

Full Length Research Paper

An examination of the programme for international student assessment (PISA) 2003 Turkish database with the aim of exploring the relationship between homework variables and mathematics achievement

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The purpose of this study is to examine the relationship between the amount of time spent on homework in all subjects (HTAS), the time spent on mathematics homework (MHT), confidence in doing mathematics homework (HCM) and the mathematics achievement of students in Turkey, based on data from the programme for international student assessment (PISA, 2003). According to the results of the multiple regression analysis, the positive variable which best predicts mathematics achievement is the students' HCM. The next best variable for predicting mathematics achievement is a negative one, which is MHT. There is no significant relationship between HTAS and mathematics achievement. The negative relationship between MHT and mathematics achievement can be explained by the fact that, in Turkey, the same amount of homework is given to all students, without taking their individual differences into account.

Key words: Homework, homework time, homework confidence, mathematics achievement, programme for international student assessment (PISA).

INTRODUCTION

It is essential for every country to attach importance to education in order to be able to keep up with the progression of time and to maintain a significant place in a globalizing world. The aim of education systems across the world is to be able to produce qualified and successful people, meaning that education systems should be continuously renovated and developed. International benchmarking studies such as the programme for international student assessment (PISA), the progress in international reading literacy study (PIRLS) and the trends in international mathematics and science study (TIMSS), which determine the achievement levels of students, shed light on the current situation with regard to the education systems in the participant

countries. Students' performances in these exams help them to assess their education systems and to be able to look at the current education systems in the participant countries with a critical eye.

PISA is a three-year research study which is arranged by the organization for economic cooperation and development (OECD). The purpose of PISA is to assess the knowledge and ability of 15-year-old students. PISA examines the concept of literacy in various subjects. The study collected data from the participant countries in the domain subjects of reading literacy in 2000, mathematical literacy in 2003 and scientific literacy in 2006. In addition, PISA has been assessing problem-solving abilities since 2003. PISA measures literacy through tests and also collects data concerning students' socio-demographic characteristics, school environments, learning styles, parents' views about themselves and motivation to perform well in related subject (OECD, 2005b).

Studies have shown that students from Turkey do not

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perform well in international exams. For example, according to the results of international benchmarking studies which aimed to assess the learning output of the eighth-grade curriculum for science and mathematics, students from Turkey who participated in the TIMSS 1999 and TIMSS 2007 performed far behind the competing countries in science and mathematics. Similarly, Turkey came 34th out of 40 countries with regard to mathematical literacy, according to the results of PISA, 2003 (OECD, 2005b). The Turkish students' failure in these exams may be related to many factors such as unusual question format, content of the subjects etc. One of these factors may be homework variables.

Cooper (1989; p.7) defined homework as "tasks assigned to students by school teachers that are meant to be carried out during nonschool hours" Due to reasons such as larger classes and not having enough time to spend on the curriculum, homework which has a very important function as it gives students the opportunity to engage in individual study and application outside of school hours.

Homework is a teaching strategy which is used by teachers all around the world (Barnes, 2001). One of the best ways for students to learn on their own and to actively engage in learning is homework. The homework habits of students provide us with clues about their achievement (Gür, 2003). Homework is also a valuable and useful educational tool for teachers, parents and students (Xu, 2005), because it is believed that the more time the student spends on her/his homework, the more successful she/he can become (Cooper, 1989; Dettmers et al., 2009; Paschal et al., 1984; Thelen, 2008; Trautwein, 2007). A study in the United States of America (USA) has shown that high-ability students spend more time on their homework compared to low-ability students. This implies that students in high-ability classes may do more homework than students in low-ability classes (de Jong et al., 2000).

In a study using experimental and control groups, Minotti (2005) examined the influence of homework based on learning styles on the achievement of middle-school students, and arrived at the conclusion that non-traditional teaching and homework given in accordance with learning styles increased levels of achievement. The use of learning styles which were appropriate for the students both improved academic achievement and increased the students' love of school (Lenehan et al., 1994). If their learning environment at home changed according to the individual preferences of the students, a positive improvement could be expected in terms of homework achievement and attitudes (Gür, 2003). For this reason, families should be aware of the learning styles of their children (Perkins and Milgram, 1996).

The teacher determines the kind of homework that is set. Yeşilyurt (2006) stated that homework given by the teacher at random reduced achievement levels.

