AN ANALYSIS OF THE EFFECTIVENESS OF QUALITY INDICATORS IN EARLY CHILDHOOD EDUCATION ON SUBSEQUENT SCIENCE COMPETENCY ON A CROSS-COUNTRY AND TURKISH CASE BASIS

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ABSTRACT

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The main aim of this study was to investigate the effectiveness of early childhood education on children's subsequent science competency in PISA assessment. In doing so, the influence of country-level and student-level factors on children's later competency on the PISA science literacy were also examined. Country-level indicators were determined following variables from past records: public and private expenditure in pre-primary education, pupil-teacher ratio, enrolment rate in pre-primary, duration in pre-primary, starting age to pre-primary education, individual countries adult literacy rate, and income per capita. As for student-level indicators, these are: attending pre-primary education, level of mother's education, mother's occupation, and student's gender. By using PISA science scores for both country-level and student-level analysis, the indicator which serves as the most significant predictor in explaining later science competency was examined.

According to this study's findings, public expenditure, pupil-teacher ratio, income, adult literacy rate and starting age to pre-primary education were effective factors influencing children's subsequent science performance on the PISA assessment. Furthermore, adult literacy rate was the only variable which had significant influence on later science performance for three country groups. Moreover, student-level analysis revealed that children perform better in the PISA science literacy as their

number of years of attendance in pre-primary education and level of their mother's education increase. Additionally, mother's occupation and student's gender also have potential influence on later science competency.

The findings also have important implications for improving the provision of Turkish early childhood education in each of these indicators. Moreover, there is an urgent need to keep up with the international trend in pre-primary education.

Key Words: Pre-primary Education, Quality Indicators in Pre-primary, Later Science Competency, PISA Assessment

ÖZ

OKUL ÖNCESİ EĞİTİMİNDE KALİTE DEĞİŞKENLERİNİN İLERİKİ FEN BAŞARILARINA OLAN ETKİSİNİN ÜLKELER-ARASI VE TÜRKİYE BAZINDAKİ DEĞİŞKENLER AÇISINDAN İNCELENMESİ

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Bu çalışma başlıca, okul öncesi eğitiminin çocukların ileriki fen başarılarına olan etkisini araştırmayı amaçlamaktadır. Çalışmada, ülke ve öğrenci düzeyine ait bazı faktörlerin, çocukların ve ülkelerin PISA fen testi performansı üzerindeki etkisi incelenmiştir. Ülke düzeyinden seçilen değişkenler geçmişe dönük kayırlar üzerinden elde edilmiş ve şu şekilde oluşturulmuştur: okul öncesine yapılan kamu ve özel eğitim harcamaları, okul öncesinde öğretmen-öğrenci oranları, okula kayıt oranı, yetişkin okur-yazarlık oranı, kişi başına düşen gelir, okul öncesine başlama yaşı ve okul öncesi eğitiminin süresi. Öğrenci düzeyinde ki değişkenlere bakıldığında okul öncesi eğitim geçmişleri, cinsiyet, anneye ait eğitim ve meslek durumları değişkenleri kullanılmıştır. Böylece, PISA fen sınavlarındaki fen testi puanları kullanılarak, ileriki fen başarısını açıklamada hangi değişkenlerin gerçekte anlamlı bir etkisi olduğunu bulmak amaçlanmıştır.

Çalışma bulguları, okul öncesinde yapılan kamu harcamalarının, öğretmen öğrenci oranlarının, yetişkin okur-yazarlık oranı, kişi başına düşen gelir düzeyinin ileriki fen başarısı üzerinde etkili olduğunu ortaya çıkarmıştır. Ayrıca, yetişkin okur-yazarlık değişkeni her üç ülke grubu içinde anlamlı çıkan tek değişkendir. Buna ek olarak, öğrenci düzeyinde yapılan analiz sonuçları, anne eğitim düzeyi ve okul öncesinde geçirilen zaman arttıkça, öğrencilerinin PISA fen testindeki başarılarının da arttığını

ortaya çıkarmıştır. Bunlara ek olarak, cinsiyet ve annenin mesleği ileriki fen başarısını etkileyen diğer faktörler arasındadır.

Çalışma sonuçları, her bir gösterge bazında, Türk okul öncesi eğitim vizyonunun geliştirilmesinde önemli çıkarımlar sunmaktadır. Üstelik sonuçlar, okul öncesi eğitiminde uluslararası eğilimi yakalamanın Türkiye için ne kadar önemli olduğunu da göstermiştir.

Anahtar Kelimeler: Okul Öncesi Eğitim, Okul Öncesi Eğitimde Kalite Göstergeleri, İleriki Fen Başarısı, PISA Sınavı

To my Mother and Father…

To Fatih, Aymelek and Seyhan Kaya…

To Metehan Buldu…

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LIST OF ABBREVIATIONS

OLS: Ordinary List Square

GDP: Gross Domestic Production

PISA: Programme for International Student Assessment

OECD: The Organization for Economic Co-operation and Development

OBADER: Okul Öncesi Eğitim Programı ile Bütünleştirilmiş Aile Destek Eğitim Rehberi

CHAPTER I

INTRODUCTION

Due to the demand for advanced skills in the labor market, people should be qualified to be creative decision-makers and problem-solvers (NSES, 1996). The potential of all humans is shaped by their educational opportunities and experiences, most especially during the early childhood period because of rapid development in brain function during this time (Fancourt, 2000; Zhang & Pelleier, 2012). Therefore, the more children are educated, the more the effects of education will follow and help them to build a successful future life (UCLG, 2013). Due to the different educational needs in today's world, it is of great importance for all nations that children's education meets multi-functional needs. To enhance sustainable growth and economic productivity, governments recognize the importance of investing in children's education during the early developmental cycle (World Bank, 2013). One of the reasons for this is related to mothers' increased participation in the labor market, which therefore makes early education more desirable not only for mothers but also for the labor market. According to an OECD report published in 2013, the needs of the female labor force are the actual driving force behind educational innovations because of competition between countries to enhance well-being in society. For this reason, many countries have regulated their education system from pre-primary education level (Figazzolo, 2008).

Moreover, most nations believe that reaching a high participation rate in early childhood education is a paramount representation of societies' progress (Uşaklı, 2010). In addition to these benefits of early education for nations, there are also various benefits for children's own well-being. It is recognized that children's early knowledge, skills and ideas play an important role in their future life and academic success (Claessens & Engel, 2013). Recent research studies have highlighted that high quality preschool education has a dramatic effect on young children's school

readiness and later school success (Burger, 2009; Essa, 2003; Taguma, Litjens & Makowiecki, 2012; Woldehanna, 2011; Zhang & Pelletier, 2012). Also, providing high-quality early experiences helps to close the gap in achievement between high and low income children and again boosts their potential to learn (Burchinal et al., 2011; Engle et al., 2011).

When considering all of these benefits of early education on children's potential in learning and later academic success, today's early childhood education programs offer better preparation in different learning areas, such as science, mathematics and language. In a similar way, science is one of the learning areas which have attracted researchers' attention in examining the effect of early childhood education on progress in particular subjects. One of the important contributions of early education is providing children with the ability to make connections between facts and solutions by teaching science knowledge during their earliest years (Saçkes, Trundle, Bell, & O' Connell, 2011). When teaching science, it is possible to foster children's innate curiosity to discover and learn. Providing high quality and experiential science teaching therefore motivates children to explore the world and organize information. According to the National Research Council (1998), teaching science knowledge to young children helps to develop scientific thinking and a positive attitude to science throughout their subsequent school life. Also, this early engagement is an important factor in reaching success in later academic performance in science. Due to children's greater potential to learn, they can easily develop scientific inquiry skills even after they first meet science knowledge (Tu, 2006). Thus, science teaching during early childhood years helps to develop children's full potential to learn, find meaning and make connections between facts. For all of these aforementioned reasons, most researchers believe that such skills begin to develop as early as toddlerhood by means of science teaching, because developmental areas, especially the cognitive area, are affected by what children have experienced and are exposed to (Butler, 2007; Campell & Jobling, 2010). Providing a rich learning environment, experiences and opportunities in children's science education, will therefore lead to more desirable learning outcomes. In that regard, it could be said that various environmental factors related to learning, most importantly in science, are crucial in learning and teaching (Eshach & Fried, 2005; Saçkes, Akman & Trundle, 2012).

However, there are number of factors in children's learning environment which can affect children's science learning and achievement. Some of these factors are the curriculum, teachers, and the quality of the learning process. In addition to these, diversity of education conditions in kindergarten settings and children's family backgrounds are other important factors which affect young children's current understanding and later science achievement. For this reason, studies have highlighted that there is a close relationship between children's science learning environment and their later academic achievement in science (Buldu, Buldu & Buldu, 2014; Pianta, LaParo, Payne, Cox & Bradley, 2002). The science learning environment covers many different variables, including children's starting age to pre-primary education, pupil-teacher ratio in kindergarten classes, parental literacy, economic conditions of family, and educational expenditure (Blatchford et al., 2003; Cardinal-Pizato, Marturano & Fontaine, 2012; Carneiro, Meghir & Parey, 2013; Elicker et al., 2007; Iacovaou, 2001). While some of these variables can be arranged and provided by government, some of them are more related to individual children's socio-economic conditions (Caro, McDonald & Willims, 2009). To investigate the effectiveness of these variables, different research has investigated each of these variables' impact on children's academic performance. For instance, classes with appropriate pupil-teachers ratios according to age group in early childhood education settings can help to develop better academic performance in subsequent academic life (Hoxby, 2000; Iacovaou, 2001). On the other hand, studies which have investigated parental literacy have revealed that there is a close relationship between parental literacy and children's later academic achievement (Jabor et al., 2011). In addition to these, by investing in young children's education, it is possible to enhance both national and individual children's well-being (Heckman, 2000). For these reasons, these variables are seen as a proxy for having a strong national education system.

These reasons demonstrate the necessity and importance of a high quality science learning environment in early childhood education which increases day by day (Watters et al., 2001). Therefore, countries have tried to teach science and provide high quality science learning environment for all young children (Berlinski, Galiani & Manacorda, 2007). Nevertheless, it is important to note that establishing well-

established education standards is quite challenging issue while trying to extend early education to all children (Britto, Yoshikawa & Boller, 2011). To this end, it important to examine which social and environmental factors help to enhance children's potential in science learning. Effectively, there is a pressing need for nations to determine which factors and indicators bring about a successful outcome in science performance. For this reason, evaluating the learning environment and assessing children's science performance can be seen as a whole evaluation process. However, actually measuring their science performance is no easy job. Particularly, measuring children's knowledge via standardized achievement tests is not seen as desirable in early childhood education because of children's developmental characteristics (Katz, 1994). Moreover, developmentally appropriate measurement is required to establish children's full potential in all developmental areas, not only their knowledge about science. The major purpose of early assessment is to identify children's ability and interests (Hills, 1999). This being the case, measuring children's ultimate educational outcomes is clearly hard to determine (Uşaklı, 2010). However, countries have tried to find ways to measure their success in overall early educational areas, such as science, language and mathematics. For this purpose, most of the European countries are paying increasing attention to cross-national comparisons to determine their success in early childhood education (Bernett & Nores, 2010). For the same reason, in recent years, one of the most popular ways to assess and compare the effectiveness of early childhood education systems and its success in different learning areas is international assessments (OECD, 2012b). The main idea of these internationally standardized assessments is assessing children's subsequent academic competency in major learning-literacy areas. One of these assessments is the Programme for International Student Assessment (PISA), which is implemented by the Organization for Economic Cooperation and Development (OECD). This international assessment is prepared in participation with various educators and researchers from all over the world. The main purpose of the PISA assessment is to assess students' skills to meet real-life challenges in different learning areas, such as science, mathematics and reading areas (OECD, 2009). Moreover, there is no grade limitation for participant students; they are simply required to be 15 years-old. This two hour pen-and-paper test, which includes

multiple choice questions and students' open-ended answers, assesses 15 year-old students' real life skills in these academic areas. The results provide countries with an opportunity to compare their performance in the international arena (Burger, 2009). PISA results provide a general picture of countries' inputs in the education system and their impact on students' outcomes. For this reason, the importance of demonstrating successful performance in the PISA assessment is becoming increasing clear to nations, since PISA provides comparative results to countries about their education systems from early childhood education to the end of compulsory education. It is important to note that PISA does not directly focus on measuring the success of early childhood education system, but the results are closely related to the availability of successful early education programs (Schütz, 2009). Moreover, PISA provides information about children's conditions during early childhood education years. Starting from here, PISA data enables the investigation of the relationship between children's later science competency and their conditions during early education. Thus it can be said that PISA is an important tool for those seeking an answer to the question of whether teaching science is worthwhile in early childhood education and if it has a great impact on children's later science achievement. In addition to students' performance in science, mathematics and reading domains, PISA also provides valuable information about student's educational and family background. When all of these factors are being considered, PISA provides valuable information about which indicators play an important role in showing higher performance in science literacy and other learning areas.

In light of the information provided above, looking closer at Turkey's performance in the PISA science literacy can give an important indication of the suitability of Turkey's education system, more specifically pre-primary education level in science teaching. As many of the PISA results have indicated, Turkey has lagged behind many European and Non-European countries in the assessment. Although there are some regulations that were implemented in the education system in order to improve Turkey's performance, these did not have a particularly positive impact on Turkey's grading compared to other countries' because these regulations were limited to primary and secondary education (OECD, 2013c). However, many European

countries believe that the main reason for being successful in international assessments is having a strong early childhood education system (OECD, 2012b). In line with this, the current study was grounded in social capital theory to better understand how school and home environments affect children's competency in science literacy. Social capital theory mainly concerns with the social, economic, interaction between individuals and govern interactions. Therefore, financial capitals, (e.g. income) and human capitals (e.g. education, socio-economic status) and cultural capitals (e.g. experiences) are main components of social capital theory (Alacacı & Erbaş, 2010). In education area, the main focus of this theory is to understand the relation between schooling and school outcomes (Goddard, 2003). School social capital focuses on the students' academic achievement and outcomes. Also, theory indicates that interaction between different capital factors (e.g. family, income, education) can enhance academic achievement. Investigating different components of social capital theory can give highly valuable information about how countries' performances change in PISA assessments. Moreover, the investigation of different kind of human and family capitals can better explain Turkish students' competency in science literacy in PISA assessment.

1.1. Statement of the Problem

Structural quality is an either ways of measuring quality in early childhood education (Espinosa, 2002). The structural indicators, such as teacher-child ratio or class size, enrollment rate in preschool services, and investment in early childhood education, provide information regarding whether the preschool services provide high quality early childhood education and care. Also, it could be said that such structural indicators provide a better environment for teaching science and other subject areas (Pianta et al., 2002). For this reason, there have been various attempts to investigate the influence of different quality indicators on learning environment and children's science performance (Cambell & Jobling, 2010; Murphy, Neil & Beggs, 2007; Tu, 2006; Watters, Diezmann, Grieshaber & Davis, 2001). However, quality indicators are not precisely defined by the researchers when explaining the successful outcomes of early education. While some of the studies are more related to socio-economical and parental factors (Burchinal, Vandergrit, Pianta & Mashburn, 2010; Early et al.,

2011; Jabor et al., 2011), some of them have focused on educational indicators such as curriculum, teachers, learning environment, etc. (Downer, Rimm-Kaufman & Pianta, 2007; Pianta et al., 2002; Zaslow, Martinez-Beck, Tout & Halle, 2011;).

On the other hand, it is important to note that the quality of education is a successive process along children's life cycle. Therefore, sustainable quality in science education during early childhood years is very important to prevent a decrease in achievement in later school life (Olgan, 2008). Therefore, as mentioned previously, PISA data helps to assess the level of children's educational attainment at the end of compulsory education (OECD, 2012a). By means of students' competency in the PISA science literacy, it is possible to investigate which indicators from the early childhood education setting play an important role in their later science literacy performance. Additionally, PISA provides information about the success of countries' education systems. It therefore enables nations to evaluate and compare the quality of learning environment in their early childhood education systems, which can arise from both the education system and students' backgrounds. For all of these reasons, the current study focused on the opportunities of education systems and indicators of governance, such as pupil-teacher ratio, educational expenditure, enrolment rate, starting school age and time spent in early education setting, and socio-economic factors, such as national economical development and literacy rate in adults. On the other hand, more specifically, determining individual student's science literacy performance in the PISA assessment is important when considering the different factors that can impact on achievement, such as gender, maternal employment and job status, and students' pre-primary education backgrounds. Additionally, in the 21st century, many of the basic solutions are required to competency in science and scientific area. The ability to use knowledge is one of the important components of science literacy. Therefore, assessing students' competency in science literacy can boost both individuals' and nations' well-being. In considering these, this study was seeking to discover what the statistically significant determinants of success or failure in the PISA science literacy.

1.2. The Significance and Purpose of the Study

There are numerous studies which have investigated quality related factors. These factors influence the quality in early childhood education, such as pupil-teacher ratios, teacher quality, and educational expenditure (Cryer, Tietze, Burchinal, Leal & Palacios, 1999; Espinosa, 2002). Nevertheless, there are only a very limited number of studies that refer to children's competency in science literacy depending on country-level indicators, such as educational expenditure, adult literacy rates, pupil-teacher ratio in pre-primary classes, enrolment rate, starting age pre-primary age, and duration of pre-primary education. As the literature has suggested, the quality of learning environment has a substantially important impact on children's later science achievement (Buldu, Buldu & Buldu, 2014; Cornell & Jobling, 2010; Raynolds, Temple, Robertson & Mann, 2001; Saçkes, 2011; Pianta et al., 2002; Tu, 2006;). Thus, by comparing different countries' early childhood education conditions and the effect of their early childhood science learning environment on their performance in the PISA science assessment, this study was intended to fill the gap in the literature concerning which indicator has the most significant effect on children's subsequent science performance. Moreover, based on cross-country data for 33 OECD and Non-OECD countries, this study utilized retrospective data from The World Bank and UNESCO statistics of which accesses open to public use for researchers. In addition to Turkey, the other participant countries to PISA are specified according to children's performance in science scores. Since the current study aimed to conduct a cross-country analysis of 33 countries and a country case analysis of Turkey, the results provide significant information on the following points:

In addition to aforementioned country-level indicators, the study uses statistical techniques to compare the impact of student-level variables on later science competency. These student-level variables comprise some maternal factors, students' pre-primary education backgrounds, and students' gender from Economic Social and Cultural Status Index (ESCS). With the combination of country- and student-level indicators, this study aimed to provide more holistic information about how subsequent science achievement is affected by students' learning environment and socio-economic conditions. In the data analyzing procedure, descriptive and

inferential statistical methods were constructed. To analyze the data, multiple regression analysis was employed.

In this regard, the study was guided by the following research questions:

1-) To what extent do the pre-primary education variables (primary enrolment rate, pupil-teacher ratio in pre-primary, starting age, and duration of pre-primary), indicators of governance (private and public expenditure), and socio-economic variables (adult literacy rate and individual income), which belong to 33 OECD and non-OECD countries, predict countries' performance in PISA science literacy from 2000 to 2012?

2-) To what extent do socio-economic status variables (gender, mother's education, occupation of mother, and attending pre-primary) predict 15 year-old Turkish students' performance in the 2012 PISA science literacy?

1.3. Operational Definition of Terms

The Organization for Economic Co-operation and Development (OECD): This agency was founded nearly fifty years ago, with the aim of improving economic and social wellbeing of people from different sides of the world (USOECD, 2014).

Programme for International Student Assessment (PISA): PISA is an international assessment launched by the OECD in 1997 (OECD, 2013a). The aim of the PISA is to answer: "How well young adults are prepared to meet the challenges of the future? Are they able to analyze, reason and communications their ideas effectively, do they have the capacity to continue learning throughout life" (OECD, 1999, p.7). Within the scope of this assessment, there are three subject domains: mathematics, science and reading literacy. It triennially evaluates students at the end of compulsory education in these key subjects.

Pre-primary Education: "The first stage of organized instruction designed to introduce very young children to the school atmosphere, with minimum entry age of 3" (OECD, 2013a, p.22).

Later School Outcomes: For the current study, it can be defined as 15 year-old students' overall academic competency in the PISA assessment at the end of compulsory education.

Gross Enrollment Rate in Early Childhood Education: It expresses the total number of enrolled children, regardless of their age, as a percentage of the number of total enrollment in official preschool age (World Bank, 2014).

Expenditure in pre-primary education (GDP): It refers to total government spending on public and private early childhood education institution. It is accounted as a as a percentage of gross domestic production (GDP) (The World Bank, 2013b).

Pupil-Teacher Ratio: The number of children enrolled in pre-primary institutions is divided by the number of preschool teachers (The World Bank, 2013b).

Class Size or Group Size: It refers to the number of children in a class. Although there are numerous variations of appropriate class size depending on age groups in pre-primary, the National Association of Education for Young Children advocates that averagely the number of children should not exceed 20 for each age group (NAEYC, 1991).

Adult Literacy Rate: It refers to the "total … percentage of the population age 15 and above who can, with understanding, read and write a short, simple statement on their everyday life"(World Bank, 2013b, parag.1). Adult literacy rate is calculated by dividing the number of literate people who are 15 years-old and above by the corresponding age group population and the result is then multiplied by 100 (World Bank, 2013b).

Economic Social and Cultural Index (ESCS): These index collect information from participant students' background information through PISA questionnaire about family, economic, education and cultural... etc.

CHAPTER II

LITERATURE REVIEW

In today's world, countries need a more scientifically literate population in order to raise the number of people qualified to be scientists, engineers, and technicians (Garbett, 2003; NSTA, 2014). Therefore, educational systems must integrate science knowledge into their daily curriculum at every grade level (Gilbart, 2006). From kindergarten to high school, the science education curriculum basically aims to improve scientific understanding and enhance students' problem solving skills. This being the case, these aims make science education an important part of a country's educational system. For all these reasons, improving the science learning environment is a growing trend among countries seeking to foster a qualified citizenship. In doing so, education systems aim to provide a high quality science learning environment and offer rich experiences to students (Pianta & Howes, 2005). For that purpose, the effort of strengthening science education must start form early childhood education level. Due to children's innate curiosity to discover and learn about the world around them, boosting their scientific understanding during their early years of life is the policy priority in most national education systems (NSTA, 2014). However, how this high quality science learning environment can be provided and how well science can be taught to children is worth investigating for researchers. The current research therefore investigated the effect of various quality indicators selected from the early childhood education system, governance and socioeconomic conditions on children's subsequent science performance in the PISA assessment.

In parallel with the aim of the study, this chapter presents relevant literature and empirical research predominantly concerning science education during early childhood years and the potential influences on children's later science competency (i.e., student and country level factors). Additionally, these influential factors under country-level factors (i.e., educational expenditure, adult literacy, income per person, pupil-teacher ratio, enrollment rates, starting preschool age and duration) and student

level factors (i.e., duration of received pre-primary education, mother's education level, mother's occupation, and student's gender) are discussed in this section.

2.1. A Snapshot of the Early Childhood Education Provisions of Turkey and OECD Countries

Turkey has the fastest population growth rate compared to the OECD countries. According to last census in 2012, Turkey's population is nearly 70 million, of which 7 million are children younger than 5 years-old. This being the case, early childhood education is increasingly the focus of policymakers because of the high rates of children in the population. By taking this into consideration, Turkey has showed progress in expansion of early education. While this expansion and increasing schooling rates is promising for Turkish Early Childhood Education, it is still behind that of other European countries (OECD, 2012a).

During the renewal process, in 2011, Turkey introduced some critical interventions in different social areas, such as health, social protection, and education (World Bank, 2013). Contrary to health and economic improvements, educational innovations have lagged behind those of other OECD countries (World Bank, 2013). This is especially disappointing in the early childhood education area. In order to breathe new life into early education, various innovative projects have been initiated in early childhood education. One of these projects is Strengthening Preschool Education in Turkey. This project has been implemented and conducted by MoNE (Ministry of National Education). Financial support of the project was provided by the EU and technical support has been provided by UNICEF since 2010 (UNICEF, 2013). This project mainly aimed to provide community based early childhood education for disadvantaged children by improving the capacity of preschool institutions. However, UNESCO (2013) reported that there are some quality problems relating to early education in Turkey despite the reforms and renewal projects. It is, however, widely acknowledged that reaching national quality standards in the short-term is very hard because of the difficulty of guaranteeing adequate funding for educational reforms and innovations (World Bank, 2013). On

the other hand, according to a UNESCO report (2012), early childhood care and education in Turkey have generally shown remarkable progress over the years, although it still shows only little improvement in some regions. Since high quality early education improves children's readiness for compulsory education, it is especially important for allowing disadvantaged children to narrow the achievement gap in later school performance (Reynolds et al., 2001). However, this report indicated that Turkey did not ensure certain standards in early childhood care and education in every part of the country. For this reason, the later academic performance of students proved variable. Specifically, rural parts of Turkey have fallen behind most of the metropolitan areas (UNICEF, 2014).

The UNESCO index divided countries into three groups dependent on their quality standards in early childhood education (ECE). In the first group, there is Belarus, which has a high ECE score (0.95 between 1.00). In the second group, there are countries which have a medium ECE score (0.80 between 0.94), such as Jamaica. As shown in Figure 2.1, in the last group, there are countries which have a low ECE score (less than 0.80), like Turkey (EFA Global Monitoring Report UNESCO, 2012).

