *Child Development, 77*(4), 1094-1111.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783-805.

Tytler, R., & Osborne, J. (2012). 'Student attitudes and aspirations toward science'. In: B. J. Fraser, K. G. Tobin & C. J. McRobbie (Eds) *Second international handbook of science education* (pp. 597-627). Springer.

UNESCO (2006). *Teachers and educational quality: Monitoring global needs for 2015*. Montreal, Canada: UNESCO Institute for Statistics.

UNESCO (2007). *Enhancing learning from access to success*. Report of the first experts' meeting: Defining areas of action, Paris. Retrieved on July 02, 2014 from http://unesdoc.unesco.org/images/0015/001556/155642e.pdf

UNESCO (2014). *Regional and Country Profiles.* UNESCO Institute for Statistics. Retrieved on June 25, 2014 from http://www.uis.unesco.org/DataCentre/Pages/regions.aspx?SPSLanguage=EN

Venturini, P., & Tiberghien, A. (2012). 'Potential learning outcomes inferred from French curricula in science education'. In: S. Bernholt, K. Neumann, & P. Nentwig (Eds). *Making it tangible: Learning outcomes in science education* (pp. 443-477). Waxmann: Münster.

Veronneau, M. H., & Dishion, T. J. (2011). Middle School Friendships and Academic Achievement in Early Adolescence: A Longitudinal Analysis. *Journal of Early Adolescence, 31*, 99-124.

Vlasceanu, L., Grunberg, L., & Parlea, D. (2004). *Quality assurance and accreditation:A glossary of basic terms and definitions*. Bucharest: UNESCO-CEPES.

Wagemaker, H. (2002). 'TIMSS in context: Assessment, monitoring, and moving targets'. In D. F. Robitaille, & A. E Beaton (Eds.). Secondary analysis of TIMSS data (pp. 3-10). Dordrecht, The Netherlands: Kluwer.

Walker, J. (2008). Looking at teacher practices through the lens of parenting style. *Journal of Experimental Education*, *76*, 218-240.

Wang, H.A., & Schmidt, W.H. (2001). 'Philosophy and sociology of science in science education: Results from Third International Mathematics and Science Study'. In F. Bevilacqua & E. Wigfield (Eds). *Science education and culture: The contribution of history and philosophy of science*. (pp. 83-103). Netherlands: Kluwer Academic Publishers.

Wayne, A. J., & Youngs, P. (2003). Teacher characteristics and student achievement gains: A review. *Review of Educational Research*, *73*(1), 89-122.

Wenglinsky, H. (2000). *How teaching matters: Bringing the classroom back into discussions of teacher quality.* (ETS Policy Information Report). Princeton, NJ: Educational Testing Service.

Wenglinsky, H. (2001). *Teacher classroom practices and student performance: How schools can make a difference*. Princeton, NJ: Educational Testing Service.

Wentzel, K. R. (2009). 'Students' relationships with teachers as motivational contexts'. In K. R. Wentzel & A. Wigfield (Eds). *Handbook of motivation* (pp. 301-322). New York: Routledge

Westbrook, J., Durrani, N., Brown, R., Orr, D., Pryor, J., Boddy, J., & Salvi, F. (2013). *Pedagogy, Curriculum, Teaching Practices and Teacher Education in Developing Countries*. Final Report. Education Rigorous Literature Review: Department for International Development.

Wheelan, S. A., & Kesselring, J. (2005). Link between faculty group development and elementary student performance on standardized tests. *The Journal of Educational Research, 98*(6), 323-330.

Willms, J. D. (2003). *Student engagement at school: A sense of belonging and participation, Results from PISA 2000*. Paris: Organization for Economic Co-Operation and Development.

Willms, J. D. (2006). *Learning divides*: *Ten policy questions about the performance and equity of schools and schooling systems.* Montreal, Canada: UNESCO Institute for Statistics. Retrieved on November 27, 2014 from http://unesdoc.unesco.org/images/0014/001470/147066e.pdf

Wood, R. E., & Locke, E. A. (1987). The relation of self-efficacy and grade goals to academic performance. *Educational and Psychological Measurement*, *47*(4), 1013-1024.

Woolfolk Hoy, A., & Davis, H. A. (2005). 'Teacher self-efficacy and its influence on adolescent achievement'. In: T. Urdan & M. F. Pajares (Eds.), *Adolescence and education: Vol. 5. Self-efficacy beliefs during adolescence* (pp. 117-137). Greenwich, CT: Information Age.

Woolfolk Hoy, A., & Spero, R. B. (2005). Changes in teacher efficacy during the early years of teaching: A comparison of four measures. *Teaching and Teacher Education, 21*(4), 343-356.

