International Journal of Human Sciences
ISSN:1303-5134

Volume: 7 Issue: 2 Year: 2010

The use of computers on students' mathematics achievement: Finding from PISA 2003

İbrahim Demir*
Serpil Kılıç**

Abstract

The purpose of this study was to examine the effects of computer using on mathematics achievement. The sample was prepared from students who participated in Programme for International Student Assessment (PISA) in Turkey. These data consisted of 3326 15 year-old Turkish students in 157 schools. Analysis was done with hierarchical linear model. Furthermore, it was shown that frequencies of the aims of students' computer use. Two-level model was used to estimate coefficients and modeled differences across school types. Results from this study indicated that male students, computer facilitates at home, cultural possessions, economic social and cultural status and quality of schools' educational resources variables had significantly positive effects and attitudes towards computers variable was no significant role in students' mathematical performance. Students who never use a home computer for learning in education obtained lower scores in mathematics.

Keywords: Hierarchical linear model; Computer use; Mathematics achievement; PISA;

***** Department of Statistics, Institute of Science, Assist. Prof. Dr., İstanbul, Turkey, idemir@yildiz.edu.tr
** Department of Statistics, Institute of Science, Research Assistant, İstanbul, Turkey, serkilic@yildiz.edu.tr

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

Introduction

Turkish education system is organized as to meet the requirements of 21st century. Increasing prosperity and welfare of Turkish citizen and society is the main purpose of the system to support and accelerate social, cultural, economic development in accordance with national unity and wholeness.

Ministry of National Turkish Education (2001) determined as providing education that aims productivity in life and occupation in accordance with national structure, culture and customs, preparing suitable education programmes, providing materials required for education and forming the necessary management and training staff who can carry out education and training services at the highest level.

Turkish education system can be summarized as follows:

Secondary education comprehends two categories of educational institutions, namely general high schools and vocational and technical high schools where a minimum of four years of schooling is completed after basic education (MONE, 2001).

Providing students with knowledge of general culture to inform them with problems of individual and social nature and to motivating them to find solutions are the aims of secondary education.

General high schools are educational institutions that prepare students for institutions of higher learning. They complete a four-year program and above basic education, and comprehend students in the 15-18 year age group. Table 1 shows number of schools, teachers and students for general high schools by education levels in 2002-2003 academic years.

Table 1 *General High Schools (2002-2003 Academic Years)*

Number of Schools, Teachers and Students by Education Levels	***Total***
Number of Schools	2550
Number of Teachers	77253
Number of Students	2030552

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

Vocational and technical high schools provide specialized instruction with the aim of training qualified personnel. The duration of instruction in these schools is also four years (Higher Education Council Student Selection and Placement Center, 2006). Table 2 shows number of schools, teachers and students for vocational and technical high schools by education levels in 2002-2003 academic years.

Table 2 *Vocational and Technical High Schools (2002-2003 Academic Years)*

Number of Schools, Teachers and Students by Education Levels	***Total***
Number of Schools	3660
Number of Teachers	60703
Number of Students	985575

The use of technology is growing all areas especially in education world. One of these areas is mathematics education. Although its importance is known in daily life, mathematics is often viewed as a difficult topic. Task of technology on education is supported and facilitated to learning. Some experts found that technology usage as a tool for developing learning mathematics (Warger, 1990).

Computers are becoming a basic tool in the areas of work, school and leisure. Computer use is a part of the school curriculum that aims to increase students' computer literacy and provide students with the skills to enhance learning and to access information. On account of the increasing importance of reaching at least a basic level of computer literacy in today's technological society, it is desirable to minimize the level of students' computer anxiety (Bowers & Bowers, 1996; Brosnan, 1998; Goss, 1996; Hemby, 1998; Presno, 1998) as high computer anxiety is considered to reduce a effectiveness of person when using a computer (Rozell & Gardner, 1999; Shelley, 1998). Also, students are increasingly supported to use the computer, the Internet and e-mail, e.g. for doing homework, looking up information on search machines, preparing and presenting talks with classmates (Kuhlemeier & Hemker, 2007). Apparently, computer technology is well placed to extend the opportunities for learning. However, computers are many-sided tools: they support a wider range of activities than those that are prominent in classrooms. Whatever parents who purchase computers may hope to encourage at home, research suggests that, for most children, game playing becomes the predominant form of domestic use (Giacquinta et al., 1993; Downes, 1999). Home computer use has been connected to improvements in general academic performance. For

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

example, a longitudinal study published in 1995 which tracked a group of students from seventh through twelfth grade, found that the students with computers at home had higher overall grades and better grades in Mathematics and English than those without home computers (Rocheleau, 1995). Students having computers at home have families with higher income and education level. But if students overuse with computer, it cannot be good at not only education but also social life.