However, homework given according to certain criteria designed to achieve goals and improve behaviors in any subject increased achievement levels. For homework to have a positive effect on academic achievement, it should be in keeping with the goals of the curriculum. (Reinhardt et al., 2009; Yuladır and Doğan, 2009). If parents help their children to do their homework and support them, the time spent on homework and achievement levels will be increased (Albayrak et al., 2004; Cooper et al., 2000), and so it is very important for young learners to receive their parents' support while doing their homework in order to fully grasp the relevant concepts (Dworetzky, 1990).

Studies have revealed that when responsible parents help their children with their homework, this homework improves the students' communication with their parents and their learning, and that students pay more attention to their homework and put much more effort into giving a better performance as they get older (Yeşilyurt, 2006). As parents think that homework facilitates better learning, that it gives students the opportunity to carry on learning and that it prepares them for the exams they will take later on, parents expect teachers to set homework (Van, 2004).

Thomas (2001) looked at the relationship between a few variables that affect mathematics achievement. Thomas used advanced mathematics courses, grades achieved in mathematics courses, the amount of homework completed in a week and eighth-grade transcript data from the national education longitudinal study of 1988 in his study. The results of the study showed that mathematics homework, which leads students to make an effort and to apply what they have learnt, helped them to succeed in the field of mathematics at a higher level and to adopt the concepts perfectly. On the other hand, Marzano et al.(2001) states that some educational strategies which increase students' success are: summarising; note-taking; collaborative learning; homework and exercises; and asking and forming questions

The relationship between time spent doing homework and achievement

Many variables can affect the time spent doing homework. The time, effort and motivation to do homework can be related to students' socioeconomic status parents and schools (Trautwein and Lüdtke, 2009). A public study which was carried out in the USA between 1977 and 1985 showed that parents were interested in their children's homework while they were in the first part of primary education in 37 and 49% respectively. This situation can be explained by the fact that parents become conscious of education and their education levels increase as the years go by (Featherstone, 1985;

Hill, 1992). Gill and Schlossman (2003) found that in the past 50 years, primary and secondary school students in the USA spent on average less than one hour on homework per day, and that the amount of time spent doing homework has not changed in the past 20 years. Many studies (Chen and Stevenson, 1989; Garden, 1987; Stevenson et al., 1986) have found correlations between the poor performances of American students in international studies and the time they spend doing homework.

While most studies (Beaton et al., 1996; Cool and Keith, 1991; Cooper, 1989; Cooper, Lindsay, Nye and Greathouse, 1998; Epstein, 1988; Gage and Berliner, 1984; Keith, 1982; Keith and Cool, 1992; Marshall, 1983; Meynsse and Tashakkori, 1994; Postlethwaite and Wiley, 1992) have found a positive relationship between the time spent doing homework and achievement, other studies have shown a negative relationship between the amount of time spent doing homework and achievement (Baker and LeTendre, 2005; Cooper et al., 2006; de Jong et al., 2000; Jaan, 2006; Kuyper and Swint, 1996; Schnyder, Niggli, Cathomas, Trautwein and Lüdtké, 2006).

Trautwein (2007) researched the effect of homework variables on achievement using the results of PISA 2000 and revealed that a frequency of homework which was suitable for the class level had a positive effect on achievement, and that there was a positive relationship between the students' achievement and the effort they put into their homework. However, the positive relationship between the variables could not be explained using the time spent doing homework.

Postlethwaite and Wiley (1992) examined the relationship between the time spent doing homework and science achievement using data from the international association for the evaluation of educational achievement (IEA) study of science II, which included students from 23 countries. According to the study results, students in outperforming countries spent more time on their homework than students from low-performing countries. This relationship was weak but positive ($r=0.09$), according to the results of the path analysis.

Marshall (1982), when evaluating the relationship between homework and mathematics achievement through a meta analysis of the findings of 23 studies, arrived at the conclusion that homework increased mathematics achievement, especially in higher grades. Cooper (1989) examined 50 studies concerning the time spent on homework and achievement, and in 43 of the studies there was a positive relationship between the time spent on homework and achievement. While there was almost no relationship between the time spent on homework during primary school and achievement ($r=0.02$ in the third-fifth grades and $r=0.07$ in the sixth-ninth grades), in secondary school, this relationship was limited but present ($r=0.25$ in the 10 to 12th grades).

