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# Where Do the Turkish Students Stand According to Their Success in Math and Science when Compared to 38 Countries

# Türk Öğrencilerinin Başarıları Matematik ve Fen Notlarına Göre 38 Ülkeyle Kıyaslandığında Nerededir?

**Nesrin Oruç***

**ABSTRACT**

The relationship between the developmental level of a country, the GNI per capita as a demographic variable, the number of computers per 1000 people, the total expenditure on education and yearly amount of instructional time for math and science were the variables that the effects of which on the scores of the 8th grade students of 38 countries and how these affect the students' success were analyzed. At the end of the paper, there is a comparison between the Turkish students' scores and the scores of the other countries. Most part of the data came from Digest of Education 2002. Other than that, OECD's and World Bank's web sites and TIMSS report were also used to obtain the data for the instructional time for math and science.

**Keywords**: Student Success, Turkish students, OECD

**ÖZET**

8. sınıf öğrencilerinin Matematik ve Fen derslerinde; ülkenin gelişmişlik düzeyi, kişi başına düşen Gayrisafi Milli Hâsıla, 1000 kişiye düşen bilgisayar sayısı, eğitime harcanan toplam gider ve yıllık ders saatleri bazında 38 ülke kıyaslanmış ve her bir etmenin başarı üzerinde ki etkisi araştırılmıştır. Makalenin sonunda, Türk öğrencilerin ve diğer ülke öğrencilerinin bir kıyaslaması yapılmıştır. Analiz için gerekli bilginin büyük bir kısmı Digest of Education 2002'den alınmıştır. Bunun yanında; Dünya Bankası ve TIMMS raporları da Matematik ve Fen derslerine ait notların veri toplamında kullanılmıştır.

**Anahtar Kelimeler**: Öğrenci Başarısı, Türk Öğrenciler, OECD.

## Introduction

Digest of Education[1], being published by the National Center for Education Statistics every year, provides data on education from all over the world. Other than Digest of Education, OECD's and World Bank's web sites were used to find out the list of developing and developed countries and the other related data. TIMSS report was also used to obtain the data for the instructional time for math and science. The aim of the paper in hand is to compare the success of the 8th grade Turkish students' math and science scores with 38 countries. These countries are; Australia, Belgium, Bulgaria, Canada, Chile, Chinese Taipei, Cyprus, Czech Republic, England, Finland, Hong Kong, Hungary, Indonesia, Iran, Israel, Italy, Japan, Jordan, Korea, Latvia, Lithuania, Macedonia, Malaysia, Moldova, Morocco, Netherlands, New Zeland, the Philippines, Romania, Russian Federation, Singapore, Slovak Republic, Slovenia, South Africa, Thailand, Tunusia, Turkey and the United States of America.

[1] The primary purpose of the *Digest of Education Statistics* is to provide a compilation of statistical information covering the broad field of American education from prekindergarten through graduate school. The Digest includes a selection of data from many sources, both government and private, and draws especially on the results of surveys and activities carried out by the National Center for Education Statistics (NCES).

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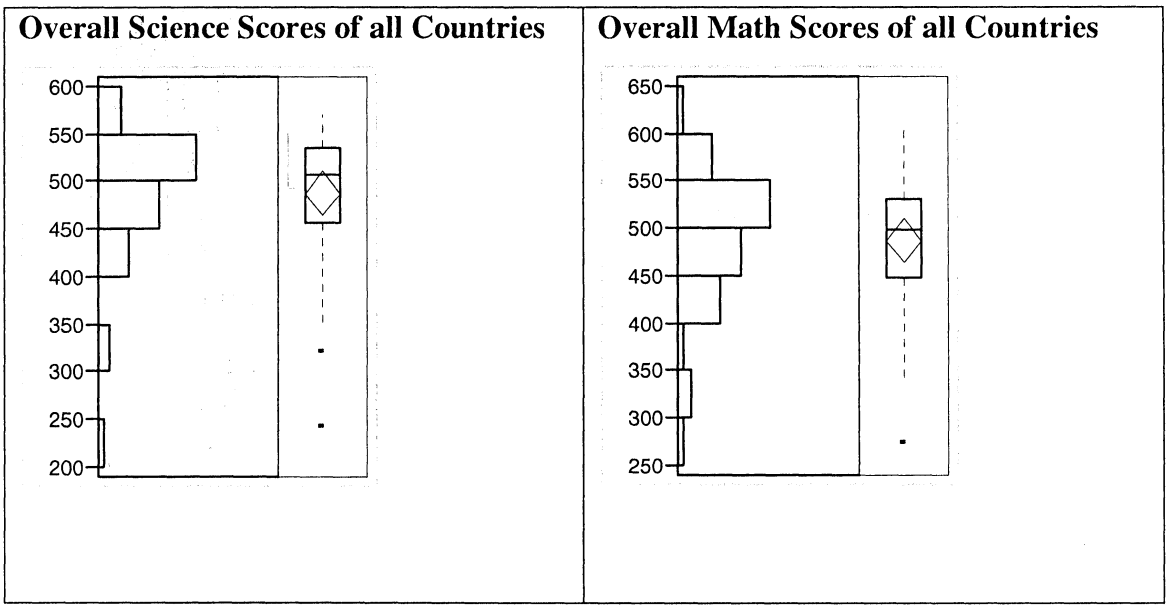
The comparison was based on the following variables:

- developmental level of a country,
- the GNI per capita,
- the number of computers per 1000 people,
- the total expenditure on education,
- yearly amount of instructional time for math and science

To start with, it was decided to divide the countries into two groups as developing and developed countries. Where does Turkey, as a developing country, stand in the list of developing countries? Or where is it among all the developed and developing countries? The results were predictable but the degree of difference between these two groups was worth investigating. The eight grade math and science overall scores of students were chosen as the database. It is important to mention here for the reader that the scores we have are out of 800.