Furthermore, use of computers might improve not only cognitive skills (Educational Software, Internet) but also non-cognitive skills (Social, Emotional) (Fiorini, 2007). As a result of this, use of computer is very important for the achievement of students.

Many people working in the different departments of the Turkish education systems discuss that there have been many problems in the function of the system. Ministry of education has carried out a reform work for improving education system since 2002-2003 academic years. One of these reform works is Programme for International Student Assessment (PISA) (Akdeniz et al., 2000).

The PISA is a collaborative effort, involving 30 OECD countries and 11 partner countries, to assess how well 15-year-old students are prepared to meet the challenges of today's knowledge societies. The assessment looks to the future, focusing on young people's ability to use their knowledge and capabilities to meet real-life challenges, rather than on the mastery of specific school curriculum. PISA is an ongoing survey with a data collection every three years. The first PISA survey was conducted in 2000 in 32 countries. The second PISA survey was conducted in 2003 in 41 countries. This survey consisted of 4855 Turkish students in 159 schools (PISA, 2003).

Review of Literature

When we examined previous studies which have been published international review, we show that there are many studies about educational achievement using multilevel regression analysis.

Recent research has provided evidence that students' computer use at home is positively associated with their performance at school. Wittwer and Senkbeil (2008) examined students' home computer use and their performance in mathematics and the other factors have been found to affect students' achievement by German students. The data took from in PISA 2003. Results showed that students' access to a computer was not linked with their mathematics performance.

Kuhlemeier and Hemker (2007) conducted into the impact of students' use of the Internet and the computer at home by using multilevel analysis. The study was conducted in the lower grades of Dutch secondary education. More than 2500 students, distributed over 116 classes in 68 schools, participated in the study. Findings indicate that the Internet skills of boys were hardly more developed than those of girls.

Wilkins (2004) investigated on the relationship between mean country mathematics and science self-concept and respective mean country achievement and geographic region. Results showed an overall positive relationship between achievement and self-concept in the countries investigated at the student level. Furthermore, at the country level, a negative relationship was found.

Brunner et al. (2008) was to analyze the effects on gender differences in mathematics. The nested factor model was used and the differences in mathematical ability were explained by specific mathematical ability and general cognitive ability. However, they found very large gender differences in specific mathematical ability favor of boys.

Thomson and De Bortoli's study (2007) showed that all Australian students had access to a computer at school and most also had access to a computer at home. Results from the study indicated that Australian students use computers frequently, and while entertainment was a large part of this, students used computers for a wide range of functions.

Wainers' study (2008) presented the analysis of the 2001 Brazilian Basic Education Evaluation System (SAEB) achievement exam in reading and mathematics. They compared the test results for each class according to internet access at home, computer ownership and frequency of computer use. The frequency of computer use had a negative effect on the test results for younger and poorer students, but computer ownership had a positive effect on the test results for older students.

Babaoğlan and Arslan (2008) were to examine the opinions of primary school students in Burdur towards effective use in the classes in terms of socio economic status and gender. Students had easy access to computers at home and at school in this study. When teachers used computers as training materials in mathematics, students understood mathematics better than the other lessons. However, Morse's study (1991) was found that the important factor preventing computer use was restrictions about budget.

A great deal of research has been accumulated particularly in the United States, however, this is not the case for Turkey. Thus, part of the purpose of this study was to contribute to the literature on mathematics achievement in Turkey. This study aimed at examining effects of computer use on mathematics achievement by two-level hierarchical linear model approach. The sample was prepared from students who participated in PISA 2003 in Turkey. Results of the study could have implications for students, teachers and parents in handling mathematics achievement. Moreover, the results of this study conducted in Turkey together with the results of foreign countries are subjected to comparative analysis.

