Mevlana International Journal of Education (MIJE)
Vol. 2(2), pp. 50-66, 30 December, 2012
Available online at http://mije.mevlana.edu.tr/

Achievement Gaps Between Different School Types and Regions in Turkey: Have They Changed Over Time?

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Article history

Received:
09.11.2012

Received in revised form:
05.12.2012

Accepted:
07.12.2012

Key words:
PISA, achievement gap, Turkey, regional differences, types of schools

Common international student assessments have become a global phenomenon in recent years. Accordingly, there has been significant emphasis on students' performances on international assessments in Turkey. This study investigates the changes in Turkish students' achievement in PISA assessments between 2003 and 2009, with specific attention paid to the achievement gaps between students who reside in different regions and who attend different types of schools in order to explore the areas that policy makers need to focus on. The results indicate that the situation in terms of the achievement gaps between different types of schools does not seem very promising, although there are some positive signs regarding closing the achievement gaps between different regions. In this context, there is a need for special attention toward improving the quality of education at the lowest performing high schools, such as general high schools and vocational high schools, in order to increase Turkish students' average achievement.

Introduction

Beginning with the emergence of human capital theory, which emphasizes the importance of education and training for socio-economic well-being (Becker, 1993), the effect of educational attainment on both individuals' income and their countries' economic growth has been paid great attention in the literature. This attention, however, has recently switched from educational attainment to educational achievement because the cognitive skills that individuals possess are seen as a more direct measure of human capital (Hanushek & Woessmann, 2010). Recent literature has indicated that there is a strong link between student achievement and economic well-being at both the individual and national levels (Barro, 2001; Hanushek & Kimko, 2000; Hanushek & Woessmann, 2008; Tyler, Murnane, & Willett, 1999). It is further observed that the impact of students' achievement in international assessments on economic growth is stronger than the impact of educational attainment (Barro, 2001). As a result, the value of assessing students' cognitive skills has been realized by many countries around the world, and the idea of what students know has started to get more attention in comparison with knowing how long students spend in schools (Hanushek & Woessman, 2010).

Common international student assessments, such as the Programme for International Student Assessment (PISA), the Trends in International Mathematics and Science Study (TIMSS), and the

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Progress in International Reading Literacy Study (PIRLS), therefore, have become a global phenomenon because these assessments provide reliable data, which makes it possible to conduct various statistical analyses with the aim of understanding both the determinants of student achievement and its socio-economic outcomes. Thus, many countries around the world have increasingly participated in international assessments of math, science, and reading to better understand their students' performances in these important subjects and compare their achievement with the rest of the world (Hanushek & Woessmann, 2010). For example, the number of countries that participated in the last three PISAs was 41 in 2003, 57 in 2006, and 65 in 2009.

Turkey has also participated in some of the well-recognized international student assessments. So far, Turkey has participated in TIMSS (1999 and 2007), PIRLS (2001), and PISA (2003, 2006, and 2009). In these international student assessments, Turkey often places among the lowest performing countries. In addition to the low performances of Turkish students in general, significant inequalities between different student groups were also illustrated in the results of these assessments (Aksit, 2007; Dinçer & Kolaşin, 2009). Therefore, Turkey's disappointing performance in these assessments has become an important subject in educational policy debates and has been reported on intensively by media (Gür, Celik, & Özoğlu, 2012), similar to what happened in many other low-performing countries (Hanushek & Woessmann, 2010). The Turkish government was also displeased with this situation and responded quickly by changing the long-held curriculum in 2005 (Gür, et al., 2012). In addition, several educational projects with different goals, such as increasing secondary education from three to four years and promoting technology integration into education, have been initiated during the last decades in order to increase Turkish students' achievements in general and eliminate the achievement gaps between different student groups (Celen, Celik, & Seferoglu, 2011).

In this context, this study aims first to report the changes in Turkish students' achievements in mathematics, science, and reading over time by using the data from the first and last PISA studies (PISA 2003 and PISA 2009) in which Turkey participated. Second, it explores the achievement gaps between students who live in different regions and students who attend different types of schools in both assessments, and investigates how these gaps have changed over this period. Results of the study make it clear if the Turkish government's educational interventions in recent years have been successful in terms of increasing general student achievement and closing the achievement gaps between different student groups. The results will also explore the areas that need to be focused on by policy makers and researchers.

Achievement Gaps between Different Student Groups in Turkey

Beyond student achievement in general, the level of equality in the education sector is also recognized as an important factor that can facilitate the development of countries (Barro & Lee, 2000). Education is seen as one of the most effective ways by which the socio-economic disadvantages that children carry from their families can be eliminated. However, if the education sector in a country cannot provide equal educational opportunities to different socio-economic groups, it is hard to ensure social mobility in the society (Dinçer & Kolaşin, 2009). Therefore, education can play an important role in the economic development of countries, not only because it enhances the human capital, but also because it can either diminish or strengthen the social inequalities (Lee, 2002). Hence, in addition to their efforts to increase general educational achievement among their students, governments should also work hard to provide quality education equally to every child in their societies.