**Figure 1**

**Overall Science and Math Scores of All Countries**



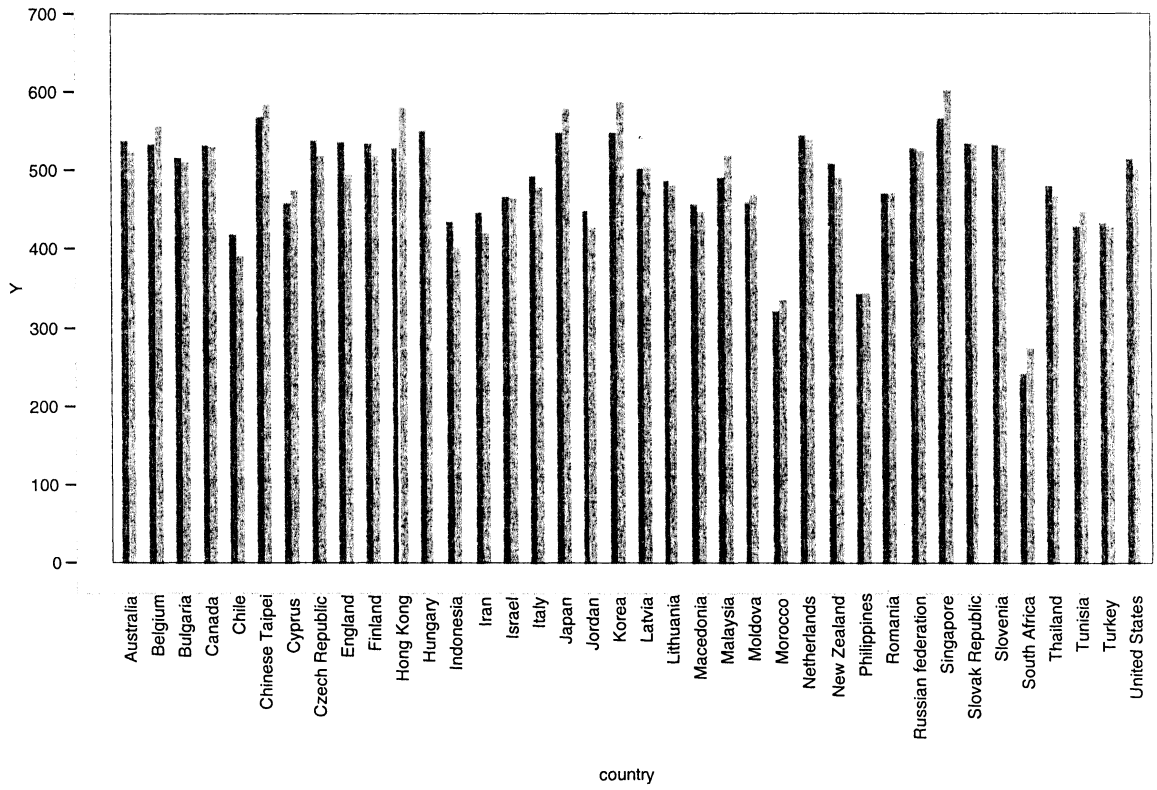
When we look at Figure 1 above, we see that generally the science score of all countries are around 400-600 with a mean score of 487.5, which means we have a normal distribution skewed to one side. It is actually not surprising to see that the scores vary between 243 and 569 since the data were collected from a variety of countries from all over the world. Countries from different continents of the world with different teaching hours, philosophies, developmental levels and understandings. However, maybe because science is a concrete subject including the same things to teach and learn, the variety among scores can be explained with different reasons. There must be other reasons for the difference among these countries. School-related factors were the ones that might have an impact on the achievement. This is basically why the yearly instructional amount of time both for science and math and the number of computers and the total expenditure on education were chosen as variables.

Figure 1 above also shows us the overall math scores of the same countries. The mean score of all countries' math score is 487.2. It is important to mention that this is not very much different from the science score of all countries: 487.5 and 487.2. There is only .3 differences between the math and science scores of these countries. The scores however vary between 604 and 275 this time. When compared to the science scores, math score of the countries are higher.

Figure 2 below shows both science and math scores of all countries. One important thing to mention here is that if a country is successful in math, the same country is also successful in science, or vice versa. Math and science are not too different from each other in that respect. Once a student is given the background in science or math, the other one follows.

