The Comparison of Turkish Students' PISA Achievement Levels by Year via Data Envelopment Analysis[*]

Seher YALÇIN[a]
Ankara University

Ezel TAVŞANCIL[b]
Ankara University

Abstract

This research aimed to determine the relative efficiency of the types of school common to three administrations of the PISA (2003-2006-2009) by comparing their results, along with the activities that are to be performed for inefficient school types and changes in the efficiency value of the school types by year. The comparative analysis was based on information obtained from student questionnaires and cognitive skills tests. Turkish students completing the PISA in 2003, 2006, and 2009 comprised the population of the survey-based study. In the study, the data obtained from the PISA tests were analyzed using Data Envelopment Analysis (DEA). The results of the study indicated that the differences in quality among high schools are still prominent. The low economic, social, and cultural index of the elementary-school-level students, and vocational high school students' inability to allocate sufficient time for study outside of school hindered these schools' efficiency, as shown in the three administrations of the PISA. Consequently, student achievement was found to vary by year, and variables to be increased or decreased for improved student success have been identified.

Key Words
DEA, PISA, School Type, Student Achievement.

Education is currently the most important component of economic and social development, and is in rapid and constant change worldwide. Education is one of the most effective tools of political, social, and cultural integration and management of changes (Milli Eğitim Bakanlığı [MEB], 2005a). Educational institutions aim to cultivate individuals able to respond to the requirements of the constantly changing world (Kutlu, Doğan, & Karakaya, 2008). Students' success in life depends on their attaining levels at which they are able to use the basic knowledge and skills they have learned during their school years (Berberoğlu, 2006). Looking at students' levels of success in their school lives, we can make some deductions for the power of rivalry in countries' future economy (Acar, 2008). By means of successful individuals will increase the workforce, which ensures the country's development. Students' academic success is considered an important representation of the effectiveness of the educational system in many countries. In the process of finding and improving

deficiencies in the educational system and its components, most decisions are made according to the findings obtained through objective instruments of measurement (MEB, 2010).

One of the examinations used by the Ministry of National Education to evaluate student success is international, and compared the educational system with those of other countries: The Program for International Student Assessment (PISA), prepared by the Organization for Economic Co-Operation and Development (OECD). The PISA is a study carried out every three year to evaluate students' knowledge in math, science, and reading skills, it evaluates how much knowledge 15-year-old students in the OECD and other participating countries have so that they can understand their place in the modern world (MEB, 2010).

Turkey participated in PISA in 2003 for the first time. The 2003 PISA results demonstrated math literacy; the average score was 425. According to the experts, this score is under even basic proficiency level. Although important reforms were made in 2006, results from that year were the same. In 2009, Turkey's PISA score increased from 425 to 446. From 2006, when the focus of field was science literacy, to the year 2009, Turkey has experienced a thirty score increase. In comparison to 2006 PISA scores, literacy scores increased by 17 (MEB, 2010). Although the scores increased, the position of Turkey in the international frame remained mostly unchanged. While Turkey stood between 37th and 44th positions among 75 countries in 2006, in 2009 Turkey remained in 41st and 43rd positions among 65 countries. The fact that the nation's standing did not change and that student success did not significantly improve should be analyzed by different statistics.

Curricula have always been the focus of developments in education, requests for change, and innovation (Sönmez, 1991). Turkey implemented new curricula to meet the educational goals of the European Union in 2004 (Akşit, 2007). In the revised curricula, the behaviorist approach was replaced by cognitive and constructivist approaches. According to constructivist learning theory, learning is not a passive process, but requires active student participation and is a continuous developmental process.

The revised curriculum assumes that active student participation in lessons will facilitate permanent learning and therefore increase success. Therefore, one of the variables used in the study is the active participation of the students in their lessons. This variable is defined as the opportunities teachers give students to speak their minds while discussing their coursework and it also includes the motivation the teacher provides for the students.

Another variable of this study is related to the time students spend studying outside the school. This variable is measured by taking the average number of hours of private courses outside school hours (either in school, home, or any other place), independent study, and doing homework. Student's active participation and time devoted to studying outside the school are the variables expected to contribute to increased levels of student success. Therefore, these variables are considered valuable for researchers.