While the crucial nature of providing a high-quality education to every student regardless of their socio-economic background is well accepted and defended, it does not seem to be happening in

many countries. There is a large body of existing literature that uniformly suggests a strong link between students' socio-economic backgrounds and their academic achievement in many developing and developed countries (Chudgar & Luschei, 2009; Sirin, 2005). In this regard, Turkey is not an exception. According to the results of PISA 2009, for example, Turkey is among the OECD countries that show the highest variation between low and high socio-economic groups in terms of students' performances in math, science, and reading (OECD, 2010). Studies that have investigated the factors associated with Turkish students' performances on both national exams and international assessments have also found a significant relationship between students' socio-economic characteristics, such as parental education, parental occupation, home environment, distance from school, sibling size, etc., and their academic achievement (Anıl, 2009; Gelbal, 2008; Mohammmadi, Akkoyunlu, & Seker, 2011; Yalcin, Aslan, & Usta, 2012). In addition, regional and school-based inequalities in terms of students' academic performances are explicit in Turkey (Alacaci & Erbas, 2010; Berberoğlu & Kalender, 2005; Dinçer & Kolaşin, 2009; Erberber, 2009).

There have been significant disparities between regions of Turkey in terms of many educational indicators, such as average educational attainment, adult literacy, and school enrollment rates (MoNE, 2010; Tomul, 2007; UNESCO, 2010). Beyond the inequalities in these quantitative indicators, differences in the quality of education between Turkish regions are also verified by the current literature. The results of international student assessments have indicated great disparities between regions of Turkey in terms of student achievement. It has been observed that while Marmara, Aegean, and Central Anatolia regions have enjoyed with the highest average scores in these assessments, two eastern regions, Eastern Anatolia and Southeastern Anatolia, have experienced the lowest average scores. These results also perfectly align with the results of national exams, such as the secondary school selection and university entrance exams (Berberoğlu & Kalender, 2005; Karip & Apaydin, 2007; Sarier, 2010).

In addition to regional disparities, there are also massive achievement gaps between students who attend different types of schools in Turkey. Turkey had the largest variance internationally between schools in terms of students' performances in PISA 2003 (Alacaci & Erbas, 2010). Given the tracking system, which is based on a highly competitive selection exam after primary education, this result is not surprising. It has been observed that science high schools and Anatolian high schools, which generally accept the highest ranked students in the secondary school selection exam, perform best in both international assessments and national university entrance exams. On the other hand, the performances of students who attend general or vocational high schools are dramatically lower (Alacaci & Erbas, 2010; Berberoğlu & Kalender, 2005; Demir, Depren, & Kilic, 2010). It is also noteworthy that there is a strong association between students' socio-economic status and the types of schools that they attend in Turkey (Alacaci & Erbas, 2010). The reason for this situation might be that parents have to spend significant amounts of money and time on private schooling, tutoring, text books, etc., in order to have their children be successful in selection exams and attend better secondary schools. This, of course, gives an undeniable advantage to children who have more educated and affluent parents, and children who live in urban areas and more developed parts of the country.

Methodology

Data Source

PISA focuses on the capabilities of 15-year olds in three main subjects: mathematics, science, and reading. While the Turkish data for PISA 2003 had a sample of 4855 15-year-old students (2090 girls and 2765 boys) attending 7^{th} (n=27), 8^{th} (n=92), 9^{th} (n=191), 10^{th} (n=2863), 11^{th} (n=1670) and 12^{th}

(n=12) grades, PISA 2009 was collected from a sample of 4996 15-year-old-students (2418 girls and 2578 boys) attending 7th (n=35), 8th (175), 9th (n=1259), 10th (n=3327), 11th (n=190), and 12th grade (n=10).

Research Questions and Empirical Strategy

This study examines three main research questions: Have Turkish students' achievements on international assessments changed significantly from 2003 to 2009? Has the achievement gap among students from different regions changed significantly over this period in Turkey? Has the achievement gap among students from different types of schools changed significantly over this period in Turkey?

In order to answer these questions, an independent sample *t* test, *Cohen-d* effect size, and one-way analysis of variance (ANOVA) were conducted. In this study, *t* test evaluates the changes in the mean scores of each subject (math, reading, or science) from 2003 to 2009, as well as the mean differences between a pair of regions and between a pair of types of schools in both 2003 and 2009. *Cohen-d* effect size is applied to calculate the magnitude of the mean difference. ANOVA is conducted to examine the relationship between a subject and regions, and subject and types of schools. To do these analyses, SPSS and Microsoft Excel are used.

Findings

Changes in Students' Achievements in Turkey

Table 1 indicates whether students' achievements in math, reading, and science have changed over time in Turkey.

Table 1. Mean of Students' Achievement Scores in 2003 and 2009

Subjects		PISA-2003	PISA-2009	T-test	d-Effect size
Math	Mean	426.72	446.51	10.56*	0.21[1]
	SD	91.81	88.06		
Reading	Mean	443.52	465.71	13.56*	0.27[1]
	SD	84.79	77.56		
Science	Mean	436.14	455.36	11.84*	0.24[1]
	SD	85.89	75.09		

*p<0.01, [1]Small effect size

We conducted an independent sample *t* test to examine whether the students' achievements in math, reading, and science have significantly changed from PISA 2003 to PISA 2009, as shown at Table 1. The test results indicated that students' achievement in each subject significantly increased in PISA 2009 (t_{math}=10.56; t_{read}=13.56; $t_{science}$=11.84). However, their magnitude of increase is small, since the *Cohen-d* effect size was around 0.2 (d_{math}=0.21; $d_{reading}$=0.27; $d_{science}$=0.24).

Achievement Gap among Students from Different Regions over Time

This section focuses on the regional differences in student achievement in Turkey. We began by analyzing how students' achievements in the same region changed from 2003 to 2009. Then, we

investigated whether the achievement gaps between students from different regions changed over this period or not.

Within Group Analyses

First, an independent sample *t* test was applied to investigate the changes in students' achievement in each region between PISA 2003 and PISA 2009, as indicated at Table 2.