## Figure 2

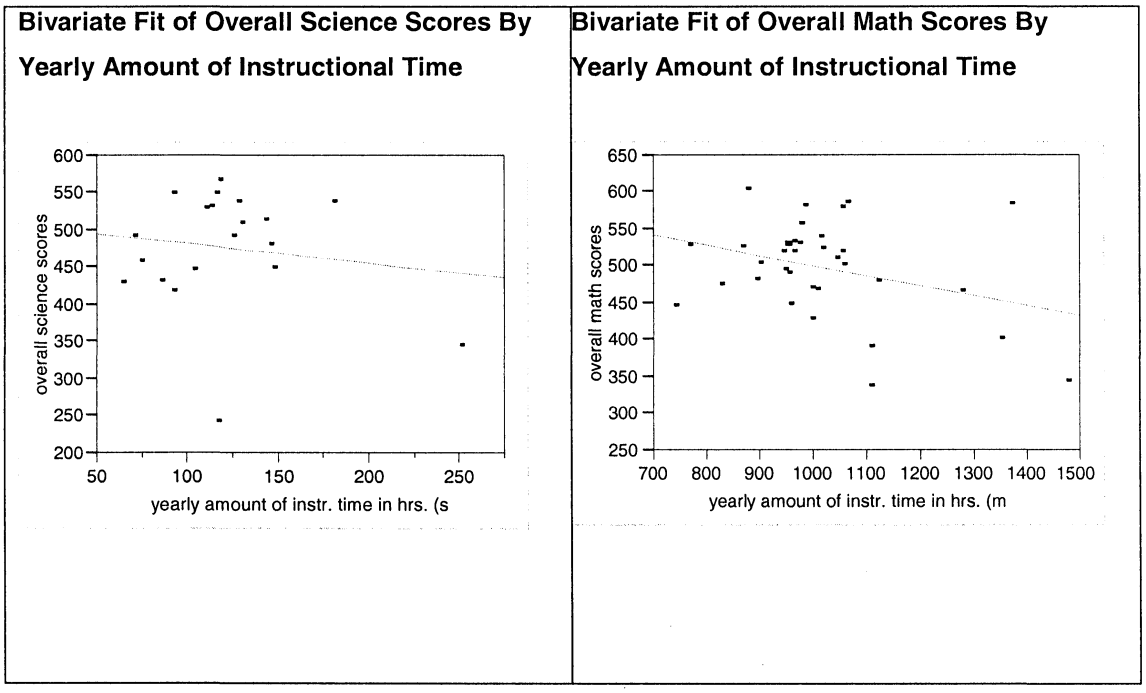
## Overall Math and Science Scores of 8th Grade Students of All Countries



As was stated earlier in the paper, the differences among the achievement levels of the countries were tried to be defined with different variables. The yearly amount of instructional time was one of them. When we analyze the figure below (See Figure 3), we see that $R^2$ is about .02, which means that only 2% of the variance in the 8th grade science scores of students' can be described by the yearly amount of instructional time. As educators we might expect the relation to be higher namely that the instructional time would have the strongest impact on the students' scores. Not different than science, the same relation is true for math too (See also Figure 3). This time the $R^2$ is .11 and only 10% of the variance in scores can be accounted to the instructional time. This means that we can only define the 10% of the success by amount of yearly instructional time. How about the other 90%? We do not know what other factors have effect on the success of 8th grade students' scores. At that point, the other variables gain importance, since we may be able to attribute the achievement to them.

## Figure 3

## Yearly Amount of Instructional Time



Since the yearly amount of instructional time as a whole did not tell us a lot, it was decided to divide the countries both for science and math scores into three groups according to the amount of instruction given. It was expected to see the countries giving high amount of instruction to be more successful when compared to the countries with low amount of instructional time. For science, since the hours varied between 65 and 252, the grouping was done as follows:

| | |
|---|---|
| Low | 65-99 |
| Medium | 100-150 |
| High | 151+ |

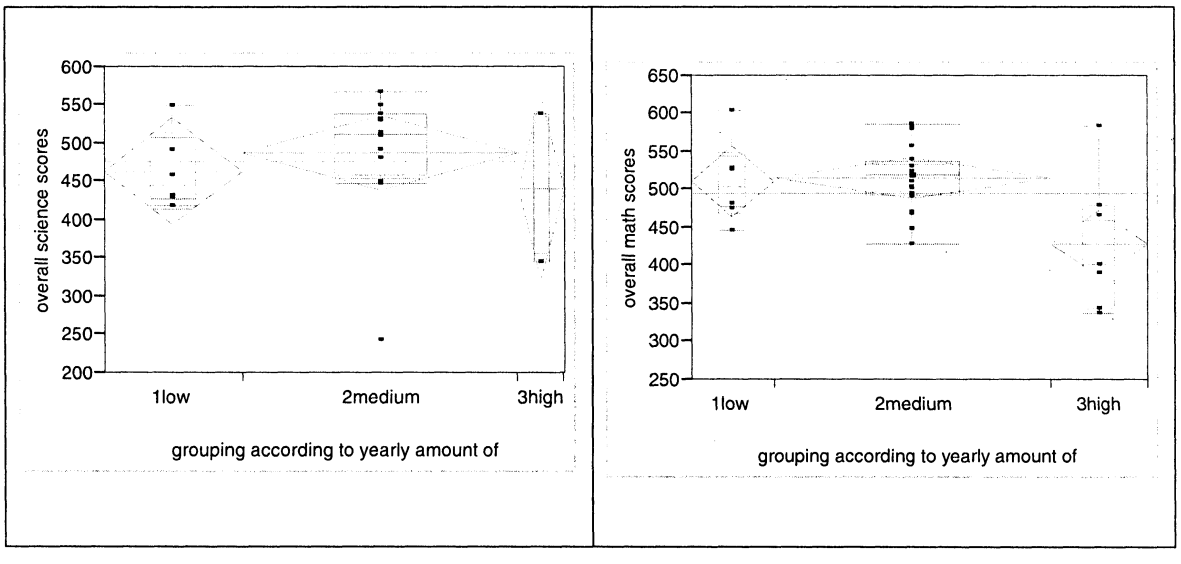
For math the yearly instructional hours varied between 745 and 1481, so the grouping was as follows:

| | |
|---|---|
| Low | 745-900 |
| Medium | 901-1100 |
| High | 1100+ |

We see from the figure below that most of the countries are in the medium group. There are only three countries in the high group. However, contrary to the expectations, it is not possible to say that the countries which devote more time to science education are better in science. The most important thing to mention here is the Philippines' situation. Being a member of the countries with high instructional time, the Philippines has got 345 for science.