One of the changes that the MEBs implemented according to the improvements plan and government programs is a study aimed to streamline the curricula and course variety in secondary schools. With this objective, the number of types of schools in Turkey will be reduced to 15, consistent with the philosophy "single management, many programs." (Gür & Çelik, 2009).

Previous PISA studies conducted in Turkey have focused primarily on the PISA 2003 and/or 2006 administrations and questionnaires, with the goal of discerning whether the impacts of mathematics/science/reading achievement can be detected by comparison of different techniques within a three-year period (Akyüz & Pala, 2010; Albayrak, 2009; Anıl, 2008, 2009; Aydın, Erdağ, & Taş, 2009; Aydoğdu, Aydın, & Dönmez, 2009; Berberoğlu & Kalender, 2005; Boztunç, 2010; Çifçi, 2006; Demir, Depren, & Kılıç, 2009; Depren, 2008; Dinçer & Kolaşin, 2009; Erbaş, 2005; Güzel, 2006; Özbaşı, Demirtaşlı, Kumandaş, & Yalçın, 2010; Özer, 2009; Şaşmazel, 2006; Tomul & Çelik, 2009; Usta, 2009; Uysal, Aydın, & Sarıer, 2009; Yıldırım, 2009) and the abroad (Afonso & Aubyn, 2005; Agasisti, in press; Cromley, 2009; Geske, Grinfelds, Dedze, & Zhang, 2006; Lynn & Mikk, 2009; Mancebón, Calero, Choi, & Perez, 2010; Nonoyama, 2005; Perelman & Santin, 2008; Salasvelasco, 2006; Sutherland, Price, Joumard, & Nicq, 2007; Wolfram, 2005; Xu, 2006). In Turkey, the research in which descriptive statistics are determined by multiple-variable variance analysis or multiple linear regression analysis have found that the levels of student success vary according to students' socioeconomic status, their parents' education level, and the type of school they attend. Furthermore, in the studies it was found out that there was no significant improvement in student success levels in these

years. In these studies, a single output variable (reading, math, or science) was used to limit the analysis. Furthermore, in the studies done carried out outside Turkey hierarchical linear modeling or data envelopment analysis were used to identify the factors efficient in changing student success, as well as changing student success itself, in different countries. Student success was has thus been seen to vary according the socioeconomic conditions and the parents' levels of education.

In the studies on PISA data in Turkey and abroad, parametric statistical methods and 2000, 2003 and/ or 2006 data were used. These studies commonly found that student success varied according to students' socioeconomic status of the student and parents' educational levels. In Turkey, a few studies (Demir & Depren, 2010; Depren, 2008) addressed DEA through PISA data, but many more of these studies (Afonso & Aubyn, 2005; Agasisti, in press; Cebada, Chaparro, & Gonzales, 2009; Ferrera, Cebada, Chaparro, & González, 2011; Mancebón et al., 2010) have been conducted abroad than in Turkey. This research aims to contribute to this work, using PISA data with the non-parametric method DEA. This study differs from previous ones in looking at other studies in a long-term comparison from 2003 to 2009. Also this study analyzes scores for reading, math, and science simultaneously. Moreover, in these studies, the variables that are efficient in increasing student success are emphasized, but recommended increases or decreases in the variables are not clearly stated (Yun, Nakayama, & Tanino, 2004).

1. It remains to be determined whether changes in available school types will affect student success. Likewise, it remains to be determined whether such changes will occur. The fact that student success is designated in terms of school years and the efficiency of educational investments are topics of growing interest worldwide. The results of the 2003 PISA, in which Turkey participated for the first time, triggered improvements to secondary school curricula. In this respect, the secondary school (6th, 7th, and 8th grades) curricula introduced in 2006 and the effects of education investments on students' academic success are two important issues to be kept in mind. Therefore, one must examine levels of success according to changes in school types and in particular through the comparison of primary school curricula introduced in 2006. This study addresses the following questions: For the periods of the 2003, 2006, and 2009 PISA,

a. Which were the efficient school types?

b. Which were the inefficient school types?

c. Which school or schools form the reference set of efficient and inefficient school types?

d. What should be required to the input levels and produce output levels for inefficient type/types of school?

2. What is the efficiency value of each school type in each year?

PISA results are a good predictor of student achievement, and the education system is of great importance for identifying problem points using long-term analysis of the PISA results. Studies using PISA data will be able to contribute to training policies and improving the quality and success rates in education and development.