World Bank, (2006). *From Schooling Access to Learning Outcomes: An Unfinished Agenda*. An evaluation of World Bank support to Primary education. The World Bank: Washington, DC. Retrieved on July 02, 2014 from http://ieg.worldbank.org/Data/reports/primary_education_evaluation.pdf

World Bank, (2011). *Improving The Quality And Equity Of Basic Education In Turkey Challenges And Options*. The World Bank: Washington D.C.

Wubbels, T., Levy, J., & Brekelmans, M. (1997). Paying attention to relationships. *Educational Leadership*, *54*(7), 82-86.

Yaman, I. (2004). *Modeling the relationship between the science teacher characteristics and eighth grade Turkish student science achievement in TIMSS-R*. Unpublished Master Thesis. Middle East Technical University.

Yoon, K.S., Duncan, T., Lee, S.W.Y., Scarloss, B., & Shapley, K.L. (2007). *Reviewing the evidence on how teacher professional development affects student achievement*, Issues & Answers Report, REL 2007–No. 033. Washington, DC: U.S. Department of Education. Retrieved on April 07, 2015 from http://ies.ed.gov/ncee/edlabs

Wimberley, C.E. (2011). *Teacher collaboration and student achievement*. Unpublished PhD thesis, Lindenwood University.

Zhang, Y. (2012). Educational Expectations, School Experiences, and Academic Achievements: A Longitudinal Examination, Working Paper. Gansu Survey of Children and Families. Retrieved on November 28, 2014 from http://repository.upenn.edu/cgi/viewcontent.cgi?article=1021&context=gansu_papers

APPENDIX A

THE MULTI-COLLINEARITY TEST RESULTS WITH VIF VALUES FOR TURKEY, ENGLAND AND FINLAND

Table A.1. The Multi-Collinearity Test Result for 1nd Level Variables with Dependent Variable named Science Achievement for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Gender	.985	1.015
Home Educational Resources	.929	1.076
Parental Involvement	.926	1.080
Bullying at School	.972	1.028
Time Spent on Homework	.989	1.011

Note. Dependent Variable: Science Achievement

Table A.2. The Multi-Collinearity Test Result for 1nd Level Variables with Dependent Variable named Attitude toward Science for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Gender	.985	1.015
Home Educational Resources	.929	1.077
Parental Involvement	.926	1.080
Bullying at School	.972	1.028
Time Spent on Homework	.989	1.011

Note. Dependent Variable: Attitude toward Science

Table A.3. The Multi-Collinearity Test Result for 1st Level Variables with Dependent Variable named Science Achievement for England

Model	Collinearity Statistics	
	Tolerance	VIF
Gender	.994	1.006
Home Educational Resources	.955	1.047
Parental Involvement	.959	1.043
Bullying at School	.993	1.007
Time Spent on Homework	.963	1.038

Note. Dependent Variable: Science Achievement

Table A.4. The Multi-Collinearity Test Result for 1st Level Variables with Dependent Variable named Attitude toward Science for England

Model	Collinearity Statistics	
	Tolerance	VIF
Gender	.994	1.006
Home Educational Resources	.956	1.046
Parental Involvement	.960	1.042
Bullying at School	.994	1.007
Time Spent on Homework	.963	1.038

Note. Dependent Variable: Attitude toward Science

Table A.5. The Multi-Collinearity Test Result for 1st Level Variables with Dependent Variable named Science Achievement for Finland

Model	Collinearity Statistics	
	Tolerance	VIF
Gender	.955	1.048
Home Educational Resources	.973	1.028
Parental Involvement	.972	1.029
Bullying at School	.976	1.024
Time Spent on Homework	.979	1.022

Note. Dependent Variable: Science Achievement

Table A.6. The Multi-Collinearity Test Result for 1nd Level Variables with Dependent Variable named Attitude toward Science for Finland

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Gender	.957	1.045
Home Educational Resources	.973	1.028
Parental Involvement	.966	1.035
Bullying at School	.978	1.022
Time Spent on Homework	.976	1.025

Note. Dependent Variable: Attitude toward Science

Table A.7. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Confidence in Teaching Science for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.957	1.045
Collaborate to Improve Teaching	.893	1.120
Teachers Emphasize Science Investigations	.942	1.061
Teachers' Professional Development	.871	1.148
Teacher Experience	.963	1.039

Note. Dependent Variable: Confidence in Teaching Science

Table A.8. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Collaborate to Improve Teaching for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.914	1.094
Confidence in Teaching Science	.888	1.127
Teachers Emphasize Science Investigations	.910	1.099
Teachers' Professional Development	.935	1.070
Teacher Experience	.964	1.037

Note. Dependent Variable: Collaborate to Improve Teaching

Table A.9. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Career Satisfaction for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Collaborate to Improve Teaching	.894	1.119
Confidence in Teaching Science	.930	1.075
Teachers Emphasize Science Investigations	.891	1.122
Teachers' Professional Development	.882	1.134
Teacher Experience	.967	1.034