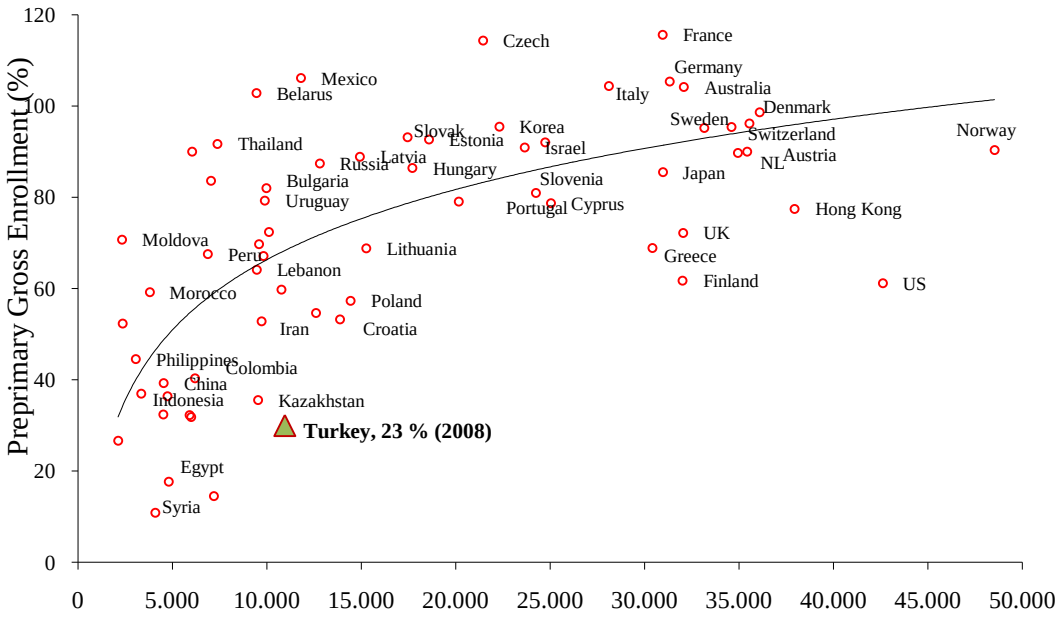
Table 1.2: The ECCE index and its components, 2010 (continued)

Rank	Countries	ECCE index	Under 5 survival rate	Children under 5 not suffering from moderate or severe stunting	Age-specific enrolment ratio of children aged 3 to 7
Low ECCE index (<0.80)					
27	Jordan	0.796	0.978	0.917	0.495
28	Palestine	0.795	0.978	0.882	0.526
29	Algeria	0.794	0.973	0.851	0.559
30	Turkey	0.794	0.977	0.897	0.506
31	Paraguay	0.774	0.967	0.825	0.529
32	Bosnia and Herzegovina	0.771	0.984	0.882	0.447
33	El Salvador	0.769	0.977	0.794	0.537
34	Sao Tome and Principe	0.768	0.931	0.684	0.690
35	Ghana	0.765	0.937	0.714	0.644
36	Honduras	0.755	0.967	0.706	0.592
37	Syrian Arab Republic	0.754	0.984	0.725	0.554

Figure 2.1 Turkey's ECE score in terms of different factors in UNESCO index

Sources: UNESCO Herkes İçin Eğitim 2012 Küresel İzleme Raporu, Gençlik ve Beceriler: Eğitimi İşe Dönüştürmek

When investigated in depth, there are some points that are important for revising early childhood education policies in Turkey (UNESCO, 2012; OECD, 2012a). Perhaps the most notable of these is the percentage of children enrolled to pre-primary education in Turkey. Contrary to the growing global trend, the pre-primary enrollment rate in Turkey has slowed down from 46% to 15% in recent years (UNESCO, 2012).



Graph 2.1 Preschool enrolment rates for 36-72 months group

Source: World Development Indicators (2009), MONE 2008-2009 academic year enrollment rate

As seen in Graph 2.1, Turkey lagged behind most of the countries in enrollment rate in pre-primary education. Low enrollment and schooling rate is the most significant problem for Turkey, which draws attention of researchers because of the impact that it has on later achievement during a person's life cycle.

In Turkey, there have been some research studies concerning the long term effect of early childhood education on children's well-being. One of these studies was conducted by Kağıtçıbaşı et al. (2009) in 1980s. The study aimed to reveal the effectiveness of high quality early childhood intervention on 4-6 year-old children from deprived backgrounds. After 20 years, findings indicated that outcomes are more favorable for children who receive high quality pre-primary education. Also,

similar studies were applied in different countries to reveal the impact of pre-primary education on subsequent educational attainment and the labor market. Goodman and Sianesi (2005) conducted a study to clarify how attendance in preschool education yields large improvements on cognitive tests. The results confirmed that the test score taken between 7 and 16 was statistically significant in favor of children who received preschool education. As well as the impact of early educational experience on cognitive development, there is another significant effect of pre-primary education is decreasing the school readiness gap between children. Rao et al. (2011) studied children from rural China to clarify the impact of preschool experience on early academic achievement.

The findings showed that children who received appropriate preschool education had a higher school readiness score than children who did not receive preschool education.

In the light of this information, most of the OECD countries realized the power of high quality education during early years on children's later school performance. Therefore, OECD countries strive to provide high quality early childhood education for all children. For instance, training requirements and generous salaries for preschool teachers are relatively higher than those of elementary school teachers in France and Germany. The result of well-trained staff and a stable workforce in pre-primary services begets high quality early childhood education. In addition to these, Sweden has recognized the importance of a low child-staff ratio, small group size and well-trained work force (Gormley, 2000). On the other hand, there are some challenges which are common in most of the OECD countries. One of these is engaging families in the early childhood education setting. For this reason, England is making concerted efforts to engage families in early childhood education settings (OECD, 2012). The desire to engage parents in the education setting can be also seen in Turkey. In 2013, the Ministry of National Education prepared special guidance for parents, which was called as an OBADER. This parent education guidance also included a program for 0-3 age groups. In this regard, various materials and methods to communicate with parents were provided to preschool teachers. Moreover, in Sweden, ensuring pedagogically qualified preschool teachers is the driving force

behind regulatory enforcement in their early education. Further, Sweden has one of the highest levels of expenditure per child in the world and the enrolment rate is highest one for 3 to 5 year old group between countries, being approximately 90-95%. Policy makers in OECD countries regard some outcome indicators as a measure for success in early childhood education, such as PISA performance and labor market outcomes. Furthermore, nearly all OECD countries have aimed at expanding their early childhood education services to include every single child.

To establish a strong early childhood education system and see its outcomes in the international arena, countries have made considerable educational reforms in their pre-primary education. At the same time, Turkey made comparable innovations by adopting a constructivist approach and focusing on child-centered education (Akpınar & Aydın, 2007). Following these educational reforms and the competition of OECD countries, a growing body of research has included comparison studies to improve early childhood education (Akpınar & Aydın, 2007; Çelen, Çelik & Seferoğlu, 2011; Gormley, 2000; Kamerman, 2000; Özgan, 2010). For example, Sweden and England have taken part in studies as reference countries in comparison research because of their strong early childhood education systems. Likewise, researchers have compared Turkish early childhood education system with other countries which have strong pre-primary education system. For example, Özgan (2010) aimed at to evaluate differences in early childhood education in OECD countries and Turkey. To investigate the current state of early childhood education in Turkey, the researcher used focus group interviews to collect opinions of preschool teachers about what should be done in order to increase the quality of early childhood education in Turkey. According to 21 preschool teachers, there was a consensus that the investment made for preschool education is insufficient as are the utilities given within the frame of preschool education.

2.2. Science Education and Quality in Early Childhood Education

It is widely known that early childhood education is an integral part of basic education, but that it differs from later grades (Education International, 2010). Unlike later education levels, assessing children's knowledge and what they understand is

particularly critical. For this reason, reaching certain standards in early education is not easy. Providing globally recognized high quality early childhood education is one of the most intangible issues to determine (Katz, 1992). Due to children's developmental features, there is no way to assess children's learning with international assessment techniques. Therefore, many countries in Eastern Europe are facing problems such as access, quality and equity of early childhood education services (UNICEF, 2012).

On the other hand, previous research has demonstrated that children's early learning has an important role their cognitive development and their subsequent academic achievements (Eshach & Fried, 2005; Olgan, 2008; Saçkes, Akman, Trundle, 2012; Sharp, Hopkin & Lewthwaite, 2011). Also, it is suggested that children's high quality learning environment plays a substantial role in enhancing children's early learning (Saçkes, Trundle, Bell & Connell, 2011). Thus, to boost children's subsequent academic achievement, the quality of their learning environment is seen as a vital part of education. Moreover, in recent years, there has been growing attention focused on teaching basic science knowledge during early childhood education. There are various aspects that emphasize the importance of science to young children during early childhood years. One of the benefits of early scientific engagement is to help develop a positive attitude toward science learning during subsequent school life. Most researchers believe that early science experiences can help to develop a positive attitude towards learning science in children's later school life (Eshach & Fried, 2005).

However, there is no exact answer as to how well science is taught to children and how later science competency is increased. For this purpose, researchers investigated some important factors in teaching science to young children. The findings of these studies highlighted that there is a positive relationship between some quality factors, namely teachers, teaching instructions, and elements of learning environment, and children's science learning outcomes (Pianta et al., 2002).

In recent years, studies have showed that hands-on science teaching in pre-primary classes is the most effective method of children's science learning. The main aim is to promote active learning within small groups (Trundle, 2009). In this regard, the

quality of science teaching and instruction can enhance children's basic science knowledge and skills. In this sense, Buldu, Buldu and Buldu (2014) investigated the quality of science teaching in Turkish K-3 classrooms by capturing curricula, instructional methods, assessment techniques, and learning environment. The findings of their study demonstrated that the quality profile of Turkish K-3 classrooms is moderate. However, a remarkable finding of the study indicated that preschool teachers' science education background is not sufficient. Besides, they are mostly not well-prepared for science activities. Moreover, findings showed that the science learning environment is an important factor in children's science learning and their later science achievement. For instance, a pupil ratio in preschool classes is one of the important environmental factors in science learning environment. Further research concerning the quality snapshot in teaching science was conducted by Campbell and Jobling (2010). To describe the quality of science teaching, they utilized interviews, observation and documentation of process. Their extensive research shed light on several issues. Most importantly, teachers reported that their confidence is low when it comes to designing appropriate science activities. For this reason, teachers stated that they need assistance in developing experiences in different science concepts. Similar to this study, Saçkes, Akman and Trundle (2012) conducted research to discover preschool teachers' science knowledge and in-class applications. The findings of this study revealed that most preschool teachers lack the confidence to design science experiments due to a lack of pedagogical content knowledge. All of these studies have highlighted that the teacher is one of the most important elements of high quality science teaching.

In addition to the findings of these studies, early science learning helps to close the gap achievement in science performance in children's later schooling (Lee, 2005; Trundle, 2010). This is highly important because the science achievement gap between the genders and different socio-economic and ethnic groups is very wide. This obvious science achievement gap between different student groups has called researchers' attention to investigate it. For this purpose, Olgan (2008) investigated the relationship between kindergarten science teaching and science achievement by considering gender, SES and race/ethnicity. The results of this study demonstrated that there is only a limited level of science teaching in kindergarten classes.

Moreover, there are various school- and student-level factors which affect children's science achievements. One of the most notable factors is children's socio-economic status in both kindergarten and first-grade. Children's gender and race/ethnicity are also influential factors affecting children's science achievement.

Taking into account all of these benefits of early science teaching, nations have started to extend their science curriculum to include early childhood education. One such good example can be seen in Turkey. A Turkish curriculum for different grades gives great importance to teaching and learning science (Buldu et al., 2014). However, the research findings above have demonstrated that providing sustained science achievement at later grades mostly depends on the quality of science teaching. Investigation of both school- and student-level factors which affect children's current and subsequent science performance can help to build better a learning environment for children. With this in mind, the PISA science literacy provides important information regarding the different factors and different performances of distinct education systems and students.

2.3. What is PISA?

This international large-scale student assessment was launched by the Organization for Economic Cooperation and Development (OECD) in 2000 and the name of this test is Programme for International Student Assessment (PISA). OECD use a paper-and-pencil test formant in PISA and students are tested in multiple content domains, namely reading, mathematics and science literacy (Monseur, Baye, Lafontaine & Quittre, 2011). So far, nearly 70 countries have participated in the assessment. Every three years, one subject domain is selected as a major area, while the other two subject domains become minor areas. For instance, the mathematics literacy domain was determined to be the major domain in the 2012 PISA assessment. In resent applications, both paper-and-pencil tests and computer based assessment strategies were used. The target age group is 15 year-old students who have completed compulsory education.

PISA is intended to provide global information about the education systems of participant countries by means of assessing students within an internationally

accepted framework (Schleicher, 2007). In this way, countries can benefit from using the results to shape their educational provision (OECD, 2013b). Also, the assessment provides an idea of the extent to which students can apply their knowledge to real life situations. For this reason, the questions are designed to test students' ability to interpret the challenges that they can face in daily life and their capacity to analyze problems. By this means, they aim to provide feedback for lifelong learning. Basically put, PISA assesses student's readiness for life (Monseur, Baye, Lafontaine & Quittre, 2011). Besides assessing students in key areas, background questionnaires regarding students' education and family information are also collected in detail (OECD, 2013b). For this reason, PISA gathers retrospective and prospective information about students' educational backgrounds.

2.4. The Sampling Process in PISA

The target population of PISA assessment is 15 year-old students attending different institutions from each country in grade 7 or higher. Although there is not a specific operational definition of age population until the testing date, the target population is intended to reach 15 years and 3 completed months and 16 years and 2 completed months students in all countries (OECD, 2012b; PISA technical report, 2003). For this reason, the aim is not to assess the students at end of compulsory education, but to also assess students who are the very same age in a country independently of national school system and regardless of the students' grade (Fuchs & WöBmann, 2007).

According to the PISA national center, the sample had to be established according to principles of scientific sampling methods to provide a representative and valid assessment (OECD, 2012a). For each country, two stage stratified sampling design is used to sample students. At the first stage of sampling design, schools are randomly selected from different districts based on their characteristics, which require the schools to include 15 year-old students. From each selected school, one school coordinator is appointed to make a list of all 15 year-old students attending the school. The student list is then sent to PISA national centers from each school and after that 35 students are selected from each list. After determining the students, the

coordinator informs these students and their families about the PISA assessment (MoNE, 2010).

2.5. Transnational and Turkish Performance in PISA

For the last few decades, numerous school reforms have launched from distinct countries in response to individual countries' performance in PISA. The driving force behind such reforms is to improve national education standards (Wöbmann, Lüdemann, Schütz & West, 2007). It is also significant that such reforms allow countries to improve their international standing in this area. PISA allows countries to compare their education systems over time and against other countries (World Bank, 2010). For this reason, these reforms have mostly based on countries' performance in the assessment since 2000.

The first PISA test took place in 2000, which marked the first attempt to assess the cross-curricular competencies of pupils' educational outcomes at the end of compulsory education. However, Turkey did not participated in first PISA assessment in 2000 due to employing other international tests (Çobanoğlu & Kasapoğlu, 2010). In this first cycle of the test, while reading literacy skills was the major area, science and mathematics were minor areas. The OECD average score is 500 for reading literacy domain and the results showed Finland, Canada and New Zealand to be the highest-scoring countries and statistically significantly above the OECD average.

Conversely, Portugal, Luxemburg and Mexico were at the other end of the list and so were statistically significantly below the average (OECD, 2004).

In many countries, the PISA results hit the front pages of prominent newspapers. For instance in England, *The Times* questioned "Are we not such dunces at all?" In response to poor performance in the PISA assessment, countries' attention focused on their own students' performance at a country-level. Governments have tried to remove some shortcomings in their education systems and their interest has tended to focus on family background and school composition (Fuchs & WöBmann, 2007). For instance, investigation in the German context revealed that schools with poor

socio-economic condition exhibited worse performance than schools with favorable conditions (Rangvid, 2006).

When the 2003 PISA came, the second cycle of the test was conducted. Mathematics literacy was chosen to be the major subject domain (OECD, 2005). To provide detailed information for countries about their education system and socio-economic conditions, PISA started to gather information from parents and teachers via questionnaires in addition to the student assessment test. When looking at the 2003 PISA results, China demonstrated the highest performance out of 41 countries. Finland and Korea followed China as high-scoring countries. Between PISA 2000 to 2003, some of countries showed a statistically significant change in their mathematic performance. For instance, Korea, Germany, Spain, Italy and Poland increased their respective scores by around ten points. Moreover, the results showed that the range of scores differed widely at a country level. For example, Finland and the Netherlands can be seen to be high performing countries, but Finland showed less variation in student performance than the Netherlands did (OECD, 2005). The other salient point of the test revealed that more than 40 per cent of students in Turkey, Mexico, Germany, Luxemburg and Hungary think that schools are not sufficiently preparing them for real life. Turkey was ranked 29th out of the 30 OECD countries (Eraslan, 2009).

In 2006, the third cycle of the PISA test was conducted with the participation of 57 OECD and partner countries. In this cycle, students' ability in explaining and applying science knowledge was assessed in the science literacy domain. When looking at the performance of countries, Finland again had the highest score with 563 points in the science domain compared to the OECD average score of 500 (OECD, 2007). Hong Kong, China, Canada and Chinese Taipei, Estonia, Japan and New Zealand also perform statistically significantly above average in science score as high-scoring countries. On the other hand, Turkey, Mexico, Bulgaria, Brazil, Argentina and Qatar showed a performance which was statistically significantly below the OECD average. Denmark, France, Hungary and Sweden demonstrated a medium level of proficiency in science. When viewed from the change in performance aspect, for instance, Finland has keep their grading stable compared to

previous test scores. When viewing the United States' ranking over the last three cycles, it appears that there was a notable decline in the rankings. In response to this low score, researchers in the United States focused on school-related factors, such as teacher quality and investment in education (Beese & Liang, 2010). As to the United Kingdom, 169 schools and 4,935 students participated in the international assessment in 2006. Although the United Kingdom had a score above the OECD average, the result was not satisfactory for them since it was not statistically significantly different from the OECD average (Bradshaw, Sturman, Vappula, Ager & Wheater, 2007). Unfortunately, Turkey performed statistically significantly below the OECD average and so ranked 43rd out of 57 countries. Moreover, Berberoğlu and Kalender (2005) stated that there was a huge achievement gap between school types and learning discrepancies between school types can be a reason for inequities in education systems and life conditions. Figure 2.2 shows countries' score distribution in the 2006 PISA assessment in the science domain.

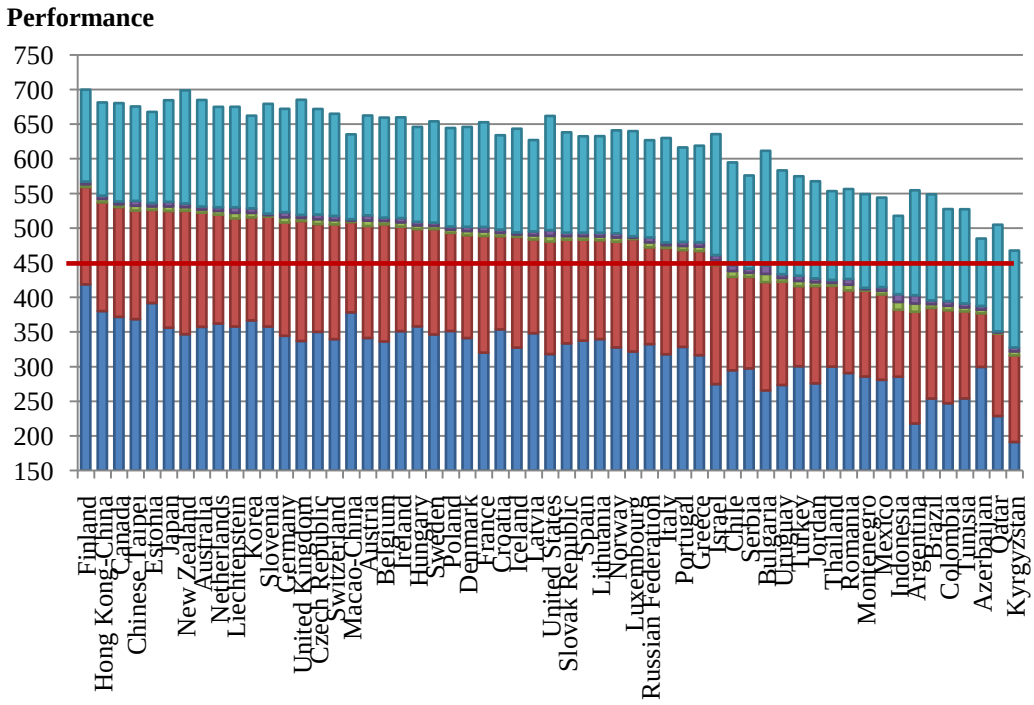


Figure 2.2 Distribution of student performance in the 2006 PISA science scale

Sources: OECD PISA 2006 database.

The PISA assessment in 2009 was carried out across 65 countries. Students' reading literacy ability was assessed in depth as a major subject area. In this cycle of the test, China showed the highest performance with a mean score of 556, while Korea and Finland were the other high performing countries at the top of the list. The United States, Sweden, Germany, Ireland, France, Denmark, the United Kingdom, Hungary, Portugal and Chinese- Taipei had an average mean score within the 65 countries. When considering Turkey, progress has been made compared to previous scores, but its ranking had not changed (Çobanoğlu & Kasapoğlu, 2010). The results of the 2009 PISA test were very important for countries to see whether their educational innovations had proved successful or not as PISA has, by this point, been running for nearly ten years. For this reason, it provides information about the outcome of educational reforms. Figure 2.3 shows the improvement in performance of some countries from 2006 to 2009. Although, most of the countries show some progress in their score point, their ranking did not change. Countries such as Turkey and Croatia have, therefore, still lagged behind the OECD average.

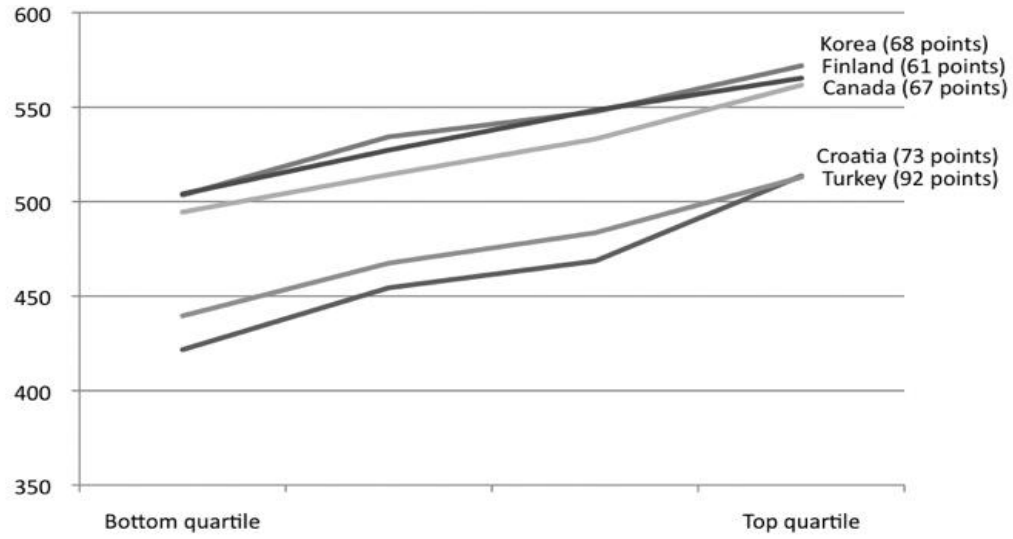


Figure 2.3 Students performance in PISA from 2006 to 2009

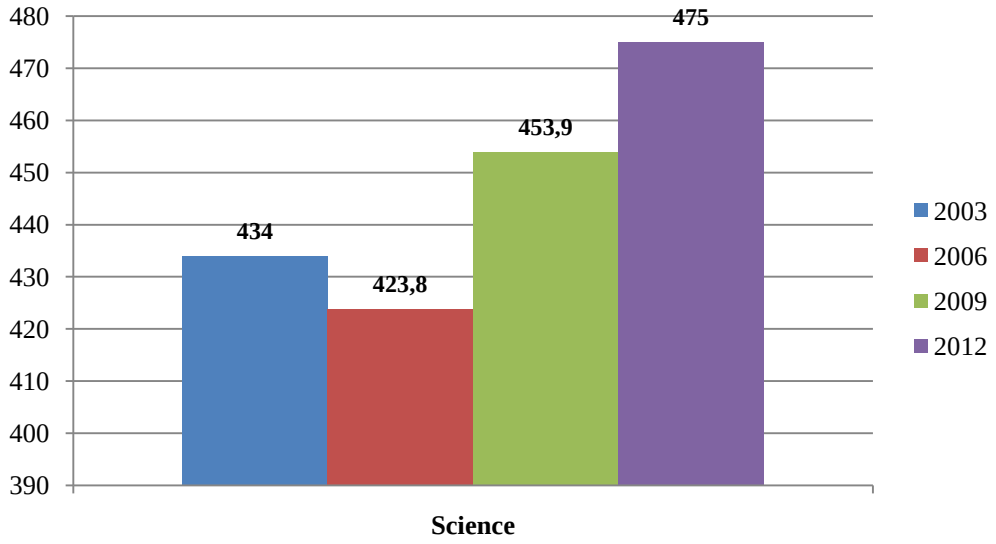
Sources: Köseleci Blanchy N. & Şaşmaz, A. (2010). *PISA 2009: Where Turkey stand in PISA*? OECD. PISA 2009 Results: Overcoming Social Background: Equity in Learning Opportunities and Outcomes, 2.

The results from the 2009 PISA test showed that there is still need for urgent improvement in education systems of some countries, notably this includes Turkey (Blanchy & Şaşmaz, 2011). Although there have been many innovations, these are generally concerned with only one or two problematic areas (Akpınar & Aydın, 2007), such as low schooling and attendance rates. According to a report of the OECD (2012b), these innovations should start in early childhood years since this permits a long lasting impact on student's academic performance. In response to the 2009 PISA results, nations started to change their focus in educational innovations from basic education to early childhood education. For this reason, it is suggested that governments invest in education from early childhood years. In this way, efficient and effective early childhood education can beget later school achievement and the ability to challenge real life problems (Heckman, 2008).

When the 2012 PISA test was employed, the highest-scoring countries were still roughly the same. The mathematics domain was the major subject area of the assessment. China had the highest score with a mean score of 613. The overall profile of the assessment revealed that 25 countries improved in mathematics. Also, the 2012 results highlighted that boys performed better than girls in the mathematics domain. Hong-Kong China, Singapore, Japan and Korea were the highest-performing countries in reading in PISA 2012 (OECD, 2013a). As seen from these results, Asian countries were outstripping European countries and being consistently the top performing countries. After all, while examining the country profiles, PISA scores ensue that countries which have strong socio-economic condition tend to demonstrate better performance in the assessment. Thus, according to international reports, economic development is the strongest factor for success in the test. Likely, this gap is also seen at a national level whereby students from favorable background achieve better scores (OECD, 2004; UNICEF, 2013). On the other hand, Turkey is one of the countries which have shown a consistent improvement in the last two PISA scores (Sedghi, Arnett & Chalabi, 2013).