## Figure 4

## Oneway Analysis of Overall Science and Math Scores by Grouping According to Yearly Amount of Instructional Time




One important thing to mention here is the mean scores of the countries with low, medium and high hours of instructional time. When we look at the figure above we see that the mean scores of the countries with high science instructional time is around 442, however, the score for countries with low teaching hours is 464. The results reveal that the more you teach math the less successful the students are. This is exactly what the figure says. The mean score for the countries teaching math with high amount of time is only 430. The score is 511 for low and 516, for countries with medium hours of teaching time.

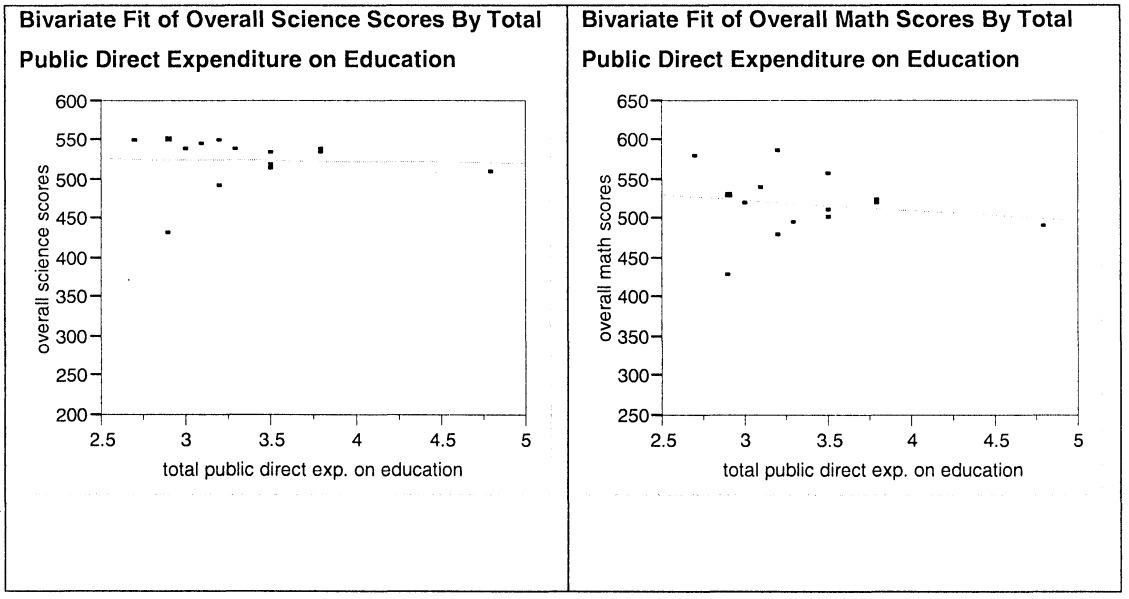
Singapore is one of the countries with a low teaching hour, however, they still do well in math, and actually it is the best country in math. Even though it is one of the countries with medium teaching hours in science, it is still very successful. Next, we have Morocco and Philippines as examples to the countries with high teaching hours and low success. Morocco

devotes 1113 hours to math instruction but students' score is only 337, which makes it one of the least successful countries in math. The Philippines, on the other hand, devotes 1481 hours to math education; however, the score 345 is still one of the least successful ones.

Other than the hours of science and math taught weekly, the total public direct expenditure on education was chosen as another variable. Since we could not describe the success by the variable of instructional time, the amount of money spent on education was decided to a factor. As an important factor, it was expected that money might have an important impact on the achievement of the students. Figure 5 below shows the relationship between the math and science scores and public direct expenditure on education.