Note. Dependent Variable: Career Satisfaction

Table A.10. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teachers Emphasize Science Investigations for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.915	1.093
Confidence in Teaching Science	.940	1.064
Collaborate to Improve Teaching	.914	1.095
Teachers' Professional Development	.877	1.140
Teacher Experience	.960	1.041

Note. Dependent Variable: Teachers Emphasize Science Investigations

Table A.11. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teachers' Professional Development for Turkey

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.924	1.082
Confidence in Teaching Science	.888	1.127
Collaborate to Improve Teaching	.958	1.044
Teachers Emphasize Science Investigations	.896	1.116
Teacher Experience	.987	1.013

Note. Dependent Variable: Teachers' Professional Development

Table A.12. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teacher Experience for Turkey

Model	Collinearity Statistics	
	Tolerance	VIF
Teacher Career Satisfaction	.919	1.088
Confidence in Teaching Science	.890	1.124
Collaborate to Improve Teaching	.897	1.115
Teachers Emphasize Science Investigations	.890	1.124
Teachers' Professional Development	.896	1.116

Note. Dependent Variable: Teacher Experience

Table A.13. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Confidence in Teaching Science for England

Model	Collinearity Statistics	
	Tolerance	VIF
Teacher Career Satisfaction	.923	1.084
Collaborate to Improve Teaching	.915	1.093
Teachers Emphasize Science Investigations	.926	1.080
Teachers' Professional Development	.935	1.069
Teacher Experience	.991	1.009

Note. Dependent Variable: Confidence in Teaching Science

Table A.14. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Collaborate to Improve Teaching for England

Model	Collinearity Statistics	
	Tolerance	VIF
Teacher Career Satisfaction	.935	1.070
Confidence in Teaching Science	.898	1.113
Teachers Emphasize Science Investigations	.925	1.081
Teachers' Professional Development	.943	1.061
Teacher Experience	.940	1.064

Note. Dependent Variable: Collaborate to Improve Teaching

Table A.15. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Career Satisfaction for England

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Collaborate to Improve Teaching	.943	1.060
Confidence in Teaching Science	.914	1.094
Teachers Emphasize Science Investigations	.916	1.091
Teachers' Professional Development	.946	1.057
Teacher Experience	.935	1.070

Note. Dependent Variable: Career Satisfaction

Table A.16. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teachers Emphasize Science Investigations for England

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.908	1.102
Confidence in Teaching Science	.909	1.100
Collaborate to Improve Teaching	.925	1.081
Teachers' Professional Development	.962	1.040
Teacher Experience	.940	1.064

Note. Dependent Variable: Teachers Emphasize Science Investigations

Table A.17. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teachers' Professional Development for England

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.913	1.096
Confidence in Teaching Science	.894	1.118
Collaborate to Improve Teaching	.918	1.090
Teachers Emphasize Science Investigations	.937	1.067
Teacher Experience	.938	1.066

Note. Dependent Variable: Teachers' Professional Development

Table A.18. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teacher Experience for England

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.902	1.108
Confidence in Teaching Science	.948	1.055
Collaborate to Improve Teaching	.915	1.092
Teachers Emphasize Science Investigations	.916	1.092
Teachers' Professional Development	.939	1.065

Note. Dependent Variable: Teacher Experience

Table A.19. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Confidence in Teaching Science for Finland

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.971	1.029
Collaborate to Improve Teaching	.930	1.076
Teachers Emphasize Science Investigations	.918	1.089
Teachers' Professional Development	.992	1.008
Teacher Experience	.993	1.007

Note. Dependent Variable: Confidence in Teaching Science

Table A.20. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Collaborate to Improve Teaching for Finland

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.926	1.079
Confidence in Teaching Science	.887	1.128
Teachers Emphasize Science Investigations	.928	1.078
Teachers' Professional Development	.993	1.007
Teacher Experience	.985	1.015

Note. Dependent Variable: Collaborate to Improve Teaching

Table A.21. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Career Satisfaction for Finland

Model	Collinearity Statistics	
	Tolerance	VIF
Collaborate to Improve Teaching	.933	1.072
Confidence in Teaching Science	.933	1.072
Teachers Emphasize Science Investigations	.881	1.135
Teachers’ Professional Development	.993	1.007
Teacher Experience	.991	1.009

Note. Dependent Variable: Career Satisfaction

Table A.22. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teachers Emphasize Science Investigations for Finland

Model	Collinearity Statistics	
	Tolerance	VIF
Teacher Career Satisfaction	.927	1.079
Confidence in Teaching Science	.929	1.077
Collaborate to Improve Teaching	.984	1.017
Teachers’ Professional Development	.996	1.004
Teacher Experience	.984	1.016

Note. Dependent Variable: Teachers Emphasize Science Investigations

Table A.23. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teachers’ Professional Development for Finland