Kuyper and Swint (1996), in their study of 900 students in grades seven to nine studying in Holland, found a negative relationship ($r=-0.19$) between the time spent on homework and achievement.

Schnyder et al. (2006) examined the relationship between the effort made with homework, the time spent on homework and achievement in learning French as a foreign language using 1832 students. In the results of the study, while a negative relationship was found between the time spent on homework and French achievement, it was seen that there was a positive relationship between the effort made with homework and French achievement.

De Jong et al. (2000), using 1394 students from 28 schools, researched the relationship between homework and mathematics achievement and found that the most important variables for explaining mathematics achievement were prior knowledge and intelligence quotient (IQ) (52.7%). Time spent on homework and motivation variables (mathematics motivation and self-confidence) explained 2.2 % of variance in mathematics achievement. When the effects of all of the variables were taken into account, 54.9% of the variance in mathematics achievement was explained. In the results of this study, it was found that the frequency of homework and the time spent on homework had almost no effect in terms of explaining mathematics achievement, and a negative ($r=-0.15$) correlation was found between the time spent doing homework and mathematics achievement.

Forty countries and a total of 231,759 15-year-old students participated in PISA 2003. In the results of the multilevel analyses, although a positive relationship between the average time spent on homework and mathematics achievement in schools existed in almost all of the countries, the strength of this relationship decreased considerably when variables such as the students' socioeconomic status and the school track were controlled for. When the student's level of ability is taken into account, the relationship between time spent doing homework and achievement becomes unclear (Dettmers et al., 2009).

According to in TIMSS 2003, in which 46 countries participated, an association between the time spent on homework and mathematics achievement was observed, and it was found that the teachers' emphasis on mathematics homework and the students spent doing homework had no statistically significant correlation with mathematics achievement ($r=-0.15$) in the inter-country comparison (Cooper et al., 2006; Jaan, 2006). Results from the PISA 2003 showed that the average amount of time per week spent doing homework by the students in the participant countries was 2.6 h. The average time spent doing homework by the Turkish students who participated in PISA 2003 was 2.8 h per week and the Turkey performed below the organization for economic

cooperation and development (OECD) countries average scores in measures of mathematics literacy and problem solving. PISA 2003, the Turkey placed 34th based on their average scores of 15-year-old students on the mathematics literacy (OECD, 2005b).

Turkey's average mathematics score is significantly lower than that of the OECD countries, although the amount of time spent on homework in a week in Turkey is a little higher than average. Similarly, in spite of the high performances of European countries such as Finland and Holland (544 and 538), their students spend only 1.4 and 1.9 h per week on homework respectively. Nevertheless, Mexico and Thailand, whose mathematics scores (385 and 417) were below average, had above-average scores for the amount of time spent on homework (4.1 and 3.5 h per week) (OECD, 2004). This situation shows that students in education systems in which less homework is given out (such as in the Czech Republic and Japan) are more successful than students in education systems in which more homework is given out (Baker and LeTendre, 2005). Moreover, these results provide an opportunity to discuss the achievements of the education systems of different countries.

When studies concerning homework are examined, it can be seen that there are continuing discussions on the amount of time which it is necessary to spend on homework. Cooper (2001) stated that the necessary amount of time to spend on homework per day in the first grade should be 10 minutes, and that as the class level increases, 10 min should be added for each level. According to Gage and Berliner (1985), the amount of time which students should spend on homework per day should be 10 to 30 min in the first-third grades, 30 to 60 min in the fifth-sixth grades, 45 to 120 min in the seventh-eighth grades and three hours in the ninth-12th grades (p. 525). Van Voorhis (2004) stated that students from preschool until the second grade should spend 20 to 30 min on homework per day and that students from the third until the sixth grade should spend 30 to 60 min on homework per day. Another view on this subject is that homework which will take at least one hour must be given to primary school students and homework which may take more than two hours should be given to secondary and upper school students (Strother, 1984). A full agreement has not been reached with regard to this subject, and so studies examining the relationship between homework and the time spent on homework and achievement will help to fill the gaps in the literature.

The purpose of mathematics homework is not only to reinforce skills, but also to provide students with analytic thinking skills, self-discipline, self-confidence and responsibility for their own learning (National Council of Teachers of Mathematics, 2000). Epstein (1988) states that the seven aims of homework in primary education are: applying practical skills; increasing learning experiences; developing responsibility, self-confidence

and time management; establishing communication between the school and parents; carrying out instructions concerning homework in the education system; informing parents about school and classroom activities and continuing the classroom policies.