Table 2.1

Turkey's Science Performances in PISA



As seen in Table 2.1, educational regulations might represent the reason why Turkey performed better in the last PISA assessment. These innovations may help to improve its performance in PISA in various ways. However, even in the last PISA assessment, the mean scores were still below the OECD average. Even worse, Turkish students were falling behind their peers in European countries in national and international assessments (Berberoğlu & Kalender, 2005). Therefore, most countries believe in the power of early childhood education to facilitate higher performance in the PISA assessment (OECD, 2010). Clearly, the association between attendance in early education and PISA success is visible. For this reason, most of the educational reforms involving early childhood education are intended to raise the overall quality of the education system.

2.6. Distribution of Turkish Students' Competency in Science Literacy in PISA

In today's world, the ability to understand scientific phenomena and solve scientific problems is vital to advanced societies (Anıl, 2011; Campbell & Jobling, 2010; Eshach & Fried, 2005; Pianta, LaParo, Payne, Cox & Bradley, 2002). For that purpose, starting from early childhood years, countries pay increased attention to ensuring that their science curriculum is complex and in depth (Morrison, 2012). The

PISA science literacy is aimed to assess students' ability in constructing and solving scientific problems. For this reason, the results of PISA in science literacy are important indicators for countries seeking to evaluate whether students have gained the ability to solve real life problem strategies.

Since 2003, Turkey has participated in PISA in three times. In every cycle of PISA, Turkey has the opportunity to assess students' improvements in academic achievement. However, the performances of Turkey in PISA were not satisfactory since the scores were well below the average across 30 OECD countries. Science literacy was the major subject area in the 2009 PISA assessment. There is also evidence from the 2009 results that students' performance did not stretch to higher achievement levels. Turkish students mostly performed at level 2 (Özenç & Arslanhan, 2010). Figure 2.4 shows that Turkey lagged behind nearly all OECD countries.

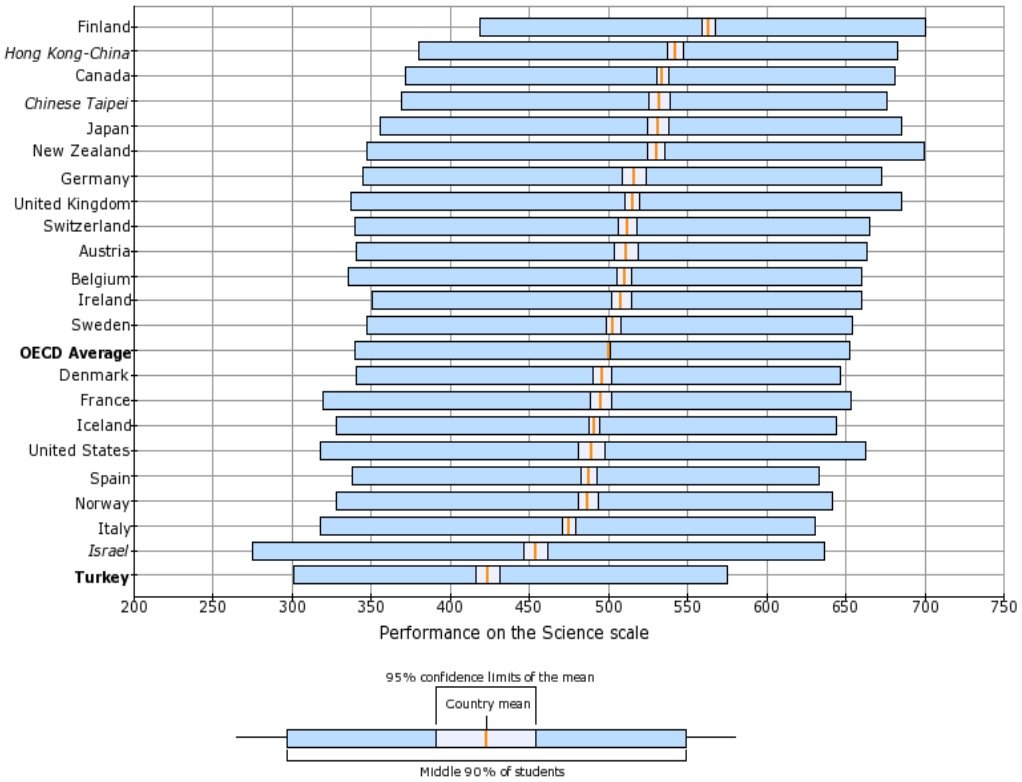


Figure 2.4 Turkey's Science Performance in 2009 PISA Assessment

These results revealed that there is still a need for innovation in education, especially in the science area. In line with this consideration, Turkey has introduced many reforms in education. For instance, in 2004, Turkey made a comparative reform in education based on accession to the European Union and globalization (Akpınar & Aydın, 2007). These innovations were somewhat beneficial since Turkey showed the highest progress in science score between 2006 and 2009, with a 30 score point increase. However, according to a report of The World Bank (2012), educational reforms in Turkey are limited in scope because these reforms mainly focus on primary and secondary education. However, to achieve permanent success, early childhood education should be the first step in increasing the effectiveness of later school achievement. With this aim in mind, these international tests and reports can provide some indicators to see where countries stand in the international arena.

2.7. The Development of Comparable Indicators

After each PISA score was announced, countries which showed poor performance at the assessment focused on their education systems in an attempt to increase their next test score. Innovation and extension of early childhood education is one of those attempts, because it is clearly seen that children with a pre-primary education background exhibited a better performance in the PISA. Based on this, PISA can also provide notable information about how children's science performance is affected by their pre-primary educational background.

In line with this, a growing body of research has already demonstrated that subsequent science performance is affected by children's early experiences and conditions during pre-primary years (Osakwe, 2009; Pianta et al., 2002; Saçkes et al., 2011). By imparting to young children a sense of wonder, an environment can be established where children can find rich learning opportunities to discover the world around them (Berlinski, Galiani & Gertler, 2009; Byrnes & Wasik, 2009). Therefore, abilities in scientific investigation, problem solving and reasoning can be boosted by science education (Eshach & Fried, 2005; Patrick et al., 2008). Moreover, such early scientific knowledge and experiences help children to deal with learning difficulties in later school performance. Also, the benefits of early science teaching are not

limited to children's later science performance since early science education can help children with the rest of their lives (Gilbert, 2006). All of these reasons mean that science teaching in early childhood years is a valuable part of the daily curriculum. Due to the substantially important benefits of early science education, educational systems include science education from kindergarten level. However, providing high quality science education and learning environment are basic needs of education systems (Tu, 2006). Determining potential influences which affect children's science learning is an utmost need for high quality science education because higher quality science education is linked to greater gains (Early et al., 2010). However, there are only limited research studies that investigate how early science experiences affect later science achievement.

On the other hand, there are some limited research studies that investigate factors which affect children's science achievement. According to Pell and Javis (2003), one of the factors which affect the quality of science teaching process is the teacher. The main factor behind the limitation in the quality of science education is teachers' limited pedagogical content knowledge. In parallel with teachers' lack of science knowledge, they spend less time conducting science activities and experiences. Moreover, Saçkes et al. (2011) revealed that some other factors also affect children's later science achievement. These factors include socio-economic status, motivation, and gender. In addition to these, learning materials, pupil-teacher ratios, and environmental conditions are other important factors related to children reaching their full potential in science learning (Blatchford, Bassett, Goldstein, & Martin, 2003; Hadzigeorgiou, 2002).

As mentioned above, in modern societies, high quality science education during the earliest years of life has become a critical issue due to the demand for a scientifically literate population (Heckman, 2000). The demand for providing high quality science education is an issue to be emphasized because of children's subsequent outcomes (Ejieh, 2006). Therefore, there have been various research studies interested in the issue of quality in science education (Buldu et al., 2014; Byrnes & Miller, 2007; Early et al., 2010; Garbett, 2003; Olgan, 2008; Saçkes et al., 2011; Tu, 2006).

However, there are far fewer research studies which investigate children's later science achievement based on overall quality factors.

Determining numerous quality factors in science teaching can provide countries with the opportunity to establish high quality early childhood education systems and science education (Saçkes, 2012; Schütz, 2009). For that purpose, investigation of the possible influence of variables at both student- and country-level can provide information necessary to gain a complete picture of the efficacy of the education system. At a country-level, educational expenditure in pre-primary education, income per person, adult literacy rates, enrollment rates to pre-primary education, duration and starting age, and pupil-teacher ratio indicators are presented. As for student-level indicators, maternal factors, pre-primary education, and gender are presented to determine children's later science performance.

2.7.1 The Rational behind Early Childhood Investment

In industrialized countries, early childhood education serves as a guide for educational quality. It signifies that early childhood education is one of the basic predictors of success during the life cycle of an individual (Belfield, 2006). While thinking of the benefits of early education, it must be remembered that it has a significant impact both on individuals and on nations. When considered the benefits of early childhood education for a child, before anything else, it helps to improve that child's cognitive development (Goodman, 2006; Osakwe, 2009; Woldehanna, 2011). Moreover, it can be seen that it leads to better academic achievement, readiness for school, general well-being, and a successful life cycle (Rao et al, 2012). Due to rich experiences with learning material and resources, it is possible to enhance children's learning (Trundle, 2009). By investing in children's environment and education, they can be provided with such rich early experiences. This is also important in early science learning, since the availability of science learning materials and sources is seen a determiner of quality of science education (UNESCO, 2004). In this way, it is possible to enhance children's science learning and provide them with a high quality learning environment.

However, the most important question to be asked is "How is investment economically significant?" The answer to this question is quite startling:

"Each dollar invested in the pre-school education of three- and four-year-old children from low-income families returns more than $9 to the nation, in present value terms" (Openheim & Macgregor, 2002, p.1).

According to Macours et al. (2008), investment in early childhood education is seen as crucial expenditure in achieving school performance and life. For this reason, educational expenditure in the country has achieved prominence because public spending is a significant determinant of social and educational outcomes (Baldacci, Teresa Guin-Siu & Mello, 2003; Heckman, 2000; Güngör & Göksu, 2013).

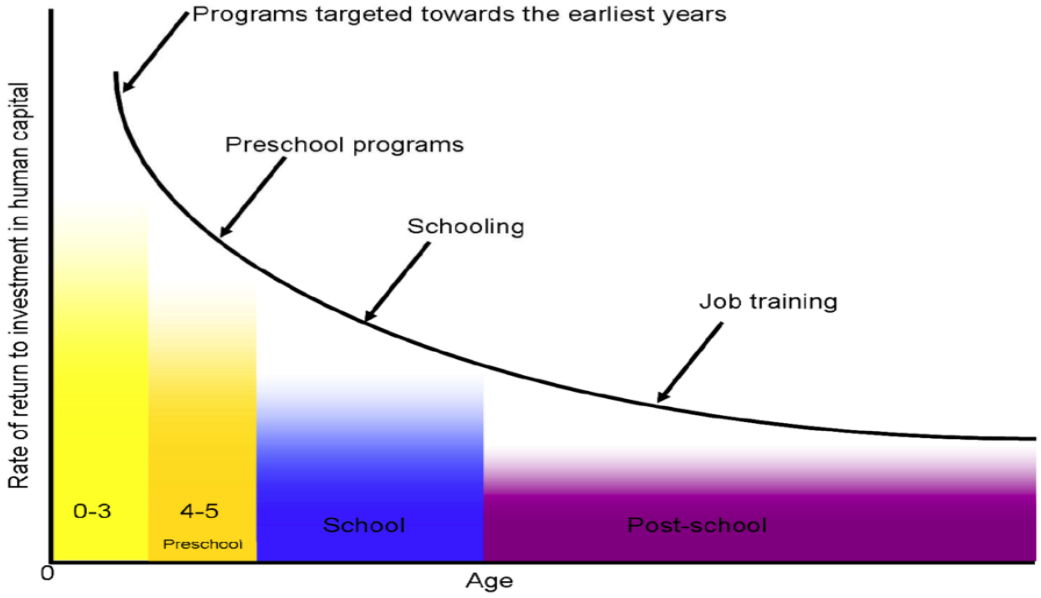


Figure 2.5 Illustration of Rate of Return on Educational Levels

Sources; Heckman, J. J. (2008). Schools, skills, and synapses, *Economic Inquiry*, 46 (3), 289-324

With this in mind, President Obama stated that a series of new investments will be undertaken which will provide high quality education for all children in US, with the return of each dollar being hugely significant for the national economy (The White House, 2013). In parallel with this, Schweinhart et al. (2005) investigated the effectiveness of preschool education on 3- and 4-year-old African-American children who have a high risk of school failure. The study involved two groups, one of which

receives no preschool education. By the age 40, the return rate was more than 16 dollars from those who received preschool education. When considering the effectiveness of early treatments, early childhood education has become a policy priority involving making new provisions or increasing spending on pre-primary education (State Planning Organization, 2012).

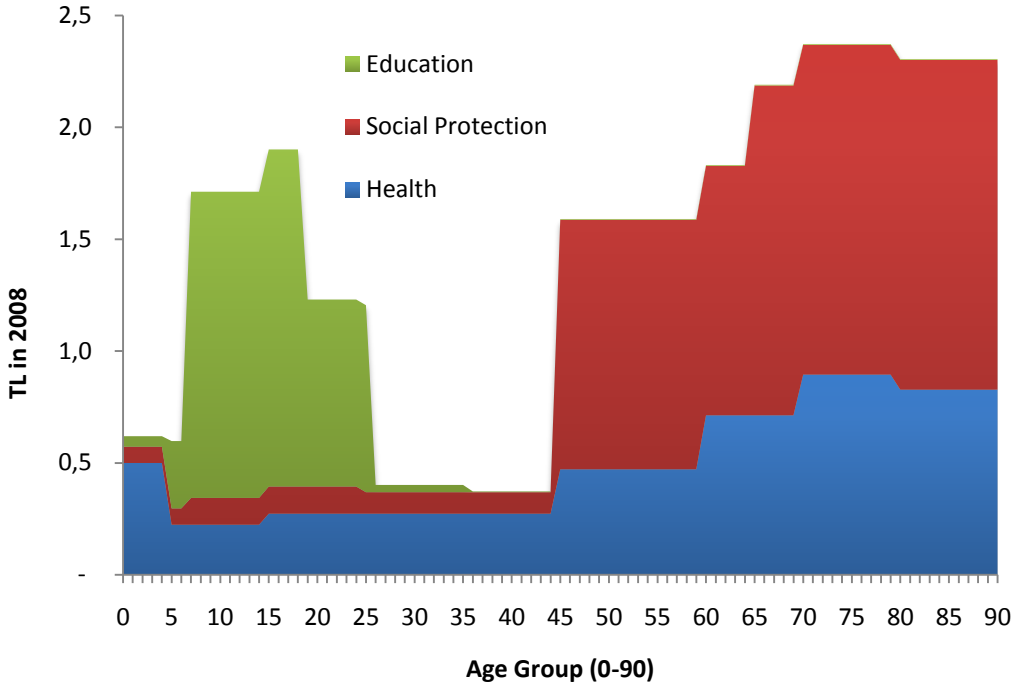


Figure 2.6 Government Expenditure on Education, Social Protection and Health for Different Age Groups

Source: Staff calculation based on Ministry of Finance study and data

When it comes to the Turkish context, Figure 2.6 is very important for understanding how much educational expenditure is allocated to children between 0-6 year-olds in Turkey. Clearly, early childhood years has the lowest spending level out of all later education levels. Until children start primary education, the expenditure level is significantly below that of other educational levels.

However, according to a report of OECD and World Bank (2012), spending for early years has a higher return rate when compared with other educational levels.

Therefore, revising the spending pattern in early childhood education can provide better provision of pre-primary education in Turkey.

2.7.2. Gross School Enrollment Rate and Starting Age in Pre-Primary

With the intention of increasing the schooling rate and attendance in early childhood education, the plan is to reach more children who should receive early childhood education. As previous research has demonstrated, the early experience of children has a unique impact on their later academic achievement (Byrnes & Miller, 2007; Marturano, Gardinal-Pizato & Victorine-Fontaine, 2012). This is the same for children's later science achievement. Through early science education, children can learn and internalize basic science knowledge. Thus, their early science foundation can help them during later school life (Early et al., 2010). All of these benefits are clear evidence of national demand for increasing their enrollment rate in pre-primary education.

When analyzing the enrollment and starting age factors, the term of gross pre-primary enrolment means the ratio of total enrolment to preschool services, from 3(4) to 5(6) years (UNESCO, 2004). Formal pre-primary education begins at 3- or 4-years-old in most of the OECD countries. Children start preschool services from 3 years of age upward, with more than 90% attendance rate in Belgium, France, Spain, Sweden, Italy, Norway and Iceland (OECD, 2013b). During recent years, there has been a significant increase in the rate of enrolment in pre-primary education in different countries where the attendance rate was quite low compared to the OECD average. For instance, the rate of enrolment in pre-primary services is promising in Turkey during the past ten years. While the gross enrolment rate of children aged 4 in preschool education was 5% in 2005, the rate increased to 19% in 2011. However, compared to the 84% gross enrolment rate in OECD countries in 2011, it is still troublingly low (OECD, 2013a).

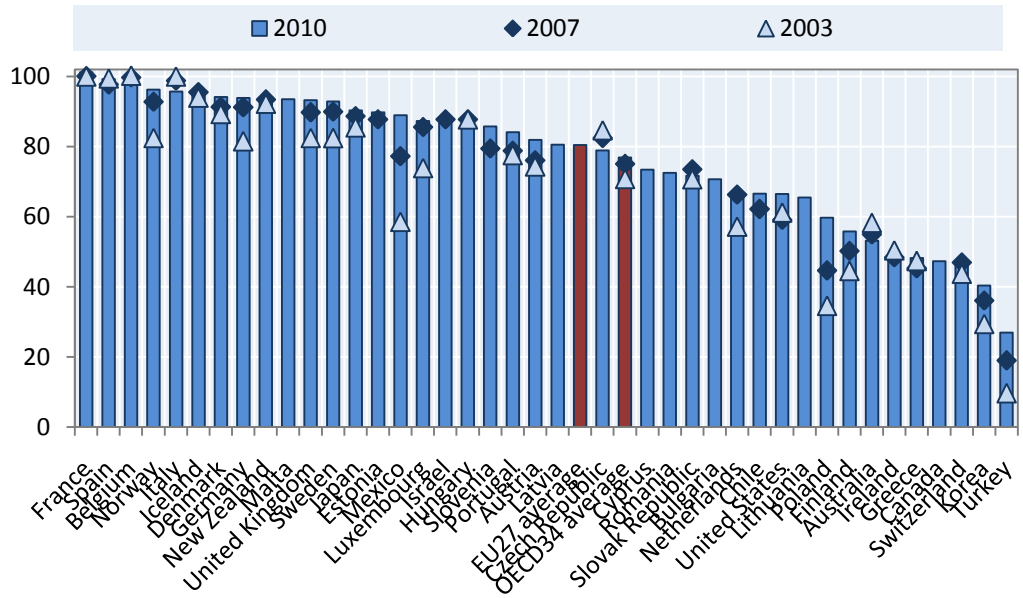


Figure 2.7 Average Enrollment Rate of Children Aged Three to Five Years of Age in Preschool education

Source: OECD data source

According to plan of the Ministry of National Education, the gross enrolment rate in pre-primary services is supposed to increase to 70% by 2023, although the present number of teachers and classrooms must be increased by more than three times in order to achieve this aim (UNICEF, 2013). Thus, it is seen that the present conditions do not meet the pre-established plans related to enrollment rate in pre-primary education (World Bank, 2013). The report of OECD (2013a) showed that more than half of OECD countries have at least a 70% enrolment rate among 3-5 year olds in 2010; however, this rate is below 50% in Canada, Greece, Ireland, Korea, Switzerland and Turkey. On the other hand, it is important to recognize why the enrolment rate low in some countries. Murungi (2013) listed various reasons for a low enrolment rate in pre-primary services, such as lack of teacher, school fees, and parental awareness. The findings showed that lack of school fees and inability to provide basic needs are the main reasons for low enrolment in pre-primary services. In line with this, the World Bank (2007) indicated that the reason for the low economic profile of families is a considerably important reason when it comes to low

enrolment. Also, one of the other important reasons for a low enrolment rate is low schooling ratios in different countries.

Therefore, due to various causes, the enrolment rate is quite still low in some countries, such as Turkey. However, pre-primary education is one of the most effective ways in eliminating inequities within society (Doyle, Hermon & Heckman, 2009). Therefore, it can be suggested that pre-primary education can be used as a tool in reducing inequalities between children. For this reason, France undertook serious expansion in schooling rate during the 1970s (Dumas & Lefranc, 2010). Moreover, the same trend was receiving increased interest from policymakers in US (Fitzpatrick, 2008). They believed that early interventions will beget improved life outcomes, especially for disadvantaged children. In line with this, the Abecedarian and Perry School projects were instituted out for low income families. In 2005, for example, Gormley and Gayer studied on the effect of the Oklahoma Pre-K program. They compared the test scores of children who participated in the Oklahoma program and children who did not. The results showed that the availability of preschool programs increased the achievement of children who attended such preschool programs in reading and mathematics.

2.7.3. Pupil-Teacher Ratio

There are numerous studies which investigate the relationship between preschool quality and children's development. These quality factors, such as classroom features, can be wide, but one of them is pupil-teacher ratio which it was reached a compromise by most of the researcher (Mashburn & Pianta, 2010; Blatchford, Bassett & Goldstein, 2003; Finn & Archill, 1999) and it is defined as the appropriate number of children who are educated or cared for by sufficient educational staff (NAEYC, 1991).

Although small class sizes have been subject to vociferous debate between researchers, small classes are still widely linked to high quality learning and teaching environment (Blatchford, Bassett, Goldstein & Martin, 2003). Parallel to this, Blatchford et al. claimed that the work-related science teaching process is affected by

small classes. Children are therefore able to produce more creative products and use problem solving skills more effectively.

Furthermore, according to Heckman (2008), the pupil-teacher ratio is a very important factor in the classroom environment during early years because of communication between teacher and children. A high quality emotional context in class is evidence for positive emotional tone, teachers' sensitivity to children's emotions and motivation. By means of a proper teacher-pupil ratio, teachers can build more healthy communication with children and so can provide immediate feedback and foster children's curiosity. In this regard, Kruif, McWilliam, Ridley and Wakely (2001) investigated the quality of teacher-child interaction at times where the teacher responds quickly and warmly to children. The findings showed that sensitive and responsive interaction with children provides opportunities to children for learning and exploring their environment. Moreover, they discovered that this appropriate interaction between children and teachers increases the classroom quality because a classroom with a lower teacher-child ratio has less detached interaction with children. According to Bascia (2010), teachers believe that they can pay more attention to children in small classes. As might be expected, teachers reported that they are better able to monitor children's activity and their behavior in small classes. On the other hand, parents believe that their children can be more social and engaged with their environment in small classes. As confirmed in the Ontario study (Bascia, 2010), small classes provide more child-centered and communicative atmosphere in class. Moreover, instructions are able to be delivered in a more exploratory and encouraging manner.

As well as the benefit of small classes on the quality of teacher-child interaction, there are numerous benefits for peer interactions also. It can be observed that fewer children in the classroom lead to less confusion throughout the day. Children can learn social and self regulation skills while interacting in group activities. For this reason, the quality of interaction increases as they build positive communication with their peers (Espinosa, 2002). Moreover, children frequently try to test their learning and ideas with peers, so they learn by means of their reactions (Copple & Bredekamp, 2009). Taking into account all of these, the National Association for

Young Children (NAEYC) recommends that group size should not exceed 20 children and there should be one member of educational staff to 10 children ages 3-5 as a minimum ratio. However, this rate is very different from that in Turkey, where there averaged 23 children per teacher in 2011, while the average of OECD countries' ratio of child to teaching staff was 14 children per teacher (OECD, 2011).

During recent years, the idea of less crowded classes has raised some precautions in pre-primary classes. Reduction in pre-primary class is a considerably popular arrangement in education. Even thought small class size is highly recommended, there is only very limited scientific evidence about the effectiveness of reduced class size on students' achievement (Hanushek, 1998). According to Hanushek, there is no significant relationship between small class size and students' performance and so there is very little evidence to believe that small class size yields better academic performance. In light of this concern, the Tennessee STAR Project, a prominent experimental study, was conducted by Word et al. (1990). Children were assigned to regular (22-24 children) and small classes (14-16 children) and they were monitored from kindergarten to third grade. In regular classes, children were split into two groups, which were designed as being with teacher aides and without teacher aides. On the other hand, children in small classes remained in these classes through third grade. The results of the experiment were highly important in establishing whether class size mattered or not. The results showed that the magnitude of a reduction of 7-10 pupils per class has a significant long term effect on students' performance. This study's results provide evidence that small classes have a lasting effect on pupil's performance as long as it started from early years. In addition to this study, Dynarski, Hyman and Schanzenbach (2011) studied the effect of small classes in primary school on collage entry, collage choice, and degree completion. The findings helped to identify that small classes increase the probability of students' attending college. Moreover, the other important finding of the study is that small classes increase the students' preference toward high-earning fields, such as science, medicine and engineering. Similarly, Krueger (1999) studied children in kindergarten and first grade in small classes. The findings showed that small classes have a significant effect on children's academic achievement and educational attainment. In addition to these studies, Rivkin, Hanushek, and Kain (2005) found similar results

with previous studies on academic achievement. Moreover, Jepsen and Rivkin (2009) investigated the effect of small classes on teacher quality and academic achievement of pupils. The results showed that small classes upgrade pupil's reading and mathematics achievement; however, there is little or no support for improvement in quality of instruction by given teachers.

All of these studies concerning pupil-teacher ratio and class size can help to illustrate the general picture of the effect of reduction in class size. Nevertheless, only the class size factor cannot reflect the main reason for improvements in pupil's academic achievement (Jepsen & Rivkin, 2009). At the same time other factors should be considered. For this reason, consideration of enrolment rates, teacher pupil ratios or the expenditure allocated for early childhood education can provide a more complete picture of achievement in later school performance. Moreover, although it is not in scope of the current study, when examining these studies, it would be useful to seek the answer to the critical question about the length of effectiveness.