The findings showed that while students' achievements in Marmara Region had significantly increased only in reading, students' achievements in the other six regions had increased in at least two subjects from 2003 to 2009. According to Cohen-d effect size, the magnitudes of increase are small in all regions but Eastern Anatolia. Students' achievements in all three subjects have significantly increased with medium effect size from 2003 to 2009 in Eastern Anatolia region.

Table 2. Mean of Students' Achievement Scores among Regions

Regions	Subjects	PISA 2003	PISA 2009	T-test	d-Effect Size
Marmara	Math	445.48	447.37	0.54	0.02
	Reading	462.94	469.24	2.15*	0.08[1]
	Science	453.24	456.64	1.16	0.04
Aegean	Math	439.75	459.27	2.91*	0.16[1]
	Reading	454.85	470.6	1.79	0.10
	Science	446.91	460.75	1.98*	0.11[1]
Mediterranean	Math	419.93	460.74	6.52*	0.36[1]
	Reading	440.29	469.98	4.51*	0.25[1]
	Science	429.51	461.58	5.53*	0.30[1]
Central Anatolia	Math	447.12	460.25	2.03*	0.10[1]
	Reading	460.74	480.41	2.77*	0.14[1]
	Science	453.68	472.62	3.24*	0.16[1]
Black Sea	Math	419.51	450.21	4.59*	0.27[1]
	Reading	440.34	473.03	4.83*	0.28[1]
	Science	431.99	459.07	4.34*	0.26[1]
Eastern Anatolia	Math	361.4	424.34	8.22*	0.60[2]
	Reading	376.04	442.12	9.27*	0.68[2]
	Science	378.88	440.08	8.97*	0.66[2]
Southeastern Anatolia	Math	379.76	394.19	1.75	0.12
	Reading	394.2	423.82	3.74*	0.26[1]
	Science	392.7	411.41	2.46*	0.17[1]

*p<0.05
[1]Small effect size (d~0.2), [2]Medium effect size (d~0.5), [3]Large effect size (d>0.8)

Between Group Analyses

Math Achievement. A one-way analysis of variance was conducted to evaluate the relationship between students' math achievement and their regions in 2003 and 2009. The results of analyses showed that there was a significant relationship between students' performance in PISA and their regions of residence in both 2003 and 2009 ($F(6, 4848) = 64.75$, $p<0.0001$ and $F(6, 4989) = 39.88$, $p<0.0001$, respectively).

The strength of the relationship between math achievement and region, as assessed by η^2, is medium, accounting for 7% and 4% of the variance of math achievement in 2003 and 2009, respectively. This indicates that the impact of region on math achievement diminished from 2003 to 2009 in Turkey. More detailed analysis is given below to comprehend the difference of variance over time between regions.

Table 3 shows independent *t* test results, which illustrate the achievement gaps in math between different regions in both PISA 2003 (lower triangle) and PISA 2009 (upper triangle), whereas Table 4 indicates the magnitude (d-effect size) of the students' math achievement gaps in these assessments.

Table 3. T-test for Students' Math Achievement Gaps between Different Regions

2003 \ 2009	Ma.	Ae.	Me.	C. A.	B. S.	E. A.	S. A.
Marmara (Ma.)		2.92*	3.32*	3.43*	0.70	-4.57*	-11.46*
Aegean (Ae.)	-1.27		0.30	0.21	-1.83	-6.12*	-12.15*
Mediterranean (Me.)	-5.79*	-3.86*		-0.11	-2.14*	-6.41*	-12.49*
Central Anatolia (C.A.)	0.40	1.51	5.70*		-2.14*	-6.54*	-12.88*
Black Sea (B.S.)	-5.47*	-3.73*	-0.08	-5.43*		-4.50*	-10.35*
Eastern Anatolia (E.A.)	-15.36*	-12.90*	-9.77*	-14.87*	-9.30*		-4.93*
Southeastern Anatolia (S.A)	-11.84*	-9.77*	-6.63*	-11.54*	-6.30*	2.67*	

* $p<0.05$

There are 21 pairs of comparison for mean differences in students' math achievement between regions. Mean differences between four pairs of comparisons [(Ma., Ae.), (C.A., Ma.), (C.A., Ae.), (B.S., Me.)] were not significant in PISA 2003, while five of them [(Ma., B.S.), (Ae., Me.), (Ae., C.A.), (Ae., B.S), (Me., C.A.)] were not significant in PISA 2009. According to these results, the earlier interpretation is confirmed, and it seems that regional differences in student achievement have decreased, but have not completely been eliminated. Additionally, the students' math achievements in Eastern Anatolia and in Southeastern Anatolia, the two lowest performing regions, were statistically lower than all other regions not only in PISA 2003 but also in PISA 2009. Although Eastern Anatolia increased its performance in math with a medium effect size, it was not enough to close the achievement gaps between any region, but Southeastern Anatolia. The Eastern Anatolia region, in fact, has closed its achievement gap in Math with the Southeastern Anatolia region and even significantly outperformed it in 2009.