The studies which use PISA data, one of the studies used internationally will be able to bring a contribution to training policies and improving the quality and success in education, development and robust aspects of the education system

This research is important because Turkish students' achievement levels on the PISA are compared by type of school and year (2003, 2006, and 2009). In other words, it can be concluded that the education system has a serious problem considering Turkey's PISA success in 2003, 2006, and 2009. For this reason, examining the PISA applications is crucial for determining problem points in the education system.

The findings of this study will be significant for useful to measurement and evaluation experts in situations that require multiple inputs (i.e, students' socio-economic status, the time students have available outside school for studying), outputs (i.e, students in math, science and reading achievement), and to those who wish to get better measurement results from their analytic work, particularly with studies analyzing multiple outputs as a single output. The fact that PISA applications include more than one input and output in different scales and that they benefit from DEA will better guide managers to understand the level of increase or decrease required in their inputs and outputs in inefficient units. It will also help us define the sources of the inefficiency by using the data from the 2009 PISA. This study will thus contribute to the field and will introduce the non-parametric method DEA to Turkey, where such studies are uncommon.

Some of the concepts used in this research can be found below:

Input: The economic, social, and cultural status index, the active participation of students in classes, and the time students have available outside school for studying. All of these were among the items from the student questionnaires in the 2003, 2006, and 2009 PISA.

Output: mathematics, science, and reading achievement scores from the 2003, 2006 and 2009 PISA.

Value Efficiency: The scores assigned to each student according to their success in math, science, and reading in relation the type of school attended.

Decision-Making Unit: The type of school according to the scores calculated among the schools administering the 2003, 2006, and 2009 PISA (Anatolian, science, general, Anatolian vocational, vocational high schools, and elementary school).

Method

Model of Research

This study used a survey model to reveal the existing status of PISA achievement among Turkish students by year.

Universe and Sampling

The subjects of the study were Turkish students participating in the 2003, 2006, and 2009 administrations of the PISA. This subject sample was determined by random sampling of students taken from the seven regions of Turkey in 2003, 2006, and 2009. For all three PISA administration periods, z scores have been calculated in relation to the common school types included in the PISA for mathematics, reading, and science achievement scores, and the data beyond the +3 and −3 range have been omitted from the analyses. After the removal of extreme values, 4637, 4592, and 4412 students were identified for 2003, 2006, and 2009 respectively (MEB, 2005b, 2007, 2010).

The Tools for Data Collection

The cognitive skill tests and student questionnaires used in the 2003, 2006, and 2009 PISA were also used as data collection tools in this study. In the PISA, different types of items are used. Most of these consist of simple multiple-choice, yes/no, or Agree/Disagree choice questions. The remaining items are open-ended and require students to give

their own short or long answers (MEB, 2010). The reliability and validity of PISA tests and questionnaires were determined using different approaches. For this reason, the views of experts, the average scores of the questions, and the answer codes were considered. The reliability coefficient was calculated with the Cronbach-alpha coefficient. For the 2003 PISA, this value was between 0.68 and 0.93 (OECD, 2005); for the 2006 PISA, it was between 0.76 and 0.92 (OECD, 2007), confirming its reliability.

Data Analysis

The data from the 2003, 2006, and 2009 PISA were taken from the official PISA website (www.pisa.oecd.org). For the first goal in the study, DEA was used. The economic, social, and cultural status index, the active participation of the students, and available time for studying outside of school were chosen as inputs in the PISA applications, and they were defined according to three cognitive skills (math, science and reading achievement scores), which were posited as outputs. The choice of DEA was made for several reasons: It helps multiple-single output analysis and also determines the steps for making inefficient schools efficient.

The second aim of the study was pursued using the Window Analysis, a DEA analysis developed by Charnes, Clark, Cooper, and Golany (1985), which is dependent on time. It is used to define how the efficiency value of time changes by year. In this analysis, for each decision-making unit, measured values are considered as if they were different decision-making units (Cooper, Seiford, & Zhu, 2004). The DEA is a linear-program-based method that aims to evaluate the performances of decision-making units at a time when different types of outputs and inputs make it difficult to make a comparison (Tarım, 2001; Thanassoulis, Portela, & Allen, 2004). The DEA is a non-parametric program developed to define the efficiency of decision-making units using linear programming (Aslankaraoğlu, 2006). The analyses in this is study followed the steps of the DEA (Kecek, 2010; Özyiğit, 2000), as shown below.