Two-Level Hierarchical Linear Models

Multilevel data arise when units are nested in clusters. To analyse this data in a double comparative design, multilevel regresssion is appropriate. By using individual-level techniques, such as Ordinary Least Squares (OLS), on a large of respondents, standard errors as to macro-levels effects will be underestimated and consequentially, parameters could unjustly lead to significant effects (Hox, 2002; Snijders & Bosker, 1999). Multilevel regression techniques solve this problem by calculating macro-level effects at the appropriate N's, threby controlling for intra-level correlations (Snijders & Bosker, 1999). Examples include students in classes, patients in hospitals and left and right eyes of individuals. We refer to elementary units (e.g. students, patients or eyes) as level-1 units and the clusters (e.g. classes, hospitals or heads) as level-2 units. If the clusters are themselves clustered into "higher level" (super) clusters, for example if students are nested in classes and classes nested in schools, the data have a three-level structure (Skrondal & Rabe-Hesketh, 2004).

Multilevel models recognize the existence of such data hierarchies by allowing for residual components at each level in the hierarchy. For example, a two-level model which allows for

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

grouping of child outcomes within schools would include residuals at the child and school level. Thus the residual variance is partitioned into a between-school component (the variance of the school-level residuals) and a within-school component (the variance of the child-level residuals). The school residuals, often called 'school effects', represent unobserved school characteristics that affect child outcomes. It is these unobserved variables which lead to correlation between outcomes for children from the same school.

Two-level hierarchical linear models consist of two sub models as it appears from the name. Within each school, it is modeled student achievement as a function of student-level predictors plus a random student-level error:

$$Y_{ij} = \beta_{0j} + \sum_{q=1}^{Q} \beta_{qj} X_{qij} + r_{ij} \qquad r_{ij} \sim N(0, \sigma^2) \qquad (1)$$

where

Y_{ij} is the achievement of child *i* in school *j*;

β_{qj} is the level-1 coefficients for $q = 0,1,...Q$;

r_{ij} is a level-1 random effect.

The indices *i* and *j* denote students and schools where there are

$i = 1,...,n_j$ students within school *j*;

$j = 1,...,J$ schools.

School level model is;

$$\beta_{qj} = \gamma_{q0} + \sum_{s=1}^{S_q} \gamma_{qs} W_{sj} + u_{qj} \qquad \text{for each } q = 0,1,...Q \qquad (2)$$

where

γ_{qs} is the corresponding level two coefficients that represent the direction and strength of association between school characteristic W_{sj} and β_{qj};

W_{sj} is the level-2 coefficients for $s = 0,1,...S_q$;

u_{qj} is a level-2 random effect.

It is assumed that the random component u_{qj}, $q = 0,1,...Q$, are multivariate normal, each with a mean of zero, and some variance, $Var(u_{qj}) = \tau_{qq}$.

Application

Students didn't answer all questions, so there were missing data (5%) that could reduce estimation efficiency, complicate data analyses; and bias results (Peugh & Enders, 2004). The data for this study describe 3326 students in 157 schools during the 2002-2003 academic years. In this study, dependent variable is mathematics achievement and independent variables of level-1 are gender, computer facilities at home, cultural possessions, economic, social and cultural status, internet/entertainment use and attitudes towards computers. independent variables of level-2 consist of school type, region type and quality of schools' educational resources. The reasons for using these variables are;

In previous studies, it was shown that effect on mathematics achievement of gender is statistically significant in most countries. Boys tended to outperform girls in mathematics and science, whereas girls outperformed boys in reading (Halpern, 2000). So, we thought that characteristic of gender effects on mathematics achievement in Turkey too.

Wittwers' study (2008) is proposed drawing on the theoretical framework. Students differ in the way they use computers that engage them in problem-solving activities. According to the previous studies, using a computer at home might also require students to apply problem-solving strategies to search the internet for getting information (e.g., Brand-Gruvel et al., 2005) or finding out how to solve problems (e.g., Nadolski et al., 2001).

Also students were asked to refer how often they would do following activities in their free times: reading classical literature, reading book of poetry, working of art. As a result of this, it is shown that such activities are related to students' academic achievement (e.g., Wittwer & Senkbeil, 2008).

The aims of secondary education are to provide the students with common general culture and to prepare them for tertiary education, life and vocational fields in accordance with their interests and talents through various programmes. School types provide different types of education for students who want to specialize in specific subjects.