Table 4. Magnitudes of Regional Differences in Math Achievement

2003 \ 2009	Ma.	Ae.	Me.	C. A.	B. S.	E. A.	S. A.
Marmara (Ma.)		0.14[1]	0.16[1]	0.15[1]	0.03	-0.27[1]	-0.62[2]
Aegean (Ae.)	-0.06		0.02	0.01	-0.11[1]	-0.41[1]	-0.76[2]
Mediterranean (Me.)	-0.27[1]	-0.21[1]		-0.01	-0.12[1]	-0.42[1]	-0.77[2]
Central Anatolia (C.A.)	0.02	0.08	0.29[1]		-0.12[1]	-0.42[1]	-0.77[2]
Black Sea (B.S.)	-0.28[1]	-0.22[1]	0.00	-0.29[1]		0.30[1]	-0.65[2]
Eastern Anatolia(E.A.)	-0.89[3]	-0.82[3]	-0.62[2]	-0.91[3]	-0.62[2]		-0.35[1]
Southeastern Anatolia (S.A)	-0.70[2]	-0.64[2]	-0.43[2]	-0.72[2]	-0.42[2]	0.19[1]	

[1]Small effect size, [2]Medium effect size, [3]Large effect size

The differences in students' math achievement had small effect size among seven pairs of comparisons, had medium effect size among seven pairs of comparisons, and had large effect size among three pairs of comparisons in PISA 2003. In PISA 2009, twelve pairs of comparisons had small effect size, five of them had medium effect size, and no pairs of comparisons had large effect size. As seen, the magnitudes of the mean differences between regions also decreased from 2003 to 2009. This was mostly caused by the significant increase in the performance of the Eastern Anatolia region. The magnitudes of mean differences in students' math achievement between Eastern Anatolia and each of the other individual regions decreased significantly (from medium or large to small) from 2003 to 2009.

Reading Achievement. A one-way analysis of variance was conducted to evaluate the relationship between students' reading achievement and their regions in 2003 and 2009. The relationship between students' performance in PISA and their regions of residence was significant in both 2003 and 2009 ($F(6, 4848) = 89.8$, $p<0.0001$ and $F(6, 4989) = 35.24$), $p<0.0001$, respectively). In addition, η^2 was calculated to find the strength of the relationship between reading achievement and region. The results show that regions accounted for 10% and 4% of the variance of reading achievement in 2003 and 2009 respectively. It can be interpreted that the impact of region on students' achievement in reading also significantly decreased from 2003 to 2009, similar to the math achievement.

Table 5 presents students' achievement gaps in reading between different regions in PISA 2003 (lower triangle) and PISA 2009 (upper triangle), while Table 6 shows the magnitude (d-effect size) of these achievement gaps.

Table 5. T-test for Students' Reading Achievement from Different Regions

2003 \ 2009	Ma.	Ae.	Me.	C. A.	B. S.	E. A.	S. A.
Marmara (Ma)		0.38	0.21	3.35*	1.03	-6.10*	-11.09*
Aegean (Ae.)	-2.09*		-0.14	2.40*	0.55	-5.66*	-9.89*
Mediterranean (Me)	-6.01*	-3.32*		2.57*	0.70	-5.56*	-9.81*
Central Anatolia (C.A.)	-0.63	1.42	5.02*		-1.78	-7.90*	-12.50*
Black Sea (B.S.)	-5.57*	-3.13*	0.01	-4.70*		-6.08*	-10.29*
Eastern Anatolia (E.A.)	-18.57*	-15.18*	-12.55*	-17.19*	-12.04*		-3.39*
Southeastern Anatolia (S.A)	-14.49*	-11.56*	-8.90*	-13.34*	-8.55*	3.09*	

* $p<0.05$

Mean differences in students' reading achievements among three pairs of comparisons [(C.A., Ma.), (C.A., Ae.), (B.S., Me.)] were not significant in PISA 2003, while seven of them [(Ma., B.S.), (Ma., Me.), (Ma., BS.), (Ae., Me.), (Ae., B.S.), (Me., B.S.), (C.A., B.S.)] were not significant in PISA 2009. As seen, the effect of region on students' reading achievement also decreased. Similar to the results of the students' math achievements, their reading achievements in Eastern Anatolia and in Southeastern Anatolia were significantly lower than the other individual regions in not only PISA 2003 but also in PISA 2009.

Table 6. Magnitude of Regional Differences in Reading Achievement

2003 \ 2009	Ma.	Ae.	Me.	C. A.	B. S.	E. A.	S.A
Marmara (Ma.)		0.02	0.01	0.15[1]	0.05	-0.36[2]	-0.60[2]
Aegean (Ae.)	-0.10[1]		-0.01	0.13[1]	0.03	-0.38[2]	-0.62[2]
Mediterranean (Me.)	-0.28[1]	-0.18[1]		0.14[1]	0.04	-0.37[2]	-0.61[2]
Central Anatolia (C.A.)	-0.03	0.07	0.25[1]		-0.10[1]	-0.50[2]	-0.75[2]
Black Sea (B.S.)	-0.28[1]	-0.18[1]	0.00	-0.25[1]		-0.41[2]	-0.65[2]
Eastern Anatolia (E.A.)	-1.08[3]	-0.98[3]	-0.80[3]	-1.05[3]	-0.80[3]		-0.24[1]
Southeastern Anatolia (S.A)	-0.85[3]	-0.75[2]	-0.57[2]	-0.83[3]	-0.57[2]	0.23[1]	

[1]small effect size, [2]medium effect size, [3]large effect size

Table 6 shows the magnitudes of mean differences in reading between regions over time. Mean differences in students' reading achievement among eight pairs of comparisons had small effect size, three pairs of comparisons had medium effect size, and seven pairs of comparisons had large effect size in PISA 2003. In PISA 2009, five pairs of comparisons had small effect size and ten of them had medium effect size, while no pair had large effect size. Similar to the findings related to math achievement, the magnitudes of mean differences in students' reading achievement between regions significantly diminished. Specifically, students' reading achievement between Eastern Anatolia and

each of the other individual regions decreased significantly (from large to medium) from 2003 to 2009, and Eastern Anatolia started to outperform Southeastern Anatolia in 2009.