2.7.4. The Relationship between Income and Achievement

Most previous research on academic achievement has considered the effect of quality indicators, such as pupil-teacher ratio, teacher quality, enrollment rates in education, and schooling rate (Schütz, 2009). As well as these indicators, studies in early childhood education showed that family background and income indicators are other remarkable factors that affect students' academic achievement (Burchinal, Vandergrift, Pianta & Mashburn, 2010; Early et al., 2010; Muchburn et al. 2008; Reardon, 2011; Schütz, 2005) Socioeconomic status has complex components, such as household income, education, and occupations (Heckman, Farah & Meaney, 2010). It is suggested that brain development is affected by children's socioeconomic contexts and conditions (Heckman, Farah & Meaney, 2010). These contexts and conditions have a strong effect on individuals' experiences from childhood through adolescence. Additionally, low socioeconomic conditions are associated with causing impaired developmental in children, especially in cognitive and emotional areas. Thus, the evidence suggests that this achievement gap between different individuals is not entirely due to innate ability. For this reason, during early years, it is very

important to eliminate these inequities between children by means of early childhood education.

In light of this information, evidence from resent research has suggested that the gap in academic achievement between children from low and high income families is widening (Reardon, 2011). Moreover, some empirical evidence has shown that children from economically disadvantaged conditions do not have all the necessary school readiness skills when entering primary education (Hair, Halle, Terry-Humen, Lavelle & Calkins, 2006). Not only school readiness skills but also educational attainment is affected by economical conditions. High income students have higher educational attainment along with higher academic achievement. There can be several reasons for less educational attainment from low income students, such as lower educational expectations of parents for their children (Rause & Barrow, 2006). There is a strong case to be made about the association between income and achievement in distinct education systems (Berlinski, Galiani & Manacorda, 2008). Thus, it is assumed that income per capita is one of the important indicators of a strong education system. Due to various causes, income affects students' overall academic performance across the country. For instance, income inequity and income achievement gap are closely related to each other (Reardon & Chmielewski, 2012). The structure of the school system is also affected by income inequity. Thus, all of these causes suggest that income inequity is one of the main reasons for low academic achievement and educational attainment. In this regard, Reardon and Chmielewski (2012) conducted a cross-comparison study to reveal how income and achievement are related to each other. The findings showed that the achievement gap varies widely in countries where the income gap is large.

2.7.5. Duration of Pre-primary Attendance

Reducing achievement gap between children from different socioeconomic conditions and providing high quality early education are increasing needs for nations' early education provisions (Murungi, 2013). As research studies have indicated that early education helps to close achievement gap between children over time. Especially, disadvantaged children can get higher benefit from pre-primary

education in eliminating inequities (Heckman, 2000; Berlinski et al., 2008; Trucker-Drop, 2012). Yet, the main point is that making decision for one or more year pre-primary attendance is sufficient to get desired outcome of early education. There are various research studies which investigated the effect of one or more than one years the outcomes of pre-primary attendance (Domitrovich et al., 2013; Berlinski, Galiani & Manacorda, 2007). With this aim, Domitrovich et al., investigated the length of preschool attendance on children's early literacy and numeracy skills. The results of the study revealed that two years attendance to preschool education was statistically significant improvement children's literacy and numeracy skills. Moreover, Rittblat, Brassert, Johnson and Gomez (2001) examined whether two years attending to Head Start can lead better developmental outcomes than one year attendance. The results of the study revealed that children who received two years Head Start education have better developmental outcomes, family environment at home and increased intellectual-cultural orientation at their later life. In addition to these, Kağıtçıbaşı, Sunar and Bekman (2001) conducted a study to reveal the effect of early intervention on children's later life process. To examine the long-term benefits of early intervention, they utilized a mother training program. The results of the study indicated that early intervention was statistically significant contributor on children's IQ.

These aforementioned benefits of early childhood education are backbone of children's later life acquisitions (Kağıtçıbaşı, 2004). For that purpose, the importance of early childhood education is increasing over time. The effort of providing high quality early education is to enable long lasting effect on their life and minimizing the inequities between children.

2.7.6. Parental Literacy and Maternal Employment

There are many factors that can influence children's academic achievement other than children's their own capacities. One of the most important of these factors is parental education (Crosnoe & Cooper, 2010). In other words, educational attainment of parents can boost children's academic achievement in each learning area (Bajracharya, 2007). There are many reasons for the high achievement on the part of

children who have educated parents. Particularly, teaching children accurate science knowledge is a highly critical issue due to preventing misconceptions while teaching science (Harlan & Rivkin, 2005). In this sense, Jabor et al. (2011) conducted a study. The results of their study demonstrated that there is a significant relationship between parental educational status and students' science achievement.

On the other hand, studies have shown that the expectations of well educated parents are higher than those of uneducated parents' (Moore & Schmidt, 2004). As well as a parent's expectation for their children's educational outcomes, Rhea and Otto (2001) indicated that mothers' education and the family income have a significant impact on children's educational outcomes. According to Mugnuson, Sexton, Davis-Kean and Huston (2007), it is important to investigate whether increases in mothers' education will improve their children's academic achievement. The study's results suggested that there is a close relationship between children's home environment and increasing their mother's education level. In addition, the adult literacy rate in most of the high-performing countries in PISA has approached 100% for many years. It can be suggested that one of the reasons for countries' success in PISA is the level of their parental literacy rate. For this reason, the relationship between children's educational outcomes and parental education level can play a great role in explaining academic success.

Besides mothers' education level, one of the other important issues in early education is mothers' employment. Especially during early years, mothers' employment can have various consequences on children's development (Korenman and Kaestner, 2005). The link between mothers' employment and children's academic achievement has been investigated (Christensen & Butler, 2011). Dunifon et al. (2012) examined the impact of maternal employment over an extended period of time on children's achievement in 9^{th} grade. The results suggested a significant association between maternal employment and children's school achievement. Children with mothers who work 30 hours have a GPA that is 5.6 percent higher than children with a mother who works 19 hours works per week. Moreover, Ara (2012) stated that children of working mothers showed higher performance than the children of non-working mothers. Ara (2012) conducted the study in Turkey to reveal the impact of

having a working mother on long term achievement of children. The findings showed that having a housewife mother tends to produce a negative association with children's long term achievement, and it also affects sons more highly than daughters.

2.7.7. Gender

Over the last few decades, there have been numerous research studies that focused on the gender gap in educational achievement (Gibb, Ferguson & Horwood, 2008; Hillman & Rothman, 2003). While some of the research indicated that female students are outperforming male students (Coley, 2001), some findings are in favor of male students (Hola, 2005). Moreover, there exists various evidence that male students perform better than females in mathematics and science (Hyde & Linn, 2006). In explaining gender differences between male and females in the achievement gap, there are different factors. Some of them are explained by biological factors. Due to various causes, males and females have different behaviors and skills determined by biological factors, such as hormones and genetics (Gibb, Ferguson & Horwood, 2008). Moreover, gender theory suggests that female and male students have different sets of behaviors and attitudes as a result of childhood socializations (Weaver-Hightower, 2003). In line with this, Gibb, Ferguson and Horwood (2008) conducted a comprehensive study about the effect of gender differences on various cognitive and educational achievements. The results suggested that, from age 8 to 25, females have higher performance than males when it comes to educational achievement. Although gender differences have not been clarified yet (Weis, Heikamp & Trommsdorff, 2013), studies conducted in different contexts help to understand the reasons for the discrepancy in achievement between the genders.

CHAPTER III

METHODOLOGY

The main aim of the current study was to examine the effect of various indicators from pre-primary education, governance and socio-economic status on science performance in the PISA assessment by utilizing both country- and student-level data. As the literature has suggested, subsequent science achievement is affected by children's early learning environment and their socio-economic conditions (Olgan, 2008; Saçkes, et al. 2011; Saçkes et al., 2013; Tao, Oliver & Venville, 2012). Parallel with this, the current study investigated these indicators' possible impacts on later science performance in the PISA assessment. To investigate the determinants of later science performance in depth, the current study is comprised of two parts: cross-country comparisons and student-level analysis from Turkey.

In the first part, the study compared the effect of cross country indicators belonging to early childhood education and socio-economic conditions on science performance by using 2000, 2003, 2006, 2009 and 2012 PISA science scores. By using PISA science scores from distinct education systems, some quality indicators from pre-primary education systems and individual children's socio-economic status were investigated to show determinants of later science competency. In the second part, it was also aimed to depict the effect of early childhood education on children's later science performance on 2012 PISA assessment. Therefore, the study aimed to focus on the Turkish context at a student-level. Together with the attending pre-primary education variable, independent variables from student-level data also included mother's education level, mother's occupation, and student's gender. By analyzing country- and student-level data at the same time, it was intended to provide more holistic information about the effectiveness of early childhood education.

Therefore, research questions were addressed to two main points:

1-) To what extent do pre-primary education variables (primary enrolment rate, pupil-teacher ratio in pre-primary, starting age and duration of pre-primary), indicators of governance (private and public expenditure) and socio-economic variables (adult literacy rate and income per people), which belong to 33 OECD and non-OECD countries, predict countries' performance in PISA science literacy from 2000 to 2012?

2-) To what extent do socio-economic status variables (gender, mother's education, occupation of mother, and attending pre-primary) predict 15 year-old Turkish students' performance in the 2012 PISA science literacy?

In light of this information, this chapter presents the building blocks of data and the methodology for regression analysis. To this end, necessary descriptions for longitudinal time series data analysis and student level analysis are provided, and a detailed description of the analytical approach is presented.

3.1. Description of the Databases

One of the most important data sources used in this study is the World Bank's education statistics. The World Bank statistics mainly aim to improve statistical capacity and provide open sources for everyone (The World Bank, 2011). This database covers nearly 2,500 indicators which are internationally comparable. These indicators describe educational access, teachers, completion, literacy, spending on education, and demography. The World Bank compiles this data from the United Nations Education and UNESCO Institute for Statistics from official responses to survey data by education authorities in each country (World Bank, 2013). Moreover, there is a close collaboration between countries and users to provide accurate data. To offer an example, country-level data is retrieved based on a set of criteria in response to international recommendations. Also, as the World Bank states (2011), the process of generating data is highly reliable because data is provided by few informants and two or three firms for a country. Additionally, this information is

validated more systematically. For this reason, World Bank statistics ensure that all data users can use these datasets confidently.

Another data source utilized in this study is UNESCO Institute for Statistics. UNESCO Institute for Statistics was established in 1999 to provide primary sources for cross-nationally comparable statistics. Users can access up to 1,000 types of regional, national and international comparable indicators. Thus, UNESCO mainly aims to gather quality statistical information for more than 200 countries from all over the world. Moreover, educational statistics include a wide number of indicators from pre-primary school enrollment rate to tertiary graduation rate for the years 1991 and 1997- 2007. Before starting its data collection procedure, UNESCO develops its own methodologies to measure key issues (UNESCO, 2014). To collect educational data, UNESCO directly uses surveys that are sent to national ministries. To provide accurate statistics, data is updated three times a year, so the database is regularly revised to provide new information (INEE, 2014). By means of the educational statistics provided by UNESCO, users can compare countries for various school level indicators. In addition to this, UNESCO statistics ensure information about countries' progress.

3.2. Variables

The current study is mainly composed of two sections. In the first section, the study aimed to compare countries depending on their performances in PISA. With this design, independent variables are country-level indicators. These indicators are seen as a proxy of quality in nationally-comparison research studies. The indicators are the representation of educational quality and socio-economic welfare of countries. The country-level variables are composed as followed:

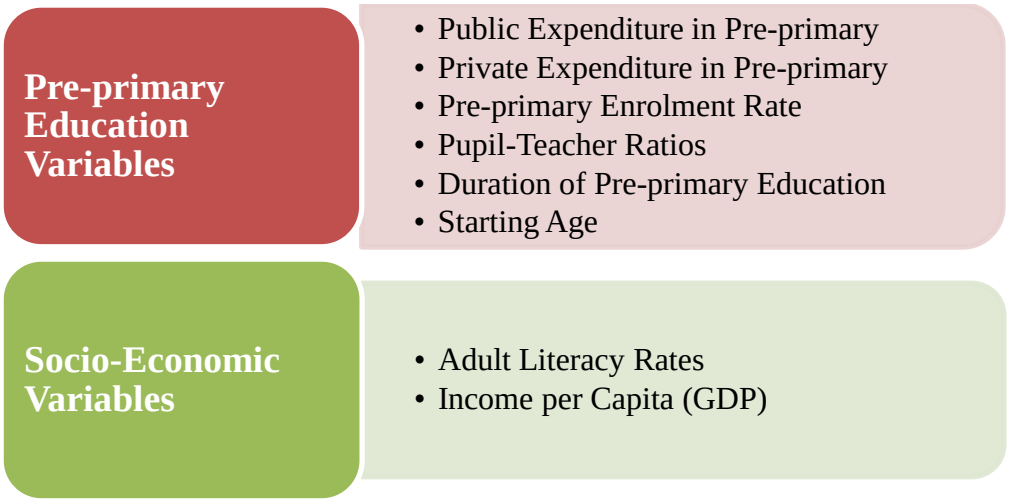


Figure 3.1. Presentation of Country-Level Variables

In the second part, the variables are composed of student-level indicators for Turkey. Based on the first section of the analysis, the four student-level variables are the representation of educational, demographic and family socio-economic background indicators from students, which were obtained from the 2012 PISA data source. To investigate 15 year-old Turkish students' performance in the 2012 PISA assessment, a regression analysis was conducted to observe changes in the relationship between student performance and pre-primary attendance. Moreover, other control variables are child's gender, mother's education and mother's occupation status. The valid information for relevant data was obtained from 3,662 students in Turkey. Student-level variables obtained from Economic, Social and Cultural Status Index from 2012 PISA assessment. All of those variables represent ranks, so all of these are continuous ordinal variables. These ranking levels as follows:

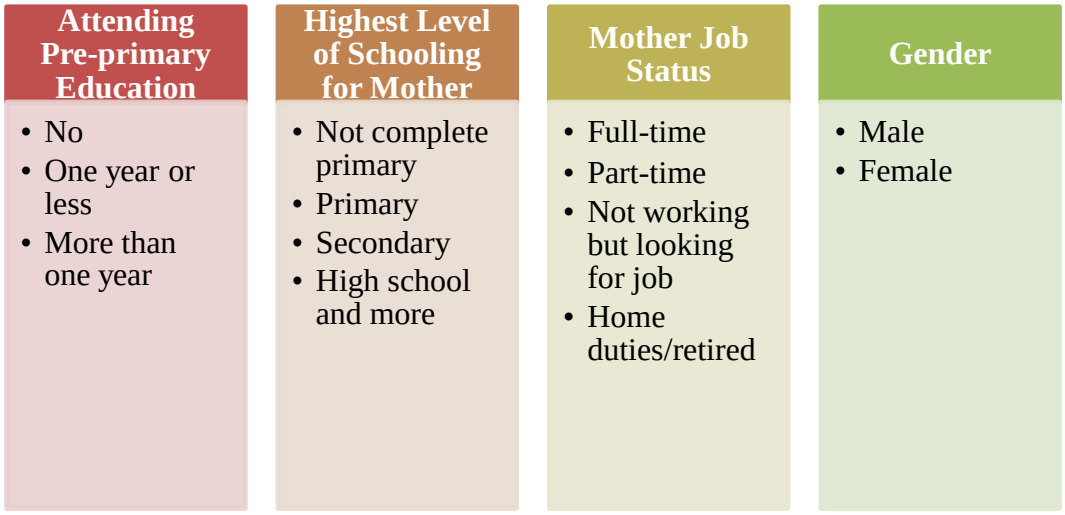


Figure 3.2. Ranks of Student-Level Variables from Turkey

Lastly, both for regression analysis for cross-national and Turkey, PISA science scores are determined as dependent variables which are all weighted for each level of analyses. The sample weight is an important issue for this variable. Therefore, participants are selected by using multisampling methods. In a country, each student who is 15 years-old has an equal chance to participate in the PISA assessment. During sample selection process for PISA assessment, non-sampling errors were highly minimized with testing and observation (Statistics Canada, 2013). For the cross-national analysis of individual countries' scores in PISA science literacy, at 2000, 2003, 2006, 2009 and 2012 are used as a dependent variable. As for the specific analysis of the Turkish context, to reveal the possible effects of variables including pre-primary education attendance, maternal factors and gender are also used as independent variables in order to predict children's later science competency and 2012 PISA science literacy scores were used as a dependent variable.

3.3. Data Collection Procedure

In this part, it was presented how the data for country and student level was decided and selected from databases.

3.3.1 Selection of Indicators: Dependent and Independent Variables for Cross-National Analysis

Based on the consideration of social capital theory and empirical findings from previous studies, several country and student levels explanatory variables were selected in order to investigate the relationship between these variables and performance in PISA science literacy scores. These indicators are: quality indicators from early childhood education, indicators of governance and socio-economic status. Moreover, student level explanatory variables were selected from economic, social and cultural status index from PISA 2012.

The dependent variable of this study is PISA science literacy scores. On the other side of the equation, independent variables are GDP per capita, adult literacy rate, gross enrollment in pre-primary education, pupil-teacher ratio, and public and private expenditure on education as of GDP. In order to have a coherent dataset, each data category is ensured to have the same definition and coverage in each country. Moreover, in order to match PISA scores with the right-hand side control variables, PISA scores in year "t" is paired with the related control variable in year "t-10". By doing this, observations for control variables are matched with the same cohort of pupils who take the PISA scores. Basic regression specification is shown below.

(1) $Y_t = \beta_0 + \beta_1 X^{s}_{(t-10)} + \beta_2 \delta^{s}_{(t-10)} + \varepsilon$

In that specification γ_t represents PISA science literacy scores in the year *t*. $X^{s}_{(t-10)}$ are the controls for pre-primary education, including private and public expenditures as a ratio to GDP, gross enrollment rate in pre-primary education, starting age in pre-primary education, duration of pre-primary education and teacher-pupil ratio in pre-primary level in year *t-10*.

Lastly, δ^s stand for social and economic controls that are per capita GDP and adult literacy rate. In that specification, β_0 is the constant and ε is the error term. The opened form of the basic regression specification is shown below.

$$\textbf{(2)}\ PISA_{t} = \beta_0 + \beta_1 Exp_{pub\ (t-10)} + \beta_2 Exp_{pri\ (t-10)} + \beta_3 Enroll_{pre\text{-}p\ (t-10)} + \beta_4 PTR_{pre\text{-}p\ (t-10)} + \beta_5 Dur_{(t-10)} + \beta_6 Startage_{(t-10)} + \beta_7 Income_{(t-10)} + \beta_8 Adullit\ (t-10) + \varepsilon$$

The dependent variable is determined as a mean score of science in PISA due to two main reasons. First, the weight of the three domains changes in every exam year, for this reason calculating means of three domains at the same level is not convenient to see a trend over time (OECD, 2009). Selecting one domain is more calculable to estimate later school achievement for the current study. Moreover, in today's world, countries need to scientifically literate population. Therefore, it is vitally important to examine to what extant students have a competency in science literacy in an international area. Addition to all of these, science literacy scores is highly important for Turkey because, it has continued to see an increase in science domain as from the year 2003 to 2012. In the contemporary world, the importance of science education is becoming more of an issue (Olgan, 2008; Lind, 1999), so it was considered that focusing on science performance in PISA would be more profitable.

3.3.2 Countries included in Coverage

To analyze the effect of educational and socio-economic variables on children's later academic performance in cross-national comparison analysis, the current study compared countries' conditions. To determine the countries to be included in the sample, first 33 OECD and non-OECD countries which participated in PISA assessments were selected for panel data analysis. The profile of selected countries shows that they have distinct educational systems at the pre-primary education level. By this means, it was aimed to increase the heterogeneity of the analysis and vary the conditions. Therefore, countries selected from each performing groups; below, on and above the OECD average. By doing this, the aim was to reveal the significance levels of each indicator by using regression analysis. Moreover, countries were

selected from different parts of the world in order to represent distinct early childhood education systems and country profiles, such as Peru, Kazakhstan, Thailand, New Zealand, Japan, Russia and Brazil.

Table 3.1

Country List Used in Cross-National Comparison

Country Name	**Abbre-viation**	**Country Name**	**Abbre-viation**	**Country Name**	**Abbre-viation**
Australia	AUS	France	FR	Peru	PER
Austria	AT	Germany	DE	Poland	POL
Argentina	ARG	Hungary	HUN	Portugal	PRT
Azerbaijan	AZE	Iceland	IS	Romania	ROU
Brazil	BR	Israel	ISR	Russia	RUS
Bulgaria	BG	Italy	ITA	Spain	ES
Canada	CA	Japan	JP	Sweden	SE
Czech Republic	CZ	Kazakhstan	KAZ	Thailand	TAI
Denmark	DK	Korea	KOR	Finland	FI
Estonia	EST	Mexico	MX	Turkey	TR
United State	US	New Zealand	NZ	United Kingdom	UK

3.3.3. Selection of Student-Level Indicators

The second section of the study compared the influence of the attendance to pre-primary education in Turkey on students' later science competency. Also, the role of students' family background factors was considered to be an inseparable part of academic performance. The construction of indicators for the analysis was obtained from the Index of Economic, Social and Cultural Status in PISA 2012. Therefore, indicators from student-level provide information about children's pre-primary attendance and gender, and their mother's education level and current occupation.

Each of the variables represents ranks, so these are ordinal variables. Moreover, these index variables are obviously nominal variables. For instance, subcategories represent ranks for level of mother education variable. Not completed primary education is 1; primary is 2; elementary is 3...etc. these sublevels of variables provide information about students' performance in the PISA assessment depending on changes in each level. After removing missing variables from aggregated data, the final dataset for this phrase included 3,662 valid values for each variable.

3.4. Data Analysis Procedure

3.4.1. Country-Level Panel Data Analysis

The current study utilized OLS Regression analysis to explain the relationship between continuous predictor and outcome variables. Lately, OLS regression analysis is more appropriate to estimate β value even when a heteroscedasticity problem exists (Wooldridge, 2002). For this reason, the current study sought to identify indicators' effects on later school outcomes through OLS regression analysis.

For the study, public and private expenditure, pupil-teacher ratio, gross enrolment rate, duration of pre-primary education, per capita as a GDP, and adult literacy rate were centralized as predictor variables. The PISA science literacy score of countries was selected as an outcome variable. Weighted data from PISA 2000, 2003, 2006, 2009 and 2012 was used as a dependent variable for the regression analysis. When entering PISA scores to the dataset, one score of countries is represented at three years intervals. For instance, the result of the 2003 PISA score variable represents three years: 2003, 2004, 2005.

The sample employed in the current study included 33 OECD and non-OECD countries that participated in PISA assessments in 2000, 2003, 2006, 2009 and 2012. As mentioned previously, countries are grouped by their performance in the PISA 2012 assessment. Country contexts are highly different from each other, so some of the indicators could be more significance depending on their conditions. Therefore,

the significance of the indicators changes according to countries' performance in the PISA assessment.

In this regard, the study addressed the issue of measuring which country-level indicators are statistically significant predictors of later student performance in the context of the PISA assessment. To analyze the data, panel data analysis was conducted because this method has more variability, less collinearity and more degrees of freedom. Addition to this, it provides an idea about the time-ordering of events. The other important benefit of panel data analysis is that it provides a control for individual heterogeneity as this could be a problem for non-experimental research, like the current study (Brüderl, 2005). The panel date analysis was conducted with OLS regression.

3.4.2. Student-Level Data Analysis for Turkey

By conducting only cross-national research, it is almost impossible to evaluate the pre-primary education system in a specific country. Therefore it is very important to take into account the demographic and socio-economic conditions of students when evaluating education systems (Bornfreund & William, 2014). Therefore, in the second part, the study aimed to reveal the effect of the students' education, demographic and socio-economic backgrounds on their performance in the 2012 PISA assessment from a Turkish context. The education background variable estimates how student performance changes depending on the years received of pre-primary education. The attending pre-primary variable are composed of three levels: no attendance in pre-primary education, one year or less attending pre-primary education, and more than one year attending pre-primary education. Moreover, related literature indicates that students' gender is an important estimator in their academic achievement performance (Bradley & Corwyn, 2002; Hyde & Linn, 2006). Also, the socio-economic background of parents, especially mothers, in Turkey is generally expected to affect the academic performance of students (Cooksey, Joshi & Verropoulou, 2009; Ural & Çınar, 2013). For this reason, mother's education level and mother's occupation status were selected as socio-economic backgrounds of students from the PISA dataset. Moreover, the explanation of variables' sublevels is

also important in understanding their effects on students' performance in the PISA test.

One of the variables in the dataset is "Attendance of pre–primary education," which provides information about students' pre-primary education background. This variable is categorized according to years of receiving pre-primary education. The "not attended pre-primary" category represents students who did not receive pre-primary education. Similarly, the "one or less years" and "more than one year" categories reflect students' background information related to the number of years of pre-primary education that they received.

In order to answer the question of "what is the highest level of schooling," information was gathered about the level of mother's education. This variable includes five subcategories: not complete primary, primary, elementary, vocational/technical schools, and high schools. In the dataset, there is no value for mothers who completed vocational/technical schools. For this reason, a vocational/technical school category was excluded from the dataset during analysis. On the other hand, "not complete primary education" represents mothers' education level, even though they did not complete primary education. Other categories, namely primary, elementary, and high school, represent mothers' completed education levels as well.

The question asked of student in the PISA assessment is "What is your mother currently doing" for the variable of mother's occupation status. All of these variables represent time spending out of home for mothers. This variable includes four sublevels: working full-time, part-time, not working but looking for a job, and home duties or retired categories. In the dataset, because of provided any value for working part-time mothers, this was excluded before analysis. The "working full-time" category provides information about mothers who work in a full time job for pay. The "not working but looking for a job" category represents a mother's current occupation status. However, these mothers may have worked or not worked in the past as well.

As for "home duties or retired" category, it represents housewife and retired mothers. The last variable is gender of the students who participated in the PISA 2012 assessment.

The sample size of the analysis is 3,662 students who participated in the 2012 PISA assessment. These students have accurate information for selected variables. In the analysis of the effect of attending pre-primary education on later achievement in Turkey, other controlling variables, like socio-economic background and gender, were employed in the current study. As explained above, the student-level variables are nominal variables. Regression analysis is only used with numerical variables since numerical variables are directly comparable. Therefore, it is possible conducting regression analysis with nominal variables. The result of regression only has valid meaning under this circumstance (Skrivanek, 2009).