Model	Collinearity Statistics	
	Tolerance	VIF
Teacher Career Satisfaction	.924	1.083
Confidence in Teaching Science	.887	1.128
Collaborate to Improve Teaching	.931	1.074
Teachers Emphasize Science Investigations	.880	1.136
Teacher Experience	.984	1.017

Note. Dependent Variable: Teachers’ Professional Development

Table A.24. The Multi-Collinearity Test Result for 2nd Level Variables with Dependent Variable named Teacher Experience for Finland

Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Teacher Career Satisfaction	.930	1.075
Confidence in Teaching Science	.895	1.117
Collaborate to Improve Teaching	.931	1.074
Teachers Emphasize Science Investigations	.877	1.140
Teachers’ Professional Development	.992	1.008

Note. Dependent Variable: Teacher Experience

APPENDIX B

HLM MODELS OF EACH COUNTRY FOR SCIENCE ACHIEVEMENT AND ATTITUDE TOWARD SCIENCE

In this appendix, 2-level HLM models explaining both science achievement and attitude toward science in Turkey, Finland and England are represented in the following tables.

Table B.1 HLM Models of Turkey for Science Achievement

TURKEY	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Gender	8.51*** (2.17)	8.51*** (2.17)	8.50*** (2.17)	8.50*** (2.17)	8.50*** (2.17)	8.50*** (2.17)	8.50*** (2.17)
Homework Time	-6.31**(2.35)	-6.31**(2.35)	-6.33**(2.35)	6.33**(2.35)	-6.35**(2.35)	-6.28** (2.35)	-6.28** (2.35)
Bullying at School	-6.60**(2.27)	-6.60**(2.27)	6.59**(2.26)	6.59**(2.26)	6.59**(2.26)	-6.59**(2.26)	-6.59**(2.26)
Parental Involvement	-0.12(0.43)	-0.12(0.43)	-0.12(0.43)	-0.11(0.43)	-0.11(0.43)	-0.13(0.43)	-0.13(0.43)
Home Educational Resources	35.77***(2.41)	35.77***(2.41)	35.72***(2.41)	35.69***(2.41)	35.68***(2.41)	35.66***(2.41)	35.66***(2.41)
Confidence in Teaching Science		11.04(6.45)	11.04(6.45)	11.03(6.46)	11.03(6.46)	11.03(6.46)	11.03(6.46)
Career Satisfaction			4.17**(1.48)	4.16**(1.48)	4.16**(1.48)	4.16**(1.48)	4.16**(1.48)
Collaborate to Improve Teach				0.81(6.48)	0.80(6.48)	0.80(6.48)	0.79(6.47)
Emphasize Science Investigation					0.03(1.51)	0.04(1.51)	0.05(1.52)
Years of Experience						8.67(5.98)	8.68(5.98)
Professional Development							1.64(1.49)

Notes. SE: Standard Error; *p<0.05 level, **p<0.01, ***p< 0.001

Table B.2 HLM Models of Finland for Science Achievement

FINLAND	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Gender	3.51(2.44)	3.50(2.44)	3.51(2.44)	3.51(2.44)	3.52(2.44)	3.51(2.44)	3.51(2.44)
Homework Time	-21.80*** (4.02)	-21.80*** (4.02)	-21.78*** (4.02)	-21.78*** (4.02)	-21.85*** (4.02)	-21.83*** (4.02)	-21.80*** (4.02)
Bullying at School	-3.13(3.13)	-3.13(3.13)	-3.17(3.13)	-3.17(3.13)	-3.15(3.13)	-3.15(3.13)	-3.13(3.13)
Parental Involvement	-1.23*** (0.36)	-1.23*** (0.36)	-1.23*** (0.36)	-1.23*** (0.36)	-1.23*** (0.36)	-1.23*** (0.36)	-1.23*** (0.36)
Home Educational Resources	15.22*** (0.81)	15.22*** (0.81)	15.21*** (0.81)	15.21*** (0.81)	15.20*** (0.81)	15.20*** (0.81)	15.07*** (0.80)
Confidence in Teaching Science		1.32 (3.88)	0.37(3.92)	0.23(3.94)	-0.28(3.99)	-0.30(3.99)	-0.29(3.99)
Career Satisfaction			1.53(1.09)	1.51(1.10)	1.46(1.10)	1.44(1.11)	1.43(1.11)
Collaborate to Improve Teaching				1.52(5.23)	0.27(5.44)	0.23(5.46)	0.19(5.47)
Teachers’ Emphasize Science					1.10(1.30)	1.08 (3.95)	1.09 (1.32)
Years of Experience						-0.23(4.16)	-0.25(4.16)
Professional Development							-0.27(1.74)