Relationship between homework-confidence and achievement

Feltz (1988: 423) defined self-confidence as "one's belief that he or she can successfully execute a desired behavior (that is his or her belief of "I will get the job done")". If a person lacks self-confidence, he or she will not behave freely, will resist making individual decisions and will always wait for help from others (Akin, 2007).

Self-confidence is used interchangeably with self-efficacy in the literature (Akin, 2007; Feltz, 1988; Finger and Walthall, 2005). Some researchers have stated that while self-confidence can be generalised or specialised to a specific area, self-efficacy can only be specialised (for example, Shrauger and Schohn, 1995). Briefly, self-efficacy means particular form of self-confidence (Vealey, 1986). Self-efficacy is an individual's belief in his or her ability to achieve a certain goal. Self-efficacy is very important in terms of mathematics homework (Lerch, 2004; Zimmerman and Kintansas, 2005). Students can solve problems in their mathematics homework with the help of their self-confidence. Zeitz (1999: 16) stated that "a good problem solver does not give up. Most beginners give up too soon because they lack confidence". Self-confidence is important in all cognitive sciences and is also an important element in mathematics, because with self-confidence, the student's mathematics achievement level will increase and she/he will be able to solve unfamiliar mathematical problems with the help of her/his self-confidence. Mathematics homework reveals the strategies which the students use to solve the problem and how they approach the problem. A lack of self-confidence makes students unable to solve the problem, and they struggle to find the solution. The reason behind this lack of self-confidence is the student's view of mathematics (Lerch, 2004), meaning that homework-confidence is one of the most important variables affecting mathematics achievement. Erktin and Ader (2004) revealed that students with greater self-confidence in the field of mathematics were more successful in university entrance exams. Zimmerman and Kitsantas (2005) examined the role of students' homework practices with regard to their self-efficacy beliefs concerning their use of specific learning processes (for example, organising, memorising, concentrating, monitoring, etc.), perceptions of academic responsibility and achievement. With this aim, the study included 179 female students living in the USA with a diverse range of socioeconomic characteristics and ethnic origins. It was

found that homework affects students' self-efficacy beliefs and perceptions of academic responsibility. High-achieving students in the field of mathematics generally have high levels of mathematics self-efficacy or self-confidence (Aşkar and Umay, 2001; Cerezo, 2004; Pajares, 1996). In the literature, there are also studies showing a negative relationship between mathematics self-efficacy and mathematics achievement. For example, the PISA 2003 results showed that Asian countries such as Japan and Korea demonstrated low mathematics self-efficacy even though they were high-performing countries with average mathematics scores of 534 and 542 respectively (Lee, 2009; Ho, 2006). Similarly, although students in Hong Kong, Korea, Japan and Singapore achieved quite high mathematics and science scores in TIMSS, the students' confidence in mathematics was fairly low (Leung, 2002).

Tuckman (1992) stated that students with low self-esteem did not do their homework due to a lack of motivation. While the frequency of homework has a positive effect on mathematics achievement, lengthy homework has a negative and non-significant effect (Trautwein et al., 2002). Students with low self-confidence do not want lengthy pieces of mathematics homework, and so teachers must consider the personal attitudes of these kinds of student when giving out homework.

Turkish mathematics curriculum

Leading up to today, there have been many changes to the curriculum in Turkey. Ultimately, instructional programmes for primary and elementary schools have been improved through the constructivist approach and were put into practice in the 2005 to 2006 school year (Bulut, 2005). Previously, the knowledge load in mathematics programmes was too much, and lessons were conducted without consideration for the individual differences between the students. These kinds of traditional instructional programme ceased to work over time. In putting together the new programme, some mathematical programmes which are used in Europe (Britain and France), North America (the USA, Canada) and in Far East Asia (Malaysia, Singapore) were adapted (Baki and Gökçek, 2005; Duru and Korkmaz, 2010; Ministry of National Education, 2005). This programme has been prepared taking into account the nature of mathematics and the educational unity of an eight-year-long primary education. In the new programme, there is a transition from the behaviourist approach to the constructivist approach. In this new approach, which has replaced traditional forms of measurement and evaluation, alternative methods of measurement and evaluation are favoured. The programme for mathematics lessons consists of five educational fields: numbers; geometry; algebra; measurement; probability and statistics.