(3) $PISA_{(i)} = \beta_0 + \beta_1 Attend_{(i)} + \beta_2 Mothereduc_{(i)} + \beta_3 MotherJob_{1(i)} + + \beta_4 Gender_{(i)}$

The regression equation indicates that attendance to pre-primary, level of mother education, job status and gender variables located in right side of the equation. Also, left side of the equation indicates children's science literacy scores in 2012 PISA assessment. Before conducting regression analysis, negatively worded items were reversed to reveal accurate direction of association between independent and dependent variables.

3.5. Limitation of the Study

For the first section of the study, the aim was to analyze distinct countries' pre-primary educational profile to assess their performance in an international arena based on students' later science outcomes. However, some of the indicators have limited observation, such as private expenditure and pupil-teacher ratio in pre-primary education. Although there was limited data concerning these variables, it was compensated by increasing the amount of data which included more countries in the analysis. For that purpose, the current study examines 33 countries by using their education and socio-economic indicators. On the other hand, the other limitation of the study is that the first part of the study could not be conducted on the basis of one

country. Due to the limited amount of pre-primary education data, the investigation of the effectiveness of Turkey's pre-primary education system on later science performance was impossible.

For the second part of the study, the aim was to investigate the impact of student's pre-primary attendance on their later science competency. In doing so, the children's gender, level of mother's education and mother's occupation variables were included in regression analysis as other predictors. However, there are also other parental factors that may affect children's later science literacy performance, such as family income. Since family income data was not collected in the 2012 PISA survey in Turkey, this variable was not included in the regression analysis. Addition to these, the current study could be done with the Hierarchical Linear Modeling instead of the multiple regression analysis. Thus, it could be possible to examine hierarchical nature of the selected independent variables.

CHAPTER IV

RESULTS

As the related literature has suggested, children's early science experiences are important in enhancing their subsequent science achievement (Pizato, Murturato & Fontaine, 2012; Saçkes et al., 2013). Moreover, teaching science during early childhood years helps to develop understanding of important science concepts (Pascall, 2010). In light of this information, the current study aimed to examine the effectiveness of different indicators from pre-primary education, governance and socioeconomic status on later performance in the PISA science literacy. To do this, various indicators from pre-primary education and socio-economic status from country-level and student-level were employed in the study. Therefore, this chapter is presented in two main sections: Cross-National Comparison of Early Childhood Education and Turkish Students' Science Performance in the 2012 PISA assessment.

In the first part of the study, a descriptive analysis was presented of country level indicators, statistical assumptions and necessary test of multiple regression analysis for time series data. The country-level variables were composed of educational and socio-economic indicators: public and private expenditure, gross enrolment rate, pupil-teacher ratio in pre-primary, duration of pre-primary education, starting age to pre-primary education, adult literacy rate and income per capita. Moreover, the empirical results of the first part of the study are presented at a country level comparison.

In the second part, the study focused on the Turkish context and students' performance in PISA. The aim was to investigate how attendance in early childhood education affects children's later competency in 2012 PISA science literacy, together with maternal factors (level of mother's education and mother's occupation) and gender. Before presenting the results of the study, descriptive analysis and

assumptions of student level indicators were explored. In light of this information, the data was used to address two following research questions:

1-) To what extent do pre-primary education variables (primary enrolment rate, pupil-teacher ratio in pre-primary, starting age and duration of pre-primary), indicators of governance (private and public expenditure) and socio-economic variables (adult literacy rate and income per people), which belong to 33 OECD and non-OECD countries, predict countries' performance in PISA science literacy from 2000 to 2012?

2-) To what extent do socio-economic status variables (gender, mother's education, occupation of mother and attending pre-primary) predict 15 year-old Turkish students' performance in the 2012 PISA science literacy?

4.1. Statistical Assumptions and Necessary Tests for Regression Analysis

The current study utilized a multiple regression analysis to predict the impact of certain variables, which reflect country and student level indicators, on later science achievement. To analyze the effects of pre-primary education on science literacy competency in PISA, the model included various independent variables from the educational and socio-economic background. Due to the wide range of indicators used as independent variables, multiple regression analysis is one of the best ways of measuring the association between dependent and more than one independent variable. Moreover, the other advantage is that multiple regressions assess the effect of each variable on outcome variables (Field, 2009). Thus, presenting the assumptions of multiple regression analysis is a necessary part of this study.

4.1.1. Multiple Regression Analysis Assumptions for Cross-National Comparison

In this part, the some important assumptions and necessary tests of OLS regression analysis were presented.

Assumption 1: Random Sampling

Random sampling refers to the random representation of the population. Additionally, to conduct regression analysis, the sample correlation should be zero between each independent variable (Field, 2009; Pallant, 2007; Wooldridge, 2002). In the current study, all of the independent and dependent variables obtained from the World Bank, OECD and UNESCO databases represent countries' general conditions for each of the country.

Assumption 2: Zero Conditional Mean

This assumption checks the value of *u* in the equation which is supposed to find zero. If one of the independent variables correlated with *u* for any reason, it can be said to be an endogenous variable, of which an explanatory variable may be correlated with the error terms, for this independent variable (Wooldridge, 2002).

This assumption means that: E(*u*_*x*1,*x*2,…, *xk*) _ 0

In the current analysis, no endogenous variable was observed, and the value of *u* is zero. For this reason, this assumption is not violated.

Assumption 3: No Perfect Collinearity

This assumption concerns only independent variables. It means that there is no exact linear relationship among any of the independent variables (Tabachnick & Fidell, 2007). In the opposite case, the regression model can suffer from collinearity and Ordinary Least Square regression cannot estimate the relationship between independent and dependent variables. The solution to this problem is quite simple. The problem can be overcome by dropping any one of the variables (Wooldridge, 2002). For the current analysis, any collinearity among variables was not found in the STATA analysis. Because of clearly demonstrating the numerical values of relationships between independent variables, this assumption was also checked in SPSS. Table 4.1 below shows collinearity values between each of the variables. As seen in the Table, the values did not indicate any collinearity problem. Moreover, Tolerance and the VIF values also provide information about the collinearity problem for each of the independent variables. To overcome the collinearity

problem, the VIF values should be less than 10 and the tolerance values should be higher than 0.2 (Pallant, 2007). As seen in Table 4.2, the VIF values are less than 10 for each of the variables. Thus, the collinearity assumption is not violated.

Table 4.1

Correlation Coefficient for All Variables in Cross-Nation Comparison

	AdltLit	Incom	Enroll	Publi	Priva	Pup/tea	StartAge	Dura.
Pearson Correlation								
AdultLit	1	.37*	.37*	.25*	.01	-.36*	-.20*	.11*
Income	.37*	1	.43*	-.01	.25	-.02	-.07*	-.21*
Enroll	.37*	.43*	1	.40*	.01	-.00	-.00	-.17*
Public	.25*	-.01	.40*	1	.04	-.35*	.38*	.57*
Private	.01	.25	.01	.04	1	.47*	-.15*	.06*
Pupil/Teach	-.36*	-.02	-.00	-.35*	.47*	1	.29*	-.50*
StartAge	-.20*	-.07*	-.00	.38*	-.15*	.29*	1	-.66*
Duration	.11*	-.21*	-.17*	.57*	.06*	-.50*	-.66*	1

*$p < .01$

Table 4.2

Collinearity Statistics for of the Each Variable

	Tolerance	VIF
AdultLit	.55*	1.83*
Income	.68*	1.47*
Enroll	.54*	1.85*
Public	.57*	1.07*
Private	.95*	1.05*
Pupil/Teach	.66*	1.52*
StartAge	.56*	1.78*
Duration	.39*	2.59*

**p >.2 for Tolerance,*
**P <10 for VIF*

Assumption 4: Linearity in Parameters

The model of the regression was written based on the equation below.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_k X_k + u$$

β_0, β_1 and, β_k are the constants of the regression equations. This equation is composed based on the population model. Thus, the key feature of this model is that all of the parameters are linear (Wooldridge, 2002).

Assumption 5: Homoscedasticity

The variance of the regression is the same for all of the combination of explanatory variables. When this assumption is fail, the regression model exhibits heteroscedasticity. It means that the variance of *u* should not depend on independent variables. If there is seen the change in variance of any of the independent variables, then heteroscedasticity occurs (Tabachnick & Fidell, 2007). Stating of the assumption is clearly seen in the equation below.

$$E(y/x) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_k X_k + u$$

Presence of Heteroscedasticity

As mentioned above, homoscedasticity refers to the variance in error terms, conditional on the explanatory variables, that is the same for all the combinations of the explanatory variables in a regression (Wooldridge, 2002). Breusch-Pagan and modified Wald tests are applied to test for the presence of heteroscedasticity. Test results yield failure of rejection of the null hypothesis, which refers errors are homoscedastic, at 5% significance level. To control this problem, robust standard errors are used in reporting estimation results.

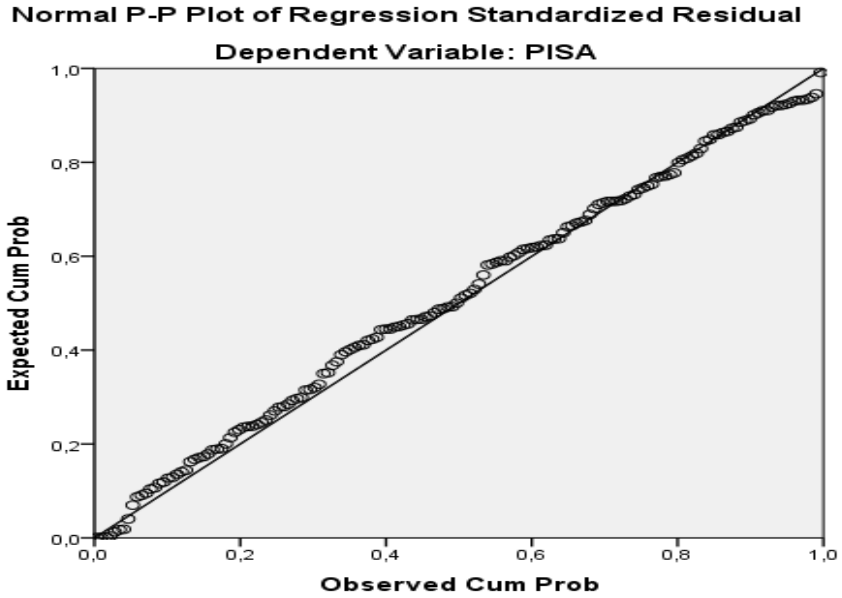


Figure 4.1 The Normal P-P Plot of Regression Analysis

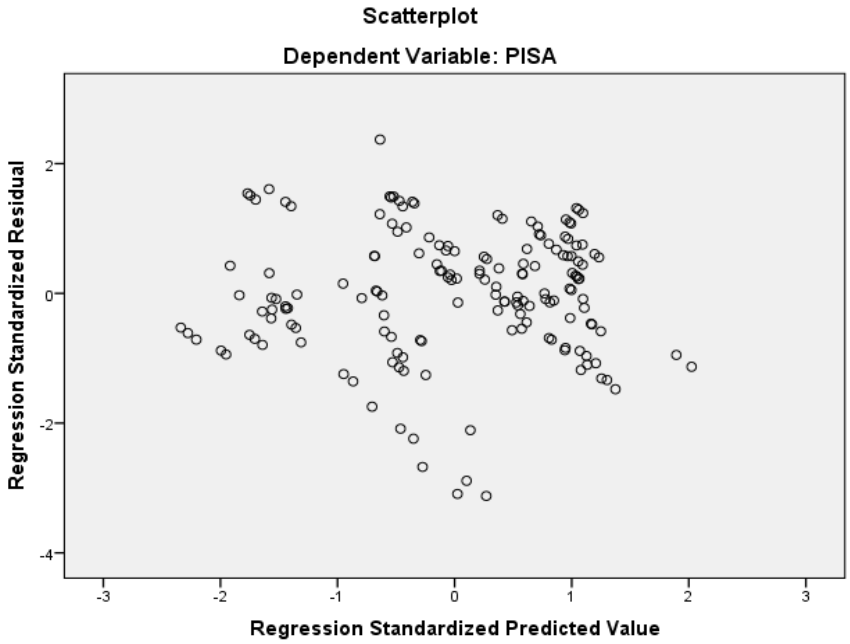


Figure 4.2 The Scatter Plots of Regression Analysis

The Normal Plot Figure 4.1 shows how closely dependent and independent variables agree with each other. The graph also shows the data to be perfectly normally distributed. Thus, the normality assumption is met. Moreover, Figure 4.2 depicts that the residuals are roughly rectangularly distributed in the scatter plot. The values are between the range +3, -3 and are concentrated on center.

4.2. Cross-National Comparison of Indicators

Research Question 1: To what extent do pre-primary education variables (primary enrolment rate, pupil-teacher ratio in pre-primary, starting age and duration of pre-primary), indicators of governance (private and public expenditure) and socio-economic variables (adult literacy rate and income per people), which belong to 33 OECD and non-OECD countries, predict countries' performance in PISA science literacy from 2000 to 2012?

Before presenting the results of the cross-national analysis, it is important to provide descriptive information of the country profiles in selected variables. Table 4.3 below displays countries' profiles and gives a brief summary of countries' educational and socio-economic conditions in the year corresponding to the 2012 PISA assessment

year. Values in the Table reflect percentages for expenditure, enrolment rates and adult literacy, and mean for pupil-teachers ratio, income, duration and starting age variables. Thus, the Table could be helpful in drawing a picture of performance in PISA and the underlying reasons behind this performance.

Table 4.3

Countries Profile in Selected Indicators in 2002 (Correspondence to 2012 PISA score)

Countries	Pub Exp %	Pri Exp %	Pre-Pri Enrol%	Pupil/ Teac	Start. Age to pre-pri	Duration	Income	Adult Lit.%
Turkey	0.02	0.03	7.3	16	3	3	3480	86
Peru	0.25	0.10	60	27	3	3	2124	88
Iceland	-	-	91	4	3	3	30979	98
Portugal	0.32	-	74	17	3	3	12759	98
Italy	0.38	0.05	100	13	3	3	21435	98
Spain	0.42	0.10	107	15	3	4	16612	98
Russia	0.56	0.01	83	7	3	4	2375	99
Sweden	0.50	-	75.5	10	3	4	28119	99
Hungary	0.71	0.06	80	11	3	4	6535	99
Israel	0.67	0.20	95	-	3	3	17195	99
Bulgaria	0.61	0.10	72	11	3	4	2031	97
Kazakhstan	0.11	0.05	27	12	3	4	1658	99

Table 4.3 (cont'd)

Thailand	0.51	0.01	93	-	3	3	1989	93
Mexico	0.52	0.08	76	22	4	2	6082	90
Brazil	0.30	-	66	23	4	3	12811	87
Argentina	0.30	0.10	62	24	3	3	2712	97
Austria	0.42	0.13	84.5	16	3	3	25679	99
Australia	0.05	0.04	101	-	4	1	31325	99
Denmark	0.65	0.15	89	6	3	4	32344	99
France	0.62	0.03	114	18	3	3	23494	99
Korea	0.05	0.10	82	22	5	1	12094	99
Japan	0.09	0.09	86	30	3	3	31236	99
Estonia	0.26	0.01	104	8	3	4	5386	100
Finland	0.30	0.03	55.8	12	3	4	25994	100
Poland	0.41	0.09	49.3	13	3	4	5184	99
Germany	0.40	0.15	102	12	3	3	24326	99
Canada	0.22	0.02	66.8	17	4	2	23425	99

Table 4.3 (cont'd)

Check republic	0.40	0.03	96	13	3	3	7685	99
United Kingdom	0.44	0.02	83	29	3	2	26997	99
United State	0.38	0.11	65	19	3	3	36819	97
New Zealand	0.16	0.10	88	11	3	2	16583	100
Romania	0.30	0.00	73	18	3	4	34062	97

As seen in Table 4.3, there are certain values of quality indicators used in the study from distinct countries. In the Table, values reflect each country's socio-economic and educational conditions in 2002, which is the last year in the dataset and corresponds to the 2012 PISA assessment year. The investigation of the Table can help to illustrate which country has maximum or minimum values within these indicators.

When the Table is investigated in detail, one of the important pre-primary indicators in the table is pupil-teacher ratios. According to the Table 4.3, this rate varies highly from country to country. For instance, Spain, Peru and the United Kingdom are examples of the countries that attract attention in the pupil-teacher ratio variable. According to Table, the rate in these countries is highly above the average rate of sampled countries. On the other hand, pupil-teacher ratio is quite high in Brazil, Argentina, and Japan.

As for the pre-primary expenditure variable, some of the European Countries, such as Denmark, France, Germany and Hungary, are spend much more on pre-primary education in terms of both public and private expenditure. These countries' pre-primary spending range is between 0.60-0.70 % in public expenditure and 0.15-0.20% in private expenditure. Aside from the big spending European countries, Australia, Korea and Japan spend significantly less on pre-primary education.

When the pre-primary education indicators are investigated in the Table, Turkey exhibits worst conditions for almost all of the variables. The values of pre-primary enrolment rate and public and private expenditure on pre-primary education are evidence of that. In most of the countries, the gross enrolment rate in pre-primary education averagely reaches nearly 60-70 %. However, according to the Table, the enrolment rate in Turkey is averagely 7%, which lags behind all of the sampled countries' rates. In the Table, it is clearly seen that the gross enrolment rate in pre-primary education exceeds 100%, even in 2002, in France, Estonia, Germany and Spain. Moreover, the table shows that Turkey is the country that spends the least on pre-primary education. In 2002, pre-primary expenditure from the public source in Turkey was 0.03% of total government expenditure. When compared with other countries, Turkey's level of expenditure is notably less.

Lastly, there are some indicators that suggest countries' socio-economic power in the international arena. In the current study, these indicators are adult literacy and income per capita. For the adult literacy variable, the Table shows that most of the European countries reached 99% adult literacy rate in 2002. However, Turkey and Brazil have minimum values among the countries analyzed in the study, which is averagely 87%. Although, the adult literacy rates of Turkey and Brazil are not very low, the rates are still below the other countries' average. The other socio-economic indicator is income per person in each country. When considering countries' economic power, Kazakhstan and Thailand have quite low income per person. Thus, this value makes Thailand and Kazakhstan place low down when it comes to national income. On the other hand, there are some European countries which place between higher-income countries, such as Denmark, Japan and United States. The average income per capita (as of GDP) is 33.000 dollars per person. When comparing their income per person with that of Kazakhstan and Thailand, it is nearly more than 15 times higher.

4.3. Panel Data Analysis in Cross-National Comparison (1991-2012)

To investigate the first research question, the panel data analysis was conducted with 33 countries and 8 variables. In the panel dataset, variables observed across time were organized as a time series. PISA science scores should match with pre-primary and socio-economic indicators in corresponding years. For this reason, retrospective data was used, which is nearly 10 years before PISA assessments because the selected preschool generation only take part in the PISA assessment when they get to 15 year-olds.

4.3.1 Regression Results for Cross-Country Analysis

The first part of the analysis was cross country comparison of 33 OECD and Non-OECD countries. As seen in the tables 4.4 and 4.5, the test was significant for this model, F (8, 166) = 39.48, $p < 0.00$, $R^2 = 0.68$, p-value for regression as a whole is 0.00. This indicates the overall significance of the test, and the model specified correctly. The total variance explained by the model was 68%, which is highly

respectable. Also, no perfect collinearity assumption was checked. Thus, it can be said that any predictive variables were too closely related to one another.

Table 4.4

ANOVA Table for Whole Model

Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**
Regression	275733.15	8	34466.64	39.485	.000
Residual	137918.49	156	872.90		
Total	413651.64	166			

Table 4.5

Model Summary

Model	**R**	**R Square**	**Adjusted R Square**	**Durbin Watson**
1	.816	.667	.650	.430

To determine which indicators had a statistically significant relationship with PISA scores, standardized OLS regression analysis was set. According to the table 4.6, the result of the regression analysis for 33 countries which have participated PISA assessment was presented below. The OLS regression analysis indicates that there is a statistically significant association between PISA science scores and public expenditure, adult literacy rates, income per capita, pupil-teacher ratio and starting age to pre-primary education in countries' competency in PISA science literacy.

Table 4.6

The Results of Regression Analysis for Cross-Country Comparison

PISA	**B**	***β***	**t**	***p*> t**
Public	34.59	-0.24	-3.95	0.002*
Private	-2.11	-0.04	-0.83	0.41
AdultLit	4.48	0.41	6.66	0.00*
Enroll	0.46	0.02	0.35	0.271
Income	0.002	0.00	7.42	0.00*
Pupil/teacher	-1.64	0.40	-4.04	0.00*
StartingAge	-5.61	6.20	0.91	0.00*
Duration	-4.55	5.13	-0.89	0.52

Note: ****p*< 0.01 *****p* < 0.05**

The results of analysis showed that most of the variables have statistically significant impacts under these countries' conditions. Public expenditure, adult literacy rates, income per capita, pupil-teacher ratios and starting pre-primary age are highly statistically significant variables in the regression model in explaining countries' success in PISA science scores.

As for public expenditure in pre-primary control, holding other variables constant one percentage point increases in the public expenditure rate will lead to an increase of 65.78 points in the PISA score in science. In this case, this is the largest beta coefficient for later academic competency at a country-level. This means that this variable makes the strongest unique contribution to explaining the dependent variable, when the variance explained by all other variables in the model is controlled for. As an indicator, adult literacy rate also has a substantial impact on PISA scores. When holding other variables constant, a one percentage point increase in adult literacy will lead to an increase of 4.48 points in PISA scores. This is also an important increase in real terms in addition to its statistical significance. If we

consider a 10 percentage point increase in adult literacy rate, it will lead to a 44.8 point increase in countries' PISA scores.

As for income per capita GDP, a one USD dollar increase in economic wealth will lead to an increase of .001 in PISA test scores. Although the effect seems small if we consider a USD 10,000 dollar difference in two countries, holding other variables constant 10 points of the difference is explained by per capita GDP. Moreover, another important variable in pre-primary education as a proxy of quality is pupil-teacher ratios. The pupil-teacher ratio has a negative coefficient sign. This means, when the number of children per teacher decreases, the science score in PISA increases. When holding other variables constant, a one percentage point decrease in the pupil-teacher ratio will lead to a 1.64 point increase in PISA science score. Lastly, the results showed that starting pre-primary age has a statistically significance impact on PISA scores. The sign of the correlation coefficient is negative again. It refers to the fact that as the age of starting pre-primary decreases, the performance of countries in PISA increases. When holding other variables constant, a one percentage decrease in starting pre-primary will lead to an increase of 5.62 points in PISA science score.

Therefore, it can be concluded that pupil-teacher ratio is a significant determinant for success in PISA science literacy in conventional significance levels.

On the other hand, private expenditure in pre-primary education is not statistically significant with regards to the multiple regression results and also private expenditure in pre-primary ends up with an unexpected negative sign in a way to make us conclude private expenditure is not a determinant of PISA success. Similarly, enrolment rate and duration of pre-primary education are not statistically significant variables according to regression results.

As can be seen from Table 4.6, the impact of the aforementioned variables on PISA science scores are statistically significant for 33 OECD and Non-OECD countries at a country level. In this regard, ordinary least squared regression was used to assess the effect of country-level variables (public and private expenditure, adult literacy rate, income per capita, enrolment rate, pupil-teacher ratio, starting pre-primary age

and duration in pre-primary), which are seen as components of high quality pre-primary education and socio-economic conditions of distinct countries, to predict later academic competency in the PISA science literacy. Preliminary analyses were conducted to ensure no violation of assumptions of normality, linearity, homoscedasticity, heteroscedasticity and multicollinearity. The full model containing all predictors was statistically significant. The total variance explained by the model as a whole was 68%, F (8, 166) = 39.48, $p < .001$. As shown in Table 4.6 most of the independent variables made unique statistically significant contributions to the model (public expenditure, adult literacy, income per capita/GDP, pupil-teacher ratio in pre-primary and start age to pre-primary). The strongest predictor of reporting the PISA science scores was public expenditure in pre-primary education (β= -0.24, $p < .001$). On the other hand, other strong predictors including pupil-teacher ratio (β= -0.23, p<.001). Also, adult literacy (β= 0.41, p<.001), starting age to pre-primary education (β= 0.60, p <.001) and income per capita (β= .00, p<.001) are statistically significant variables in predicting success in the PISA science literacy. Although income per capita shows weak correlations, it is a statistically significant predictor in the PISA science literacy. The regression equation for predicting PISA science literacy is: PISA science literacy = $-0.24.X_{public} + 0.41.\ X_{adultlit} + 0.001.X_{income} -0.23.X_{pupiltea} + 0.60.X_{startage}$

4.4. Turkey at a Glance: Student-Level Analysis

Research Question 2. To what extent do socio-economic status variables (gender, mother education, occupation of mother and attending pre-primary) predict 15 year-old Turkish students' performance in the 2012 PISA science literacy?

As reported in the first part of the analysis, it is important to determine the effect of indicators which have statistically significant impacts on countries' success in the PISA assessment. Nevertheless, it is quite hard to evaluate the early education program in a country without taking into account the demographic and socio-economic conditions of students (Bornfreund & William, 2014). For this reason the second research question seeks to evaluate the conditions and scores of Turkish students who participated in the latest PISA test. For this analysis, there are four

independent variables from students' background knowledge. There variables are: pre-primary attendance, level of mother's education, mother's occupation status and student's gender. The 2012 PISA science scores of students are determined as a dependent variable. There are 3,662 students, who all have accurate information for the selected variables. For this reason a descriptive Table for student-level variables was formed as follows:

Table 4.7

Descriptive of Students Characteristics- 2012 PISA Assessment

	N	**Mean**	**Min. Score**	**Max. Score**
notattend	2658	459	426	498
oneorless	792	498	468	537
morethanone	212	532	509	553
notcomplete	498	437	429	468
primary	1924	466	426	487
elementary	589	465	455	490
vocational	0	0	0	0
highschool	651	461	426	490
fulltime	193	479	452	528
parttime	0	0	0	0
notworking	213	491	426	553
homeduties	3256	469	429	537
female	1810	475	426	541
male	1852	468	429	553

As seen in Table 4.7, the highest mean score in PISA belongs to more than one year attendance in pre-primary education, which is 532, within the pre-primary attendance variable. This means that such students performed better than other students who attended less than one year or not attended pre-primary education.