Science Achievement. A one-way analysis of variance was conducted to evaluate the relationship between students' science achievement and their region in 2003 and 2009. The relationship between students' science achievement and their regions of residence was significant in both 2003 and 2009, ($F(6, 4848) = 66.34$, $p<0.0001$ and $F(6, 4989) = 37.74$), $p<0.0001$, respectively). The strength of the relationship between science achievement and regions is assessed by η^2. Results indicated that regions accounted for 7% and 4% of the variance of science achievement in 2003 and 2009, respectively. Again, it seems that the effect of region on students' achievement in science decreased from 2003 to 2009.

Table 7 presents achievement gaps between students from different regions in PISA 2003 (lower triangle) and PISA 2009 (upper triangle), while Table 8 shows the magnitude (d-effect size) of the students' science achievement gaps in PISA 2003 (lower triangle) and PISA 2009 (upper triangle).

Table 7. T-test for Students' Science Achievement from Different Regions

2003 \ 2009	Ma.	Ae.	Me.	C. A.	B. S.	E. A.	S. A.
Marmara (Ma.)		1.18	1.43	4.96*	0.68	-3.86*	-11.43*
Aegean (Ae.)	-1.60		0.20	3.00*	-0.40	-4.25*	-10.79*
Mediterranean (Me.)	-6.13*	-3.86*		2.81*	-0.60	-4.44*	-11.03*
Central Anatolia (C.A.)	0.10	1.56	5.76*		-3.38*	-6.95*	-13.98*
Black Sea (B.S.)	-5.10*	-3.13*	0.53	-4.84*		-3.87*	-10.31*
Eastern Anatolia (E.A.)	-15.48*	-12.76*	-9.63*	-14.77*	-9.69*		-5.49*
Southeastern Anatolia (S.A)	-12.44*	-10.06*	-6.92*	-11.89*	-7.10*	2.29*	

* $p<0.05$

The mean differences in students' science achievement (Table 7) are very similar to the ones in their math achievement (Table 5). The mean difference in students' science achievement among four pairs of comparisons [(Ae., Ma.), (C.A., Ma.), (C.A., Ae.), (B.S, Me.)] were not significant in PISA 2003, while six of them [(Ma., Ae.), (Ma., Me.), (Ma., BS.), (Ae., Me.), (Ae., B.S.), (Me., B.S.)] were not significant in PISA 2009. Additionally, similar to students' math and reading achievements, their science achievement in Eastern Anatolia and in Southeastern Anatolia was statistically lower than all other regions in both PISA 2003 and PISA 2009.

Table 8. Magnitude of Regional Differences in Science Achievement

2003 \ 2009	Ma.	Ae.	Me.	C. A.	B. S.	E. A.	S. A.
Marmara (Ma.)		0.06	0.07	0.22[1]	0.03	-0.23[1]	-0.62[2]
Aegean (Ae.)	-0.08[1]		0.01	0.16[1]	-0.02	-0.28[2]	-0.67[2]
Mediterranean (Me.)	-0.29[1]	-0.21[1]		0.15[1]	-0.03	-0.29[2]	-0.68[2]
Central Anatolia (C.A.)	0.00	0.09	0.29[1]		-0.18[1]	-0.44[2]	-0.83[3]
Black Sea (B.S.)	-0.26[1]	-0.18[1]	0.03	-0.26[1]		-0.26[1]	-0.65[2]
Eastern Anatolia (E.A.)	-0.90[3]	-0.82[3]	-0.61[2]	-0.90[3]	-0.64[2]		-0.39[1]
Southeastern Anatolia (S.A)	-0.73[2]	-0.66[2]	-0.45[2]	-0.73[2]	-0.48[2]	0.17[1]	

[1]small effect size, [2]medium effect size, [3]large effect size

Table 8 illustrates the effect size of mean differences in students' science achievement between regions. While mean differences in students' science achievement among seven pairs of comparisons had small effect size, six pairs of comparisons had medium effect size, and three pairs of comparisons had large effect size in PISA 2003. In PISA 2009, seven pairs of comparisons had small effect size, seven of them had medium effect size, and one had large effect size. The magnitude of mean differences in students' science achievement between Eastern Anatolia and other individual regions also decreased (from large to medium or medium to small) from 2003 to 2009. This result is also similar to those regarding to students' math and reading achievements.

Achievement Gaps among Students from Different Types of Schools over Time

This section examines whether the achievement gaps among students from different types of schools has changed over time in Turkey. There are eight types of Turkish schools in PISA data. While only one is a junior high school, the others are different types of high schools. We began with analyzing how students' achievements from the same type of school have changed over time.

Within Group Analyses

An independent sample *t* test was applied to investigate the achievements of students from different types of schools in PISA 2003 and PISA 2009, as indicated at Table 9. The findings showed that while students' achievement in junior high school and Anatolian Vocational high school significantly increased in only one subject (math), students' performances from General high schools, Anatolian high schools, Anatolian technical high schools, and Vocational high schools increased at least in two subjects. However, performances from students in Science high schools significantly decreased in all three subjects, while performances from students in Technical high schools decreased in two subjects and performances from students in Anatolian vocational high schools decreased in one subject.