This programme acknowledges the importance of the students' reasoning, problem-solving, associating, searching and technological skills (Baki and Gökçek, 2005; Bulut, 2005; Ersoy, 2006; Memnun and Akkaya, 2010). The knowledge load in the programme has been reduced, and the knowledge is delivered according to the cognitive, affective and psychomotor features of the students, as well as their age (Duru and Korkmaz, 2010; Yapıcı and Demirdelen, 2007).

Aim of the study

The purpose of this study is to examine the relationship between the amount of time spent on homework in all subjects (HTAS), the time spent on mathematics homework (MHT), confidence in doing mathematics homework (HCM) and the mathematics achievement of students in Turkey, based on data from the programme for international student assessment (PISA, 2003).

METHODOLOGY

As the relationship between the results of the student questionnaire (which aims to measure the performances of 15-year-old students in Turkey) and mathematics achievement is being examined, this study constitutes correlational research.

Sample

The tests and surveys of the PISA 2003 project were conducted in May 2003, using 4855 students who were born in 1987. The students were randomly selected from 12 primary and 147 high schools from seven geographical regions in Turkey. The types of school which took part in the PISA 2003 study were as follows: high schools ($n=2917$; 60.1%); Anatolian vocational high schools ($n=7271$; 15.0%); vocational high schools ($n=633$; 13.0%); Anatolian high schools ($n=200$; 4.1%); private high schools ($n=161$; 3.3%); primary schools ($n=119$; 2.5%); science high schools ($n=63$; 1.3%) and police academies ($n=35$; 0.7%) (total $n=4855$; 100%).

Instruments

Mathematics achievement test

The mathematics literacy test was composed of 85 items of varying levels of difficulty from four areas of mathematics: geometry, algebra, arithmetic and probability. Turkey's mean score for the mathematics literacy test was 423, in a range of 356–550 ($SD=105$, Cronbach's $\alpha=0.92$) (OECD, 2005b).

Homework time for all subjects (HTAS)

The time spent doing homework for all subjects was measured using the following question:

"Including all of your studying and homework, on average, how many hours do you spend each week on the following?" The students were asked to enter the number of hours in a blank field. The mean of these items was 5.9 ($SD=5.7$, Cronbach's $\alpha=0.71$).

Mathematics homework time (MHT)

The amount of time spent doing mathematics homework was measured using the following question: "With regard to mathematics homework done outside of your regular mathematics classes, on average, how much time do you spend each week on the following?" The students were asked to enter the number of hours in a blank field. The mean for the items was 2.8 (SD=2.7, Cronbach's $\alpha=0.72$).

Homework-confidence in mathematics (HCM)

The PISA 2003 index of confidence in doing mathematics homework was derived from the students' responses to eight questions. HCM was measured using the following question: "How confident do you feel about having to do the following mathematical tasks?" The items were rated on a four-point Likert scale ranging from 4 ("Very confident") to 1 ("Not at all confident"). The mean of these items was 2.76 (SD=0.77, Cronbach's $\alpha=.88$).

Statistical analyses

The data used in this study were collected by OECD (2005a). During the data analysis, items relating to three latent factors concerning homework in the student questionnaire were tested using confirmatory factor analysis. Multiple regression analyses were conducted to predict mathematics achievement. LISREL 8.7 (Jöreskog and Sörbom, 2004) and statistical package for the social sciences (SPSS) 17.0 were used for the data analysis.

RESULTS

Confirmatory factor analysis (CFA)

The aim of CFA is to prove that items which are identified using theoretical knowledge (observed variables) are related to latent factors and that the latent factors are related to one another. As a result of the CFA intended to determine the efficacy of the model, a variety of cohesion indices in different numbers were used (Hinkin, 1998). The model parameters were estimated using maximum likelihood (Jöreskog and Sörbom, 2004).

In this study, in order to evaluate the absolute fit, χ^2 (χ^2 : minimum fit function test), the goodness of fit index (GFI), the comparative fit index (CFI) and the root mean square residual (RMR) were used. The normed fit index (NFI) and the Tucker-Lewis index (TLI) were used as incremental fit measures. The results relating to the models are summarized in Table 1.