1. **Choosing the Decision-making Units:** In this study, the type of schools was the decision-making unit.

2. **Choosing the Input and Output:** Among the items found in the 2003, 2006, and 2009 PISA student questionnaires, the items believed to help determine the efficacy of the program

initiated in 2006 were chosen, along with the input variables. For input variables, the economic, social, and cultural index, the active participation of students in classes, and their available time to study outside of school were chosen. As the output variable, for each PISA period, math, science and reading achievement scores were chosen.

3. The Validity and the Availability of the Data

4. Choosing the DEA Model and Measuring the Relative Efficiency: DEA models can be divided into two groups: One focuses on input and the one on output. In this research, under the assumption of constant return to scale, the CCR model was identified and used as the best way to ensure the best output (Bektaş, 2007).

5. Efficiency Values: The type of school whose efficiency value is 1 is considered as efficient. The closer the value gets to 1, the more efficient the type of school will be.

6. Reference/Control Group: Applying the same methods used by efficient groups for inefficient groups is assumed to raise the level of efficiency of the latter.

7. Choosing Targets for Inefficient Units: Attainable targets are proposed to improve the performance of inefficient decision-making units (Aslankaraoğlu, 2006; Aydagün, 2003).

8. Evaluation of the Results

In this study, data obtained from the 2003, 2006, and 2009 PISA cognitive skills tests (mathematics, science, and reading) and student surveys were analyzed with SPSS (Version 17) and EMS programs v1.3.0 package (Scheel, 2000).

Results

In the three administrations of the PISA, the science high schools were found to be the most efficient school type. The Anatolian high schools were found efficient in the 2006 and 2009 PISA. Primary schools were the least efficient type of school in the three periods of the PISA. The low levels of active in-class participation and math scores of the Anatolian high school-level students lowered the efficiency of this school type in the 2003 PISA. Furthermore, the low economic, social, and cultural index and math scores of students in the General, Anatolian vocational, vocational high schools, and elementary schools lowered the efficiency of these schools in the 2003 PISA.

Efficiency Values by School Type According to the 2003 PISA, and Steps to Improve Efficiency

The only efficient school type according to the 2003 PISA was the science high schools. The school types, ranked by efficiency, are as follows: science, Anatolian, general, Anatolian vocational, vocational high, and primary schools. According to the results of current research, all inefficient school types should take the science high schools as a model. Relatively low math scores and low levels of student participation in the Anatolian high schools, along with the low ESCS scores, lowered the efficiency of these schools, while students in the other types of schools had lower math scores, which also lowered their efficiency.

Efficiency Values by School Type According to the 2006 PISA and Steps to Improve Efficiency

The science and Anatolian high school demonstrated 100% efficiency. Except for the Anatolian vocational high schools, all of the inefficient schools used the science high schools as their model. Anatolian vocational high schools should take both Anatolian and science high schools as their model. The lack of available study time outside of school and low math scores of students in the vocational and Anatolian vocational high schools lowered the efficiency of these school types, causing these students to have lower values than the students in general high schools with relatively low science and math scores.

The low ESCS values and low math scores of primary school students lowered the efficiency of their schools. Apart from the inefficient primary schools, all schools were given Anatolian high schools as well as Science high schools as models to emulate. We recommend that primary schools take both Anatolian high schools and Science high schools as their models. We also recommend that all school types, except for the Anatolian vocational high schools, take Anatolian high schools as their model, while primary schools should take science schools as their model.

Efficiency Values by School Type According to the 2009 PISA, and Steps to Improve Their Efficiency

The lack of available study time outside of class and low math scores of students of general and vocational high schools lowered the efficiency of Anatolian vocational high schools. Moreover, students with low ESCS values and math scores in vocational high schools and primary schools lowered the efficiency of these school types

Changes in Efficiency By Year According to the PISA

The efficiency values of primary schools and vocational high schools in 2006 decreased in 2009. The general and Anatolian vocational high schools increased their efficiency values from 2006 to 2009. According to the 2003 PISA, the school type showing the greatest increase in 2006 was the vocational high school. According to the 2006 PISA, the Anatolian vocational high schools showed the greatest increase in 2009 of all the school types.