Student Level variables

Mathematics Achievement (Y_{ij}): Mathematics performance of a student is measured four subjects: Geometry, Algebra, Arithmetic and Probability. 85 different questions were asked to the students in the questionnaire. Table 3 shows that levels of mathematics score.

Table 3 *Levels of Mathematics Scores*

Level	**Scores**	
	Minimum	**Maximum**
0	-	357.77
1	358.78	420.07
2	420.08	482.38
3	482.39	544.68
4	544.69	606.99
5	607.00	669.30
6	669.31	-

Cultural Possessions (CP): The PISA 2003 index of cultural possession (CULTPOSS) is derived from students' responses to the three items. These variables are classical literature, book of poetry, works of art and the scale construction is done through IRT scaling. Positive values on this index indicate higher levels of cultural possessions (PISA, 2003).

Computer Facilities at Home (CF): The PISA 2003 index of computer facilities at home (COMPHOME) is derived from students' responses to the three items. These variables are a computer you can use for school work, educational software and a link to the Internet and the scale construction is done through IRT scaling. Positive values on this index indicate higher levels of computer facilities at home (PISA, 2003).

Economic, social and cultural status (ESCS): The PISA 2003 index of economic, social and cultural status (ESCS) is derived from three variables related to family background: the index of highest level of parental education in number of years of education according to the ISCED classification, the index of highest parental occupation status and the index of home possessions.

Internet/entertainment use (IU): The PISA 2003 index of ICT internet/entertainment use is derived from students' responses to the six items. A five point scale with the response categories recoded as "almost every day" (=0), "a few times each week" (=1), "between once a week and once a month" (=2), "less than once a month" (=3) and "never" (=4) is used. All items are inverted for IRT scaling and positive values on this index indicate high frequencies of ICT internet/entertainment use (PISA, 2003).

Attitudes towards computers (ATC): The PISA 2003 index of attitudes toward computers is derived from students' responses to the four items. A four point scale with the response categories recoded as "strongly agree" (=0), "agree" (=1), "disagree" (=2), and "strongly agree" (=3) is used. All items are inverted for IRT scaling and positive values on the index indicate positive attitudes toward computers (PISA, 2003).

School Level Variables

Quality of Schools' Educational Resources (QSER): The PISA 2003 index of quality of schools' educational resources is measuring the school principal's perceptions of potential factors hindering instruction at school. A four-point scale with the response categories recoded as "not at all" (=0), "very little" (=1), "to some extent" (=2), and "a lot" (=3) is used (PISA, 2003).

Results and Discussions

Descriptive statistics are found in Table 4 and Table 5.

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

Table 4 *Frequencies of the categorical predictors of school performance*

Independent Measures	**In %**
Gender (G)	
Male	57,0
Female	43,0
Region Type (RT)	
Southeast Anatolia Region	7,6
Aegean Region	13,3
Mediterranean Region	14,4
Central Anatolia Region	18,2
Black Sea Region	11,6
Eastern Anatolia Region	7,9
Marmara Region	27,0
School Type (ST)	
Police Colleges	0,7
Vocational High Schools	13,0
Anatolian Vocational High Schools	15,0
Science High Schools	1,3
Anatolian High Schools	4,1
Primary Schools	2,5
Private High Schools	3,3
General High Schools	60,1

Table 5 *Descriptive statistics of the continuous predictors of school performance*

Independent measures	**Min**	**Max**	**Mean**	**sd**
Computer Facilities at Home	-1,67	1,05	-1,19	0,85
Cultural Possessions	-1,27	1,34	-0,10	0,93
Quality of Schools' Educational Resources	-3,23	2,20	-1,31	0,94
Economic, social and cultural status	-4,56	2,21	-,96	1,07
Internet/entertainment use	-2,70	3,14	-0,24	1,06
Attitudes towards computers	-3,46	1,34	0,16	0,97

Our analysis of the data from PISA 2003 dataset revealed a relationship between students' mathematics achievement and use of computer at home using two-level hierarchical linear model. Data was analyzed using SPSS 15.0 after selecting the variables that is related to the mathematics achievement.