The chi-square statistic is an extremely sensitive statistical test, and with large samples such as the present one (n=652), it is not a practical test of model fit (for example, Cheung and Rensvold, 2002; Maydeu and D'Zurilla, 1996). For this reason, in order to evaluate the absolute fit, the χ^2/df measure was used. The χ^2/df ratio should be ≤ 5.0 , the RMR should be $\leq .10$, the GFI,

CFI, AGFI, NFI and TLI should at least be .90 and the root mean square error of approximation (RMSEA) should be less than 0.08 (Browne and Cudeck, 1993; Byrne, 1994; Kelloway, 1998; Segars and Grover, 1993; Schermelleh et al., 2003). For the model which incorporated all of the items, all of the measures except the χ^2 , χ^2/df , GFI, and adjusted goodness-of-fit index (AGFI) surpassed the acceptable levels. On the other hand, when the factor loadings (regression weights) between the observed variables and the latent variables in the scale were examined individually, it was found that their t-values were significant. Table 2 shows the estimated residual variances, factor loadings ($\lambda\chi$) and t-values. All observed variables were significantly pertained to their underlying latent construct ($p < 0.00$).

Taking the CFA results in Table 2 into account, the items were brought together, factor loadings were calculated and indices were formed. These indices which were formed by taking the CFA results into account were determined as the variables which were considered to predict mathematics achievement. In order to find which variable best predicted the mathematics achievement score, mathematics literacy was attained using the average sub-test scores.

Zero-order correlational results regarding homework variables and mathematics achievement

The zero-order correlations between the four measures are presented in Table 3. The Pearson correlations between the students' homework variables reported in the questionnaires and mathematics achievement were examined. As Table 3 shows, even though the amount of the relationship between HTAS and mathematics achievement is quite weak, the relationship seems significant ($r=0.046$, $p < 0.01$). This can be due to large sample size (n=4855). The same situation is observed for the relationship between HTAS and HCM ($r=0.78$, $p < 0.01$), and MHT and mathematics achievement ($r=0.05$, $p < 0.01$). HCM was moderately positively correlated to mathematics achievement ($r=0.538$, $p < 0.01$) and MHT ($r=0.117$, $p < 0.01$). As the correlations between the independent variables and the dependent variables are significant, and the correlations between the explanatory variables are lower than $r=0.80$, this shows that the independent variables can be used in the regression (Büyükoztürk, 2006; Roscoe, 1975).

Standard multiple regression analysis results: Homework variables affecting mathematics achievement

In the study, standard multiple regression analysis was

Table 1. Fit statistics of the LISREL models.

Latent variable	χ^2	χ^2 / df	NFI	TLI	CFI	GFI	AGFI	RMSEA	RMR
HTAS	21.02	3.00	0.98	0.96	0.98	0.99	0.94	0.02	0.02
MHT	13.94	2.32	0.97	0.95	0.98	0.98	0.95	0.07	0.04
MHC	73.23	3.85	0.98	0.98	0.99	0.97	0.95	0.07	0.03

HTAS: homework time for all subjects; MHT: mathematics homework time; HCM: homework-confidence in mathematics; : minimum fit function test; NFI: normed fit index; TLI: Tucker-Lewis Index; CFI: comparative fit index; GFI: goodness-of-fit index; AGFI: adjusted goodness-of-fit index; RMSEA: root mean square error of approximation; RMR: root mean square residual; * $p < 0.01$.

Table 2. CFA for LISREL estimates, residual variances and t-values.