Discussion

Student success varied annually. It remains to be determined which variables should be increased or decreased to improve student success. The findings gathered through the first analysis of 2003 PISA, in the studies of Berberoğlu and Kalender (2005), and Berberoğlu (2007); it has been suggested that general, vocational, and Anatolian high schools participating in the 2003 PISA showed low performance levels, with general high schools and primary schools in particular being below the international average and that science high schools and Anatolian high school showed consistently high performance levels. These findings parallel those of Depren (2008) for the best school types according to the 2003 PISA. Çifçi (2006) asserted that the students participating in the PISA 2003, are below the Turkish average, and the type of school affects student success.

In their findings for the 2006 PISA, Demir et al. (2009) suggested that the type of school has an effect on students' math scores, and the most efficient schools are the science high schools, followed by the Anatolian high schools. These findings parallel those of Albayrak (2009).

Dinçer and Kolaşin (2009) found that the success of individual schools varies significantly in Turkey. A report announced by the Education Reform Initiative (Eğitim Reformu Girişimi [ERI], 2011) showed that schools differed in socioeconomic conditions. A study by the Ministry of National Education (MEB, 2010) about the PISA studies showed that the differences between the schools and the school types are evident, and the effect of socioeconomic condition on the schools is clear. Student success varies by socioeconomic conditions, which is also seen in studies carried out in Turkey internationally on the PISA.

These findings suggest that the Ministry of National Education should improve the efficiency of the curriculum by aiming to decrease the curricula and number of school types nationwide if necessary. Equality of opportunity is not maintained under the current system, and the differences in quality affect students in high school entrance examinations. This study also suggests considering the socioeconomic conditions of students, some other precautions should be taken.

Future research can be conducted with different output variables. A nationwide comparison may be done if the data are made available. Since the names of the schools attending EARGED in 2009 weren't disclosed and the legal requirements of the PISA prevented school questionnaires from being included in this research, some questions remain. If the data are made public, they can be used in the school questionnaires. The increase in the decision-making units would make it possible to use more output and input variables and to make the efficiency values more distinguishable. Therefore, researchers can study different output and input variables by increasing the number of decision-making units (for example, considering each participating school a decision-making unit).

References/Kaynakça

Acar, O. (2008). *PISA sonuçları ışığında Türkiye'nin rekabet gücünün değerlendirilmesi*. Ankara: TEPAV. http://www.tepav.org.tr adresinden edinilmiştir.

Afonso, A., & St. Aubyn, M. (2006). Cross-country efficiency of secondary education provision: A semi-parametric analysis with non-discretionary inputs. *Economic Modelling, 23*(3), 476-491.

Agasisti, T. (in press). *The efficiency of Italian secondary schools and the potential role of competition: A data envelopment analysis using OECD-PISA 2006 data*. *Education Economics*.

Akşit, N. (2007). Educational reform in Turkey. *International Journal of Educational Development, 27,* 129-137.

Akyüz, G. ve Pala, N. M. (2010). PISA 2003 sonuçlarına göre öğrenci ve sınıf özelliklerinin matematik okuryazarlığına ve problem çözme becerilerine etkisi. *İlköğretim Online, 9*(2), 668-678, 2010. http://ilkogretim-online.org.tr adresinden edinilmiştir.

Albayrak, A. (2009). *PISA 2006 sınavı sonuçlarına göre Türkiye'deki öğrencilerin fen başarılarını etkileyen bazı faktörler* (Yüksek lisans tezi, Hacettepe Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Anıl, D. (2008). The analysis of factors affecting the mathematical success of Turkish students in the PISA 2006 evaluation program with structural equation modeling. *American-Eurasian Journal of Scientific Research, 3*(2), 222-227.

Anıl, D. (2009). Uluslararası öğrenci başarılarını değerlendirme programı (PISA)'nda Türkiye'deki öğrencilerin fen bilimleri başarılarını etkileyen faktörler. *Eğitim ve Bilim, 34*(152), 87-100.