In this study, level-1 model is;

$$Y_{ij} = \beta_{0j} + \beta_{1j}(G) + \beta_{2j}(ESCS) + \beta_{3j}(CP) + \beta_{4j}(CF) + \beta_{5j}(ATC) + \beta_{6j}(IU) + r_{ij} \qquad (3)$$

where the level-2 model is;

$$
\begin{aligned}
\beta_{0j} &= \gamma_{00} + \gamma_{01}(ST_1) + \gamma_{02}(ST_2) + \gamma_{03}(ST_3) + \gamma_{04}(ST_4) + \gamma_{05}(ST_5) + \gamma_{06}(ST_6) + \gamma_{07}(ST_7) \\
&\quad + \gamma_{08}(QSER) + \gamma_{09}(RT_1) + \gamma_{10}(RT_2) + \gamma_{11}(RT_3) + \gamma_{12}(RT_4) + \gamma_{13}(RT_5) + \gamma_{14}(RT_6) + u_{0j} \\
\beta_{1j} &= \gamma_{10} \\
\beta_{2j} &= \gamma_{20} \\
\beta_{3j} &= \gamma_{30} \\
\beta_{4j} &= \gamma_{40} \\
\beta_{5j} &= \gamma_{50} \\
\beta_{6j} &= \gamma_{60}
\end{aligned} \tag{4}
$$

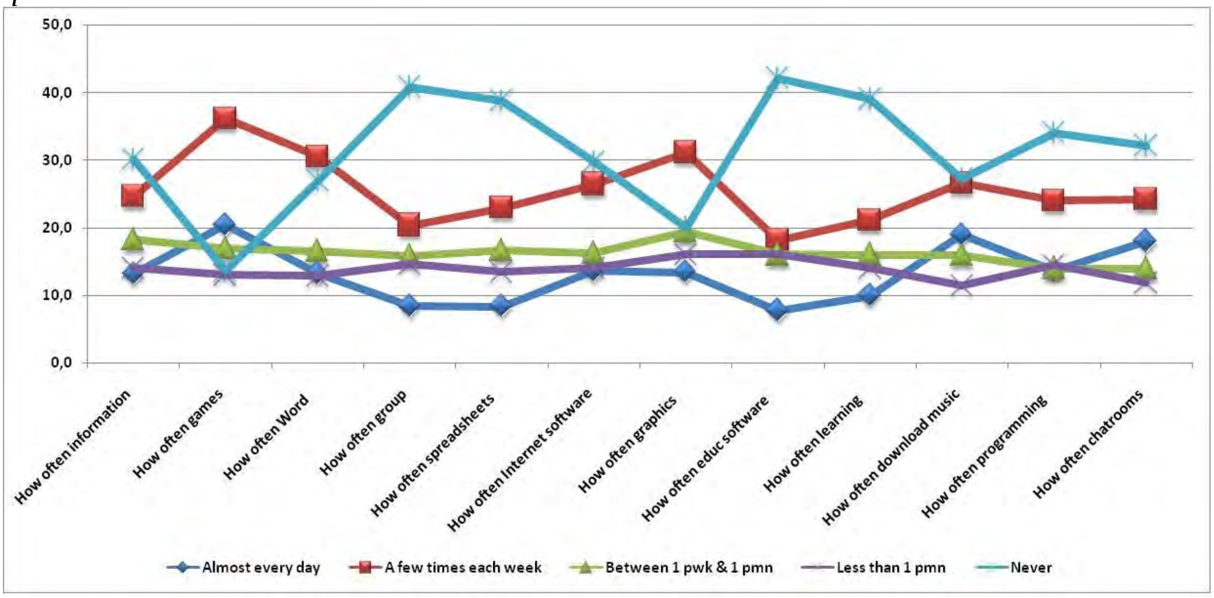
Table 6 *Two Level Model Output*

	b	**SE**
Intercept	440,52*	9,03
Gender		
Male	29,29*	2,60
Female	0[a]	0
Region Type		
Southeast Anatolia Region	-55,19*	15,54
Aegean Region	-0,58	13,03
Mediterranean Region	-17,22	12,16
Central Anatolia Region	-4,76	11,49
Black Sea Region	-8,66	13,09
Eastern Anatolia Region	-55,88*	15,10
Marmara Region	0[a]	0
School Type		
Police Colleges	175,18*	45,38
Vocational High Schools	-43,31*	11,83
Anatolian Vocational High Schools	19,06**	10,66
Science High Schools	240,56*	32,56
Anatolian High Schools	110,80*	19,23
Primary Schools	-81,03*	17,96
Private High Schools	94,18*	21,18
General High Schools	0[a]	0
Computer Facilities at Home	5,73*	1,57
Internet/entertainment use	-13,28*	1,23
Attitudes towards computers	-0,89	1,25
Cultural Possessions	3,22*	1,40
Quality of Schools' Educational Resources	8,67*	4,22
Economic, social and cultural status	10,68*	1,55