Latent and observed variable	$\lambda\chi$	SE	t
Q29. Including all of your studying and homework, on average, how many hours do you spend each week on the following? (HTAS).			
Homework or other work set by your teachers: hours per week.	0.78	0.39	40.02
Remedial lessons given at school: hours per week.	0.79	0.38	38.23
Enrichment lessons given at school: hours per week.	0.60	0.64	35.93
Working with a tutor: hours per week.	0.79	0.38	40.79
Attending "out-of-school" classes: hours per week.	0.55	0.70	33.42
Other studies: hours per week.	0.60	0.64	35.93
Q31. How confident do you feel about having to do the following mathematical tasks? (HCM).			
Using a "train timetable" to work out how long it would take to get from one place to another.	0.74	0.45	21.40
Calculating how much cheaper a TV would be after a 30% discount.	0.72	0.48	20.44
Calculating how many square metres of tiles you need to cover a floor.	0.79	0.38	23.47
Understanding graphics presented in newspapers.	0.69	0.52	19.29
Solving an equation like $3x+5= 17$.	0.60	0.64	16.37
Finding the actual distance between two places on a map with a 1:10,000 scale.	0.66	0.56	18.44
Solving an equation like $2(x+3)=(x + 3)(x - 3)$.	0.59	0.65	15.91
Calculating the petrol consumption rate of a car.	0.68	0.54	19.1
Q33. With regard to mathematics homework done outside of your regular mathematics classes, on average, how much time do you spend each week on the following? (MHT).			
Homework or other work set by your mathematics teacher: hours per week.	0.35	0.88	8.63
Remedial mathematics lessons given at school: hours per week.	0.77	0.41	19.86
Enrichment mathematics lessons given at school: hours per week.	0.87	0.24	22.52
Working with a mathematics tutor: hours per week.	0.47	0.78	11.74
Attending "out-of-school" classes: hours per week.	0.33	0.89	8.14
Other studies (including other mathematical activities such as mathematics contests and maths club): hours per week.	0.30	0.91	7.21

SE: standard err : Λ -x.

used to determine the extent to which the predictive variables predicted mathematics achievement. The aim of using regression analysis is to understand the connection between one dependent variable and one or more independent variables, and to explain the type of the connection. In situations in which, there is only one independent variable and one dependent variable' or 'there is the same number of dependent and independent variables, simple linear regression analysis is utilised. In

situations in which there are two or more independent variables, multiple regression analysis is utilised. In standard multiple regression analysis, all variables are taken into account without looking to see whether or not they have a significant effect on the explained variance in the variable which is dependent on the regression equation, and the common effects of all predictive variables on the dependent variable are examined (Büyüköztürk, 2002; Tabachnick and Fidell, 1996). Before

Table 3. Zero-order correlations for the variables in this study.

Variable	Mathematics achievement	HTAS	MHT	HCM
Mathematics achievement	1	0.046*	0.05*	0.538*
HTAS	0.046*	1	0.296*	0.078*
MHT	0.05*	0.296*	1	0.117*
HCM	0.538*	0.078*	0.117*	1

*p<0.01.

Table 4. Standard multiple regression analysis results for factors affecting mathematics achievement.

Variable	B	SE	β	t	p
Constant	235.744	5.789		40.723	0.01
HTAS	0.462	0.248	0.024	1.862	0.063
MHT	-1.352	0.263	-.065	-5.149	0.01
HCM	8.631	0.193	0.544	44.700	0.01

R=0.542; R²=0.29

the analysis, the regression assumptions were tested.

With the aim of predicting mathematics achievement, the results of the multiple regression analysis between HTAS, MHT, MHC and mathematics achievement are given in Table 4.

When Table 4 is examined, a medium-level and .01-level significant relationship was revealed between the average HTAS by 15-year-old students in Turkey, the average MHT, HCM and mathematics achievement (R=0.542, R²=0.29, p<0.01). These three predictive variables together explain approximately 29% of the total variance in mathematics achievement, which was the dependent variable.

According to the standardized regression coefficient (β), the sequence of the predictive variables with regard to mathematics achievement in terms of their relative importance is as follows: HCM and MHT. The regression equation derived using multiple regression analysis relating to predicting mathematics achievement is given as:

$$\text{Mathematics achievement} = 235.744 + 0.462 (\text{HTAS}) + 8.631 (\text{HCM}) - 1.352 (\text{MHT})$$

When the results of the regression analysis are examined, we can see that the HCM variable predicts mathematics achievement in a significant and positive way. The more HCM which students have, the more their mathematics score increases. This also shows that the MHT variable predicts mathematics achievement in a significant and negative way. The less time that students spend doing mathematics homework, the more their mathematics achievement increases. No significant

relationship was found between homework time for all subjects (HTAS) and mathematics achievement.

DISCUSSION

This study, using the results of PISA, aims to determine the relationship between the HCM of 15-year-old students in Turkey, HTAS, average MHT and mathematics achievement. This research is important as it reveals the predictive power of homework variables, which are considered to be one of the factors affecting the mathematics achievement of students in Turkey.