Aslankaraoğlu, N. (2006). *Veri zarflama analizi ve temel bileşenler analizi ile Avrupa birliği ülkelerinin sıralanması* (Yüksek lisans tezi, Gazi Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Aydagün, A. (2003). *Veri zarflama analizi* (HUTEN Yıl Sonu Semineri). Hava Harp Okulu, Havacılık ve Uzay Teknolojileri Enstitüsü, İstanbul.

Aydın, A., Erdağ, C. ve Taş, N. (2009). 2003-2006 PISA okuma becerileri fen değerlendirme sonuçlarının karşılaştırmalı olarak değerlendirilmesi (Sınavda en başarılı beş OECD ülkesi-Türkiye örneği). *Kuramda ve Uygulamada Eğitim Bilimleri Dergisi, 11*, 2561-2572.

Aydoğdu, E., Aydın, A. ve Dönmez, A. (2009, Ekim). *2003-2006 PISA fen bilimleri sonuçlarının karşılaştırmalı olarak değerlendirilmesi (Sınavda en başarılı beş OECD ülkesi-Türkiye örneği)*. XVIII. Ulusal Eğitim Bilimleri Kurultayı'nda sunulan bildiri, Ege Üniversitesi, Eğitim Fakültesi, İzmir.

Bektaş, A. (2007). *Ankara'daki özel liselerin etkinliğinin veri zarflama analizi ile ölçümü* (Yüksek lisans tezi, Gazi Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Berberoğlu, G. (2006). *Sınıf içi ölçme ve değerlendirme teknikleri*. Ankara: Morpa Kültür Yayınları.

Berberoğlu, G. (2007). *Türk bakış açısından PISA araştırma sonuçları*. http://www.konrad.org.tr/Egitimturk/07girayberberoglu.pdf adresinden edinilmiştir.

Berberoğlu, G. ve Kalender, İ. (2005). Öğrenci başarısının yıllara, okul türlerine, bölgelere göre incelenmesi: ÖSS ve PISA analizi. *Eğitim Bilimleri ve Uygulama, 4*(7), 21-35.

Boztunç, N. (2010). *Uluslararası öğrenci değerlendirme programı (PISA)'na katılan Türk öğrencilerin 2003 ve 2006 yıllarındaki matematik ve fen bilimleri başarılarının incelenmesi* (Yüksek lisans tezi, Hacettepe Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Cebada, E. C., Chaparro, F. P., & Gonzales, D. S. (2009). *Comparing public-private school management through a new educational malmquist index approach*. Retrieved from http://2010.economicsofeducation.com/user/pdfsesiones/120.pdf

Cooper, W. W., Seiford, L. M., & Zhu, J. (2004). Data envelopment analysis: History, models and interpretations. In W. W. Cooper, L. M. Seiford, & J. Zhu (Eds.), *Handbook on data envelopment analysis* (pp. 1-39). New York: Kluwer Academic Publisher.

Cromley, J. G. (2009). Reading achievement and science proficiency: International comparisons from the programme on international student assessment. *Reading Psychology*, *30*, 89-118.

Çifçi, A. (2006). *PISA 2003 sınavı matematik alt testi sonuçlarına göre Türkiye'deki öğrencilerin başarılarını etkileyen bazı faktörlerin incelenmesi* (Yüksek lisans tezi, Hacettepe Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Demir, İ., & Depren, Ö. (2010). Assessing Turkey's secondary schools performance by different region in 2006. *Procedia Social and Behavioral Sciences, 2*, 2305-2309.

Demir, İ., Depren, Ö. ve Kılıç, S. (2009, Ekim). *Öğrencinin aile yapısının ve sahip olduğu imkanların matematikte başarılı olmasına etkileri*. Uluslararası 5. Balkan Eğitim ve Bilim Kongresi'nde sunulan bildiri. Trakya Üniversitesi Eğitim Fakültesi, Edirne.

Depren, Ö. (2008). *Veri zarflama analizi ve bir uygulama* (Yüksek lisans tezi, Yıldız Teknik Üniversitesi, İstanbul). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Dinçer, M. A. ve Kolaşin, U. G. (2009). *Çalışan annelerin çocukları daha başarılı*. İstanbul: Betam.

Eğitim Reformu Girişimi. (2011). *PISA 2009 sonuçlarına ilişkin değerlendirme*. http://erg.sabanciuniv.edu/sites/erg.sabanciuniv.edu/files/PISA2009DegerlendirmeNotu_Final_08022010.pdf adresinden edinilmiştir.