## Figure 5[b]

## Total Public Direct Expenditure on Education




[b] World Bank Database http://www.worldbank.org

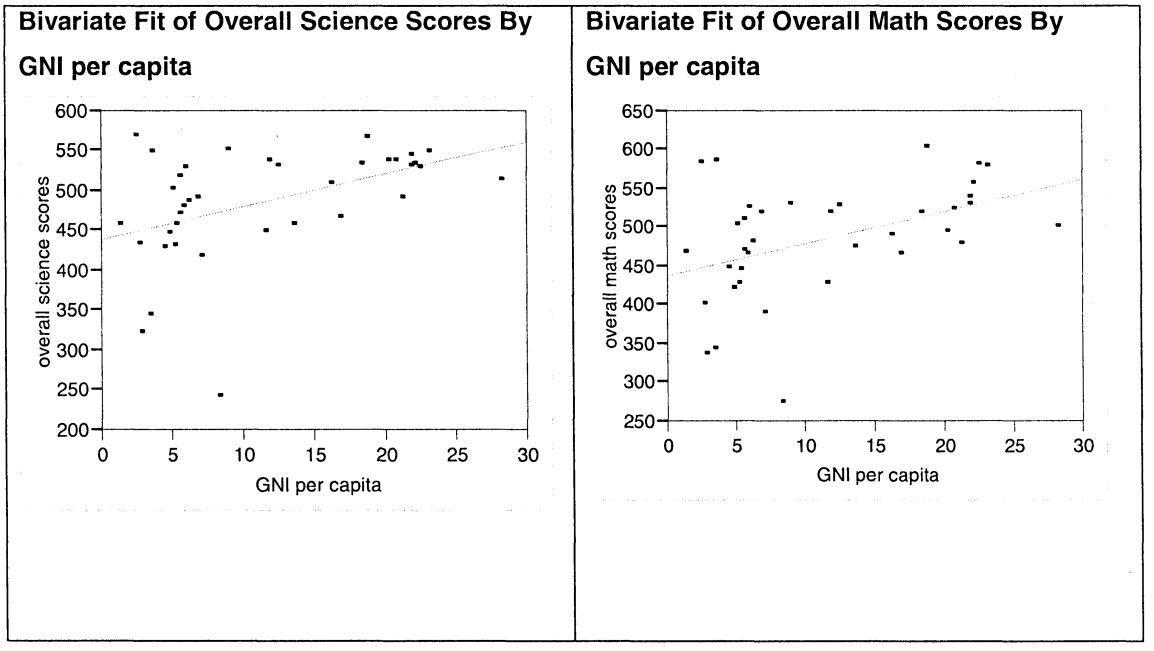
The figure tells us a lot. When we look at the $R^2$s, we see both math and science scores of students' cannot be explained by total amount of expenditure on education either. For science $R^2$ is .001 and for math it is .02. In this case we can only explain .01% and 2% of the variance in the 8th grade scores. Still we cannot explain for about 98% of the variance. Neither yearly instructional time nor total expenditure on education can explain the majority of the variance.

New Zealand, which is the country that the highest percentage of the gross domestic product is spent for education is not a very successful one. Another striking comparison can be made between Japan and Australia. Japan with 550 science score only spends 2.7% of the gross domestic product to education; however Australia with a score of 540 (which is not so different from Japan) spends 3.8% of its gross domestic product to education.

Here, however, there is something important to mention. When we look at the figure above we see a country, Japan, which spends only 2.7 billion dollars for education to be one of the most successful countries both in science and math. Hungary and Turkey are following Japan with an expenditure of 2.9 billion. What is striking here is the difference between Turkey and Hungary. Even though both countries spend the same amount of money for education, their success level is totally different from each other. Turkey with a science score of 433 is one of the least successful countries; however, Hungary with the same amount of expenditure has a score of 522, which makes it one of the successful countries. This leads us to the conclusion that the amount of money spent on education does not have a direct impact on the success of students. Here, again, I have to mention that we only have the total amount of expenditure data for the 14 countries out of 38, which makes it harder to reach to strong conclusions.

## Figure 6

## GNI per Capita




Up to now, we have analyzed the effects of yearly instructional time and total amount of expenditure on education, and still we are not able to explain the success or the failure of countries with these variables. This led me to use GNI per capita[c] as another variable. At a glance, GNI per capita and total public direct

[c] GNI per capita (formerly GNP per capita) is the gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of

expenditure seem to be the same, but the general amount of money spent on education by the government and individual income were worth investigating separately.

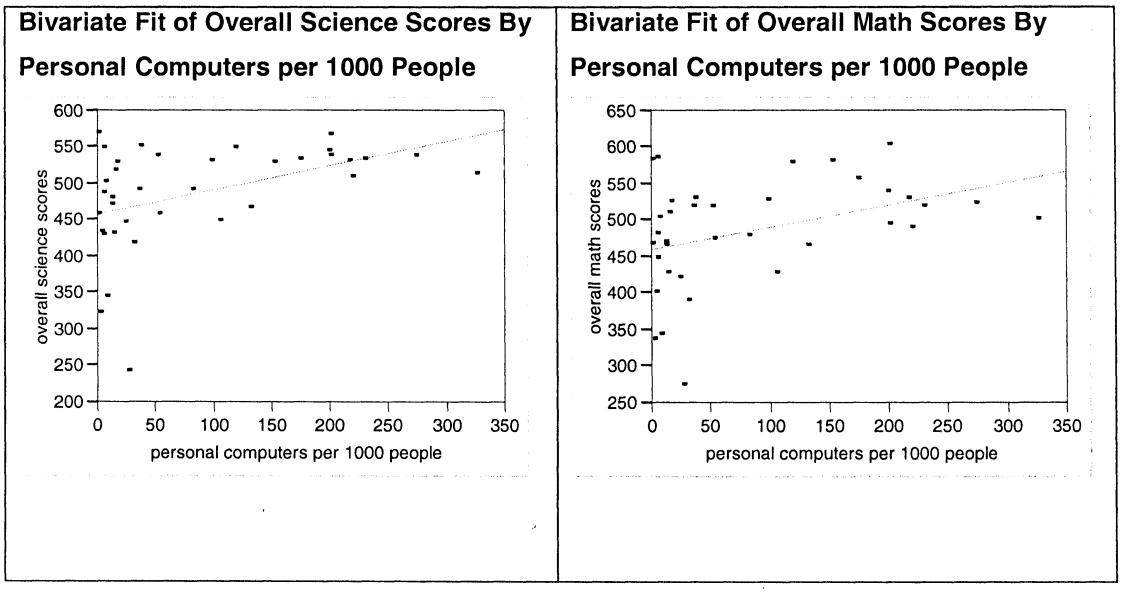
Figure 6 seems to tell us more about the relationship between the outcome measures and the GNI per capita. We have to admit that GNI per capita has the biggest impact among the other variables we have analyzed so far. This time the $R^2$ for science is .2 and for math it is .19, which is almost .2. This means that we can explain the 20% of the variance in the 8th grade students' scores by GNI per capita. What is interesting is how the $R^2$s are close to each other both for math and science, almost the same.