[a] Reference group
*p<0.05
**p<0.10

As shown in Table 6, the *b* coefficients in hierarchical model reflected possible changes in the dependent variable with respect to this reference group. There is a significant role in students' mathematical performance between Eastern Anatolia Region and Southeast Anatolia Region when Marmara Region is a reference group. Also, all of the variables except the attitudes towards computers variable were significantly associated with their performance in mathematics. That is, students with a higher socio economic status also had higher scores in mathematics. Female students achieved lower scores than male students, and students who have a computer in their home were, on average, higher achievers than those students who haven't any computer in their home. Furthermore, students with higher cultural possession and the schools which have higher quality of educational resources had higher scores in mathematics. We estimated that the mean mathematics score of Science high schools was 240,56 scores more than that of General high schools. Also, we found that the mean mathematics score of Primary schools was 81,03 scores less than that of General high schools. Students who use their computers for internet and entertainment have lower scores in mathematics than others. Figure 1 is shown frequencies of the aims of using computer.

Figure 1. *Frequencies of the aims of using computer based on the 12 items of the student questionnaire in PISA 2003*



In a next step, we analyzed the extent to which the frequency of students' computer use at home was related to mathematical performance. We showed that students who use a home computer for internet/entertainment and program/software use obtain lower scores in mathematics. Furthermore, students who never use a home computer for learning in education obtain lower scores in mathematics. In these reasons were shown that the most of the computer users (approximately %34) never used their home computers for program and software use.

Conclusions and Recommendations

In this study, it is an important difference in Southeast Anatolia and Eastern Anatolia Regions as a reference group is Marmara Region. Other regions are similar to Marmara Region. The regions which take place in İstanbul, Ankara and İzmir in three big cities are similar in mathematics achievement. Because there are major differences among Southeast Anatolia and Eastern Anatolia Regions with other regions for the purposes of school facilitates, this state is an inevitable real. If the government shares more budget for education reforms, especially the east of Turkey, these problems can be solved.

Students' computer use at home variable is positive effect on mathematics achievement in this study. Recent research has showed that students' home computer use is positively associated with their mathematics performance at school (Waner et al., 2008). But Wittwer and Senkbeil found that students' access to a computer was not linked with mathematics achievement.

According to Penhale (1994), internet use attains to correct information at short time. Holmes' study (1996) was shown that interactive and cooperative learning atmosphere for students was provided with computer assisted education. Internet/entertainment use variable has a negative effect on mathematics achievement in this study. According to Figure 1, students who use computer for programme/software lower than students who use computer for internet/entertainment. However, students' attitudes towards computers variable has not a great effect on achievement. We don't forget that technology can be used support education, not supplant it.

It was shown that economic, social and cultural status is the most important variable on the mathematics achievement. Also, from the most to the least important variables on mathematics achievement are economic, social and cultural status**,** gender, quality of schools' educational, computer facilities at home and cultural possession respectively.

According to previous research students' demographic characteristics, such as students' gender and immigration background were significantly associated with their mathematical competence (e.g., Livaditis et al., 2003).

There are eight school types in Turkey. This statement has some advantages and disadvantages. If teachers and parents lead students towards schools which supply to interest and skills of students, students go to one of the school types. But if not correct instruction to them, students who have different capabilities are under the necessity of studying in same class. For this reason, it cause discipline problems in these classes (Karagözoğlu, 2005). However, PISA was hold in 2003 by the OECD showed that participating Turkish students had difficulties with problem solving skills (Yüksel-Şahin, 2008) and reported low mathematics scores. Science High Schools and Police Colleges have higher mathematics achievement than other school types. Also, all of the school types should be upgraded the higher level at future.