Erbaş, K. C. (2005). *Uluslararası öğrenci başarı belirleme programında (PISA) Türkiye'de fen okuryazarlığını etkileyen faktörler* (Yüksek lisans tezi, Orta Doğu Teknik Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Ferrera, J. M. C., Cebada, E. C., Chaparro, F. P., & González, D. S. (2011). Exploring educational efficiency divergences across Spanish regions in PISA 2006. *Revista de Economia Aplicada, 57*, 117-145.

Geske, A., Grinfelds, A., Dedze, I., & Zhang, Y. (2006). Family background, school quality and rural-urban disparities in student learning achievement in Latvia. *Prospects: Quarterly Review of Comparative Education, 36*(4), 419-432.

Gür, B. S. ve Çelik, Z. (2009). *Türkiye'de millî eğitim sistemi: Yapısal sorunlar ve öneriler*. Ankara: Siyaset, Ekonomi ve Toplum Araştırmaları Vakfı. http://www.setav.org/public/HaberDetay.aspx?Dil=tr&hid=27373 adresinden edinilmiştir.

Güzel, İ. Ç. (2006). *A cross-cultural comparison of the ımpact of human and physical resource allocations on student's mathematical literacy skills ın the programme for ınternational student assessment (PISA)* (Doktora tezi, Orta Doğu Teknik Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Kecek, G. (2010). *Veri zarflama analizi teori ve uygulama örneği*. Ankara: Siyasal Kitabevi.

Kutlu, Ö., Doğan, C. D. ve Karakaya, İ. (2008). *Öğrenci başarısının belirlenmesi: Performansa ve portfolyoya dayalı durum belirleme*. Ankara: PegemA Yayıncılık.

Lynn, R., & Mikk, J. (2009). Sex differences in reading achievement. *TRAMES, 13*(63/58), 3-13.

Mancebón, M. J., Calero, J. Choi, A., & Perez, D. (2010). The efficiency of public and publicly-subsidized high schools in Spain. Evidence from PISA-2006. *Munich Personal RePEc Archive*. Retrieved from http://mpra.ub.uni-muenchen.de/22354/1/MPRA_paper_22354.pdf

Milli Eğitim Bakanlığı. (2005a). *Talim Terbiye Kurulu program geliştirme çalışmaları*. http://ttkb.meb.gov.tr/programlar/prog_giris/prg_giris.pdf adresinden edinilmiştir.

Milli Eğitim Bakanlığı. (2005b). *PISA 2003 Uluslararası Öğrenci Değerlendirme Projesi Ulusal Nihai Rapor*. Ankara: Eğitim Araştırma ve Geliştirme Dairesi Yayınları. http://www.earged.meb.gov.tr/dosyalar%5Cdokumanlar%5Culuslararasi/pisa_2003_ ulusal_raporu.pdf adresinden edinilmiştir.

Milli Eğitim Bakanlığı. (2007). PISA *2006 Uluslararası Öğrenci Değerlendirme Projesi, Ulusal Ön Rapor*. Ankara: Eğitim Araştırma ve Geliştirme Dairesi Yayınları. http://www.earged.meb.gov.tr/ dosyalar/dokumanlar/uluslararasi/PISA2006.pdf adresinden edinilmiştir.

Milli Eğitim Bakanlığı. (2010). *PISA 2009 Uluslararası Öğrenci Değerlendirme Projesi, Ulusal Ön Rapor*. Ankara: Eğitim Araştırma ve Geliştirme Dairesi Yayınları. http://www.earged.meb.gov.tr/pdf/pisa2009rapor.pdf adresinden edinilmiştir.

Nonoyama, Y. (2005). *A Cross-national, multi-level study of family background and school resource effects on student achievement* (Doctoral dissertation, Columbia University). (UMI No. 3188772)

Organisation for Economic Co-operation and Development. (2005). *PISA 2003 technical report*. Paris: Author. Retrieved from http://www.oecd.org/dataoecd/49/60/35188570.pdf.

Organisation for Economic Co-operation and Development. (2007). *PISA 2005 technical report*. Paris: Author. Retrieved from http://www.oecd.org/dataoecd/0/47/42025182.pdf.