As for mother's education level, this variable has five subcategories: not complete primary, complete primary, complete elementary, complete vocational school and

complete general high school. However, within the subcategories, there is any value for completing vocational school from Turkey. For this reason, completing vocational and technical schools (ISCED level 3B, 3C) was excluded from the dataset, and four subcategories were used in the analyses. Table 4.7 showed that the lowest mean score is 437 within the mother's education level variable, which belongs to students whose mother did not complete primary education. Also, it is clearly seen that 437 is lowest score within each of the variables in the Table. Moreover, mean scores of the mother's education variable revealed that the mean score in PISA increases as the level of mother's education increases.

As a variable, mother's occupation status is also used in the model. This variable is composed of four subcategories: fulltime, part time, not working, and home duties-retired. As seen in the Table 4.7, part time job status has any value from Turkey, so this category was excluded from the dataset. When analyzed in the Table 4.7, mean scores of each category have close values. Students whose mothers' work in a full time job have a mean score of 465, which is the lowest score within the mother's occupation status variable. Students whose mothers are not working now have a mean score of 491. Moreover, students whose mother is retired or stays at home have a mean score of 469 in the 2012 PISA science literacy.

Lastly, gender is another variable in the model. This variable was already dichotomous variable. Female students were coded as a "0" and male students were coded as a "1". As shown in Table 4.7, the mean score of female students, 475, was higher than mean score of male students, 468.

4.4.1. Results of Student-Level Analysis from Turkey

In this part, multiple regression analysis was conducted for student-level analysis that involved the interaction between categorical variables and continuous scores from the PISA test 2012. Independent variables were comprised of students' socio-economic backgrounds and demographic information. The current regression analysis measured PISA science literacy scores at an ordinal level.

In analyzing continuous ordinal variable in regression analysis, it should represent ordering in a real terms. For instance, with the increase of the education level, the values of the coding increase.

Assumption 1: Sample Size

As sample size is important in regression analyses, it was also considered in the current multiple regression analysis. As reported in the descriptive table, the sample size of each of the categories is quite large. Whole data in the current analysis was obtained from 3,662 students. Mainly, there were four variables from students. According to Tabachnick and Fidell (2007) sample size should be N > 50 +8M. (50+8.4 = 86), so sample size is 3662 > 86. Moreover, according to Stevens, sample size should be 15 subjects. (15.4= 60), 3662 > 60, so sample size assumption is not violated.

Assumption 2: Multicollinearity

When there is a perfect linear relationship among the predictors, the estimates for a regression model cannot be uniquely computed. The term collinearity implies that two variables are nearly perfect linear combinations of one another. When more than two variables are involved it is called multicollinearity, although the two terms are often used interchangeably.

The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can become wildly inflated. In this section, we will explore some STATA commands that help to detect multicollinearity. We can use the *Variance Inflation Factor* "VIF" command after the regression to check for multicollinearity.

Table 4.8

Variation Inflation Factor Values to Check Multicollinearity

Variable	**VIF**	**1/ VIF**
Attend Pre-Pri.	0.64	1.56
Level of Mother Edu.	0.65	1.54
Mother occupation in time	0.88	1.34
gender	1.00	1.00

As Pallant (2007) states, the VIF values should be less than 10 and the tolerance values should be higher than 0.2 to overcome the collinearity problem. As is seen in Table 4.8, the VIF values are less than 10 for each of the variables and also 1/VIF is higher than 0.2. Thus, the collinearity assumption is not violated.

Table 4.9

ANOVA Table of Student Level Analysis

Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Regression	2326247.41	4	581561.852	4246.73	.000
Residuals	500938.70	3658	136.943		
Total	2827186.1	3662			

Table 4.10

Model Summary of Student Level Analysis

Model	**R**	**R Squared**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.90	.82	.82	11.70

The full model containing all predictors was statistically significant, F (4, 3658) = 4246.73, p < .001, indicating that the model was able to distinguish an association between predictors that are pre-primary attendance, level of mother's education, mother's occupation status, gender and dependent that is PISA science scores. The total variance explained by the model as a whole was 82%.

Table 4.11

Result of the Effect of Student Backgrounds on PISA Scores

PISA	**B**	***β***	***t***	***P***
Attend Pre-pri.	23.53	0.49	56.49	0.00*
Level of Mother Edu.	11.54	0.52	60.58	0.00*
Mother Occupation	0.35	0.01	1.43	0.15
Gender	-7.64	-0.14	-19.75	0.00*

Note: ****p* **< 0.001

When looking at the results in Table 4.11, multiple regression analysis with nominal variables was conducted to explore the relationship among each independent variable (attendance to pre-primary, level of mother's education, mother's occupation status, gender) and the dependent variable (2012 PISA science literacy score). Multivariate analysis consisted of multiple linear regression analysis of the independent variables on dependent variable to address the extent of how much years of pre-primary attendance and mother's education level, mother's occupation and gender are related to and predicts later competency in PISA science literacy.

As shown in Table 4.11 only one of the independent variables did not make a statistically significant contribution to model (mother occupation variable). The strongest predictor of reporting the PISA science scores in the model was level of mother education (β= 0.52, p < .001) and attendance to pre-primary (β= 0.49, p < .001). Also, there was a significant but negative association between PISA science scores and gender (β= -7.64, p < .001), with female students' score being 7.6 points higher than male students in PISA science literacy. Additionally, mother occupation variable was not found to be statistically significant contributor to the model. The regression equation for predicting PISA science literacy is: PISA science = $0.49.X_{attendpre\text{-}pri} + 0.52.X_{motheredu} - 7.64.\ X_{gender}$

4.5. Summary of Key Findings

Key findings belonging to the cross-country and Turkish Case analyses are summarized below:

4.5.1. Cross-Country Key Findings

1. The regression analysis results for the 33 countries, the findings revealed that:

- Public expenditure, adult literacy, income per people, pupil-teacher ratio, and starting age to pre-primary were found to be statistically significant contributors to countries' PISA science performance.
- Private expenditure, enrollment rate and duration of pre-primary education variables were not found to be statistically significant determinants of countries' performance on PISA science literacy.

4.5.2. Turkish Case Analysis

1. Children's pre-primary attendance was found to be statistically significant contributor to their science performance in the 2012 PISA science literacy.

- As the year of receiving pre-primary education increases, children's performance in the PISA science literacy likewise increased.

2. Children whose mother completed high school showed higher performance in the PISA science literacy than children whose mother completed primary, elementary or did not complete primary education.

- It was found that children whose mother completed primary and elementary level education were not statistically significant from each other.

3. Mother occupation status were not found to be statistically significant contributor to the student's 2012 PISA science literacy scores

4. There was a relationship between students' gender and their science performance in the PISA assessment. Female students showed better performance in the PISA science literacy than male students.

CHAPTER V

DISCUSSION

Early childhood education provides a wide range of benefits for countries suffering from social and economic issues. Furthermore, early education is an important tool for providing a better life for children in terms of equitable outcomes and lifelong learning. Similarly, early science education has recently become a main aspect of early childhood education because of its great contribution to children's development and later achievement in science. However, children's living conditions, teachers, learning environment, school facilities, and resources are factors that influence the effectiveness of early science education and children's subsequent science outcomes. Therefore, this study used country- and student-level data to investigate the effects of various factors on later science achievement.

This chapter was composed of three main parts: discussion of findings, educational implications, and recommendations for future studies. In the discussion section, the results of the study at the country and student level were discussed in detail. The results of the study were interpreted with caution, and some factors were controlled to delineate correlations. In the second and third parts, there were some educational implications and suggestions for future research in Turkey.

5.1. Discussion of Findings

In this part, it was presented the discussion of the results of the country-level and student-level analysis.

5.1.1. The Dual Face of Spending: More or Better?

In the first part, one of the main focuses of the study was to investigate the association between private and public expenditure in pre-primary education and

students' competency in science literacy. Previous research studies have revealed that physical learning environment, science equipment, materials, and sources are important factors for boosting children's science learning (Buldu et al., 2014; Saçkes et al., 2011) and these opportunities can help reveal children's potential in science learning. The abundance of science materials can boost children's and teachers' motivation in science teaching (La Paro & Pianta, 2000; Yi, 2006).

All of these physical environmental factors somehow depend on educational funds. By investing in children's learning environment, their achievements in later life can be enhanced (Haskin & Barnett, 2010). Similarly, to investigate the effect of pre-primary expenditure on children's competency in science literacy in PISA, countries' PISA science scores were determined as a dependent variable in the current study. Although the results do not show the cause and effect correlation in detail, they do provide an idea of countries' spending and its effect on education. The results of these country-level analyses revealed that public expenditure in pre-primary education is a statistically significant predictor of nations' performance in PISA science literacy. Findings show that successful PISA science scores can be increased by spending more money on public institutions. As for private expenditure, it is not statistically significant in the context of this model.

The results of the current study are especially important for Turkey because the level of spending in both the public and private sectors in Turkey is incomparably less than it is in other European Countries (TED, 2007; World Bank, 2013). In addition, Turkey spent the least amount of money compared to all other countries in the study. This being the case, the result for expenditure level in pre-primary education refers directly to Turkey. Public spending is highly important because it minimizes the undesired effect of inequity from socio-economic conditions (MoNE, 2010). For this reason, most European countries prefer to allocate more money to the public sector than the private one.

Since the main purpose of public spending is to provide education for all (Batare, 2012), public schools are the predominant institutions in pre-primary education in most European countries, such as Turkey. In Turkey, many more children have enrolled in public preschools than in private preschools (World Bank, 2005). This

trend has also been seen in other countries such as Denmark, Norway, Sweden, Finland, and France (Robson, 2009). Most of these countries prefer to use public resources and provide free early education. The underlying reason for governments' effort is to provide equality for children whose families do not have sufficient economic means. In addition, the public sector is more preferable for low-income families because of the high cost of private preschool institutions (World Bank, 2013).

The results of the current study are consistent with some of the international reports and hypotheses about the effective return of pre-primary education expenditure (Heckman, 2009; OECD, 2012; World Bank, 2013). In this regard, one of the studies on the effectiveness of education expenditure was conducted by Reinikka and Smith (2004). They developed the Public Expenditure Tracking Survey (PETS) to evaluate the flow of public funds and other resources. This method was applied in Uganda, Peru, and Zambia to understand why public expenditure produced unsatisfactory results in these countries. The study revealed that efficiency in the use of resources is more important than increases in public expenditure. Moreover, one of the studies done by the European Central Bank (2006) described the relationship between poor use of resources for quality education and students' performance. Similarly, the increase in public expenditure level did not reflect the educational outcome. To demand improvements in the quality of education and later school success, the United States has spent more money on children and families than it has on the elderly due to cash and cost benefits in recent years, which is in contrast to all OECD countries (Isaacs, 2009). Isaacs claimed that the United States' spending trend has not supported this purpose. There is little evidence to support the idea of spending more on children than the elderly. For this reason, Isaacs believed that there was no exact trend in the allocated budget for different education levels, so it is important to define the term "spending on children" to clarify how much money countries actually spend on early education. Therefore, it is necessary to explore the efficiency and equity of education spending rather than the amount of spending (World Bank, 2007). Belfield (2006) suggests that a clear frame for expenditure allocated in pre-primary education should be drawn based on children's age and enrolled programs. Nevertheless, sometimes the problem is not about the definition or amount of

spending in early childhood education. The problem could be the need for an improvement in the effectiveness of spending. This being the case, analyzing the effectiveness of expenditure becomes an important indicator of educational quality (Clements, 1999; Sopek, 2012; Sutherland, Price & Gonand, 2009). In line with this purpose, Clements (1999) conducted a research study in Portugal to assess the efficiency of education expenditure at the primary and secondary levels. In the study, Clements indicated that although Portugal's education expenditure is high relative to the OECD average, the spending pattern in Portugal is considerably insufficient, and sources have not been transferred to education levels efficiently according to OECD reports. Since then, Clements has claimed that educational outcomes have not been improved by increasing the level of expenditure. In line with this, the study revealed that the spending pattern needs to be altered and that the education system in Portugal needs to increase its efficiency. Similarly, Granado, Fengler, Ragatz, and Yavuz (2007) conducted a study to investigate the main characteristics of public education spending in Indonesia. This analysis shed light on the efficiency and equity of education spending. In doing so, researchers took into account various indicators such as teacher earnings, other paid workers, and enrollment rates in the country. The results of the study showed that Indonesia does not need to increase its spending levels; instead, the country needs to improve the quality of its education by improving the efficiency of education spending. To this end, Batare (2012) investigated the characteristics of public spending to identify some problems related to the efficiency of educational spending in Latvia. The study showed that the educational budget is not efficiently distributed between types of educational areas, such as special education. Such efficiency analyses showed that the primary problem in spending is related to the efficiency of allocated education spending plans.

On the other hand, another problem is the difficulty in finding information on spending level in both private and public sectors (Batare, 2012). Generally speaking, educational expenditure in pre-primary education was funded by private and public sources. However, calculating expenditure for the public and private sector in early childhood education is problematic because it is difficult to determine the number of children receiving education and the type of early childhood education that is being taught across the country (Belfield, 2006). For this reason, the total expenditure on

early childhood education is not completely known. In addition, evaluating the effectiveness of expenditure in early childhood education is especially difficult to determine in country-specific studies without considering cross-country spending (Hernandez, Cabrera & Guzman, 2014). Moreover, expenditure on education is not only considered for academic achievement, but also for economic growth. According to Idrees and Siddiqi (2013), a $1 increase in public expenditure in education brings an approximate increase of $20 in gross domestic production, which is a meter of economic growth. They also revealed that public education expenditure has a greater impact on economic growth in developing countries than it does in developed countries.

According to the research studies above, the association between effective expenditure and educational achievement and benefits for nations are clearly related to each other. Statistics showed that Turkey has spent less than most other OECD countries. While these countries spend around 0.3 to 0.5 percent of their GDP on early childhood education, Turkey spends around 0.03 percent of its GDP on early childhood education (World Bank, 2013). The country has also taken innovative steps in Turkish early childhood education by getting financial help from international agencies such as UNICEF. Yet, Turkey cannot provide much financial support to educational innovations by itself (Bekman & Gürlesel, 2005) due to its insufficient expenditure on early childhood education. According to a report by the World Bank (2013), the Turkish government needs to raise its expenditure level on early childhood education from 0.03 to 0.23 percent of its GDP to obtain high-quality pre-primary education. In addition, some cost–benefit studies about spending on early childhood education were conducted in Turkey (Kağıtçıbaşı, Sunar & Bekman, 2001; Kaytaz, 2004). According to Kaytaz (2004), considerably more money needs to be allocated for early childhood education so that enrolment rates reach 25%. Moreover, Kağıtçıbaşı et al. (2001) conducted a study to revel the long-term effects of preschool education on low-income children's well-being. The results of the study showed that early childhood education has an impact on these children's later jobs, income, and education opportunities.

5.1.2. Insight into Class Ratios

Within the aim of the current study, one of the predictors of students' performance on the PISA science literacy was pupil–teacher ratios during pre-primary education. The countries sampled in the current study have differing teacher–pupil ratios. While this ratio was quite low in most European countries, some of the countries—such as Turkey, Argentina, Peru, Thailand, and Mexico—had considerably high ratios. The relationship between the alteration of countries' overall pupil–teacher ratios in pre-primary education and countries' scores in PISA year by year was compared. The results of multiple regression analysis showed that there is a statistically significant relationship between pupil–teacher ratios in pre-primary and PISA science literacy scores of countries. In addition to these results, it is important to investigate the results of other studies conducted in different contexts and countries. Similar findings have been found in various research studies conducted to evaluate the effect of pupil–teacher ratios on children's later academic competency in various learning areas (Blatchford, Bassett, Goldstein & Martin, 2003; Mashburn & Pianta, 2010).

Consistent with the current study's results, some research results have indicated that small classes during early grades can, in some circumstances, improve students' overall achievement (Heckman, 2008; Iacovou, 2001). To investigate the effect of smaller classes on quality of learning and teaching, Blatchford et al. (2003) conducted a study. One of the most distinguished findings of the study was the relationship between the percentage of duration of teaching in pre-primary classes. It was observed that teaching time in smaller classes is longer than it is in larger classes. Moreover, Finn, Gerber, and Boyd-Zaharias (2005) attempted to determine the relationship between participation in small classes during K–3 and students' achievement. Using Student Teacher Achievement Ratios (STAR) experimental data and following these students in high school, the researchers concluded that attending small classes in early grades had a positive effect on early academic performance. The STAR Experiment aimed to discover the role of small classes in academic achievement during early grades. Almost 12,000 students, who attended the same classes from kindergarten to grade 3 participated in the experiment. The results of the

experiment indicated that children enrolled in small kindergarten classes outperformed children enrolled in regular-sized classes (Finn & Achilles, 1999). In the study, however, students who enrolled in small classes faded out after one year, and their achievements decreased by the end of the third grade.

When looking more closely at the policies in the United States, it was found that billions of dollars were invested in reducing class size in the late 1990s. However, the cost–benefit tests for class reduction did not indicate that these policies benefitted school finances (Chingos, 2011). On the other hand, Hoxby (2000) conducted a prominent high-quality longitudinal study in the United States to assess the effect of class size on students' overall academic achievement. Students assigned to small and large classes were monitored in the 1980s and 1990s. The overall results of cross-sectional analysis did not show a statistically significant relationship between class size and students' achievement. When the above-mentioned study results were evaluated, it was found that there was no consensus between studies to indicate strong evidence of the effect of pupil–teacher ratios on academic achievement.

As indicated in the current study, when countries' pupil–teacher ratio in pre-primary classes was evaluated for students' later competency in PISA science literacy, this indicator was substantially significant. This result suggests that a reduction in pre-primary class size can bring better results in terms of later science competency. Turkey, however, is one of the countries that have crowded pre-primary class size. The pre-primary pupil–teacher ratio in Turkey is quite high in comparison to NAEYC's (2005) suggestion, which is eight children per teacher at the pre-primary level. While most countries have decreased their pre-primary pupil–teacher ratios over the years, Turkey has showed an increasing trend in this indicator. In 1991, the pupil–teacher ratio was 15 children per teacher; in 2010, this value reached 23. However, more research studies need to be conducted in Turkey regarding this issue because there are limited studies focused on class size and achievement in the long term. One of these studies was conducted by Denizel, Güven, and Cevher (2005). The results of their study showed that preschool teachers' classroom management skills were not affected by class size.

In addition to the desired effects on later academic achievement, there are many other benefits to keeping class size at a certain level, especially for teachers. During early years, teaching young children requires high energy levels and relentless attention. Thus, while managing small groups and fewer children, teachers can more easily devote their time to each child. Therefore, teachers can have longer conversations with children and observe their interests more easily. Thus, these benefits naturally ensure high-quality pre-primary education and its effect on children at later life stages (Barnett, Schulman & Shore, 2004). In this regard, it can be said that Turkey fails in proving large educational benefits to children.

5.1.3. Reasons for Expansion in the Pre-Primary Education Enrollment Rate

International data sources show that enrollment rates in early education have recently grown around the world, especially in Spain, Korea, and Japan. As addressed in the relevant literature, early childhood education plays a crucial role in child development (Barnett & Yarosz, 2007; Goodman & Sianesi, 2007; Woldehenna, 2011). However, increasing the enrolment rate could be affected by maternal employment, regions, ethnicity, income, and family education level. By means of this comparable research, the effect of enrolment rate on competency in science literacy in PISA assessment was analyzed in the presence of education and income variables. Although the results of the analysis did not indicate a statistically significant association between enrolment rate and PISA success, countries with high enrolment rates tend to show better performance on PISA assessments.

To assess the importance of pre-primary enrolment rates for high-quality education, Barnett and Yarosz (2007) investigated the reasons for differentiation in pre-primary enrolment rates in the U.S. They reported that pre-primary enrolment remains highly unequal, and that the least access to pre-primary education is seen in middle-income families. Moreover, the study found that maternal employment plays a substantial role in enrolment rates because the attendance rates of children with employed mothers is higher than it is for children with unemployed mothers.

According to the report from UNICEF (2014), early childhood education can provide children with an equal opportunity within society. A growing body of evidence

showed that preschool attendance helps children to improve their cognitive and non-cognitive skills (Berlinski, Galiani, & Manacorda, 2007; Burchinal et al., 2011; Gerdinal-Pizato, Marturano, & Fontaine, 2012). For this reason, early education can provide an opportunity to close the gap between advantaged and disadvantaged children. To investigate disadvantaged children's preschool attendance, Magnuson, Meyers, Ruhm, and Waldfogel (2005) conducted a study. Their results suggest that children who attend preschool have relatively high academic skills later on. More importantly, this effect is more notable in disadvantaged children. Based on this result, the researchers suppose that preschool enrolment helps to narrow the school's readiness gap between advantaged and disadvantaged children.

Most of the countries that were analyzed in this study already had nearly 100 percent pre-primary enrolment rates. Therefore, talking low enrolment rates in pre-primary education is not an issue for these countries. Nevertheless, Turkey fails in enrolment rates in pre-primary education. According to the Education Personnel Union's study, Turkey had a 43 percent enrolment rate in pre-primary education in the 2010–2011 school year. However, as seen in Figure 5.1, an unequal enrolment rate in pre-primary education is highly notable among different districts in Turkey.

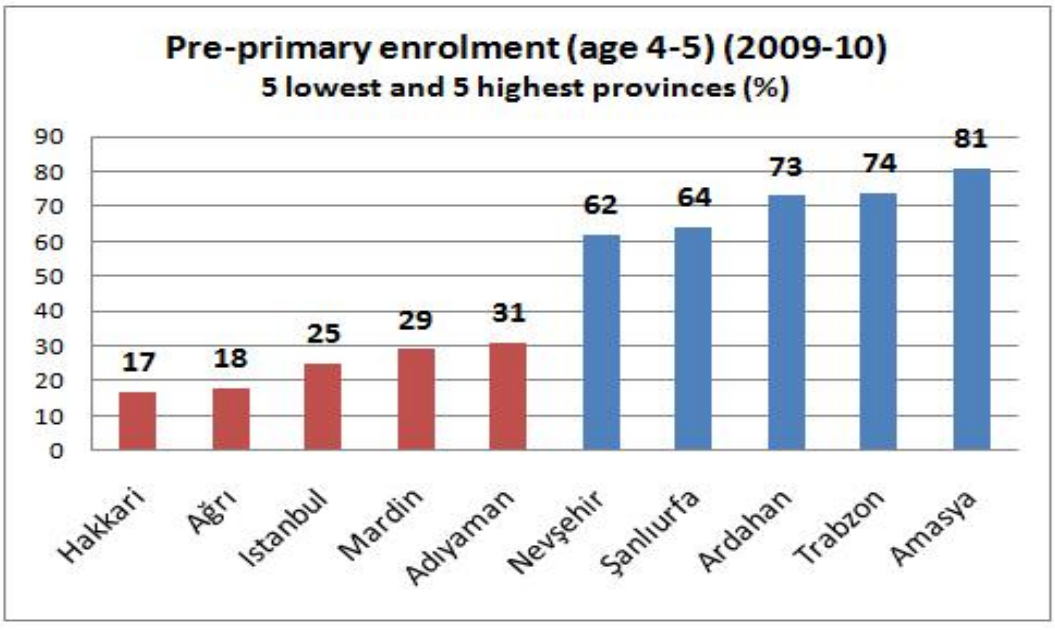


Figure 5.1 Enrollment Rate in Different Cities in Turkey

Therefore, the Ministry of National Education aims to extend pre-primary education for 60–72-month-old children (UNICEF, 2014). However, as stated by Bekman and Gürlesel (2005), the reason for low enrolment rate could be the target audience of early childhood education. To put it simply, Turkish early education programs give more priority to 5-year-oldchildren'seducation. This being the case, other age groups have more limited access to pre-primary education. Conversely, according to Kaytaz (2004), the capacity of private preschools in Turkey is limited, so pre-primary enrollment in Turkey is low.

5.1.4. Richness of Countries

In the country-level model, one of the indicators is national income, which is a proxy of societal well-being in evaluating its effectiveness on countries' performance on PISA. The result of the current study revealed that income variables have a significant impact on countries' performance on the PISA assessment.

In educational settings, income is an important issue because low-income parents are less able to provide a stimulating environment to enhance their children's cognitive development (Oxford & Lee, 2011; Conger & Donnellan, 2007). Likewise, the main idea behind the section of this variable is to understand whether the level of economic development of countries lies behind a well-established education system. Therefore, individual countries' income per capita was evaluated to understand its effect on children's performance on PISA. The results revealed that income is statistically significant variable in predicting later academic performance.

Moreover, there are various student-level research studies investigating families' income level on children's academic achievement (Cheadle, 2008; Dahl & Lochner, 2012; Kaushal, Magnuson & Waldfogel, 2011; Olgan, 2008; Reardon, 2011). To give an example, Olgan (2008) stated that children's socio-economic status was a significant factor in their science achievement in kindergarten and first grade. Moreover, Reardon (2011) claims that the income achievement gap is growing day by day, so it is greater than it was before. In addition, there is another problem with families' low socio-economic status: the negative impact that family stress level has in terms of parents' financial strain. Briefly stated, it is suggested that this form of

stress limits the parents' response to their child and has an inverse effect on child outcomes (Oxford & Lee, 2011, Wilkins, 2009). It is important to note that such results from several studies provide information on how income indirectly influences children's developmental outcomes, similar with the current research results. On the other hand, Kılıçarslan conducted a study to reveal the relationship between family income and children's readiness for reading. The results of the study highlighted that income was a significant contributor to children's interest in books and readiness for reading. At the same time, Erdil (2010) highlighted that early intervention reduced inequities, especially in low-income and at-risk children.

5.2. The Country Case of Turkey

The study includes two levels of analysis. After cross-national analysis, student-level analysis was applied to understand the effect of Turkish students' socio-economic backgrounds on their subsequent competency in PISA science literacy. Turkey is one of the countries that placed its rank below the OECD average. For this reason, the results of the study are substantially important for Turkey. However, it could be more useful to investigate individual countries' special socio-economic backgrounds from the student level by giving suggestions. Thus, investigating some indicators more specifically could be beneficial when giving suggestions for pre-primary education in Turkey. In this way, some indicators from the country level and student level are related to the same research results in the literature.