So what does that mean? The wealthy the people the successful the children? The countries with a low gross national income seem to be less successful when compared to the countries with a high national gross income. However, this does not mean that we can explain everything with that. There are of course some exceptions. Maybe Korea and Chinese Taipei could be good examples for that. Korea with a 3.700$ total expenditure on education has a science score of 549 and a math score of 587, which are higher than the most of the countries with a higher GNI. For Chinese Taipei the situation is almost the same. 569 in science and 585 in math are really high scores and higher than the scores of countries with higher GNI per capita.

The opposite is also possible. South Africa has an 8.480$ GNI per capita, but the scores of the students are remarkably lower than the scores of other countries having approximately the same amount of GNI. This explains that there must be other reasons why these children do not perform well on science and math. A country can be poor but still perform well, but there is no country that is rich and performs bad.

**Figure 7**[a]

**Personal Computers per 1000 people**




primary income (compensation of employees and property income) from abroad. GNI, calculated in national currency, is usually converted to U.S. dollars at official exchange rates for comparisons across economies, although an alternative rate is used when the official exchange rate is judged to diverge by an exceptionally large margin from the rate actually applied in international transactions. http://www.worldbank.org

As another demographic variable used was the number of personal computers per 1000 people (See Figure 7).

Here again we almost have the same results for GNI. We can say that the countries in which people have more computers per person seem to be more successful than the countries which do not. However, $R^2$s are still not very high. Both for math and science it is, rounding, about .2. Again we are only able to explain 20% of the variance in the 8th grade students' science and math scores.

The figure above also shows the outliers. Not different from GNI per capita results, Chinese Taipei and Korea are creating miracles again. In Korea the number of people having computers (out of 1000) is only 6.4, which means only 6 people out of 1000 have computers. It is even worse in Chinese Taipei, only 2 people, rounding, out of 1000 have computers. Are these countries low achievers? No. They are again two of the most successful countries out of 38.

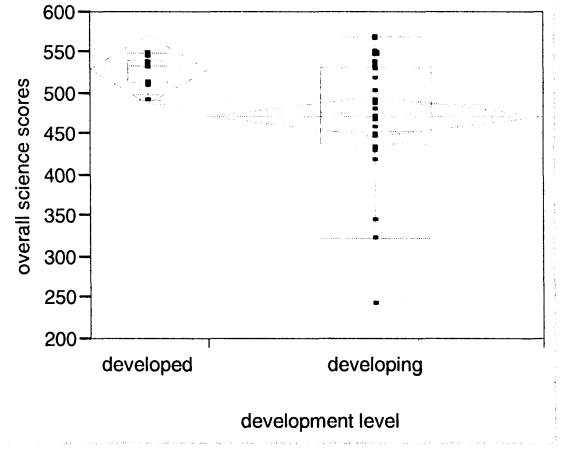
Here again, we need to mention South Africa as another outlier. The number of people having computers out of 1000 is 27.9, which can be said to be 30. It is almost 15 times more than the number of people having computers in Chinese Taipei, but the science score of the students is 243 and the math score is only 275.

The last variable was the developmental level of the countries we had. According to the OECD's list of developed countries (http://www.oecd.org) the countries were divided into two categories as developed and developing; it was analyzed if the developmental level of a country has an effect on the achievement. According to the list, Australia, Belgium, Canada, England, Finland, Italy, Japan, Netherlands, New Zealand, and USA are the developed countries. All the other countries are considered as developing for the analyses below.

Figure 8 below shows the oneway analysis of overall science scores by the developmental level of the countries. When we look at the $R^2$ of the science score and developmental level relationship we see it to be .13, which can be rounded as .1 and which can be interpreted as only the 10% of the variance in the science scores described by the variable developmental level.

## Figure 8[d]

## Oneway Analysis of Overall Science Scores by Development Level




[d] Digest of Education 2002. (2003). National Center for Education Statistics. Washington DC:USA. http://www.oecd.org

**Quantiles**

| Level | Minimum | 10% | 25% | Median | 75% | 90% | Maximum |
|---|---|---|---|---|---|---|---|
| Developed | 493 | 494.7 | 513.75 | 535 | 541.25 | 549.5 | 550 |
| developing | 243 | 342.8 | 438.25 | 477 | 532.25 | 553.6 | 569 |

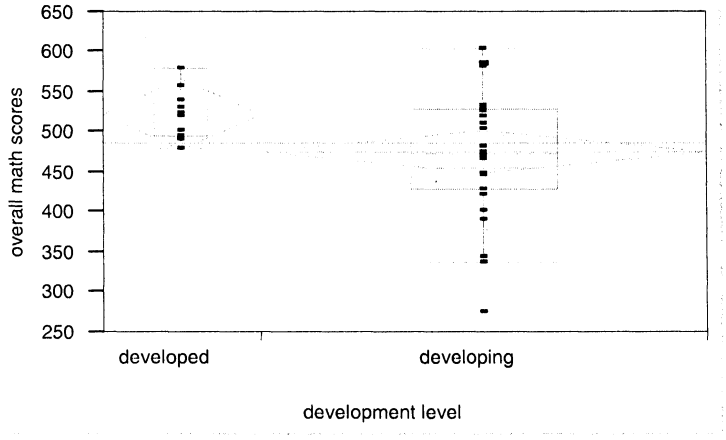
The most striking thing about the figure above is the existence of a great difference among the mean scores of developed and developing countries. The mean score of the developed countries is 529.400, however the mean score of the developing countries is 472.536. This big difference between the mean scores of overall science scores tells how development can affect the achievement level.