Table 9. Changes in Students' Achievement in Different Types of Schools

Type of School	Subject	PISA-2003	PISA-2009	T-test	d-Effect Size
Junior High School	Math	308.20	326.99	2.29*	0.29[1]
	Reading	329.47	332.88	0.45	0.06
	Science	333.13	335.10	0.27	0.03
General High School	Math	401.06	436.09	16.47*	0.51[2]
	Reading	421.84	464.06	20.94*	0.64[2]
	Science	414.39	448.10	17.99*	0.55[1]
Anatolian High School	Math	539.69	566.57	4.81*	0.38[1]
	Reading	537.93	551.79	2.69*	0.21[1]
	Science	541.99	548.12	1.2	0.10[1]
Science High School	Math	695.55	614.14	-10.07*	-1.62[3]
	Reading	646.14	570.17	-10.44*	-1.68[3]
	Science	670.49	578.00	-13.07*	-2.10[3]
Vocational High School	Math	365.07	394.40	9.88*	0.49[2]
	Reading	395.05	424.01	9.7*	0.48[2]
	Science	380.10	415.72	13.3*	0.65[2]
Anatolian Vocational High School	Math	457.12	444.64	-2.04*	-0.15[1]
	Reading	478.06	484.92	1.28	0.09
	Science	463.50	465.78	0.42	0.03
Technical High School	Math	463.37	468.99	0.51	0.08
	Reading	462.95	439.44	-2.26*	-0.37[1]
	Science	459.43	443.70	-1.6*	-0.26[1]
Anatolian Technical High School	Math	452.85	466.01	1.99*	0.21[1]
	Reading	459.07	467.23	1.42	0.15[1]
	Science	451.83	469.38	2.9*	0.31[1]

*$p<0.05$
[1]Small effect size, [2]Medium effect size, [3]Large effect size

Between Group Analyses

Math Achievement. A one-way analysis of variance was conducted to evaluate the relationship between students' math achievement and the type of school that they attended in 2003 and 2009. The relationship between math scores and type of school was significant in both 2003 and 2009 ($F(7, 4223) = 310.11$, $p<0.0001$ and $F(7, 4688) = 765.95$), $p<0.0001$, respectively).

The strength of the relationship between math achievement and type of school, assessed by η^2, is large, with type of schools accounting for 34% and 53% of the variance of math achievement in 2003 and 2009 respectively. The effect of the type of school that students attend on their achievement has significantly increased in Turkey. More detailed analysis is given below to comprehend the difference of variance for math achievement over time among different types of schools.

Table 10 shows independent *t* test results to investigate the achievement gaps in math between students from different types of schools in PISA 2003 (lower triangle) and PISA 2009 (upper triangle), whereas Table 11 indicates the magnitudes (d-effect size) of these gaps.

Table 10. T-test for High Schools' (HS) Differences in Math Scores

2003 \ 2009	1	2	3	4	5	6	7	8
Junior HS (1)		20.34*	42.68*	36.02*	12.36*	19.31*	14.48*	18.99*
General HS (2)	12.85*		50.58*	28.62*	-18.86*	2.44*	3.90*	5.58*
Anatolian HS (3)	25.97*	24.47*		7.39*	-62.34*	-31.47*	-11.34*	-17.92*
Science HS (4)	32.29*	29.97*	14.01*		-34.89*	-24.71*	-14.10*	-18.58*
Vocational HS (5)	7.38*	-10.38*	-27.89*	-32.46*		13.8*	8.78*	13.13*
Anatolian Vocational HS (6)	18.7*	13.98*	-12.55*	-22.97*	19.11*		2.73*	3.51*
Technical HS (7)	15.67*	8.75*	-8.65*	-19.47*	12.93*	0.79		-0.30
Anatolian Technical HS (8)	16.96*	10.27*	-11.97*	-22.43*	15.39*	-0.71	-1.25	

* $p<0.05$

There are 28 pairs of comparison for type of school differences in students' math achievement. The mean differences among three pairs of comparisons [(6, 7), (6, 8), (7, 8)] were not significantly different in PISA 2003, while only one of them [(7, 8)] was not significantly different in PISA 2009. Thus, it seems that the achievement gaps between different types of schools in Turkey have not decreased and even became larger in 2009 compared to 2003.

Table 11. Magnitude of High Schools' (HS) Differences in Math Scores

2003 \ 2009	1	2	3	4	5	6	7	8
Junior HS (1)		1.80[3]	3.95[3]	4.74[3]	1.11[3]	1.94[3]	2.34[3]	2.29[3]
General HS (2)	1.21[3]		2.15[3]	2.94[3]	-0.69[2]	0.14	0.54[2]	0.49[2]
Anatolian HS (3)	3.01[3]	1.80[3]		0.78[3]	-2.84[3]	-2.01[3]	-1.61[3]	-1.66[3]
Science HS (4)	5.03[3]	3.82[3]	2.02[3]		-3.63[3]	-2.80[3]	-2.40[3]	-2.44[3]
Vocational HS (5)	0.74[2]	-0.47[2]	-2.27[3]	-4.29[3]		0.83[3]	1.23[3]	1.18[3]
Anatolian Vocational HS (6)	1.93[3]	0.73[2]	-1.07[3]	-3.10[3]	1.20[3]		0.40[1]	0.35[1]
Technical HS (7)	2.01[3]	0.81[3]	-0.99[3]	-3.02[3]	1.28[3]	0.08		-0.05
Anatolian Technical HS (8)	1.88[3]	0.67[2]	-1.13[3]	-3.15[3]	1.14[3]	-0.06	-0.14	

[1]small effect size, [2]medium effect size, [3]large effect size

Table 11 shows the magnitude of mean difference in math scores between different types of schools over time. While the mean difference in students' math achievement among four pairs of comparisons had medium effect size [(5, 1), (5, 2), (8, 2)], all other comparisons had large effect size in PISA 2003. For PISA 2009, two pairs of comparisons had small effect size [(6, 7), (6, 8)], three of them had medium effect size [(2, 5), (2, 7), (2, 8)], and all others had large effect size.