When children use home computers are generally has positive effect of their performance; but when children use computers instead of participating in social activities, it raises concerns about the possible effects on their physical and psychological well-being (Subrahmanyam et. al., 2000). More importantly, the results of this study also shows that other after-school activities such as reading classical literature, reading book of poetry, working of art, seems to be positively linked to students' achievement at school. We suggest that social activities for assessing students' leisure times should be provided at schools. For example school managements can make sports grounds and establish instructional clubs.

We can no longer spend mathematics classroom time doing everything we did in the past paper-and-pencil era and covering the many new topics and methods that students need for the technologically intensive future they face. Nowadays paper-and-pencil computation and manipulation algorithms can be done better by computers.

Computers with built-in graphing software for enhancing mathematics teaching and learning are now over ten years old. But especially many of schools in the east of Turkey haven't any computer laboratory, so government should make an investment in these school types and these laboratories are equipped with materials for education. To do that school management may increase the number of library materials, audio-visual resources and computers. The government should give a course to teacher. Because the new understandings required of teachers include not only technical skills but an understanding of the relevance of the various features and information provided by the software to their own instructional and curricular priorities, as well as pedagogical strategies for using the software in the context of other constraints, such as time limitations and prerequisite student skills. To finish those understandings, many schools provide formal staff development for teachers on computer skills; and some facilitate informal contact among teachers so that the understandings may spread in the normal course of their Professional interactions (Becker, 1999).

In this study, these problems were shown and some recommendations are made to remedy the mentioned problems. It is believed that structure of the education system should be reorganized for filling the need of the millennium.

References

Akdeniz, A.R., Ayas, A. & Çepni, S. (2000). Türk Eğitim Sisteminde Değişim ve Gerekçeler. IX. Ulusal Eğitim Bilimleri Kongresi Bildiriler-I. Erzurum.

Babaoğlan. E. & Arslan, D. (2008). Primary School Students' Opinions About Effective Use of Computers in the Class. XIII. International Educational Technology Conference. Eskişehir. 306-312.

Becker, H. J. (1999). *Internet Use by Teachers: Conditions of Professional Use and Teacher-Directed Student Use*. Teaching, Learning, and Computing: 1998 National Survey. Center for Research on Information Technology and Organizations the University of California. Irvine and the University of Minnesota.

Brand-Gruvel, S., Wopereis, I. & Vermetten, Y. (2005). Information problem solving by experts and novices: Analysis of a complex cognitive skill. *Computers in Human Behavior*, *21*, 487-508.

Bowers, D. A., & Bowers, V. M. (1996). Assessing and coping with computer anxiety in the social science classroom. *Social Science Computer Review, 14(4)*, 439–443.

Brosnan, M. J. (1998). The impact of computer anxiety and self-efficacy upon performance. *Journal of Computer Assisted Learning, 14(3)*, 223–234.

Brunner, M., Krauss S., & Kunter, M. (2008). Gender differences in mathematics: Does the story need to be rewritten? *Intelligence*, *36*, 403-421.

Downes, T. (1999). Playing with computer technologies in the home. *Education and Information Technologies, 4,* 65–79.

Fiorini, M. (2007). The Effect of Home Computer Use on Children's Cognitive and Non-Cognitive Skills. *LSAC Research Conference*.

Giacquinta, B. J., Bauer, A. J., & Levin, J. (1993). *Beyond technology's promise*. Cambridge, UK: Cambridge University Press.

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

Goss, M. W. (1996). Computer anxiety and computer experience: A new look at an old relationship. *The Clearing House, 69(5),* 271–276.

Halpern, D. F. (2000). *Sex differences in cognitive abilities*. Third Edition. London: Erlbaum.

Hemby, K. V. (1998). Predicting computer anxiety in the business communication classroom—facts, figures and teaching strategies. *Journal of Business and Technical Communication, 12(1),* 89–108.

Higher Education Council Student Selection and Placement Center (ÖSYM). (2006). Selection and Placement of Students in Higher Education Institutions in Turkey. Ankara.

Holmes, C. O., & Warden, J. T. (1996). CIStudio: A Worldwide Web-Based, Interactive Chemical Information Course. Journal of Chemical Education, 73(4), 325-331.

Hox, J. (2002). *Multivariate Analysis: Techniques and Applications*. Mahwah NJ/London: Lawrence Erlbaum.