Özbaşı, D., Demirtaşlı, N., Kumandaş, H. ve Yalçın, N. (2010, Mayıs). *PISA uygulamasına katılan öğrencilerin ve ebeveylerinin demografik ve sosyo-ekonomik göstergelere ait özelliklerinin 2003 ve 2006 yılları arasındaki değişimi*. Eğitimde ve Psikolojide Ölçme ve Değerlendirme II. Ulusal Kongresi'nde sunulan bildiri, Mersin Üniversitesi, Eğitim Fakültesi, Mersin.

Özer, Y. (2009). *Uluslararası öğrenci değerlendirme programı (PISA) verilerine göre Türk öğrencilerin matematik ve fen bilimleri başarıları ile ilişkili faktörler* (Yüksek lisans tezi, Hacettepe Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Özyiğit, T. (2000). *Gelişmekte olan ülkelerin göreli sosyo-ekonomik performanslarının değerlendirilmesi* (Yüksek lisans tezi, Galatasaray Üniversitesi, İstanbul). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Perelman, S., & Santín, D. (2008). Measuring educational efficiency at student level with parametric stochastic distance functions: An application to Spanish PISA results. *Education Economics, 19*(1), 29-49.

Salasvelasco, M. (2006, August). *Do private schools produce better outcomes than public schools? Evidence for Spain*. Paper presented at the Aarhus School of Business, Aarhus, Denmark.

Scheel, H. (2000). *EMS: Efficiency measurement system users manual, Version 1.3*. Dortmund, Germany: Universität Dortmund.

Sönmez, V. (1991). *Eğitim felsefesi*. Ankara: Adım Yayıncılık.

Sutherland, D., Price, R., Joumard, I., & Nicq, C. (2007). *Performance indicators for public spending efficiency in primary and secondary education* (OECD Economics Department Working Papers, No. 546). OECD. Retrieved from http://dx.doi.org/10.1787/285006168603

Şaşmazel, G. A. (2006). *Uluslararası öğrenci başarı belirleme programında (PISA) Türk öğrencilerin fen bilgisi başarılarını etkileyen faktörler* (Yüksek lisans tezi, Hacettepe Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Tarım, A. (2001). *Veri zarflama analizi: Matematiksel programlama tabanlı göreli etkinlik ölçüm yaklaşımı*. Ankara: Sayıştay Yayın İşleri Müdürlüğü.

Thanassoulis, E., Portela, M. C., & Allen, R. (2004). Incorporating value judgment in DEA. In W. W. Cooper, L. M. Seiford, & J. Zhu (Eds.), *Handbook on data envelopment analysis* (pp. 132-216). New York: Kluwer Academic Publisher.

Tomul, E., & Çelik, K. (2009). The relationship between the students' academics achievement and their socioeconomic level: Cross regional comparison. *Procedia Social and Behavioral Sciences, 1*, 1199-1204.

Usta, H. G. (2009). *PISA 2006 sınav sonuçlarına göre Türkiye'deki öğrencilerin fen okuryazarlığını etkileyen faktörler* (Yüksek lisans tezi, Ankara Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Uysal, Ş., Aydın, A. ve Sarıer, Y. (2009, Ekim). *2003-2006 PISA matematik sonuçlarının karşılaştırmalı olarak değerlendirilmesi (Sınavda en başarılı beş OECD ülkesi-Türkiye örneği)*. XVIII. Ulusal Eğitim Bilimleri Kurultayı'nda sunulan bildiri, Ege Üniversitesi Eğitim Fakültesi, İzmir.

Wolfram, S. (2005). Measuring the socio-economic background of students and its effect on achievement on PISA 2000 and PISA 2003. *Annual Meeting of the American Educational Research Association, 7*-11.

Xu, J. (2006). *Families, investments in children and education: A cross-national approach*. Available from ProQuest Dissertations and Theses database. (UMI No. 3219909)

Yıldırım, K. (2009). *Uluslararası öğrenci değerlendirme programı (PISA) 2006 yılı verilerine göre Türkiye'de eğitimin kalitesini belirleyen temel faktörler* (Doktora tezi, Gazi Üniversitesi, Ankara). http://tez2.yok.gov.tr/ adresinden edinilmiştir.

Yun, Y. B., Nakayama, H., & Tanino, T. (2004). A generalized model for data envelopment analysis. *European Journal of Operational Research, 157*, 87-105.