Reading Achievement. A one-way analysis of variance was conducted to evaluate the relationship between students' reading achievement and type of school that they attended in 2003 and 2009. The relationship between reading scores and type of school was significant in both 2003 and 2009 ($F(7, 4223) = 310.11$, $p<0.0001$ and $F(7, 4688) = 765.95$), $p<0.0001$, respectively). The strength of the relationship between reading achievement and type of schools, assessed by η^2, is large, accounting for 30% and 41% of the variance of reading achievement in 2003 and 2009 respectively. The effect of the type of school students attend on their reading achievement increased from 2003 to 2009, similar to results regarding math achievement.

Table 12 shows independent *t* test results to investigate students' reading achievement gaps between different types of schools in PISA 2003 (lower triangle) and PISA 2009 (upper triangle), whereas Table 13 indicates the magnitude (d-effect size) of the students' reading achievement gap between different types of schools in PISA 2003 (lower triangle) and PISA 2009 (upper triangle).

Table 12. T-test for High Schools' (HS) Differences in Reading Scores

2003 \ 2009	1	2	3	4	5	6	7	8
Junior HS (1)		24.96*	39.08*	30.38*	17.06*	25.47*	11.09*	18.73*
General HS (2)	14.34*		34.71*	17.41*	-18.49*	6.08*	-2.98*	0.60
Anatolian HS (3)	26.25*	23.00*		2.92*	-47.23*	-17.61*	-13.33*	-15.37*
Science HS (4)	29.63*	25.62*	10.92*		-23.69*	-12.69*	-12.96*	-13.18*
Vocational HS (5)	9.55*	-8.67*	-25.61	-27.68*		17.8*	1.85*	8.09*
Anatolian Vocational HS (6)	20.94*	15.74*	-10.21*	-18.17*	19.34*		-5.20*	-2.96*
Technical HS (7)	15.13*	6.48*	-9.54*	-17.24*	10.03*	-2.16*		2.89*
Anatolian Technical HS (8)	17.05*	8.29*	-12.20*	-19.40*	12.59*	-3.52*	-0.52	

* $p<0.05$

The mean differences between only one pair of comparisons was not significantly different in both PISA 2003 and PISA 2009 [(7, 8) and (2, 8), respectively)].

Table 13 shows the magnitude of mean differences in reading scores among the different types of schools over time. While the mean differences in students' reading achievement among two pairs of comparisons had small effect size and three of them had medium effect size, all other comparisons had large effect size but (7, 8) in PISA 2003. For PISA 2009, three pairs of comparisons had small effect size, five of them had medium effect size, and all others had large effect size, but (2, 8).

Table 13. Magnitude of High Schools' (HS) Differences in Reading Scores

2003 \ 2009	1	2	3	4	5	6	7	8
Junior HS (1)		2.21[3]	3.69[3]	4.00[3]	1.54[3]	2.56[3]	1.79[3]	2.26[3]
General HS (2)	1.35[3]		1.48[3]	1.79[3]	-0.67[2]	0.35[1]	-0.42[2]	0.05
Anatolian HS (3)	3.04[3]	1.69[3]		0.31[1]	-2.15[3]	-1.13[3]	-1.89[3]	-1.42[3]
Science HS (4)	4.62[3]	3.27[3]	1.58[3]		-2.46[3]	-1.44[3]	-2.20[3]	-1.73[3]
Vocational HS (5)	0.96[3]	-0.39[2]	-2.08[3]	-3.66[3]		1.03[3]	0.26[1]	0.73[2]
Anatolian Vocational HS (6)	2.17[3]	0.82[3]	-0.87[3]	-2.45[3]	1.27[3]		-0.77[2]	-0.30[1]
Technical HS (7)	1.95[3]	0.60[2]	-1.09[3]	-2.67[3]	0.99[3]	-0.22[1]		0.47[2]
Anatolian Technical HS (8)	1.89[3]	0.54[2]	-1.15[3]	-2.73[3]	0.93[3]	-0.28[1]	-0.06	

[1]small effect size; [2]medium effect size; [3]large effect size

Science Achievement. A one-way analysis of variance was conducted to evaluate the relationship between students' science achievement and type of school in 2003 and 2009. There was a significant relationship between science scores and type of school in 2003 and 2009 ($F(7, 4223) = 310.11$, $p<0.0001$ and $F(7, 4688) = 765.95$), $p<0.0001$, respectively).

The strength of the relationship between science achievement and type of school, assessed by η^2, is large, with type of school accounting for 35% and 46% of the variance of science achievement in 2003 and 2009 respectively. More detailed analysis is given below to understand the difference of variance for science achievement over time among types of schools.

Table 14 shows independent *t* test results to investigate students' science achievement gap from different types of schools between PISA 2003 (lower triangle) and PISA 2009 (upper triangle), whereas Table 15 indicates the magnitude (d-effect size) of the students' science achievement gap between PISA 2003 (lower triangle) and PISA 2009 (upper triangle).