Notes. SE: Standard Error; * p < 0.05 level, **p < 0.01, *** p < 0.001

Table B.3 HLM Models of England for Science Achievement

ENGLAND	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
	Coefficient (SE)	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**
Gender	-5.85* (2.43)	-5.85* (2.43)	-5.71* (2.39)	-5.71* (2.39)	-5.71* (2.39)	-5.71* (2.39)	-5.71* (2.39)
Homework Time	5.24*(2.61)	5.15(2.61)	5.16(2.61)	5.16(2.61)	5.16(2.61)	5.15(2.61)	5.15(2.61)
Bullying at School	-3.04(2.90)	-3.04(2.90)	-3.04(2.90)	-3.04(2.90)	-3.04(2.90)	-3.04(2.90)	-3.06(2.90)
Parental Involvement	0.21(0.35)	0.21(0.35)	0.21(0.35)	0.21(0.35)	0.21(0.35)	0.21(0.35)	0.21(0.35)
Home Educational Resources	13.96*** (0.74)	14.06*** (1.04)	14.05*** (1.04)	14.05*** (1.04)	14.05*** (1.04)	14.05*** (1.04)	14.05*** (1.04)
Confidence in Teaching Science		27.79* (14.05)	27.78* (14.04)	27.78* (14.04)	27.78* (14.04)	27.79* (14.05)	27.78* (14.04)
Career Satisfaction			7.76(7.32)	7.74(7.32)	7.70(7.33)	7.70(7.33)	7.67(7.34)
Collaborate to Improve Teac				-14.54 (11.06)	-14.52 (11.06)	-14.50 (11.07)	-14.51 (11.07)
Teachers' Emphasize Science Investigations					1.38(3.34)	1.40(3.35)	1.41(3.35)
Years of Experience						11.00 (10.63)	11.05 (10.64)
Professional Development							-4.54(2.76)

Notes. SE: Standard Error; * $p < 0.05$ level, **$p < 0.01$, *** $p < 0.001$

Table B.4 HLM Models of Turkey for Attitude toward Science

TURKEY	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
	Coefficient (SE)	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**
Gender	0.12** (0.04)	0.12** (0.04)	0.13** (0.04)	0.14** (0.04)	0.16*** (0.05)	0.17** (0.05)	0.16** (0.05)
Homework Time	0.08(0.04)	0.09(0.04)	0.09(0.04)	0.09(0.04)	0.10(0.04)	0.10(0.04)	0.11(0.04)
Bullying at School	- 0.17*** (0.04)	- 0.17*** (0.04)	- 0.16*** (0.04)	- 0.14*** (0.05)	- 0.13*** (0.05)	- 0.13*** (0.05)	- 0.13*** (0.05)
Parental Involvement	0.11*** (0.01)	0.12*** (0.01)	0.12*** (0.01)	0.11*** (0.01)	0.13*** (0.01)	0.14*** (0.02)	0.11*** (0.01)
Home Educational Resources	0.09*** (0.01)	0.09*** (0.01)	0.08*** (0.01)	0.08*** (0.01)	0.08*** (0.01)	0.10*** (0.01)	0.10*** (0.01)
Confidence in Teaching Science		0.16(0.09)	0.16(0.09)	0.17(0.09)	0.17(0.09)	0.17(0.09)	0.15(0.09)
Career Satisfaction			0.03(0.02)	0.03(0.02)	0.04(0.02)	0.04(0.02)	0.05(0.02)
Collaborate to Improve Teaching				-0.05(0.09)	-0.04(0.09)	-0.02(0.10)	-0.04(0.09)
Teachers' Emphasize Science Investigations					0.04*(0.02)	0.04*(0.02)	0.05*(0.02)
Years of Experience						-0.40*** (0.08)	-0.38*** (0.08)
Professional Development							-0.02 (0.02)

Notes. SE: Standard Error; * p < 0.05 level, **p < 0.01, *** p < 0.001

Table B.5 HLM Models of Finland for Attitude toward Science

FINLAND	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	Coefficient (SE)	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**
Gender	-0.26*** (0.05)	-0.26*** (0.05)	-0.24*** (0.05)	-0.23*** (0.06)	-0.23*** (0.06)	-0.24*** (0.05)	-0.25*** (0.05)
Homework Time	0.21*** (0.08)	0.22*** (0.08)	0.22*** (0.08)	0.24*** (0.09)	0.25*** (0.09)	0.27*** (0.09)	0.27*** (0.09)
Bullying at School	-0.05(0.05)	-0.05(0.05)	-0.05(0.05)	-0.04(0.05)	-0.03(0.05)	-0.03(0.05)	-0.06(0.05)
Parental Involvement	0.07*** (0.01)	0.07*** (0.01)	0.08*** (0.01)	0.09*** (0.01)	0.11*** (0.02)	0.12*** (0.02)	0.10*** (0.02)
Home Educational Resources	0.21*** (0.08)	0.20*** (0.08)	0.22*** (0.08)	0.23*** (0.08)	0.25*** (0.09)	0.25*** (0.09)	0.26*** (0.09)
Confidence in Teaching Science		-0.07(0.08)	-0.07(0.08)	-0.11(0.09)	-0.13(0.09)	-0.13(0.09)	-0.10(0.08)
Career Satisfaction			0.00(0.02)	0.00(0.02)	0.02(0.02)	0.03(0.03)	0.03(0.03)
Collaborate to Improve Teaching				-0.08(0.09)	-0.09(0.09)	-0.07 (0.09)	-0.05(0.10)
Teachers' Emphasize Science Investigations					0.05*(0.02)	0.06*(0.02)	0.09*(0.03)
Years of Experience						-0.15* (0.07)	-0.07* (0.08)
Professional Development							-0.01(0.03)

Notes. SE: Standard Error; * $p < 0.05$ level, **$p < 0.01$, *** $p < 0.001$

Table B.6 HLM Models of England for Attitude toward Science

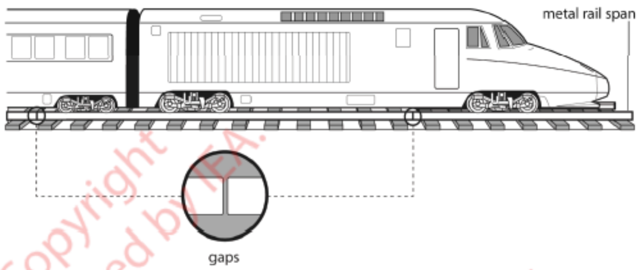
ENGLAND	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
	Coefficient (SE)	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**	**Coefficient (SE)**
Gender	-0.59*** (0.05)	-0.58*** (0.05)	-0.60*** (0.05)	-0.59*** (0.05)	-0.55*** (0.06)	-0.54*** (0.06)	-0.54*** (0.06)
Homework Time	0.42*** (0.06)	0.43*** (0.06)	0.45*** (0.06)	0.44*** (0.06)	0.47*** (0.07)	0.46*** (0.07)	0.47*** (0.07)
Bullying at School	-0.09* (0.04)	-0.09* (0.04)	-0.08* (0.04)	-0.08* (0.04)	-0.09* (0.04)	-0.07* (0.04)	-0.06* (0.05)
Parental Involvement	0.10*** (0.01)	0.11*** (0.01)	0.13*** (0.01)	0.13*** (0.01)	0.14*** (0.01)	0.16*** (0.02)	0.16*** (0.02)
Home Educational Resources	0.16*** (0.02)	0.16*** (0.02)	0.15*** (0.02)	0.17*** (0.02)	0.18*** (0.02)	0.19*** (0.03)	0.20*** (0.03)
Confidence in Teaching Science		-0.01(0.13)	-0.01(0.13)	-0.03(0.13)	-0.02(0.13)	-0.09(0.14)	-0.07(0,14)
Career Satisfaction			0.04(0.07)	0.03(0.07)	0.03(0.07)	0.07(0.07)	0.07(0.07)
Collaborate to Improve Teaching				-0.02(0.10)	-0.02(0.10)	-0.01(0.10)	-0.02(0.10)
Teachers' Emphasize Science Investigations					-0.02(0.03)	-0.02(0.03)	-0.03(0.03)
Years of Experience						0.10**(0.04)	0.11**(0.04)
Professional Development							0.15 (0.10)

Notes: SE: Standard Error; * p < 0.05 level, **p < 0.01, *** p < 0.001

APPENDIX C

TIMSS 2011 8TH GRADE EXAMPLE SCIENCE ITEMS

ID: S032238	Science Grade 8	Block_Seq: S01_08



Which of the following best explains why some railroad tracks are laid down with gaps between the metal rail spans?

Ⓐ To allow for the metal tracks to expand on hot days.

Ⓑ To allow for the metal tracks to expand on cold days.

Ⓒ To allow for cooling of the tracks by air in the gaps.

Ⓓ To allow for vibration of the tracks due to the train.

S032238

Content Domain
Physics

Topic Area
Energy Transformations, Heat, and Temperature

Cognitive Domain
Applying

Maximum Points
1

Key
A

Figure C.1 8th Grade Multiple Choice Science Item, Example 1

ID: S032160	Science Grade 8	Block_Seq: S01_10

What is the main difference between planets and moons in our solar system?

Ⓐ All planets can support life; moons cannot.

Ⓑ All planets have atmospheres; moons do not.

Ⓒ All planets orbit the Sun; all moons orbit planets.

Ⓓ All planets are larger than all moons.