5.2.1. Starting Age and Time Spent in Pre-Primary School

A cross-national comparison of countries was conducted based on the evaluation of quality indicators from distinct countries. The current study found that starting pre-primary age plays an important role in predicting students' competency in PISA science literacy. Moreover, children's time spent in pre-primary education is another important factor in enhancing students' competency in science literacy. However, the study revealed that duration of pre-primary education was not statistically significant contributor of countries' science literacy scores in PISA assessment.

As indicated in most of the studies, pre-primary education is a highly important factor in children's cognitive development before entering the world of knowledge (Haque, Nasrin, Yesmin & Biswas, 2013). In addition, high-quality pre-primary education is a strong predictor of the future prosperity of nations (Heckman, 2009). In this regard, to reveal the effects of process in effective pre-primary settings, England's Department for Education and Skill (2007) conducted a study. The results of the study showed that getting an early start (2–3 years of age) in high-quality education had benefits for children, even at the age of 10. For cross-county analysis, starting pre-primary education early showed a crying need to narrow the gap between countries' performance on the PISA assessment. However, there is an important point to talk about in terms of the benefits of pre-primary education, which is only possible in high-quality pre-primary settings. The more time that is spent in pre-primary education, the greater the desired outcomes are in effective pre-primary settings. Similar findings have also been reported by Berlinski, Galiani, and Manacorda (2007). They evaluated the effect of pre-primary attendance on children's subsequent school outcomes. The results of the study found that as time went on, the difference between years of school attendance in children who attended pre-primary education and children who did not increased. In addition, Berlinski and his collogues (2007) revealed the influence of pre-primary attendance on later school achievement in another study. The findings of the study showed that the test scores of children who attended one year of pre-primary education were 8 percent higher than children's test scores who did not attend pre-primary education. Moreover, the findings showed that pre-primary school attendance positively affected students' self-control, motivation, class participation, and attention in third grade.

In a cross-national analysis, although starting age of pre-primary education was a substantially important factor in explaining students' competency in science literacy, duration did not have a significant effect on PISA performance. There were various examples of education systems in the dataset. This could be because ineffective pre-primary education systems do not allow these children to gain such skills as they stay in pre-primary education for longer (OECD, 2011). Thus, it not possible to assume all of those pre-primary education systems provides high quality education standards. In the second part of the study, a more specific analysis was conducted with micro

data from students who participated in the PISA assessment in Turkey. The student data includes retrospective information about the number of years of pre-primary attendance. The findings of the study revealed that pre-primary attendance has significant positive effects on children's outcomes. As the number of years in pre-primary education increases, so do students' scores on the PISA science literacy.

5.2.2. Students' Socio-Economic Backgrounds

For the country-level analysis, adult literacy is one of the variables in the model that helps predict performance on the PISA science literacy. The importance of this is that adult literacy rate was a statistically significant variable for countries' performance in an international area. Overall, countries with high rates of adult literacy performed better on the PISA assessment. In the second part, a more specific result was presented for Turkey in terms of the influence of mother's education level on children's later science competency in PISA assessment. The results showed that mother's education level was an influential student-level variable for PISA scores on the science literacy. According to student level data from PISA Economic, Social Cultural Status Index, as the mothers' completed level of education increased, so did the students' scores. For this reason, parental literacy was one of the most substantial variables in the model in terms of explaining students' competency in PISA science literacy.

As we all know, parents are their children's first teachers. Early parenting plays an important role for children because parents can provide their children with a better future by boosting their skills and capacity (Conger & Donnellan, 2007). When viewed from this perspective, parental education level is widely recognized as a substantially important contributor to children's educational outcomes (Davis-Kean, 2005; Dearing, McCartney, & Taylor, 2002; Jabor et al., 2011). For this reason, to investigate the influence of parental factors on students' competency in PISA science literacy, the researchers have focused on family socio-economic status. One of the factors in socio-economic status is parental education level (Ara, 2012; Crage, 2006; Dubow, Boxer & Hesmann, 2009). Similarly, Dubow, Boxer, and Huesmann (2009) conducted a study to determine the long-term effects of parental education level and

occupation by utilizing a sample of 8-year-old children and their parents. By controlling socio-economic status and children's IQ, indices of the children's later success was obtained 40 years later. The study results showed that there is strong support for parental education level having an effect on children's later competency in different learning areas. Moreover, Jabor et al. (2011) investigated the effect of parental literacy on students' high school science performance. The results of the study revealed that there was a statistically significant relationship between students' science GDP and parental educational status. In addition, Davis-Kean (2005) conducted a study to reveal the impact of parental literacy on children's later success. The study results showed that parents' years of education had a direct effect on young children's achievement, but that income was not directly related to this. To explain the reason behind this, some studies point out the relationship between parental education level and parenting style. Parallel with this, according to Beifield (2006), one of the main reasons behind the parental factor in education is that the influence of parents' choices may enhance the effectiveness of early education.

On the other hand, the results of the current study revealed no association between students' competency in PISA science literacy and mothers' occupational status. According to the study results, another influential student-level variable was mother's occupational status. The results revealed an important fact about mother's occupation and children's competency in science literacy. After controlling for other variables in the model (gender, mother's level of education, and number of years of pre-primary attendance), the PISA scores of students whose mothers worked full-time were compared to the scores of students whose mothers were not currently employed. These students' scores were not significantly different from each other. Similarly, Ara (2012) found that there was no significant difference between working mothers and non-working mothers regarding official timing with their children's education. The reason behind this could be that non-working mothers can create an environment in which to facilitate children's science learning at home more than full-time working mothers can. Full-time working mothers may spend less time with their children, so this could explain the insignificant results between working and non-working mothers. However, when students whose mothers were not working now were compared to students whose mothers dealt with home duties or were retired, the

scores significantly differed from each other. Students whose mothers dealt with home duties/retired were more successful on the 2012 PISA science literacy. This result was consistent with the research literature, suggesting that parental occupational status is related to academic achievement (Akinsanya, Ajayi & Salomi, 2011; Bala, 2011; Udida, Ukwayi & Ogodo, 2012).

5.2.3. Gender

When we viewed the results of the 2012 PISA assessment, we found that female students performed better on the science literacy than male students in some of the countries that participated in the PISA assessment (OECD, 2013b). Similarly, the current study found the same results in the gender differences in science for Turkey in PISA. The study's findings revealed that female students outperformed male students on the 2012 PISA science literacy. When holding all other variables constant (number of years in pre-primary attendance, level of mother's education, and mother's occupational status), there was a difference of 6 points between female and male student performance in the 2012 PISA science literacy. Actually, when Turkey was compared to other countries in terms of gender differences, it did not show a large gap between the performance of males and females (OECD, 2010).

Contrary to the findings of the current study, most of the research results have shown that males traditionally outperform females in the areas of science and mathematics. These studies indicated that science achievement generally favors male students, especially in science (Bradley & Corwyn, 2002; Hyde & Linn, 2006; Saçkes et al., 2011). However, this condition appears to have been disappearing in recent years, and some research studies disprove that male students are more successful in science (Gibbs, Fergusson & Horwood, 2008). In 2006, Cevher and Buluş investigated how preschool children's academic self changes with gender. The study results revealed that girls' academic self-esteem is lower than boys'. Moreover, Uslu and Uslu (2013) conducted a study to examine preschool children's school readiness according to gender and parental education. The study found no statistically significant differences between female and male students' school readiness skills. A similar study examining children's school readiness skills was conducted by Erkan (2011).

The study findings suggested that gender did not create a substantial difference in terms of children's school readiness levels.

In addition, Olgan (2008) found that teachers' observations about children's past and current performance in science activities favored female students. However, direct assessment results showed that male students outperformed female students in science. The study results showed that there is no consensus in gender achievement gap issues. In this regard, Linver, Davis-Kean, and Eccles (2002) emphasized that there has been a decline in gender differences in terms of academic achievement over the past few decades, especially on standardized tests. To investigate young children's motivation in science learning, Patrick, Mantzicopoulos, and Samarapungavan (2009) conducted a study on sex differences in kindergarten classes. The study results revealed that integrated inquiry science activities were more beneficial for girls than boys in enhancing their science liking. Apart from this, no substantial differences were found between girls' and boys' motivation in science learning. In addition, Miller, Blessing, and Schwartz (2006) conducted a study to investigate gender differences in high school and students' views of science. Contrary to common belief, the findings of the study showed that female students are more interested in science and scientific issues than male students.

In general, while some of the findings indicated that male students perform better than female students (Hola, 2005; Johnston, 1996), some of them suggested that female students' academic achievement was higher than male students' (Gibbs et al., 2008). As is seen, gender gap still is a topic of heated debate. In that point, it is more beneficial to discuss what might be the reason of achievement differences in males and females. In lower grades, according to Dee (2005), girls and boys show equal performance in mathematics and reading. However, when it comes to their science achievement, as children grow older boys perform better than girls in science (Dee, 2005). Additionally, teachers' opinion about students' gender and their academic performance can be another factor. For instance, some teachers privilege boys or girls in science and mathematics areas. Lastly some of the research indicated that social, cultural, and biological reasons can influence gender gap in students' academic achievement (Dee, 2005; Robinson & Rubienski, 2007).

5.3. Educational Implications

The current study presents a body of evidence for which indicators play a crucial role in explaining the effectiveness of pre-primary education on later science literacy scores. The results have some implications for policymakers to take new agendas for innovations in early childhood education. As can be seen, early childhood education is beneficial in strengthening countries' economic and social outcomes (Berlinski et al., 2008; Heckman, 2009). The results of the study provide a body of information about country profiles in their early childhood education system. One of the main findings of the current cross-country analysis revealed that adult literacy, public expenditure, income, starting age, and pupil–teacher ratios all made unique contributions to countries' performance in PISA science literacy. In this context, Turkey is one these countries and has worst values in some of the indicators.

Public expenditure: First, the study results clearly show that public expenditure plays an important role in countries performance in PISA assessments. However, Turkey spent the least out of all the groups in the study. It is hoped that the results of the current study will help to realize the importance of public spending on pre-primary education. Therefore, one of the suggestions of this study is for Turkey to raise its current public spending in pre-primary education and to plan a detailed pre-primary expenditure agenda for the public sector. The study also shows the need for cost–benefit research in early childhood education in Turkey.

Pre-primary Enrollment Rate and starting age: At the same time, the other salient problem in Turkish early childhood education is the low enrolment rate in pre-primary education. The results of the study suggest that attending pre-primary education has a significant effect on children's later success. However, the enrolment rate in Turkey in 2011was only about 29%. In most instances, the gross enrollment rate shows a value of over 80% in Japan, South Korea, and New Zealand (UNESCO, 2006). From this point of view, the pre-primary enrolment rate in Turkey is quite a bit below the rest of the world (World Bank, 2014). Therefore, most children in Turkey do not receive early childhood education. This study indicated that there is a need to increase the number of children who are attending pre-primary education.

However, another important point is the starting age of pre-primary education. Attending pre-primary education can reduce the undesired results of income inequities, gender disparities, and maternal employment because of the limited time it provides to deal with children. By waiting until they are five or six, children's conditions cannot be made better, as seen in the study results. For this reason, raising awareness is extremely important. This can be done by raising parents' awareness of the importance of early education via flyers or television announcements. Moreover, a system could be developed by the Ministry of Turkish Education to track young children not attending early education. Hence, these precautions may help to raise the enrollment rates of early childhood education programs in Turkey. In addition, there is a great discrepancy in enrolment rates between the districts of Turkey. The east side of Turkey (Southeastern and Eastern Anatolia), especially, has quite a low enrolment rate in pre-primary education. To overcome this problem, more preschools could be built and the cost of pre-primary education could be supplied by the government.

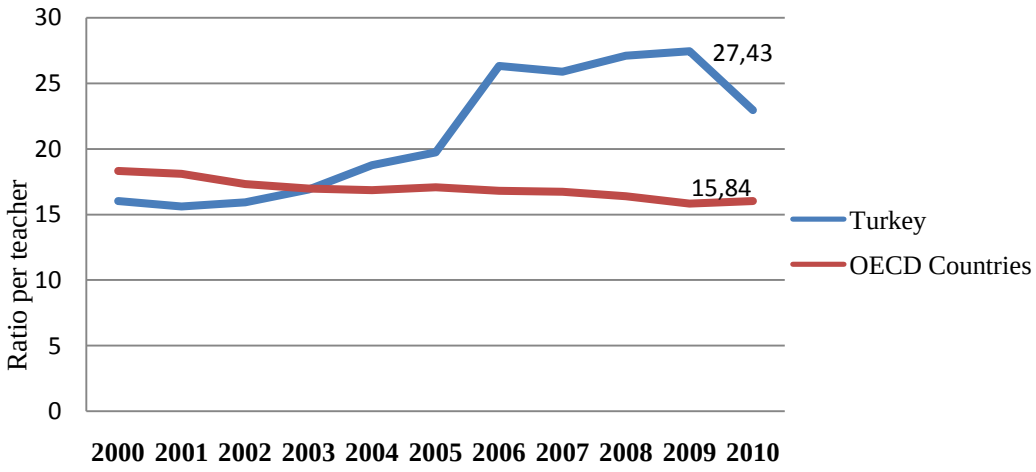
Another considerably important point is that attending early childhood education is especially crucial for disadvantaged and at-risk children in terms of closing the gap in later academic achievements in science, mathematics, and reading. As a matter of fact, a rather large portion of educational expenditure should be allocated to the private sector. Moreover, the cost of private school is often too much for disadvantaged children (EFA, 2012), and most children suffering from income inequality are deprived of early education. Yet, public spending can help disadvantaged children from low-income families to reach early education and narrow the gap in later academic achievement and school readiness. Thus, investing in disadvantaged and at-risk children's education is an effective strategy for reducing the social cost within society (Heckman, 2009). In this regard, it could be suggested that pre-primary education can be provided by the government, like in most European countries (such as Finland, Germany, and France). The result of the current study provides strong support for the effect of early childhood education attendance on later science competency in PISA science literacy. For this reason, parents should be informed of the effectiveness of early childhood education on children's well-being. Especially in low- performing countries, the more time children spend in early

childhood education, the more successful they will be in school in the future. For this reason, in most OECD countries, children start preschool at the age of three. In the French early childhood education system, the government financially supports pre-primary education at the age of three (Jacobson, 2001). By doing so, it can be ensured that parents voluntarily put their children into kindergarten.

Pupil-Teacher ratio: On the other hand, according to the study findings, pupil–teacher ratio seems to have an effect on performance in subsequent academic life. Unfortunately, the pupil–teacher ratio in Turkish pre-primary classes is far above that of the OECD average. Table 5.1 below shows the class size gap between Turkey and other OECD countries.

Table 5.1

Pupil-Teacher Ratios of Turkey and OECD Countries



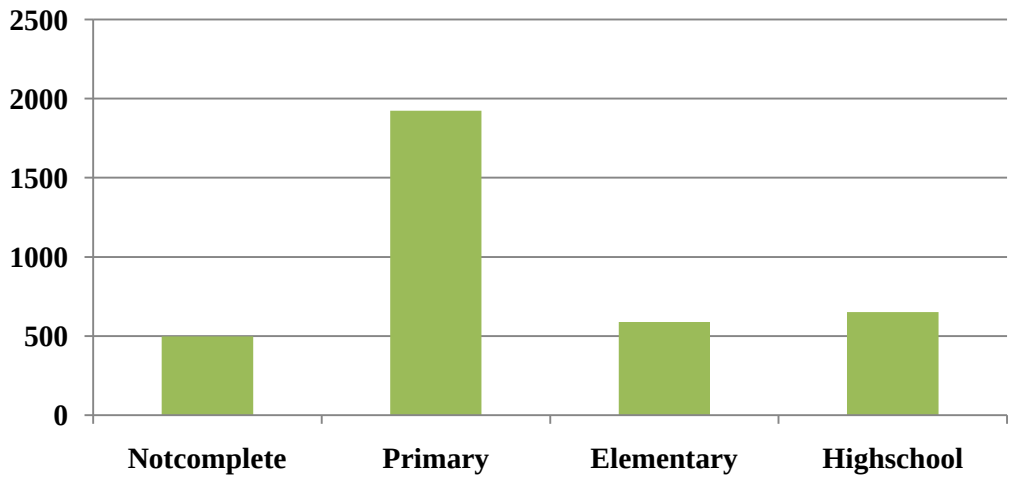
In most country examples from all over the world, the pupil–teacher ratio is, on average, 7–8 children per teacher. However, this ratio is 27 children per teacher in Turkey (World Bank, 2013). According to NAEYC's suggestions, this ratio should be 8 children per teacher for 4–5- year-olds (Bernet, Schulman, & Shore, 2004). In addition, the American Academy of Pediatrics suggests that there should be 16 children per teacher in each class for 4–5-year-olds. To put it simply, the pre-primary pupil–teacher ratio in Turkey is far above that of the universal average. To improve the quality of peer interaction and in-class activities, the child–teacher ratio should be

at a certain level (Duflo, Dupas, & Kremer, 2007). In addition, an appropriate number of children in class can help preschool teachers give more individualized attention to each student and spend less time managing the class (Barnett, Schulman & Shore, 2004). It is therefore important to decrease the number of children in Turkish preschool classes as soon as possible.

Parental Education and maternal employment: The current study also found that parental education, especially level of mother's education, has an important influence on students' science literacy scores, as previous studies have revealed the importance of parental education. In this regard, Turkey's adult literacy rate has increased by 95.78 percent in recent years thanks to literacy campaigns. Although this rate has dramatically increased over the last year, it changes substantially between different districts in Turkey (TUİK, 2013).

Table 5.2

Number of Mothers according to education levels from PISA data



In the table 5.2 above, vertical line represents the number of mothers and the horizontal line represents education levels. As seen in Table 5.2 above, the number of mothers who did and did not complete primary education is higher than the number of mothers who completed higher levels of education. Similarly, according to the *Education at a Glance* report (OECD, 2009), parents with a low level of

education represent 85% of the entire population of Turkey. Therefore, Turkey ranks last among comparative countries in terms of parental educational attainment. Thus, it is clear that parents' education level should be raised as soon as possible. Moreover, one of the possible ways to educate parents is through involvement in their children's activities. Parents can be engaged in education and learn with their children. Moreover, family literacy programs could be designed for uneducated parents.

Finally, early childhood education provides valuable opportunities for mothers who are working fulltime. For this reason, mothers and fathers can be informed about full-day preschool and kindergarten.

Gender: The results of the current analysis also showed that Turkish female students showed better performance in PISA 2012 science literacy. To reduce gender gap achievement, it gives training for teachers to differing learning styles for boys and girls. Moreover, preschool teachers should provide equal chance to all children in the class regardless of their gender.

Income: As shown from the results of the current study, income is an important factor on students' performance in PISA science literacy. In that point, the current study focused on income per person a proxy of countries' economical welfare and performance in educational area. For this reason, it is important to eliminate the undesired results of income inequity between societies. To minimize the effect of income disparity, expanding early childhood education in deprived parts of the countries is vitally important for disadvantaged children.

Private Expenditure: Private sector in early education is not dominant in most of the OECD countries (OECD, 2012). The underlying reason is that these countries aim to provide free early education for all children and therefore transfer their funding to public sectors in early childhood education. In this way, it is possible to reach all children from each part of the country. At this point, countries that show lower-performance in PISA assessment can reduce the fee of private sector to open doors to all children in need.

5.4. Recommendations for Future Research

This study presents the relationship between some of the indicators relevant topre-primary education and socio-economic status— which are a proxy of quality in early childhood education— and PISA science literacy scores. The research findings could be useful for guiding future research studies. First, public expenditure, which is a country-level variable, is vitally important for enhancing the effectiveness of early childhood education. Yet, for future research, it could be beneficial for examining how public expenditure on pre-primary education could be spent more efficiently by conducting cost–benefit research studies.

Another potential direction for future studies would be to investigate how students' science performance varies with age between male and female students. It may be useful to investigate this topic to determine why female students are better at science in later grades (Miller, Blessing, and Schwartz, 2006) and male students are better at science in early childhood (Saçkes et al., 2011). In addition, results of the student level analysis for Turkey indicated that competency in science literacy increases with increasing spending time in pre-primary education. For this reason, examining the year factors in achievement gap is important in evaluating the effectiveness of early childhood education. Therefore, it would be best if future studies could examine the efficiency and effectiveness of the science teaching process in kindergartens in Turkey.

The current study compared distinct countries' early education systems and their performance in an international area by utilizing quantitative methods. Similar studies can be conducted by utilizing qualitative methods. In this way, it would be possible to investigate the differences between above and below average OECD countries in depth to help guide their early education systems. With this design, it can be suggested that focus group interview with preschool teachers to collect in-depth information about maternal factors, gender, and income issues can be collected of early education in Turkey.

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APPENDICES

APENDIX I: TURKISH SUMMARY

Giriş

Toplumda fen okur-yazarı olan insan ihtiyacının giderek artan bir ihtiyaç olmasından dolayı, ülkeler arasındaki rekabeti daha da arttırmaktadır. İyi bir eğitim ortamı içinde, yetiştirilecek her bilim insanı, mühendis ve bunun gibi daha birçok meslek dalı o toplumun uluslar arası arenada söz sahibi olmasına biraz daha katkıda bulunacaktır (NSES, 1996). Bu sebeple birçok ülke okul öncesi eğitim çağından başlayarak eğitim sisteminde reformlarla yapmakta ve giderek daha kaliteli eğitim verme gereksinimini karşılamak için ellerinden geleni yapmaktadırlar. Okul öncesi çağından itibaren yapılan tüm değişiklik ve yenilikler, çocuğun toplumda daha iyi bir yer edinmesini sağlamayı ve ona gelecekte daha iyi bir yaşam sunmayı amaçlamaktadır. Özellikle, çocukların ileriki başarı performansları arasındaki farkın giderilmesinde, onların düşünme becerilerinin daha da gelişmesinde öneli bir rol oynamaktadır. Bu bağlamda son yıllarda yapılan çalışmalar göstermektedir ki, okul öncesi eğitim çocukların okula hazırlık becerilerinin geliştirilmesinde ve ileriki akademik başarılarının artmasında oldukça önemli bir etkiye sahiptir. Ayrıca okul öncesi eğitimi sayesinde toplumda gelir düzeyi düşük ve yüksek düzeyden gelen çocuklar arasındaki başarı farkı olabildiğince aza indirgenebilmektedir (Burchinal ve ark., 2011). Bu açıdan bakıldığında, okul öncesi eğitim çocuğa daha iyi bir eğitim, iş ve yaşam olanağı elde etmesini sağlarken, diğer taraftan da toplumda da büyük katkı sağlamaktadır. Okul öncesi eğitimi özellikle annelerin iş hayatına katılabilmelerinde ve toplumdaki iş gücüne kadınların da katılmaları için büyük olanaklar sağlamaktadır. Ülkelerin gelişimi ve büyümesi için eğitilmiş topluma duyulan ihtiyacın ilk adımı okulöncesi eğitimi sayesinde atılmaktadır.

Diğer taraftan çocuğun aldığı kaliteli okul öncesi eğitimi, onun ileriki okul başarısından, sosyal becerilerine kadar birçok alanda yaşıtlarının önüne geçmesine

yardım edecektir. Bu sayede, okul öncesi dönemde verilen her bir bilgi tanesi çocuğun hayatında çok önemli dokunuşlar yapmamıza yardım edecektir. Bu sebepledir ki, okul öncesi dönemde önemle üzerinde durulan ve müfredata katılması için çok çaba harcanan alanlardan biri de fen eğitimidir. Araştırmalarda da ifade edildiği gibi, çocuklar çevrelerini keşfetmeye ve incelemeye doğal olarak eğilimlidirler. Erken yaşlarda, çocukların deneyimlediği ve öğrendiği her bir bilgi onların ileriki fen başarılarında etkin bir rol oynayacaktır (Tu, 2006). Bu sebeple, birçok araştırmacı erken yaşta fen eğitiminin nasıl ve ne koşulda verilmesi gerektiğini araştırmaktadır. Bu araştırmaların çoğu, çocukların öğrenme çevrelerinin nasıl düzenlendiği ve hangi faktörlerin öğrenmeyi desteklediğini üzerinedir (Eshach & Fried, 2005; Saçkes, Akman & Trundle, 2012). Bu çalışmaların bazılarında, müfredat, öğretmen, okul koşulları ve öğrenme süreçleri gibi faktörler ele alınmıştır. Bunların yanı sıra, okul dışı faktörler de ele alınmış ve bu çerçevede farklı araştırmalar yapılmıştır. Örneğin çocukların ailelerine dair eğitim, ekonomik gelir ve kültürel bilgiler, ekonomik ve sosyal faktörleri incelenmiştir. Bu sayede, araştırmalar çocukların öğrenme ortamları ve onların ileriki akademik başarıları arasında yakın bir ilişki olduğunu vurgulamaktadır (Buldu, Buldu & Buldu, 2014; Pianta, LaParo, Payne, Cox & Bradley, 2002). Çocukların öğrenme ortamını onların öğrenmelerinde etkili olabilecek birçok farklı etmeni içinde barındırmaktadır. Birçok çalışmada da ele alındığı gibi bunların başında, okul öncesi eğitime başlama yaşı, okul öncesi eğitimi alma süresi, sınıflardaki öğretmen-çocuk oranları, aile okur-yazarlık oranları, ailelerin ekonomik koşulları ve okul öncesi eğitim harcamaları gelmektedir (Blachford, ve ark., 2003; Cardinal- Pizato, Marturano & Fontaine, 2012; Carneiro, Meghir & Parey, 2013; Elicker ve ark., 2007). Bu değişkenlerden bazıları, devlet tarafından sağlanılıp, düzenlenirken bazıları da çocuğun kendi koşulları ile yakından ilişkilidir (Caro, McDonald & Williams, 2009). Bu değişkenlerden her birinin etkisinin çocukların ileriki akademik hayatları üzerine olan etkisini araştırmak için, farklı dizaynlarda birçok araştırma yapılmıştır. Örneğin, okul öncesi sınıflarda yaş gruplarına göre uygun sayıdaki sınıf mevcudu, çocukların ileriki başarıları üzerinde pozitif yönde bir etki oluşturduğu görülmüştür (Hoxby, 2000; Iacovaou, 2001). Diğer taraftan çalışmalar, anne baba okur-yazarlık ve eğitim durumlarının da çocukların başarısı üzerinde anlamlı bir etki yarattığını ortaya çıkarmıştır (Jabor ve

ark., 2011). Tüm bu sebeplerden dolayı, bu göstergelerden her biri ülkelerin eğitim kaliteleri ve uluslararası başarı düzeyleri hakkında bilgi vermektedir.