Table 14. T-test for High Schools' (HS) Differences in Science Scores

2003 \ 2009	1	2	3	4	5	6	7	8
Junior HS (1)		22.99*	41.42*	33.26*	14.14*	23.41*	12.09*	20.01*
General HS (2)	13.01*		42.32*	22.08	-15.99*	5.51*	-0.57	4.33*
Anatolian HS (3)	27.12*	26.07*		5.07*	-52.33*	-23.19*	-13.25*	-15.31*
Science HS (4)	32.56*	30.17*	13.37*		-28.13*	-17.86*	-14.24*	-14.87*
Vocational HS (5)	7.06*	-11.14*	-29.93*	-33.02*		15.01*	3.59*	10.74*
Anatolian Vocational HS (6)	8.95*	14.18*	-13.81*	-23.09*	20.04*		-2.70*	0.64
Technical HS (7)	4.77*	7.33*	-10.83*	-20.48*	12.08*	-0.60		2.86*
Anatolian Technical HS (8)	6.11*	8.59*	-14.39*	-23.40*	14.55*	-2.23*	-1.04	

* $p<0.05$

Mean differences among three pairs of comparisons [(6, 7), (6, 8)] were not significant in PISA 2003, while only one of them (6, 8) was not significant in PISA 2009.

Table 15 shows the magnitudes of mean differences in students' science achievement between different types of schools over time. The mean differences in students' science achievement among three pairs of comparisons [(6, 7), (6, 8), (7, 8)] were not significant, five of them had medium effect size, and all others had large effect size in PISA 2003. For PISA 2009, only one pair of comparisons (6, 8) was not significant, four of them had small effect size [(2, 6), (2, 8), (6, 7), (7, 8)]; three of them had medium effect size [(2, 5), (3, 4), (5, 7)], and all other comparisons had large effect size.

Table 15. Magnitude of High Schools' (HS) Differences in Science Scores

2003 \ 2009	1	2	3	4	5	6	7	8
Junior HS (1)		2.03[3]	3.84[3]	4.37[3]	1.45[3]	2.35[3]	1.96[3]	2.42[3]
General HS (2)	1.22[3]		1.80[3]	2.34[3]	-0.58[2]	0.32[1]	-0.08	0.38[1]
Anatolian HS (3)	3.14[3]	1.92[3]		0.54[2]	-2.38[3]	-1.48[3]	-1.88[3]	-1.42[3]
Science HS (4)	5.07[3]	3.85[3]	1.93[3]		-2.92[3]	-2.02[3]	-2.42[3]	-1.96[3]
Vocational HS (5)	0.71[2]	-0.52[2]	-2.43[3]	-4.37[3]		0.90[3]	0.50[2]	0.97[3]
Anatolian Vocational HS (6)	1.96[3]	0.74[2]	-1.18[3]	-3.11[3]	1.25[3]		-0.40[1]	-0.06
Technical HS (7)	1.90[3]	0.68[2]	-1.24[3]	-3.17[3]	1.19[3]	-0.06		0.46[1]
Anatolian Technical HS (8)	1.79[3]	0.56[2]	-1.36[3]	-3.29[3]	1.08[3]	-0.18	-0.11	

[1]small effect size; [2]medium effect size; [3]large effect size

Conclusions

It is verified by extant research that the quality of education people receive has prominent impacts on their own economic well being as well as on their country's economic growth. Thus, both researchers and policy makers have started to pay special attention to students' achievement in their countries. In addition, the importance of closing the achievement gaps between different student groups is well-recognized. In this context, this study investigates the changes in Turkish students' achievement on PISA assessments between 2003 and 2009. Specific attention was also paid to the achievement gaps between students who reside in different regions and who attend different types of schools. Changes in these achievement gaps from 2003 to 2009 were also investigated.

In general, Turkish students' performances in all three subjects—Math, Science, and Reading, were significantly increased in PISA 2009 compared to PISA 2003, but the magnitudes of these increases were small. This result suggests that although there are some positive signs of improvement, there is a need for more effort to increase students' achievement in Turkey since Turkey is still among the lowest performing countries in international student assessments. According to the results of the further statistical analyses, the regional differences regarding students' achievement in all three subjects have started to diminish in Turkey. Interestingly, students from the Eastern Anatolia region, which was the lowest performing region in PISA 2003, show the highest increase in their performances. The Eastern Anatolia region not only outperformed the Southeastern Anatolia region, but also started to decrease

the magnitudes of the achievement gaps with the western regions of Turkey in PISA 2009. Although there are small increases in their performances, students from the Southeastern Anatolia region could not show enough improvement to close the extensive achievement gaps that they have had with the other regions of Turkey.

Beyond this, the results of the analyses related to achievement gaps between students from different types of schools are not encouraging at all. There is not enough evidence to suggest that the achievement gaps between different types of schools are going to diminish in the near future. Interestingly, however, students' achievement in Science high schools, which had the highest average scores in all three subjects, significantly decreased with large effect sizes in PISA 2009. This result can be explained by the increase in the numbers of Science high schools in Turkey during the last decade. Many new Science high schools were opened, especially in less developed parts of Turkey. Thus, it is reasonable to see these decreases in their average score.

In sum, it can be concluded that Turkey has been making strides in increasing students' achievement during the last several years. However, significant achievement gaps between different student groups, specifically between regions and different types of schools, still exist. Although there are some positive signs regarding closing the achievement gaps between different regions, the situation in terms of the achievement gaps between different types of schools does not seem very promising. In this context, it is important for policy makers to take necessary actions to provide quality education to all students regardless of their region of residence and types of school that they attend. Specifically, there is a need for special attention to be paid to the quality of education at the lowest performing high schools, such as general high schools and vocational high schools, in order to increase Turkish students' average achievement. In addition, the situation in the Southeastern Anatolia region should be more closely investigated and necessary supports should be provided to increase student achievement in this region.

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