S032160

Content Domain
Earth Science

Topic Area
Earth in the Solar System and the Universe

Cognitive Domain
Knowing

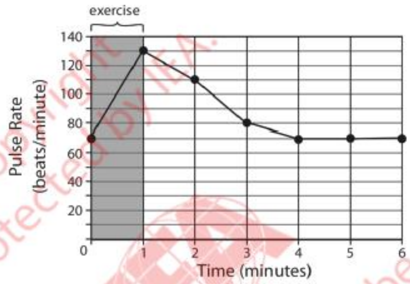
Maximum Points
1

Key
C

Figure C.2 8th Grade Multiple Choice Science Item, Example 2

ID: S042304	Science Grade 8	Block_Seq: S03_01

John measures his pulse rate before he exercises. It is 70 beats per minute. He exercises for one minute and measures his pulse rate again. He then measures it every minute for several minutes. He draws a graph to show his results.



What can be concluded from his results?

Ⓐ His pulse rate increased by 50 beats per minute.

Ⓑ His pulse rate took less time to slow down than to increase.

Ⓒ His pulse rate after 4 minutes was 80 beats per minute.

Ⓓ His pulse rate returned to normal in less than 6 minutes.

S042304

Content Domain
Biology

Topic Area
Characteristics, Classification, and Life Processes of Organisms

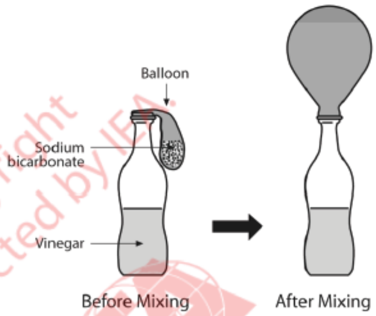
Cognitive Domain
Reasoning

Maximum Points
1

Key
D

Figure C.3 8th Grade Multiple Choice Science Item, Example 3

ID: S032056 | Science Grade 8 | Block_Seq: S01_05



As shown in the diagram, the balloon inflates when the sodium bicarbonate in the balloon is mixed with the vinegar.

What causes this to happen?

S032056

Content Domain
Chemistry

Topic Area
Chemical Change

Cognitive Domain
Applying

Maximum Points
1

Key
See scoring guide

Figure C.4 8th Grade Open-ended Science Item, Example 4

ID: S052091 | Science Grade 8 | Block_Seq: S02_05

The amount of carbon dioxide in the air is increasing in a large city due to the growing number of vehicles. The mayor wants to plant more trees.

Do you agree with the mayor's suggestion?

(Check one box.)

☐ Yes

☐ No

Explain your answer.

S052091

Content Domain
Biology

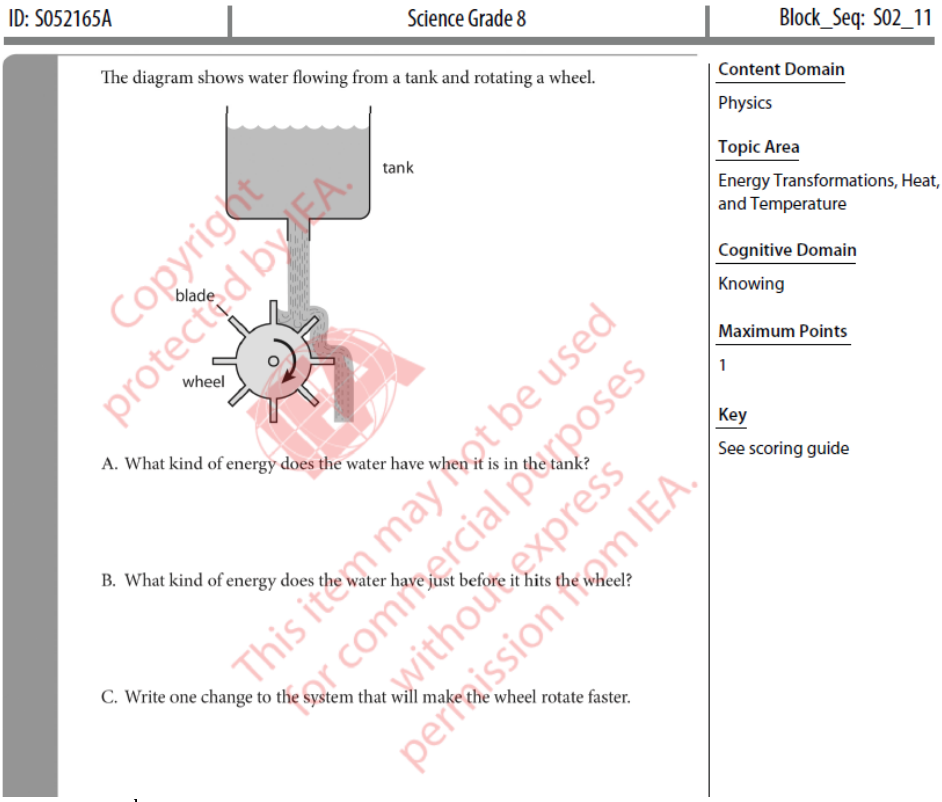
Topic Area
Ecosystems

Cognitive Domain
Reasoning

Maximum Points
1

Key
See scoring guide

Figure C.5 8th Grade Open-ended Science Item, Example 5



ID: S052165A | Science Grade 8 | Block_Seq: S02_11

The diagram shows water flowing from a tank and rotating a wheel.