However, when the score of each country is analyzed separately we see a big exception for the situation we have. Chinese Taipei (569), as the most successful country is not a developed one and has the highest science score among all the countries. The most successful developed country is Japan with a score of 550. Also Hungary with a score of 552 and Korea with a score of 549 in science are more successful than the developed countries Australia (540), Belgium (535), Canada (533) and Netherlands (545). Italy, as the least successful developed country is behind most of the developing countries with a science score of 493.

As for the math scores of developed and developing countries the situation is not so different. Still developed countries are more successful than developing countries at math (See Figure 9) according to the mean score of all countries. Developed countries have a mean score of 522.1. On the other hand developing countries' mean score is 476.4.

**Figure 9**[e]

**Oneway Analysis of Overall Math Scores by Development Level**



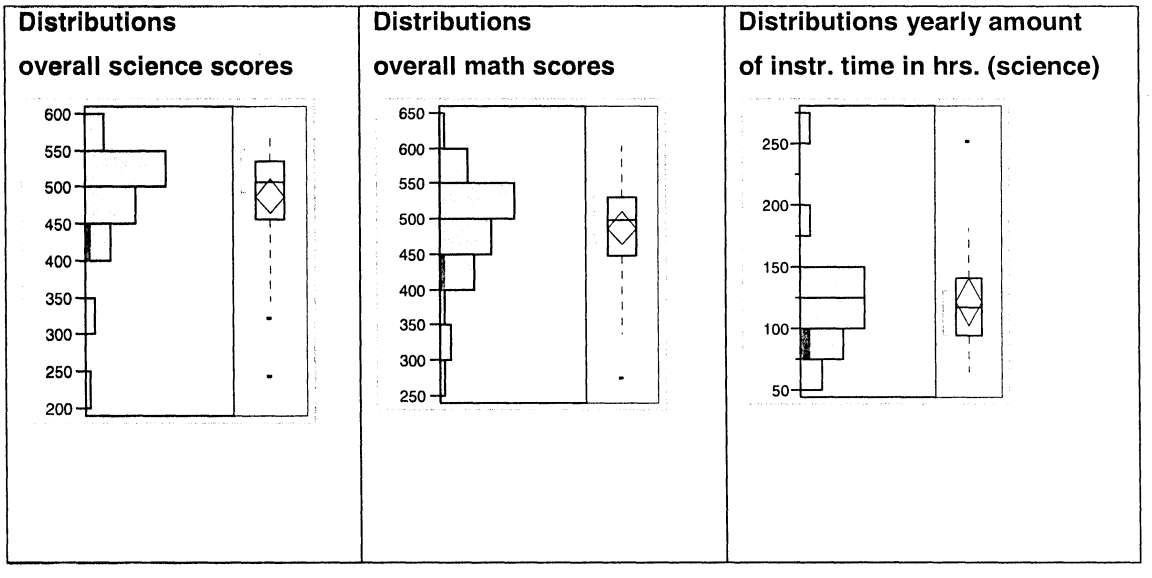

[e] Digest of Education 2002. (2003). National Center for Education Statistics. Washington DC:USA. http://www.oecd.org

What we have discussed for the science scores of countries seems to be applicable for the math scores too. Even though the mean score of developed countries is higher, there are some developing countries which are more successful than developed countries. This time Singapore, as a developing country, with a score of 604 is the most successful country among all.

## TURKEY AMONG THE OTHER COUNTRIES

As it was stated early in the beginning of the paper, one of the other concerns was to see Turkey among all the other countries and compare the achievement level of the Turkish students with the others. Since Turkey is a developing country, it was believed that it would be more meaningful to compare the results of the science and math scores of Turkish students with those of other students coming from other developing countries. In order to have a better understanding we below compared Turkey for all variables we have with the other countries.