Karagözoğlu, G. (2005). Eğitim Sistemimizde Reform Çalışmalarına Genel Bakış. Eğitimde Yansımalar: VIII Yeni İlköğretim Programlarını Değerlendirme Sempozyumu. Kayseri.

Kuhlemeier, H., & Hemker, B. (2007). *The impact of computer use at home on students Internet skills*. National Institute for Educational Measurement (Cito). The Netherlands.

Livaditis, M., Zaphiriadis, K., Samakouri, M., Tellidou, C., Tzvaras, N., & Xeniditis, K. (2003). Gender differences, family and psychological factors affecting school performance in Greek secondary school students. *Educational Psychology, 23,* 223-231.

Morse, R. H. (1991). Computer Uses in Secondary Science Education. ERIC Digest ERIC Clearinghouse on Information Resources Syrocuse NY.

Nadolski, R. J., Kirschner, P. A., Van Merrienboer, J. J. G. & Hummel, H. G. K. (2001). A model for optimizing step size of learning tasks in competency-based multimedia practicals. *Educational Technology Research and Development, 49,* 87-103.

OECD, Programme for International Student Assessment (PISA) 2003. (2005). *Technical report*. OECD: Paris.

Penhale, S. J., & Stratton, W. J. (1994). Online Searching Assignment in a Chemistry a course for Nonscience Majors. Journal of Chemical Education, 71, 227-229.

Peugh, J. L., & Enders, C. K. (2004). Missing Data in Educational Research. *Review of Educational Research, 74,* 525-556.

Presno, C. (1998). Taking the byte out of Internet anxiety: Instructional techniques that reduce computer/ Internet anxiety in the classroom. *Journal of Educational Computing Research, 18(2),* 147–161.

Republic of Turkey Ministry of National Education (MONE). (2001). The Turkısh Educatıon System and Developments in Education. Ankara.

Rocheleau, B. (1995). Computer use by school-age children: Trends, patterns and predictors. *Journal of Educational Computing Research 1*, 1–17.

Rozell, E. J., & Gardner III, W. L. (1999). Computer-related success and failure: A longitudinal field study of the factors influencing computer-related performance. *Computers in Human Behavior, 15(1),* 1–10.

Shelley, J. O. (1998). Factors that affect the adoption and use of electronic mail by K-12 foreign language educators. *Computers in Human Behavior, 14(2),* 269–285.

Demir, İ., Kılıç, S. (2010). The use of computers on students' mathematics achievement: Finding from PISA 2003. *International Journal of Human Sciences* [Online]. 7:2. Available: http://www.insanbilimleri.com/en

---

Skrondal, A., & Rabe-Hesketh, S. (2004). *Generalized Latent Variable Modeling*. A CRC Press Company: London.
Snijders, T. A., & Bosker, R. J. (1999). *Multivariate Analysis: An Introduction to Basic and Advanced Multilevel Modelling*. London: Sage Publications.
Subrahmanyam, K., Kraut, R. E., Greenfield, P. M., & Gross, E. F. (2000). The Impact of Home Computer Use on Children's Activities and Development. *The Future of Children, Children and Computer Technology, 10, • No. 2 – Fall/Winter 2000.*
Thomson, S., & De Bortoli, L. (2007). PISA 2003 Australia: ICT use Familiarity at School and Home. ACER Research Monograph Number 62.
Wainer, J., Dwyer, T., Dutro, R. S., Covic, A., Maqalhoes, V. B., Ferreira, L. R. R., Pimenta, V .A. & Claudio, K. (2008). Too Much Computer and Internet Use is Bad for Your Grades, Especially ıf you are young and poor: Results from the 2001 Brazillian SAEB. Computers & Education, v.51, n.4, 1417-1429.
Warger, C. (1990). Technology in Today's Schools. Alexandria, VA: Association for Supervision and Curriculum Development.
Wilkins, J. L. M. (2004). Mathematics and Science Self-Concept: An International Investigation. *The Journal of Experimental Education, 72(4),* 331-346.
Wittwer, J., & Senkbeil, M. (2008). Is students' computer use at home related to their mathematical performance at school?. *Computers & Education 50,* 1558-1571.
Yüksel-Şahin, F. (2008). Mathematics Anxiety among 4^{th} and 5^{th} grade Turkish Elementary School Students. International Electronic Journal of Mathematics Education, Vol 3, Number 3.