A. What kind of energy does the water have when it is in the tank?

B. What kind of energy does the water have just before it hits the wheel?

C. Write one change to the system that will make the wheel rotate faster.

Content Domain
Physics

Topic Area
Energy Transformations, Heat, and Temperature

Cognitive Domain
Knowing

Maximum Points
1

Key
See scoring guide

Figure C.6 8th Grade Open-ended Science Item, Example 6

Source: Foy, P., Arora, A., & Stanco, G.M. (2013). *TIMSS 2011 User Guide for the International Database: Released Items Science 8th Grade*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

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2010-2014	METU-SSME	Research Assistant
2010-2014	Cito TURKEY	Content Developer

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PUBLICATIONS

A. Papers Published in Journals:

Ipekcioglu, S. & Gökce, S. (2013). Factors affecting Turkish students' science achievement. Cito Eğitim: Kuram ve Uygulama, V. 22, pp. 21-28.

Sahin, A. E. & Ipekcioglu, S. (2013). Through Quality with the 6th Cito Turkey Seminar Days. Cito Eğitim: Kuram ve Uygulama, V. 19, pp. 31-38.

Yılmaz-Tuzun, O., Ipekcioglu, S. & Caliskan, M. (2012). Effective Science Education and Turkey Profile with Cito Turkey Data. Cito Eğitim: Kuram ve Uygulama, V. 18, pp. 17-26.

Berberoglu, G., Arikan, S., Caliskan, M., Ekinci, P., Ipekcioglu, S. & Sevgi, S. (2012). How to provide content validity in large-scale exams?. Cito Eğitim: Kuram ve Uygulama, V. 17, pp. 9-22.

Ipekcioglu, S. & Koyuncu, F. (2011). Developing science process skills in the field of science and technology. Cito Eğitim: Kuram ve Uygulama, V. 11, pp. 41-52.

B. Papers Presented in Conferences:

Ipekçioğlu, S. & Gokçe, S. (2013). "Factors affecting Turkish Students' Science Achievement: TIMSS 2011". ECER, İstanbul, Turkey. (International Conference - Oral Presentation).

Ipekcioglu, S., Geban, O. & Celebi, O. (2013). "Influences of Student and School Characteristics on Scientific Literacy Skills of Turkish Students in PISA". NARST, San Juan, Puerto Rico. (International Conference - Oral Presentation).

Ipekcioglu, S. & Geban, O. (2012). "Turkish Students' Affective Characteristics and Their Relation to Scientific Literacy Measures in PISA". International Applied Education Congress, Ankara, Turkey. (International Conference - Oral Presentation).

Ipekcioglu, S. & Uzuntiryaki, E. (2012). "The relationship between students' attitude and self-efficacy, and scientific literacy skills: Programme for International Student Assessment (PISA) 2006". 10th National Science and Mathematics Education Conference, Nigde, Turkey. (National Conference - Oral Presentation).

Ipekcioglu, S., Elmas, R., Geban, O., Dogruoz, P., & Ertepinar, H. (2010). "Effectiveness of Problem Solving Oriented Instruction on Fluid Force Topic" International Conference on Education and Educational Psychology (ICEEPSY), Kyrenia, Cyprus. (International Conference - Oral presentation).

Ipekcioglu, S., Elmas, R., Geban, O., & Gunay, B. (2010). "Effect of Conceptual Change Instruction on Understanding of Atoms and Molecules Topic" International Conference on Education and Educational Psychology (ICEEPSY), Kyrenia, Cyprus. (International Conference - Oral presentation).

WORKSHOPS

IEA-Hamburg, IEA Spring Academy: "Multilevel Modeling with Large Scale Assessment Data (PIRLS & TIMSS), Hamburg/GERMANY, 11-13 May 2015.

University of Ghent, Summer School, Prof. Dr. Leoniek Wijngaards-de Meij, "Multilevel Analysis for Grouped and Longitudinal Data" by HLM 7 Programme, Ghent/BELGIUM, 15-17 April 2015.

University of Zurich, Statistics Workshop, "Multilevel Analysis with MPlus". Zurich/SWITZERLAND, 09-10 September 2014.

IEA-Hamburg, IEA Spring Academy: "Analysis using the international large-scale assessment databases of TIMSS, PIRLS, ICCS, and PISA". Hamburg/GERMANY, 6-8 May 2014.

inGenious Summer School: "Shaping the future of maths and science education" İstanbul/ TURKEY, 24-26 August 2012.