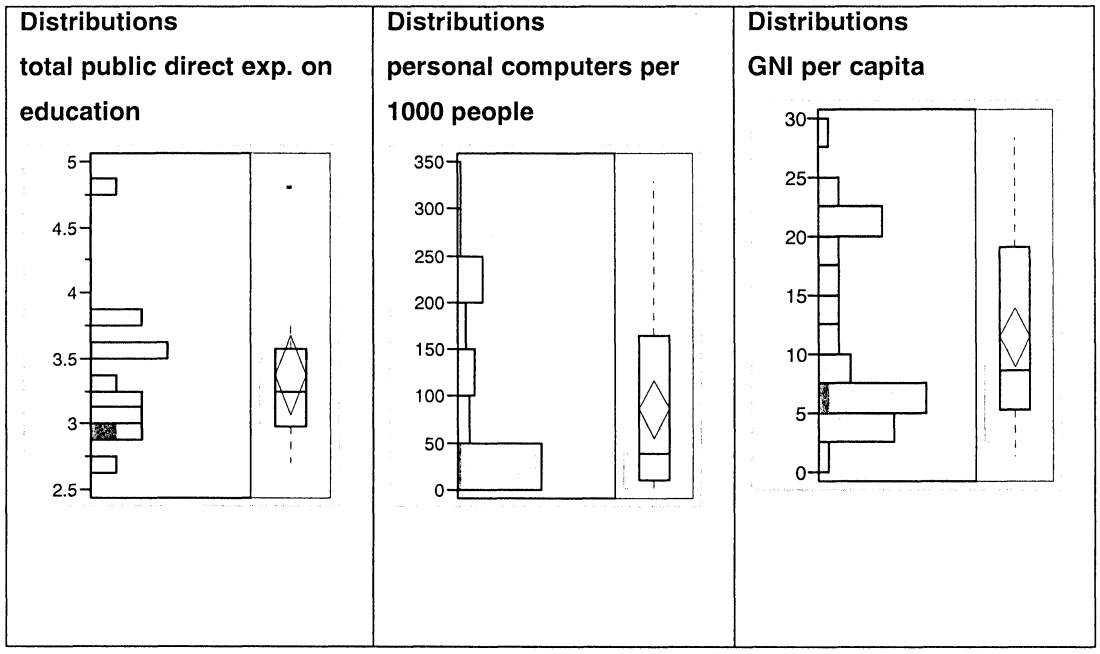
**Figure 10**




For all the variations we have above, overall science score, overall math score and the yearly amount of instructional time Turkey seems to always be below the SD. For overall science scores it is 1.9, for math scores 2.4 and for the yearly amount of instructional time for science it is 3.9 below the SD. No comparison for the math yearly amount of instructional time was made since we did not have data for Turkey.

Below, Figure 11 shows us the situation of Turkey for the other variables we have. In this case the variables are: total public direct expenditure on education, number of computers per 1000 people and GNI per capita.

**Figure 11**




Turkey is 3.8 SD below the mean for the total direct expenditure on education, 3.3 SD below for the number of computers per 1000 people, and 2.3 SD below the GNI per capita.

Both in math and science, 8th grade students in Turkey got below the mean score of the developing countries. In science, the mean score of the developing countries is 472.5 and Turkey has got a score of 433. When we look at math grades, the situation is the same. Turkey's 429 points of math score is lower than the mean score of all the developing countries which is 474.7. However, Turkey still falls into 1SD of the mean both in math and science scores of all countries.

When we analyze the average size of the 8th grade mathematics classes (Digest of Education, p. 472), we see Turkey to have the largest fifth class size among all the other countries. The average size of a math class in Turkey is given as 43 students per class, which comes after Philippines and South Africa with 50 students and Indonesia with 45. It is not surprising to see that Turkish students are not so successful when compared to the other countries having 20-25 students in a math classroom. Even this can be a reason for the low achievement of Turkish students in math.

In the same sense, the number of pupils per teacher in public and private elementary and secondary schools is striking for Turkey. Since all the data we used for the above analyses were for the 8th grade students, we took the number of pupils per teacher in year 1985 for 8th grades. Turkey with a number of 41.3 pupils per teacher is the number one on the list. Among the other 18 countries which we have data about the same situation, Spain comes second with a number of 21.4 students per teacher for the same grade. It is a known fact that there is a shortcoming of teachers in Turkey, but it was not expected the number to be so different from the other countries.

## RESULTS AND DISCUSSION

This analysis was an attempt to compare the Turkish students' Math and Science scores with other 38 countries. Developmental level of a country, the GNI per capita, the number of computers per 1000 people, the total expenditure on education and yearly amount of instructional time for math and science were the variables that the effects of which on the scores of the 8th grade students of 38 countries were analyzed.

Among the variables analyzed for the study; instructional time, total public direct expenditure and the developmental level did not have any statistically significant effect on math and science scores of 8th grade students. It is only GNI per capita which had statistically significant

effect on achievement. The countries with a low gross national income seem to be less successful when compared to the countries with a high national gross income.

When we look at the instructional time for science and math and compare Turkey with the other countries in the same group we still see Turkey to be a low achiever. Since we only have data for the instructional time for science for Turkey, we could only make a comparison for math scores. Turkey with 87 hours of instructional time for science is in the low group and has a science score of 433; however, the other countries in the same group have a mean score of 464.

Even though the results of the analysis on the effect of having computers on math and science scores did not reveal a high $R^2$, we wanted to do a separate analysis and compare Turkey to the other countries. In Turkey, only 14.7 people among 1000 have computers in their houses. In this category we see the United States of America to have the highest number which is 328.1. However, when we compare the science and math scores of the United States of America with Turkey, we see they are not so different at all. United States of America has a science score of 515 and math 502. Turkey, on the other hand, has a science score of 433 and 429. Even though at a glance the difference among the scores might seem to be high, on a test of out of 800, this is not a very big difference.

As for the GNI per capita, Turkey being a member of the developing countries had a low GNI per capita when compared to most of the other countries. In Turkey GNI per capita per person is only 5.3 thousand dollars. The mean of the GNI of the countries we have is 11.45 thousand dollars. This is more than twice the GNI amount of Turkey. The analyses we did for the effect of GNI on the science and math scores show us that there is not a very strong effect of it on achievement; however, no one can deny the negative effects of poverty on education.

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