In the findings of this research, it was found that the most positive variable which was an effective predictor of mathematics achievement is HCM. The more HCM students have, the more their mathematics achievement increases. Pajares (1995) studied the relationship between 329 high school students' self-efficacy beliefs and their general mental ability with regard to their mathematical problem-solving performance. They found that even when mental ability was controlled for, there was a positive and strong relationship between the students' self-efficacy beliefs, their mathematical ability and their mathematical problem-solving performance. On the other hand, Wolters and Pintrich (1998) conducted a study of 545 seventh and eighth grade students. They examined the relationship between the students' motivation towards mathematics, social sciences and English lessons with the regulatory strategies they use and their level of achievement in these lessons. They found that the students with high self-efficacy in mathematics, social sciences, and English lessons used regulatory strategies more and achieved higher marks

than the students with low self-efficacy. Umay (2002) examined whether or not there was a difference in the perceptions of mathematical self-efficacy between junior and senior primary school mathematics pre-service teachers. It was found, based on the statistics, that the perceptions of self-efficacy among the seniors were significantly higher than among the juniors. In addition, the findings of Shih and Alexander (2000) study of 84 fourth-grade Taiwanese students showed that the students with high self-efficacy were more successful. A similar study conducted by Pietsch et al. (2003) showed that high-school students with high self-efficacy also achieved a better performance in mathematics, while students with low self-efficacy achieved a worse performance in mathematics. The results of our study also show parallels with the studies conducted by Aşkar and Umay (2001), Cerezo (2004), Erktin and Ader (2004), Lavonen and Laaksonen (2009), Pajares (1996) and Thorpe (2006).

The results of our study show that the average MHT was negatively related to achievement in mathematics. Nevertheless, this reveals a result which is contrary to the positive relationship which is hypothetically expected (Beaton et al., 1996; Cool and Keith, 1991; Cooper, 1989; Cooper et al., 1998; Epstein, 1988; Gage and Berliner, 1984; Keith, 1982; Keith and Cool, 1992; Marshall, 1982; Meynsse and Tashakkori, 1994; Postlethwaite and Wiley, 1992), although it is in line with the findings of some other studies (Baker and LeTendre, 2005; Cooper et al., 2006; de Jong et al., 2000; Jaan, 2006; Kuyper and Swint, 1996; Schnyder et al., 2006). In the study by Burstein (1993: 36) of Japanese and French students, a negative relationship was found between the time spent on homework and achievement. The reason why this relationship is negative may be that teachers give the same amount of homework to all students, without taking the individual differences between them and their learning levels into account. In the USA, clever students spend more time on their homework than less talented students. This situation can be explained by the fact that clever students receive more homework from their teachers (Burstein, 1993; Keith et al., 1986). In the education system in Turkey, more and less talented students receive the same amount of homework, meaning that more talented students finish their homework in less time than less talented students. Education systems in different countries result in different relationships between the amount of time spent on homework and achievement.

There is no significant relationship between the average HTAS and mathematics achievement. This result is in accordance with the findings of studies by Cooper et al. (2006), Dettmers et al. (2009), Jaan (2006) and Trautwein (2007). In these studies, the relationship between the amount of time spent doing homework and mathematics achievement was either not clear-cut or

was meaningless.

Conclusions

International benchmarking studies such as PISA and third international mathematics and science study (TIMSS) report low levels of attainment for Turkey (Aksit, 2007; OECD, 2004; TIMSS, 1999, 2007). One of these attainment areas is mathematics, which is included in the 16 indicators of the quality of school education (European Commission, 2005). The reasons why students fail in these exams may be related to many factors. In this study, homework variables used to predict mathematics achievement and variables which were related among them were examined. It was found that there is a significant and positive relationship between homework-confidence in mathematics (HCM) and mathematics achievement. This shows that the more HCM the students have, the better their performance in mathematics. The fact that there is a negative relationship between MHT and mathematics achievement can be explained by the fact that the same amount of homework is given to all students in Turkey, without taking their individual differences into account. In order for Turkey to improve its students' achievements in international examinations in mathematics, examining the instructional systems of countries such as Finland, Hong Kong, China, Korea, Japan, etc. which have been successful in these examinations may prove to be useful.

Limitations

This study has several limitations. Variables were examined using the limited number of questions in the questionnaire. Another limitation of this study is that a limited number of observed variables were used in determining the consequences of the latent variables using CFA.

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