Bu çalışmaların sonuçlarında da ifade edildiği gibi okul öncesi eğitiminde, ülkelerin kaliteli eğitim ortamına duyduğu ihtiyaç her geçen gün artmaktadır (Watters ve ark., 2001). Bu yüzden, birçok ülke okul öncesi yıllarında kaliteli bir fen eğitimi vermeyi amaçlamaktadır (Berlinski, Galiani & Manacorda, 2007). Ancak, okul öncesi fen eğitiminde iyi yapılandırılmış ve belirli standartları yakalamış bir eğitim vermek ve bunu toplumun her kademesindeki çocuğa ulaştırmak sanıldığı kadar kolay bir iş değildir (Britto, Yoshikawa & Boller, 2011). Bu sebeple, çocukların öğrenme ortamları ve akademik ve sosyal başarılarını bir bütün olarak değerlendirmek çok daha anlamlı olacaktır. Özellikle çocukların fen alanında gösterdikleri akademik performansı değerlendirmek oldukça karmaşık bir konudur. Çocukların gelişim özelliklerinden ve tüm gelişim alanlarına yönelik değerlendirme ihtiyacından ötürü, onları standart testlere tabi tutmak ve başarı düzeylerini belirlemek nerdeyse imkânsız bir noktadır. Ancak, ileriki yıllarda katıldıkları ulusal ve uluslararası sınavlarda ve onların gösterdikleri performanslarına bakarak onların başarıları hakkında araştırmalar yapmak son yıllarda giderek artan bir eğilimdir. Özellikle ülkeler arası kıyaslamalar yaparak, onların uluslar arası arenada gösterdikleri başarı düzeylerini belirlemek ve eğitim sistemleri hakkında bir fikir sahibi olmak araştırmacıların daha da çok ilgisini çekmektedir. Bu amaçla PISA araştırmacılar tarafından kullanılan ve eğitim sistemlerini hakkında bilgi edinmemizi sağlayan en önemli uluslararası kaynaklardan biri olarak görülmektedir. Özellikle son yıllarda yapılan PISA uygulamaları, ülkelerin performanslarında okul öncesi eğitiminin etkililiğinin ne denli etkili bir faktör olduğunu ortaya koymuş ve bu alanda önemli bilgiler edinmemizi sağlamıştır (OECD, 2012). PISA uygulamasının temelinde yatan amaç öğrencilerin belirli alanlarda sahip oldukları bilgileri gerçek hayatta ne derece kullanabildikleri hakkında bilgi vermektir. PISA uygulamaları, 3 yılda bir OECD tarafından dünyadan birçok ülkenin katılımı ile yapılmaktadır. OECD' ye üye olan ve üye olamayan ülkelerden arasından seçilen ülkelerde, 15 yaşındaki öğrencilerin katılımı ile gerçekleştirilmektedir. Genellikle 2 saatlik kalem-kâğıt sınavından oluşan bu uygulamada çoktan seçmeli veya açık uçlu sorular bulunmaktadır. Ayrıca, PISA

uygulamaları öğrencilerin başarılarını ölçmekten ziyade, onların fen, matematik ve okuma alanlarındaki okur-yazarlıkları hakkında bilgi vermeyi amaçlamaktadır.

Bunlara ek olarak belirtmek gerekir ki, PISA uygulamaları direk olarak okul öncesi eğitim sistemleri hakkında bilgi vermese de, ülkelerin gösterdikleri performanslar ile onların okul öncesi eğitim sistemleri arasında yakın bir ilişki vardır. Bu sayede, PISA bize okul öncesi eğitiminin etkililiği hakkında çok önemli bilgiler vermektedir. Bu amaçla PISA verilerinden yola çıkarak, öğrencilerin ve ülkelerin sahip oldukları eğitim koşullarının, sosyoekonomik düzeyin ve devlet uygulamalarının onların PISA' da ki yeterliliklerine ne derece etki ettiğini araştırmak, eğitim sisteminin geliştirilmesinde çok yardımcı olacaktır. Benzer şekilde, Türkiye'nin PISA'da ki performansı, ülkedeki genel eğitim sistemini olduğu kadar okul öncesi eğitiminin de değerlendirilmesi imkânı sağlayacaktır.

Araştırmanın Amacı

Ülke ve öğrenci düzeyinde yapılan bu iki boyutlu çalışma, okul öncesi döneme ait eğitim ve sosyoekonomik göstergeler ile PISA uygulamasındaki puanlara ile arasında bir ilişki olup olmadığını göstermektir.

Çalışmanın Önemi

Okul öncesi eğitiminde kaliteyi belirlemek amacıyla değişik faktörlerin araştırıldığı çok sayıda çalışma bulunmaktadır. Bunlar öğretmen-öğrenci oranları, öğretmen kalitesi veya eğitim harcamaları gibi faktörlerdir (Cryer, Tietze, Burchinal, Leal & Palacio, 1999; Espinasa, 2002). Ancak, çok az sayıda araştırma bu faktörlerin, ülkelerin gösterdikleri uluslararası platformda gösterdikleri akademik performansı nasıl etki ettiğini araştırmaktadır. Bu göstergeler baz alındığında, eğitim harcamaları, yetişkin okur-yazarlık düzeyi, gelir düzeyi, öğretmen öğrenci oranları, okul öncesi eğitime kaydolma oranları, okul öncesine başlama yaşı ve okul öncesi eğitiminin süresi benzer çalışmalarda ön plana çıkan ortak göstergelerdir.

Diğer taraftan, araştırmalarda öğrenme ortamının kalitesinin, çocukların ileriki yeterlilikleri üzerinde belirleyici rol oynayan etmeler arasında yer aldığını göstermektedir (Buldu ve ark., 2014; Cornell & Jobling, 2010; Raynolds, Temple,

Robertson & Mann, 2001; Saçkes, 2011). Bu sebeple, ülkelerin okul öncesi eğitim sistemlerine ait göstergelerin PISA performanslarına olan etkisi üzerinden karşılaştırmalı bir analiz yaparak, alanda karşılaştırmalı çalışmalara duyan ihtiyaç giderilmeye çalışılmıştır. Bu sebeple OECD ve OECD üyesi olmayan 33 ülkenin yer aldığı bu analizde, ülkelerin okul öncesi eğitimi ve sosyoekonomik faktörlerinden elde edilmiş geriye dönük veriler üzerinden onların PISA performansı arasındaki ilişki açıklanmaya çalışılmıştır. Bunun yanı sıra, öğrenci düzeyinde yapılan analiz, Türkiye' de zorunlu eğitimi (eski sisteme göre 5 yıllık ilkokul ve 3 yıllık ortaokul eğitimini kapsayan süreç) tamamlamış öğrencilerin, fen okur-yazarlıklarını etkileyen faktörlerin belirlenmesinde faydalı olacaktır.

Önemli Terimlerin Tanımları

Ekonomik Kalkınma ve İşbirliği Örgütü (OECD): Yaklaşık elli yıl önce kurulmuş ve ülkelerin ekonomisine katkı bulunmayı amaçlayan uluslar arası düzeyde bir kuruluştur.

Uluslar Arası Öğrenci Değerlendirme Programı (PISA): OECD tarafından 1997 yılında başlatılmış uluslara arası değerlendirme programıdır (OECD, 2013). PISA uygulamasının temel amacı, 15 yaşındaki öğrencilerin gelecekte karşılaşacakları zor durumları nasıl çözecekleri hakkında bilgi vermek ve onların analiz etme, iletişim kurma, fikir yürütme gibi becerilerine yönelik bir değerlendirme sağlamaktır (OECD, 1999).

Okul Öncesi Eğitim: Organize edilmiş uygulamaların ilk basamağı olan okul öncesi eğitim, erken çocukluk döneminde ve okul atmosferinde içerisinde çocuklara sunulur (OECD, 2013).

İleriki Okul Ürünleri: PISA 'dan elde edilen puanlar

Okul Öncesi Eğitime Kayıt Olma Oranları: Yaş grubuna bakmaksızın, okul öncesi eğitime kayıt olan toplam örenci sayısının toplam kayıt olma oranına yüzdesi.

Okul Öncesi Eğitim Harcamaları: Okul öncesi eğitimde, kamu ve özel sektörde harcanan toplam harcama.

Öğretmen-Öğrenci Oranları: Okul öncesi eğitime kaydolan toplam öğrenci sayısının, toplam öğretmen sayısına olan oranı.

Yetişkin Okuryazarlık Oranı: Yetişkin okur-yazarlık oranı, okur-yazar insan sayısının ilgili yaş grubundaki toplam insan sayısına bölünüp, 100 ile çarpılmasıyla elde edilir (Dünya Bankası, 2013b).

Ekonomik Sosyal ve Kültürel İndeks (ESCS): PISA öğrenci anketleri sayesinde çocuklara ait ekonomik, kültürel ve eğitim geçmişlerine dair bilgilerin toplandığı bir indeks.

YÖNTEM

Bu çalışma okul öncesi eğitiminin, çocukların ileriki fen başarısını nasıl etkilediğini incelemek amacıyla, PISA fen okur-yazarlık alanındaki sonuçlarından yararlanarak yapılmıştır. Bu amaç doğrultusunda çalışmanın değişkenleri ülke ve öğrenci düzeyi olmak üzere iki farklı seviyeden belirlenmiştir.

Çalışmanın ilk kısmı olan ülke düzeyinde okul öncesi eğitiminin etkililiğinin kıyaslanması amacıyla yapılan analizde 33 ülke yer almıştır. Her bir ülkeye ait, okul öncesinde yapılan kamu ve özel eğitim harcamaları, okul öncesinde öğretmen-öğrenci oranları, okula kayıt oranı, yetişkin okur-yazarlık oranı, kişi başına düşen gelir, okul öncesine başlama yaşı ve okul öncesi eğitiminin süresi değişkenleri analizde yer almıştır. Bu değişkenler, ülkelerin gösterdikleri performansları kıyaslayabilmek amacıyla, geriye dönük olarak kaydedilmiş değerler üzerinden oluşturulmuştur. Bu sayede, ülkelerin okul öncesi eğitim koşullarını, PISA performanslarına ne düzeyde etki ettiği ve hangi göstergelerin bu performansta istatistiksel olarak önemli bir etkisinin olduğu araştırılmıştır. Analize başlamadan önce ülkelerin performans dağılımları göz önünde bulundurulup, çeşitliliğinin arttırılması için değişik performans düzeyinden ülkelerin analizde yer alması sağlanmıştır.

Çalışmanın ikinci kısmında, Türkiye'den 2012 PISA sınavına katılan 3662 öğrencinin fen okur-yazarlık performansları, okul öncesi eğitimi kurumuna devam

edip etmedikleri ve devam süreleri, cinsiyet, anneye ait eğitim ve meslek durumları değişkenleri açısından incelenmiştir.

Araştırma Soruları

Bu araştırmada iki ana araştırma sorusu bulunmaktadır:

Araştırma Sorusu 1: OECD üye ve üye olmayan 33 ülkeye ait okul öncesi eğitim değişkenleri (kaydolma, öğretmen-öğrenci oranları, okul öncesi eğitime başlama yaşı, süresi), hükümet göstergeleri (kamu ve özel okul öncesi eğitim harcamaları) ve sosyoekonomik göstergeler (yetişkin okuryazarlık oranı ve gelir düzeyi) ne ölçüde ülkelerin PISA uygulamasındaki performanslarını ne ölçüde (2000 den 2012 yılları arasında) tahmin etmektedir?

Araştırma Sorusu 2: Sosyoekonomik göstergeler (cinsiyet, anne eğitim düzeyi, anne çalışma durumu ve okul öncesi eğitimine katılım) ne ölçüde Türkiye'den PISA 2012 uygulamasına katılan 15 yaşındaki öğrencilerin fen okur-yazarlık alanındaki yeterliliğini ne ölçüde tahmin etmektedir?

Araştırma Yöntemi

Bu araştırmanın nicel bir çalışma olup, ülke ve öğrenci düzeyinde elde edilen veriler, regresyon analizi kullanılarak değerlendirilmiştir. Analizin birinci kısmında 33 ülkeden elde edilen verilerin analizinde ülke kıyaslaması yapılmış ve panel veri seti kullanılarak analiz edilmiştir. Araştırmanın ikinci kısmında, 2012 PISA ekonomik, sosyal ve kültürel statü indeksinden elde edilen veriler (cinsiyet, anne eğitim düzeyi, anne çalışma durumu ve okul öncesi eğitime katılım) ile öğrencilerin fen okur-yazarlık yeterlilikleri arasındaki ilişki incelenmiştir. Öğrenci düzeyinden elde edilen verilerin analizinde yine çoklu regresyon analizi kullanılmıştır.

Veri toplama Aracı ve Oluşum Süreci

Analiz için elde edilen veriler OECD, Dünya Bankası ve UNESCO veritabanlarından ulaşılmıştır. Bu veritabanlarından elde edilen veriler, ülke genelinde değişik en az üç veri toplama şirketinden elde edilerek oluşturulmaktadır. Elde edilen bilgilerin güvenirliği ve geçerliği sistematik olarak test edilmiştir. Diğer taraftan, daha

derinlemesine bilgi edinmek amacıyla, Türkiye'den PISA 2012 uygulamasına katılan öğrencilerin aile bilgileri, cinsiyet ve okul öncesi eğitimine katılımı gibi değişkenler kullanılarak bir regresyon analizi yapılmış ve öğrencilerin fen okur-yazarlık alanındaki yeterliklerinin bu değişkenlerden ne derece etkilendiği incelenmiştir.

Veri Analiz Süreci

Dünya Bankası, UNESCO ve OECD' nin veritabanlarından elde edilen değişkenlere bağlı olarak PISA fen okur-yazarlık alanındaki performansın nasıl değiştiğini incelemek amacıyla, bu veriler arasındaki ilişki çoklu regresyon analizi kullanılarak incelenmiştir. Araştırmanın ilk kısmı olan ülkeler arası kıyaslamada, ülke düzeyinde kurulan modelin denklemi aşağıdaki gibi oluşturulmuştur;

(1) $PISA_{t} = \beta_0 + \beta_1 Harc_{kamu\ (t-10)} + \beta_4\ ÖÖO_{okulöncesi\ (t-10)} + \beta_6\ Başyaş_{(t-10)} + \beta_7\ Gelir_{(t-10)} + \beta_8\ Okuryaz\ (t-10) + \varepsilon$

Araştırmanın ikinci kısmında ise, Türkiye' den katılan 15 yaş gurubu öğrencilerin fen okur-yazarlık yeterlilikleri hakkında daha ayrıntılı bilgi edinmek amacıyla, PISA ekonomik, sosyal ve kültürel statü indeksinden elde edilen veriler yine çoklu regresyon yöntemi kullanılarak analiz edilmiştir. Bu amaçla kurulan modelin denklemi aşağıdaki gibi belirtilmiştir;

(2) $PISA_{(t)} = \beta_0 + \beta_1 Katılım_{(t)} + \beta_2\ AnneEğit_{(t)} + \beta_3\ AnneİŞ_{1\ (t)} + + \beta_4\ Cinsiyet_{(t)}$

Bulgular ve Tartışma

İlk araştırma sorusu kapsamında, ülkelerin okul öncesi eğitim sistemlerine ve sosyoekonomik statülerine ait değişkenleri ile PISA fen okur-yazarlık alanındaki performansları arasındaki ilişki incelenmiştir. Analiz sonuçları okul öncesinde yapılan kamu harcamalarının, yetişkin okur-yazarlık düzeyinin, kişi başına düşen gelirin, okul öncesi sınıflardaki öğretmen öğrenci oranlarının ve okul öncesi eğitime başlama yaşının, ülkelerin PISA fen okur-yazarlık alanındaki performansları üzerinde istatistiksel olarak anlamlı bir etkiye sahip olduğunu göstermiştir.

Bu model çerçevesinde, diğer tüm değişkenler sabit tutulduğunda, okul öncesi eğitiminde yapılan kamu harcamalarının 1 birimlik artışı, ülkelerin PISA fen okur-yazarlık puanlarında 34, 59 puanlık bir artış yaşanmasına neden olmuştur. Diğer taraftan yetişkin okuryazarlık oranının da, ülkelerin puanları üzerinde yaklaşık 4,48 artışa neden olduğu görülmüştür. Ülke genelinde kişi başına düşen gelir oranları ise istatistiksel olarak anlamlı bir etki oluştururken, bir birimlik gelir artışı, puanlarda küçükte olsa bir artışa neden olmuştur. Okul öncesi eğitim değişkenlerinden öğretmen-öğrenci oranları ile PISA puanları arasında beklendiği gibi negatif bir ilişki olup, diğer tüm değişkenler sabit tutulduğunda 1 birimlik düşüşün, ülkelerin puanlarını 1,64 puan arttırdığı görülmüştür. Ayrıca okula başlama yaşında da benzer bir ilişki olup, birimlik düşüş puanlarda 5,61' lik bir artışa neden olmuştur.

İkinci araştırma sorusunu yanıtlamak amacıyla oluşturulan regresyon modeli, okul öncesinde geçirilen süre ile öğrencilerin PISA 2012 fen okuryazarlık puanları arasında doğru orantılı bir ilişki olduğunu ve öğrencilerin okul öncesi sınıflarında geçirdiği süre arttıkça PISA fen okur-yazarlık puanlarının da arttığını göstermiştir. Ayrıca öğrencilerin cinsiyetleri de fen okur-yazarlık puanları üzerinde anlamlı bir etki oluşturmaktadır. PISA 2012 fen okur-yazarlık sonuçları, kız öğrencilerin erkek öğrencilerden yaklaşık 6 puan daha fazla skora sahip olduklarını göstermiştir. Öğrencilerin anne eğitim düzeyi ve meslek türleri için yapılan analizde, sonuçlar daha önce yapılmış çalışmalar doğrultusunda benzer sonuçlar olduğunu göstermiştir. Özellikle anne eğitim seviyesi arttıkça, öğrencilerin PISA fen okur-yazarlık puanlarında da önemli bir artış olduğu görülmüştür.

Kısaca özetlemek gerekirse ise, mevcut çalışma okul öncesi eğitimini öğrencilerin ileri fen okur-yazarlık performansları üzerinde istatistiksel olarak anlamlı bir etkiye sahip olduğunu göstermiştir. Bununla beraber, bazı kalite göstergeleri ve sosyoekonomik değişkenler, ülkelerin performansları ile anlamlı bir ilişki olduğunu göstermiştir. Diğer taraftan, Türkiye' den PISA uygulamasına katılan 15 yaş gurubu öğrencilerin performansları adına çok daha ayrıntılı bilgi edinmek için yapılan analiz, cinsiyet, anne eğitim düzeyi ve anne çalışma durumuna ait verilerin, bu ilişkide anlamlı bir rol oynadığını bulunmuştur.

Araştırmanın Sınırlılıkları

1. Araştırmada ele alınan yaklaşık 12 yıllık aralık içinde bazı verilerde gözlem yetersizliği söz konusudur. Özellikle kamu ve özel harcama değişkenlerinde sınırlı sayıda veri olduğundan, en fazla 33 ülke analize dahil edilebilmiştir.

2. Bu araştırma deseninde, ikinci araştırma sorusuna cevap vermek için yapılan çoklu regresyon analizinin yanı sıra, HLM analizi kullanılarak, farklı düzeyden değişkenler arasında gruplandırma yapılarak, öğrencilerin fen okuryazarlık yeterliliği alanındaki etkileri daha detaylı olarak incelenebilir.

3. Ailelerin gelir düzeyi çalışma kapsamında ele alınılmak istenmiştir. Ancak Türkiye'den elde edilen gelir düzeyi değişkeni 2012 PISA veri tabanında yer almadığından, analizin ikinci kısmında bu değişkene yer verilememiştir.

Doğurgalar

Türkiye nüfusuna bakıldığında, nüfusun çok önemli bir kısmını 5 yaş ve altındaki çocukların oluşturduğu görülmektedir. Bu nedenle, Türkiye'de okul öncesi eğitime duyulan ihtiyaç oldukça fazla olduğu söylenebilir. Ancak Türkiye' de ki okul öncesi eğitim kurumlarına kaydolma oranları incelendiğinde, bu düzeyin diğer ülkelerin çok gerisinde olduğu açıkça görülmektedir. Yine ülke içerinde bu orana bakıldığında ise, Türkiye'nin doğu ve batı bölgeleri arasında oldukça yüksek bir kaydolma farkı olduğu görülmektedir. Bu sebeple, okul öncesi eğitimi yaygınlaştırmak ve ailelerin okul öncesi eğitiminin önemi hakkında bilgilerinin artmasını sağlamak gerekmektedir. OECD ülkelerindeki trende bakıldığında, okul öncesi eğitime kaydolma yaşının 3 yaş civarında olduğu ve ortalama 3 yıl süren bir eğitimin verildiği görülmektedir. Bu sebeple, ailelerin çocuklarını olabilindiğince erken yaşlarda okul öncesi eğitim kurumlarına kaydettirmelerinin, onların gelişim alanlarında ve akademik becerilerinin artmasına büyük destek sağlayacağı ile ilgili bilgilendirilmeleri gerekmektedir. Okul öncesi eğitiminin yaygınlaştırılmasında ve erken yaşlarda bu imkândan yararlanma olanağının arttırılması için, Milli Eğitim Bakanlığı tarafından hazırlanan televizyon spotları, aileleri okul öncesi eğitimin çocuğa sağladığı faydalar hakkında bilinçlendirmede ve kaydolma oranlarının artmasında önemli rol oynayacaktır.

Diğer taraftan, mevcut çalışma okul öncesi eğitim seviyesindeki kamu harcama artışının, ülkelerin uluslar arası değerlendirme uygulamalarındaki performansını arttırdığını göstermektedir. Ancak, çalışma kapsamında ele alınan ülkeler içinde en düşük harcama düzeyi Türkiye' ye ait olup, bu seviyenin en kısa sürede arttırılması önerilmektedir. Bu sebeple, okul öncesinde kamu harcamaları adına yeni bir bütçe planı hazırlanması gerekmektedir. Ayrıca, sadece harcama oranlarında ki artışın göz önünde bulundurulmasının yanı sıra bu artış için fayda zarar analizleri yapılmalı ve harcamanın etkililiği arttırılmalıdır. Okul öncesi eğitimi için ayrılan bütçenin arttırılması ve okul öncesi çağındaki çocuklara parasız eğitim sağlamak, toplumun dezavantajlı kesimden gelen çocuklar için eğitimde fırsat eşitliği sağlayacaktır.

Çalışma kapsamında ön plana çıkan bir diğer önemli nokta ise okul öncesi sınıflardaki öğretmen öğrenci oranlarıdır. Bu oranın özellikle Türkiye' de çok yüksek olduğu görülmektedir. Bu sebeple, Milli Eğitim Bakanlığı tarafından belirlenen politikada, okul öncesi sınıf mevcutlarında azalmaya gitmek yapılacak ilk adımlardan biri olmalıdır. Ayrıca Türkiye adına daha ayrıntılı bilgi edinmek amacıyla yapılan analiz sonuçları anne eğitim durumunun çocukların fen okur-yazarlıklarında anlamlı bir etkiye sahip olduğunu göstermektedir. Bu sebeple, ülke genelinde annelerin eğitime devam edebilmelerini teşvik etmek için aile eğitim programları tasarlanabilir. Bunun yanı sıra, okullarda eğitimlerine devam etmek isteyen anne-babalar için eğitim programları hazırlanabilir.

Son olarak cinsiyete bağlı olarak kız ve erkek öğrencilerin ortalama puanlarının birbirinden farklı olduğu ve ortalama olarak kız öğrencilerin puanlarının daha yüksek olduğu görülmüştür. Bu konuda aileler ve öğretmenler çocukların küçük yaşlardan itibaren eğilimlerini dikkatli bir şekilde takip etmeli ve gözlemlemedir. Öğretmenin cinsiyetten ve toplumdaki alışıla gelmiş bazı inanışlardan bağımsız olarak, çocuklara başarma duygusunu aktarması çok önemlidir. Bunların yanı sıra, araştırmalar küçük yaşlarda kız çocuklarının lego gibi 3 boyutlu oyuncakları tercih etmediklerini veya erkeklerin evcilik gibi oyunlarda yer almak istediklerini bu yüzden de ileriki yıllarda onların yaratıcılık ve problem çözme becerilerinin yeterince gelişmemesine neden olabileceğini söylemektedir (Alexandra, 2009). Bu sebeple, öğretmenler her türlü fen aktivitesi için çocuklara eşit fırsat sağlamada özen göstermelidir. Öğretmenler, hem

erkek hem de kız öğrencilerin aktif katılımı sağlamak amacıyla bir proje oluşturup, onların bir bütün olarak katılımını sağlayabilir.

İleriki Çalışmalar için Öneriler

İleriki çalışmalar için aşağıdaki öneriler sunulmuştur:

- Okul öncesi kamu harcamalarının eğitim başarısının artmasında önemli bir rol oynadığı mevcut çalışmada belirlendiğinden, bu kapsamda ülke genelindeki harcamanın ne kadar etkili yapıldığını araştıran çalışmalar yapmak faydalı olacaktır.

- Benzer bir çalışma, nitel analiz yöntemlerinden faydalanılarak yapılabilir. Böylece ülkeler arasındaki performans farkların nelerden kaynaklanabileceği daha ayrıntılı olarak incelenmiş olacaktır.
- Cinsiyete bağlı olarak görülen başarı farklarının, yaşa göre nasıl değiştiğini incelemek amacıyla, boylamsal çalışmalar yapılabilir. Bu sayede ne tür faktörlerin cinsiyete bağlı başarı üzerinde etkiye sahip olduğu incelenebilir.

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APPENDIX II

TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : KAYA

Adı : ELİF

Bölümü : İlköğretim Okul öncesi Öğretmenliği

TEZİN ADI: An Analysis of the Effectiveness of Quality Indicators in Early Childhood Education on Subsequent Science Competency on a Cross-Country and Turkish Case Basis

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamından kaynak göstermek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks, sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. ☐

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: