TEACHER AND CLASSROOM CHARACTERISTICS: THEIR RELATIONSHIP WITH MATHEMATICS ACHIEVEMENT IN TURKEY, EUROPEAN UNION COUNTRIES AND CANDIDATE COUNTRIES

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

GÖZDE AKYÜZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DOCTOR OF PHILOSOPHY
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

JUNE 2006

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. Canan ÖZGEN
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. Ömer GEBAN
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.
.

Prof. Dr. Giray BERBEROĞLU
Supervisor

Examining Committee Members

Prof. Dr. Petek AŞKAR	(HACETTEPE Uni., BOTE)	___________
Prof. Dr. Giray BERBEROĞLU	(METU, SSME)	___________
Prof. Dr. Ömer GEBAN	(METU, SSME)	___________
Assoc. Prof. Dr. Safure BULUT	(METU, SSME)	___________
Asist. Prof. Dr. Esen UZUNTİRYAKİ	(METU, SSME)	___________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Gözde Akyüz

Signature :

ABSTRACT

TEACHER AND CLASSROOM CHARACTERISTICS: THEIR RELATIONSHIP WITH MATHEMATICS ACHIEVEMENT IN TURKEY, EUROPEAN UNION COUNTRIES AND CANDIDATE COUNTRIES

Akyüz, Gözde
Ph.D., Department of Secondary Science and Mathematics Education
Supervisor: Prof. Dr. Giray Berberoğlu

June 2006, 124 pages

The purpose of this study is to investigate the effects of mathematics teacher and classroom characteristics on students' mathematics achievement across Turkey, European Union countries and the other candidate countries by analysing the data collected from student and teacher background questionnaire and mathematics achievement test in the Third International Mathematics and Science Study (TIMSS-R). Mathematics teacher characteristics were divided into three groups as teacher's background variables, teacher's instructional practices and class characteristics. Except Cyprus, in all the other countries, there was sufficient amount of between-class variance to build explanatory models. After home educational resources (HER) of students was taken as a control variable, explanatory models were built by using Hierarchical Linear Modeling (HLM). The amount of variance explained by the full model ranged from 26 % in Romania to 74 % in Netherlands. There were substantial differences among the countries, especially in the teacher's instructional practices. It was found that mean of HER had high effect on student mathematics achievement in all the countries except Romania. It is recommended that the factors that were found to have significant effects on student learning should be explored in experimental settings.

Keywords: Teacher Effect, Mathematics Achievement, TIMSS, HLM

ÖZ

ÖĞRETMEN VE SINIF ÖZELLİKLERİ: TÜRKİYE, AVRUPA BİRLİĞİ ÜLKELERİ VE DİĞER ADAY ÜLKELERDE MATEMATİK BAŞARISI İLE İLİŞKİLERİ

Akyüz, Gözde
Doktora, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Prof. Dr. Giray Berberoğlu

Haziran 2006, 124 sayfa

Bu çalışmanın amacı, Türkiye, Avrupa Birliği'ne üye ülkeler ve diğer aday ülkelerdeki matematik öğretmeni ve sınıf özelliklerinin öğrenci matematik başarısına etkisini, Üçüncü Uluslararası Matematik ve Fen Çalışmaları (TIMSS-R) öğretmen, öğrenci anketleri ve öğrenci başarı testi verilerini kullanarak incelemektir. Matematik öğretmeni nitelikleri öğretmenin temel nitelikleri, öğretim uygulamaları ve sınıf özellikleri olmak üzere üç gruba ayrılmıştır. Güney Kıbrıs Rum Kesimi dışındaki diğer tüm ülkelerde açıklayıcı model oluşturacak miktarda sınıflar arası varyans vardır. Öğrencilerin ev eğitim kaynakları kontrol değişkeni olarak alınıp hiyerarşik lineer modelleme (HLM) kullanılarak açıklayıcı modeller oluşturulmuştur. Tam model tarafından açıklanan varyans %26 (Romanya)- %74 (Hollanda) aralığındadır. Özellikle öğretmenin öğretim uygulamaları arasında olmak üzere ülkeler arasında büyük farklar vardır. Ev eğitim kaynakları sınıf ortalamasının, Romanya dışında diğer tüm ülkelerde, öğrenci başarısını önemli ölçüde etkilediği bulunmuştur. Öğrenci başarısına anlamlı etkisinin bulunduğu belirlenen değişkenlerin deneysel çalışmalarla incelenmesi gerektiği düşünülmektedir.

Anahtar Kelimeler: Öğretmen Etkisi, Matematik Başarısı, TIMSS, HLM

To My Father

ACKNOWLEDGMENTS

Writing this dissertation would not be possible without the support of many people. Firstly, I want to thank my supervisor, Prof. Dr. Giray Berberoğlu for his valuable support, thoughtful questions and guidance throughout my graduate study.

A huge thank to my dear parents, Suvar and Taner Çömlekoğlu, there are no words to describe my appreciation and gratitude for their support during my doctoral study. They always have faith and pride in me. I am very proud to have them as my parents. I also thank my brothers, Erhan and Gürhan for their support.

I want to thank my mother- and father-in law, Şenay and İbrahim Akyüz, for their support and sacrifice throughout this process.

I would like to thank my dear husband, Ersin, for his confidence in me and provided motivation to stay focused on my study and for his unwavering faith that I could succeed. I also want to thank my smart and beautiful daughter, İpek, who was born in my doctorate process. Her birth fostered me in finishing my dissertation. She is the most wonderful baby. I adore her.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Educational systems throughout the world place high importance on teaching and learning of mathematics and a high level of resource allocation is devoted to maintaining and improving efficiency and effectiveness in mathematical activities. Mathematics is seen as contributing to the intellectual development of individual students as preparing them to live as informed and functioning citizens in contemporary society and as providing them with the potential to take their places in the fields of commerce, industry, technology and science (Cockroft Report, 1982). Therefore, in most of the education systems in the world, mathematics occupies a central place in the school curriculum and nearly 15 % of the school time is devoted to mathematics lessons (Robitaille & Garden, 1989). As a result of the almost universal consensus on the importance of mathematics in school and business life, the efficacy of mathematics teaching and learning deserves continued and sustained scrutiny.

Current discussions about the teaching and learning mathematics attributes considerable importance to the role of teacher in mathematics classroom. Although attempts to develop teacher-proof curricula have first appeared in the form of programmed learning materials, then in the textbooks of the modern mathematics era and more recently by use of technology, none of them could take the place of the teacher in the classroom (Grouws, 1991). Teachers have the most direct, sustained contact with students and considerable control over what is taught and the climate for learning. So, knowledge, skills and dispositions of teachers are critical in improving student achievement and nearly everyone accepts the premise that teachers make a difference in the lives of their students.

Many of the teacher effect research revealed the association between teacher behaviors and patterns of teacher-student interactions and student outcomes and it is seen that some teachers reliably elicit greater student achievement gains than others because of differences in how they teach (Brophy & Good, 1986). What and how teachers teach are affected both by their conceptions of subject matter disciplines in mathematics and by their beliefs about their students and by their understanding of appropriate pedagogy (Thompson, 1984).

The importance given to the effect of teacher on student outcomes is evident in many models that identify the factors affecting students' mathematics related outcomes, e.g. Mathematics Teaching Cycle (Simon, 1997); Shavelson et al's model that points out the indicators for monitoring mathematics and science education (cf. Howie, 2003), The Model of Educational Opportunities developed by The Survey of Mathematics and Science Opportunities (SMSO) Project team (Cogan & Schmidt, 1999).

SMSO project, which was carried out by a multi-national research team, shows the different patterns in mathematics classrooms. Researchers made classroom observations in six countries; France, Japan, Spain, USA, Norway and Sweden. They developed the conceptual model of educational opportunities which includes the key aspects of the educational opportunities that any system may provide to its students and their relationships. Their analysis indicated that specific dimensions of the curriculum's content were interacting with aspects of classroom activity to yield specific lessons that differed qualitatively from one another. They named these patterns as "characteristic pedagogical flow" (CPF) which refers to the recurrent patterns that can be observed across classroom lessons in a certain country. CPF for a specific country derives from the interaction of teachers' instructional practices and subject matter. Since teachers are the key people in this process, their background and beliefs are important factors in this interaction. Researchers suggest that further investigations should be carried out in these aspects which are important in the comparative study of mathematics education (Cogan and Schmidt, 1999). The patterns of instructional practices are mostly the results of the choices and decisions made by individual teachers, they may also stem from the specific educational systems that trained teachers, gave them resources, arranged their working climate and shaped their experiences as teachers. So, it is possible to see some common patterns in the beliefs and instructional practices of mathematics teachers in each country different from the other countries (Schmidt et al., 1999).

1.1 Information about IEA and TIMSS

Comparative education can deepen the understanding of the education system and society. It can provide assistance to policy-makers and administrators and it can be a valuable component of teacher education programs. Neville (1988) lists the major aims of comparative education as;

1. Identifying what is happening elsewhere might help improve our own system of education.
2. Describing similarities and differences in educational phenomena between systems of education and interpreting why these exist.
3. Estimating relative effects of variables on outcomes both within and between systems of education.
4. Identifying general principles concerning educational effects.

There are many organizations around the world such as The International Association for the Evaluation of Educational Achievement (IEA), Organization for Economic Cooperation and Development (OECD), UNESCO and World Bank which support the collection of information on the provision of education across developed and developing countries. IEA has been the major pioneer of the studies that investigates the factors influencing achievement outcomes across the countries of the world.

Centers of educational research from more than 50 countries are members of IEA. It has carried out a sustained program of research studies into factors that have an effect on educational achievement, participation rates and attitudes towards school and school learning. Through these comparative research projects, IEA mainly aims to provide international benchmarks that may assist policy-makers in identifying the comparative strength and weaknesses of their educational system and provide high quality data that will increase policy-makers' understanding of key school- and non-school-based factors that influence teaching and learning and serve as a resource for identifying areas of concern and action, and for preparing and evaluating educational reforms. First International Mathematics Study (FIMS,1964), Second International Mathematics Study (SIMS, 1980-82), Third International Mathematics and Science Study (TIMSS, 1995), TIMSS-R (1999) and TIMSS (2003) are the large scale studies in mathematics education that IEA has carried out up to now.

TIMSS 1995, which was intended to monitor the success of mathematics and science instruction and the context in which it occurs in each of the participating countries, is a large international assessment that has been conducted in the field of education. It was different from the earlier studies in that through the mechanisms of curriculum analysis, a video study, achievement tests and background questionnaires, an extensive amount of data was collected which provides a unique opportunity to observe and examine how mathematics and science instruction is provided in more than 50 countries. Furthermore, it established international benchmarks for achievement and key policy variables which are schooling, curriculum and instruction that allow countries to monitor their performance in an increasingly global community. Although, most of the international studies focus only on the achievement of students and only emphasize the ranking of the students, TIMSS focuses on the characteristics of instructional practices and also on the affective characteristics of students and teachers in order to establish the relationship of various variables. Like in SIMS, TIMSS also examined the differences among the intended curriculum -which is what the system would like children to be taught, implemented curriculum -which is what they are actually taught and attained curriculum -which is what they actually learn.

After TIMSS 1995, another study which is called as the Trends in International Mathematics and Science Study (TIMSS –R), was designed to provide trends in eighth-grade mathematics and science achievement in an international context in

1999. Thirty-eight countries participated in TIMSS-R and of these twenty-six participated in the study both in 1995 and 1999. TIMSS-R focused on the population of the grade in which the majority of 14-year old students were included. TIMSS addressed four research questions which were;

1. What are students expected to learn?
2. Who delivers the instruction?
3. How is instruction organized?
4. What have students learned?

The design of TIMSS-R was uniform across the participating countries like in the other IEA studies and the procedures were standardised. Each country selected a representative sample of a minimum of 150 schools and one intact classroom which was mostly at grade 8 was tested from each selected school. TIMSS-R data collection was done near the end of the school year in every country. The same achievement test containing a combination of mathematics and science items was administered in each country after translated into the languages of instruction and appropriate contextualization adjustment was carried out. A rotated booklet design was used. Eight comparable booklets, each containing 26 items were administered. The content areas are fractions and number sense; measurement; data representation, analysis and probability; geometry; and algebra. The performance expectations determined for mathematics test are knowing, using routine procedures, investigating and problem solving, mathematical reasoning, and communicating. The perspectives of mathematics test are attitudes, careers, participation, increasing and habits of mind (Gonzales & Miles, 2001).

The students who were tested answered questions related to their attitudes towards mathematics and science, their academic self-concept, classroom activities, home background, and out-of- school activities. The mathematics teachers of sampled students responded to questions about teaching emphasis on the topics in the curriculum frameworks, instructional practices, professional training and education, and their views on mathematics and science.

The data gathered from questionnaires and achievement tests were examined by the international study center and published in TIMSS database (http://timss.bc.edu/timss1999.html). Then researchers from different countries started to investigate their research questions i.e. secondary analysis have been carried out.

1.2 Hierarchical linear modelling

Various statistical techniques have been used in secondary analysis of TIMSS data. The most popular and recommended one by the researchers in the last decade is hierarchical linear models (HLM) which are a type of model used for analyzing data in a clustered or nested structure. For example, students who are nested within classrooms, which are nested within schools. In this situation, it is expected that students within a cluster, such as a classroom or school, would share some similarities due to their common environment. Hierarchical linear models are also known as *multilevel models*, *random coefficient models*, or *random effects models*. HLM can be used to analyze a variety of questions with either categorical or continuous dependent variables. With hierarchical linear models, each level (student, classroom, school) is formally represented by its own sub-model. It is possible to postulate hypotheses about relations occurring at each level and across levels and also to assess the amount of variation at each level (Raudenbush & Bryk, 2002, p. 5).

1.3 Purpose of the study

The purpose of this study is to investigate mathematics teachers' characteristics and class characteristics across Turkey, European Union (EU) countries and the other candidate countries of EU and study the effects of mathematics teacher and class characteristics on students' mathematics achievement by using TIMSS-R data after home educational resources (HER) of the students were taken into consideration. In this study, firstly the groups of countries, namely Turkey, EU countries and other candidate countries will be analyzed in order to compare the models by culture.

Then separate analysis of countries will be done in order to confirm the findings and test the consistency of outcomes within the groups. The study will compare and contrast the mathematics teachers' characteristics in different cultures with respect to their;

1. Background characteristics; i.e. gender, teaching experience in years and level of education they completed;
2. Instructional practices in class; i.e. time spent on various activities, emphasis on problem solving, emphasis on homework, use of textbook, use of calculator, small group work in class, conceptions about mathematics;
3. Class characteristics; i.e. class climate, limitations to teaching in class, class size and average of students' HER.

There are three research questions in this dissertation to be answered. These are;

1. How much do classes vary in their mean achievement in each group?
2. Which factors at the teacher and class level have significant effects on the mathematics achievement of the students across Turkey, European Union countries and candidate countries after home educational resources of students is controlled?
3. How much variance in the mathematics achievement can be explained by the factors related to teacher and class characteristics when home educational resources of students is controlled?

Firstly, the proportion of teachers for the variables included in mathematics teacher background questionnaire of TIMSS data for each group of country will be presented. Then four two-level hierarchical linear models will be built in order to explore the effects of teacher and class characteristics on students' mathematics achievement by adding successively the blocks of variables, namely teacher's background, teacher's instructional practices, class characteristics and mean of HER.

1.4 Significance of the study

It is evident that teacher characteristics such as their background, conceptions related to mathematics and teaching it, instruction in mathematics classes are of the critical factors that affect student outcomes. Therefore, it is worth to study teacher characteristics and their impact on students. There are some studies that investigated mathematics teachers and their characteristics in Turkey e.g. Özgün Koca, 2002; Baydar and Bulut, 2002; Doğan, M., 2000. However, the number of these studies are limited and they mostly choose their samples from pre-service teachers probably due to the convenience in sampling. There are not any study that shows the similarities and differences of mathematics teachers' characteristics in Turkey when compared to the mathematics teachers in other nations. The studies that compare teachers in various countries are also limited in the world (Bracey, 2003).

This study will contribute to the literature in two aspects; firstly by giving information about Turkish mathematics teachers' characteristics and secondly by identifying the similarities and differences in backgrounds, teaching practices of teachers and some class characteristics and determining their impacts on student outcomes in Turkey and European Union (EU) countries. This information may provide an additional step through closing the gaps in education systems, in particular certain teacher characteristics between EU and Turkey, which is a candidate country for EU and hoping to be a member of EU in the near future.

The TIMSS Project, which is the most extensive cross-national comparative study of mathematics and science education ever attempted provides an extensive source of data to compare and contrast different teacher characteristics across various cultural settings. Turkey indicated rather a poor performance in 1999 TIMSS. Evaluating teacher characteristics and their impacts on student outcomes with reference to some other competing countries might provide an extensive information to educational policy makers. The information gathered will provide us the opportunity to criticize the traditional teaching practices in mathematics classes and be aware of the choices that should be made in mathematics teacher education programs and mathematics instruction at school. So the study will provide information for improving the educational system.

The studies like TIMSS will also be repeated in the coming years as a result of globalisation in the world. Therefore, analysing the current situation is also important in order to analyse the trends in students achievement and their teachers' characteristics for the future comparisons.

Multilevel analysis techniques are important in the educational research. In this study, hierarchical linear modelling techniques will be employed. This method has been used widely in the world in recent years and accepted by most of the researchers due to the nested structure of the data. As a result of using this method, the shortcomings of traditional regression analysis methods will be overcome.

CHAPTER 2

LITERATURE REVIEW

In this chapter of dissertation, firstly information about comparative studies is provided. Then SMSO model, which was theoretical framework of TIMSS studies, and Hierarchical Linear Models and their relevance to this study is explained. The variables that were mostly studied in a teacher effect research are given providing the prior studies about them. In the last section of this dissertation, secondary analyses of TIMSS data that explored the factors identified in this dissertation are provided.

2.1 Comparative studies

Many comparative studies in mathematics education has been conducted in the last 50 years. There is an almost universal recognition that the performance of a country's educational system is a key element in establishing a nation's competitive advantage in an increasingly global economy. Therefore the countries need to know how well their students when compared to students from other countries in terms of the outcomes of schooling and in terms of how their educational systems differ from others' (Beaton & Robitaille, 1999). The implicit argument is that increased provision and improved instructional quality are likely to produce better prepared students who will become better prepared workforce in the future. Especially, mathematics and science education are of particular concern to both developed and developing countries because of their links to success in industry and technology (Wagemaker, 2002).

IEA has conducted large-scale survey studies such as FIMS, SIMS, TIMSS and TIMSS-R which investigate factors that have an effect on educational achievement, participation rates, and attitudes towards school and school learning at international level. In order to examine the processes between students, between schools and between countries systematically, firstly a theoretical model should be developed. Secondly, it is necessary for data to be collected should be sufficiently comparable across countries. Then statistical procedures for the testing of models should be developed in order to provide strong estimates of effects and efficient estimates of error for the examination of statistical significance (Keeves, 2001).

The theoretical framework of Third International Mathematics and Science Study (TIMSS) base on the Survey of Mathematics and Science Opportunities (SMSO) project which was a development project charged with developing the research instruments and procedures that would be used in TIMSS. SMSO project was based on a coherent conceptual model illustrating the potential relationships among the factors in a way that highlighted the importance of curriculum and the classroom. The classroom is the educational focal point where curricular intentions are transformed into potential learning opportunities by teachers which may be realized by students in their own experiences (Cogan & Schmidt, 1999).

As it is seen from the model in figure 1.1, teachers transform the curricular intentions which are determined mostly by the system to potential learning opportunities. Therefore, the teacher plays a central role by attempting to provide the conditions under which learning will occur most successfully for the students in a particular class at a particular time. Teacher characteristics such as their backgrounds and beliefs influence instruction and thus the student outcomes. Teachers' age, gender, education, teaching experience are important background characteristics. Teachers' beliefs about subject matter and teaching and learning the subject also influence their instructional practices and students' achievement (Thompson, 1992). Teachers plan the classroom instructional practices which include textbook usage, lesson structure, instructional materials, student assessment, teacher-student interaction, homework and in-class grouping of students.

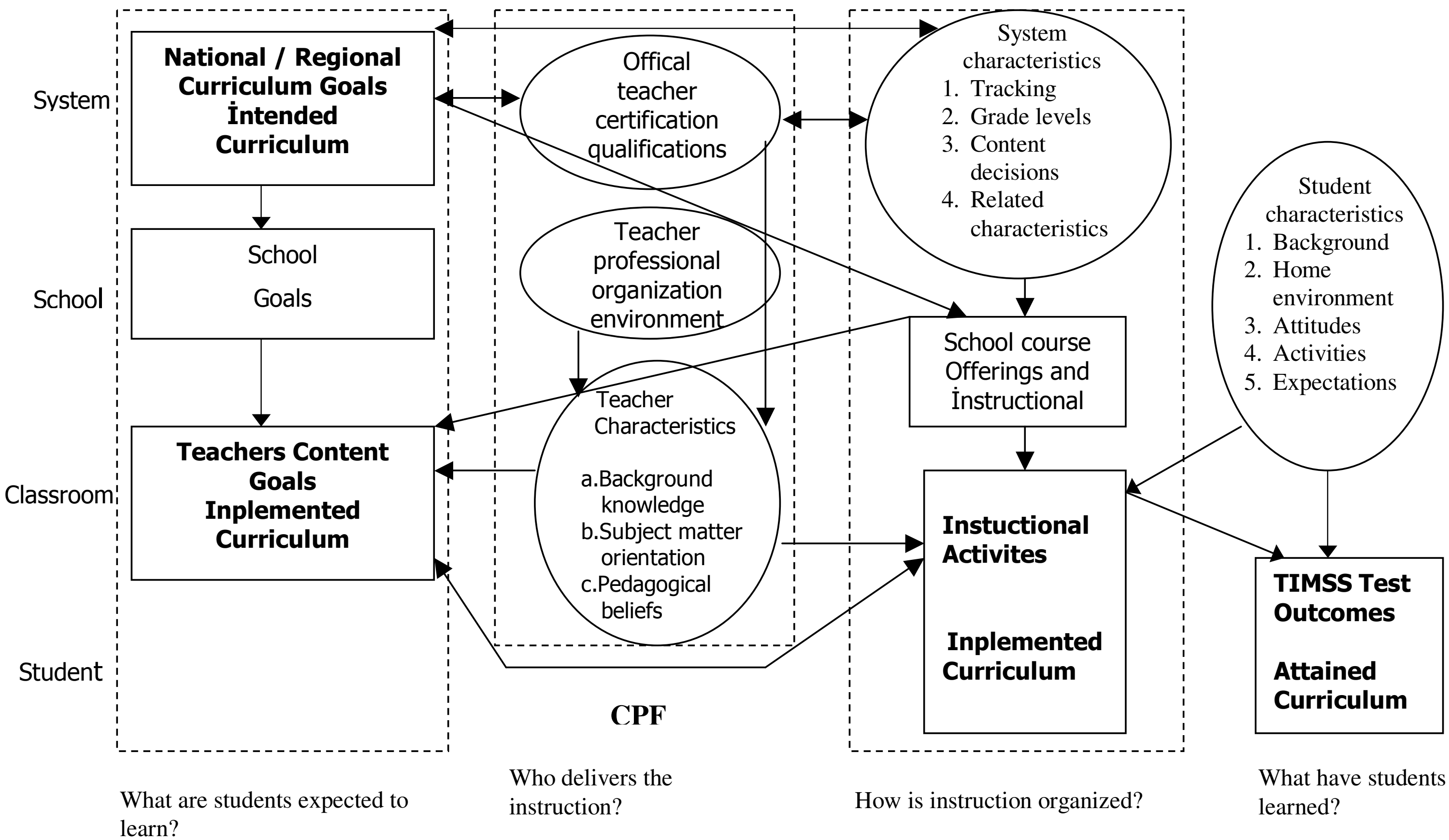

Figure 1.1 SMSO Conceptual Model of Educational Opportunity

The analysis in SMSO project showed that the instructional practices of teachers were different in each country. As a result of the examination of the classes in different countries, the survey instruments for TIMSS were developed. The data gathered from TIMSS provides the researchers investigate the effects of teachers and schools on the mathematics and science achievement of students in international context. There were many secondary analyses on the TIMSS data that compare the countries especially the high- versus low- performing countries. The studies have been conducted in both descriptive and inferential levels for comparing education systems, identifying factors affecting student outcomes, quality of schooling. In the recent studies, hierarchical linear modelling techniques have been used because of nested structure of data.

2.2 Hierarchical Linear Modelling

Hierarchical linear modelling (HLM) is a particular regression technique that is designed to take into account the hierarchical structure of educational data (Raudenbush & Bryk, 2002). Generally, regression analysis is used in monitoring to examine the relationships among a dependent variable, such as academic achievement and one or more independent variables, such as students' prior achievement and socioeconomic status. Because of the nested structure of the data in TIMSS i.e. students nested within classes, classes nested within schools and schools nested within countries, hierarchical linear modelling is important in analyzing the data without bias. Not considering the multilevel structure of the data in the analysis results in problems such as aggregation bias, misestimated standard errors and heterogeneity of regression (Raudenbush & Bryk, 2002). These can be explained briefly as follows:

- Aggregation bias can occur when a variable takes on different meanings which results in different meanings at different organizational levels. For example, average social class of a school may have an effect on student achievement above and beyond the effect of the individual child's social class. HLM solves this problem by facilitating the decomposition of any observed relationship between variables into separate level-1 and level-2 components.

- Misestimated standard errors occur when the dependence among individual responses within the same organization, such as classroom, is not taken into account. The reasons of the dependence may be the shared experiences of the individuals within the organization or the sampling procedure. Hierarchical linear models solve this problem by incorporating into the statistical model a unique random effect for each organizational unit. The variability in these random effects is taken into account in estimating standard errors.
- Heterogeneity of regression occurs when the relationships between individual characteristics and outcomes vary across organizations. This problem is solved by estimating a separate set of regression coefficients for each organizational unit and then modelling variation among the organizations in their sets of organizations as multivariate outcomes to be explained by organizational factors.

The basic idea underlying HLM is that there are separate analyses for each unit in a hierarchical structure. The simple two-level model that will be employed in this dissertation can be applied to investigate a range of questions that policy makers might pose. There are more complex hierarchical linear models; indeed the statistical analyses specified at each level are not limited to linear regressions and the models can include three or even four levels.

Most of the research on school and teacher effect focus on four principal questions which constitute a useful framework for the study of basic two-level hierarchical linear model (Willms, 1999). The questions are;

- To what extent do schools vary in their outcomes?
- To what extent do outcomes vary for students of differing status?
- What policies and practices improve levels of schooling outcomes?
- What policies and practices reduce inequalities in outcomes among students of differing status?

The first question concerns the level of schooling outcomes attained by students in a schooling system. It is fundamental to gauge the effects of particular schooling processes or interventions or to determine where efforts at improving schools might best be placed. The second question is about equality of outcomes in a schooling system. The third and fourth questions ask why some schools have better or worse outcomes than others and why some schools are more or less successful in reducing inequalities among students of differing status (Willms, 1999).

2.3 Building a Theoretical Model for Studying Teacher Effect

A two-level hierarchical linear model is appropriate for exploring teacher and class effects on mathematics achievement. In this model, students are at the first level and teacher and class variables are at the second level. The variables included in these studies could be categorized in three groups;

1. Dependent variables
2. Level 1 variables - Student variables
3. Level 2 variables - Teacher-classroom variables

2.3.1 Dependent variable

The dependent variables that have been used in exploring the effects of teacher and class characteristics include student achievement, student attitude, student engagement, student discipline problems, development of independence, good work habits. It would be better if more than one measure is used in the studies that explore the effect of teacher in order to develop a more complete picture of how teacher influences student outcomes (Brophy & Good, 1986). However, mostly student achievement is used, probably because of its reliability and objectivity in measurement.

2.3.2 Level 1 Student background variables

While investigating the teacher effect, some student background characteristics should be taken into consideration for statistical adjustment in order to develop a correctly specified model. Ability, socio-economic status, motivation, race, gender, special educational needs are some of these factors. These variables are mostly established as they are strongly related to educational achievement (Kyriacou, 1997).

In most of the studies socio-economic status (SES) is chosen as the covariate. However, SES variable is not constructed in the same way in the studies. Mostly, it is a combination of some of the following variables;

- Father and mother's level of education
- Number of books at home
- Father and mother's occupation
- Possessions at home such as computer, study desk etc.
- Number of people living at home

There is evidence that students from homes with extensive educational resources have higher achievement in mathematics and other subjects than those from less advantaged backgrounds. TIMSS 1995 showed that this was true of students from homes with large numbers of books, with a range of educational study aids, or with parents with university-level education (Beaton et al, 1996).

Other student background variables such as age, gender, ethnicity and student explanatory variables such as attitudes, beliefs may also be considered.

2.3.3 Level 2 Teacher and classroom variables

After statistical adjustment of student background, it is possible to have a more accurate perception of the effects of teacher and class characteristics on students' achievement. Basing on the model developed by SMSO project and literature, teacher variables can be listed as;

1. Teacher education (Goldhaber and Brewer, 1997; Wayne and Youngs, 2003; Rivkin, Hanushek, & Kain, 2005)
2. Teacher experience (Braswell et al., 2001)
3. Teacher's gender
4. Teacher's pedagogical beliefs, conceptions about the subject matter (Clark and Peterson, 1986; Romberg and Carpenter, 1986; Steinberg, Haymore and Marks, 1985; Thompson, 1984; Thompson, 1992)
5. Teacher's instructional practices (Koehler and Grouws, 1992)
6. Teacher's duties at school
7. Use of variety of instructional materials such as calculators, computers, textbooks (Grouws and Cebulla, 2000; Braswell et al., 2001; Hembree and Dessart, 1986)
8. Student-teacher interaction (Grouws and Cebulla, 2000; Davidson, 1985; Slavin, 1990)
9. Homework given to students (Braswell et al., 2001)
10. Assessment of students (Rodriguez, 2004)
11. Emphasis on problem solving (NCTM, 2000)

Wayne and Youngs (2003) reviewed the studies which investigated the relationship between teachers' preparation for teaching mathematics and students' mathematics achievement. Relationships were described for four categories of teacher characteristics which were college ratings, test scores, degrees and course work and certification status. They interpreted that the studies confirm that students learn more from teachers with certain characteristics. In the case of teachers' college ratings and test scores, positive relationships exist across all subject areas. In the case of degrees, coursework and certification, findings have been inconclusive except in mathematics. The study (Goldhaber and Brewer, 1997) showed that mathematics students whose teachers have master's degrees in mathematics had higher achievement gains than those whose teachers had either no advanced degrees or advanced degrees in nonmathematics subjects. In addition, the students whose teachers had bachelor's degrees in mathematics learned more than students whose teachers had nonmathematics bachelor's degrees. In contrast, other studies did not indicate that teachers with graduate-level training in a content area performed better than did teachers having an undergraduate degree in their content area (Rivkin, Hanushek, & Kain, 2005).

The beliefs about the nature of mathematics, beliefs about teaching and learning mathematics and the instructional practices are related to each other. This claim is supported by the literature. Studies (Clark and Peterson, 1986; Romberg and Carpenter, 1986; Steinberg, Haymore and Marks, 1985; Thompson, 1984; Thompson, 1992) about teachers' thinking and decision making point out that how teachers interpret and implement curricula is influenced significantly by their knowledge and beliefs. Ernest (1991) also states that knowledge of mathematics alone does not account for differences in practice across mathematics teaching. He thinks that the research literature on mathematics teachers' beliefs indicates that teachers' approaches to mathematics teaching depend fundamentally on their systems of beliefs, in particular, on their conceptions of the nature and meaning of mathematics and on their mental models of teaching and learning mathematics. Teachers' beliefs and instructional practices also show variation across different education systems in different cultures. There has been a growing emphasis on the cross-cultural studies in education in the last century.

Braswell et al. (2001) analyzed NAEP 2000 data their major findings can be listed as;

- Generally, students in grades 8 and 12 with higher scores reported higher levels of parental education in 2000. This result is consistent with past NAEP assessments.
- In 2000, eighth-graders whose teachers majored in either mathematics or mathematics education had higher average scores than did students whose teachers did not major in these subjects.

- Eighth-graders in 2000 who were taught by mathematics teachers with 11 or more years of experience had higher average scores than those taught by teachers with 2 years or less of experience.
- Eighth-graders whose teachers reported that they permitted unrestricted use of calculators had higher average scores in 2000 than did the students whose teachers restricted calculator use. Also more frequent use of calculator was associated with higher scores.
- In 2000, the majority of students at all three grade levels reported that they did mathematics textbook problems in school every day. Eighth- and twelfth-graders who reported doing textbook problems in school every day had higher average scores than did students who reported doing textbook problems less frequently.
- In 2000, eighth-graders who reported spending a moderate amount of time on mathematics homework had higher average scores than did those who spent either no time on homework or more than 1 hour. The average scores of eighth-graders, generally increased as the amount of homework that teachers reported assigning increased.

From a meta-analysis of seventy-nine non-graphing calculator studies, Hembree and Dessart (1986) concluded that the use of hand-held calculators improved student learning especially in students' understanding of arithmetical concepts and in their problem-solving skills. Grouws and Cebulla (2000) stated that one valuable use for calculators is as a tool for exploration and discovery in problem-solving situations and when introducing new mathematical content. By reducing computation time and providing immediate feedback, calculators help students focus on understanding their work and justifying their methods and results. The graphing calculator is particularly useful in helping to illustrate and develop graphical concepts and in making connections between algebraic and geometric ideas.

Grouws and Cebulla (2000) stated that using small groups of students to work on activities, problems and assignments can increase student mathematics achievement by citing the studies of Davidson (1985) and Slavin (1990). Davidson (1985) reviewed studies that compared student achievement in small group settings with traditional whole-class instruction. In more than 40 % of these studies, students in the classes using small group approaches significantly outscored control students on measures of student performance. In only two of the 79 studies did control-group students perform better than the small group students, and in these studies there were some design irregularities. Slavin (1990) concluded in his review of 99 studies that cooperative methods were effective in improving student achievement. The most effective methods emphasized both group goals and individual accountability. Grouws and Cebulla (2000) also suggest that whole-class discussion following individual and group work improves student achievement. Besides academic achievement, small group work has positive impact on affective outcomes of students (Slavin, 1990).

National Council of Teachers of Mathematics (NCTM, 2000) points out the importance of problem solving at all grade levels. Problem solving is considered as the major mean of learning mathematics. Teachers have important role in developing their students' problem solving abilities. They should develop supportive environments that encourage students to explore, take risks, share failures and successes, and question one another while developing the confidence they need to explore problems and the ability to make adjustments in their problem-solving strategies. Bay (2000) stated that research findings support that teaching problem solving positively impacts student achievement in problem solving and in skill and conceptual development.

2.4 Secondary Analysis of TIMSS-R

The variables presented at teacher and class level were investigated in various studies using TIMSS data. Keeves (2001) reviewed the IEA studies including mathematics, science, civic education, reading. He identified some key findings. These are:

1) There are marked differences in average levels of achievement between the students in school in the more developed countries and those in the less developed countries.

2) Student achievement in mathematics is positively related to the time given to the study of the subject at school, both in comparisons across countries and between students within countries.

3) The achievement of students is related to the time spent on homework after other factors influencing achievement have been taken into account.

4) In less developed countries, the use of a textbook has effect on student learning.

5) Measures of SES are positively related to students achievement in all countries, at all age levels and for all subjects.

6) The effects of home background variables are similar across subject areas. However, the effects of the learning conditions in the schools differ between subject areas and in some subject areas are equivalent to or greater in the size of their influence than the effects of the home.

Schmidt et al. (1999) categorized the teachers in four groups. Discipline-oriented teachers conceive mathematics as abstract and indicate that remembering formulas, mastering algorithms and basic computations were important. Process-oriented teachers indicate that real world use of mathematics is important. They think that mathematics as more conceptual and emphasize creativity. The third group of teachers are procedure-oriented teachers. They think that mathematics is abstract and they employ useful representations of the real world. The fourth group is eclectic teachers. They indicate a high level of importance on most things. They are both discipline oriented and process-oriented. They don't have a distinctive character. In their categorization in TIMSS data, half or more of the teachers in Hong Kong, Japan, Korea, Belgium (Flemish) and Switzerland, but less than 15 % of teachers in Canada and Spain are discipline-oriented and only about 10 % or less of teachers in Belgium (Flemish), Hong Kong, Israel, Japan, Korea, Singapore and Thailand were process-oriented teachers.

Howie (2003) reported the conditions of schooling in South Africa and their effects on mathematics achievement of students. She identified the school-level factors that explain the students' performance on TIMSS-R by using multivariate and partial least square analysis. The location of the school, the students' home language and teachers' unions were the factors that have a direct effect on students' achievement. Although the recent findings in school effectiveness research did not support the idea that resources have influence on the performance of students, she claimed that the situation might be different for developing countries by referring to the report of The World Bank which lists libraries, time on task, homework, textbook provision, teacher knowledge, teacher experience, laboratories, teacher salaries and class size as important for effective schooling in developing countries. However, the findings related to resources within school and class size in general were not significant factors for achievement on their own, despite much debate on the lack of resources and large class sizes in South Africa.

Stemler (2001) examined school effectiveness in mathematics and science at the 4th grade, using data from IEA's TIMSS study. 14 countries were included in the study. They were the countries which possessed sufficient between school variability in mathematics achievement to justify the creation of explanatory models of school effectiveness. The variables were chosen to represent the domains of student involvement, instructional methods, classroom organization, school climate and school structure. By using two-level hierarchical linear modelling, six explanatory models for each subject were analyzed. In general, about one-quarter of the variability in mathematics and science achievement was found to lie between schools. The research findings revealed that after adjusting for differences in student backgrounds across schools, the most effective schools in mathematics and science had students who reported seeing a positive relationship between hardwork, belief in their abilities and achievement. In addition, more effective schools had students who reported less frequent use of computers and calculators in the classroom. These relationships were found to be stable across explanatory models, cultural contexts and subject areas.

Philippou and Christou (1999) investigated the relationships between teachers' conceptions, cultural factors and students' learning from the data of 12 participating countries in 3 groups; high achieving countries (East-Asian countries), medium-achieving countries (European countries) and low achieving countries (from 3 different continents). Median polishing analysis was performed on the combined responses of teachers from each of the three groups of countries and on the teachers' responses from each separate country. They found that teachers from the four high-achieving East Asian countries tend to interpret mathematics as an algorithmic rather than as a coherent subject, contrary to teachers from the four European countries. Within the European countries, German teachers were different from the teachers of England, Sweden and Fr. Belgium when the teaching and learning scales are concerned. The researchers interpreted that moderate consistency in teachers' conceptions among European countries may be due to the multicultural structure of European societies and the tendency to extol numerous ideals and doctrines. The similarity between Cypriot and Greek (in the 3rd group) teachers strengthens the culture effect criterion, given the common heritage, language, religion and other links between the two countries.

Bos and Kuiper (1999) modelled TIMSS data to explore influencing factors on achievement in mathematics in grade 8. Ten education systems from central and western Europe were included in the study. The included latent variables in their model were homework, teaching styles, school climate, students' gender, maternal expectation, friends' expectation, success attribution mathematics, instructional practices, class climate, attitude towards mathematics, home educational background, class size, effective learning time assessment and out-of-school activities. General path model explains the 19 % or less of the variance in mathematics achievement. In many systems, home educational background and students' attitudes towards mathematics have a positive relation with achievement in mathematics, out-of-school activities a negative. Assessment usage, instructional formats such as cooperative learning, effective learning time did not show a significant path coefficient in the majority of the education systems.

Kupari (2003) investigated the typical features of mathematics instruction and mathematics teachers' beliefs about mathematics and teaching and learning of it in the first phase of his study. In the second phase, he investigated the relationship of the instructional practices and teachers' beliefs. The findings show that teachers devoted most of their time to guided and individual student practice. The most frequent approach that teachers use was students working individually with the assistance of their teacher followed by whole class instruction. Homework was also important in mathematics instruction. More than four-fifths of the Finnish mathematics teachers saw mathematics primarily as a practical and structural guide for addressing real situations, while the rest felt that mathematics is primarily an abstract subject. He used hierarchical cluster analysis to analyze the relationship between teachers' beliefs and instructional practices. He identified two groups of teachers with contemporary/constructivist (CC) and traditional/mechanistic (TM) beliefs. The findings show that teachers with different beliefs, plan their lessons differently. Teachers with CC beliefs think that understanding the students is essential for teaching, several representational forms should be used in teaching and being able to think creatively. By contrast, teachers with TM beliefs believe that mathematics is a set of algorithms and rules and if students have difficulties they should have more individual practice during the lessons. The conclusions about instructional practices were similar to the Norwegian lesson descriptions explained in SMSO Project (Cogan & Schmidt, 1999). So, the results support the presence of cultural components in the teaching of mathematics. The study has implications for teacher education.

Fullarton et al (2003) analyzed TIMSS data of Australia for the grades 4 and 8 in both mathematics and science. Three-level hierarchical linear model was built to investigate the effects of student, teacher/classroom and school level factors. This investigation revealed that most of the variation in mathematics and science achievement arises from differences among students rather than their classrooms and schools. Verbal ability, socio-economic and socio-cultural background and attitude towards mathematics had significant effects on the performance of students. At the classroom level, class composition variables, namely class mean of attitude towards mathematics and class mean of verbal ability test and at the school level mean of SES were the only factors that had significant effects on mathematics achievement of students. The study did not identify any effects of teacher background such as age, gender, educational qualifications, teaching experience or approaches to teaching mathematics on achievement. The reason of this was shown as the difficulty of capturing the details of what happens in the classroom.

Van den Broeck, Van Damme and Opdenakker (2005) analyzed the effects of student-, teacher- and school-level factors on students' achievement in Belgium (Flemish) data. Selecting two classes from each school made it possible to build three-level hierarchical linear model. As a national option, the extended versions of student, teacher and school questionnaires were used. Also a parents' questionnaire and a numerical and spatial intelligence test was conducted. To ascertain class characteristics, questions on classroom climate (a class with disruptive students, a quiet class and a study-oriented class) and the constructivist learning environment were included in the extension of the teacher questionnaire. Information referring to the age and the experience of the teacher was gathered through the international questionnaire. The average intelligence score of the class was calculated to make the group composition with respect to ability operational. By means of null model, it was found that almost 58 % of the total variance in mathematics scores is situated at the student level, 28 % is due to differences between classes and 14 % is due to differences between schools. Together with study-oriented class and disruptive student factors, average intelligence score, which produced a very pronounced decline in deviance, explained more than 90 % of the variance at class level and more than one-third of the variance at the school level. After adding student level factors to the model, some of the class and school level factors were no longer significant. The researchers stated that more effort should be made to develop class and school level factors in the future TIMSS questionnaires.

Rodriguez (2004) investigated the relationship between assessment practices and achievement. U.S. TIMSS data was used to estimate this relationship. Several student level characteristics were important explanatory variables regarding variation in mathematics achievement, including mathematics self-efficacy, effort, and level of uncontrollable attributions. At the classroom level, teacher assessment practices had significant relationships to classroom performance. In addition, cross-level interactions (between student characteristics and teacher practices) suggested that classroom assessment practices might uniquely interact with student characteristics in their role of motivating student effort and performance.

2.5 Summary

In this chapter, theoretical framework of the study was explained and studies including the factors that will be analyzed in this thesis were reviewed. It was observed that the factors that have positive impact on student learning in educational literature, sometimes had no effect or negative significant effect in the secondary analysis of TIMSS data. The reason of it mostly stated as the instruments used in TIMSS Project.

CHAPTER 3

METHODOLOGY

In this chapter of the dissertation; research questions, instruments, variables included in the study, population and sample, data collection in TIMSS project and data analysis of the thesis are presented.

3.1 Research Questions

1. How much do classes vary in their mean achievement in each group?
2. Which factors at the teacher and class level have significant effect on the mathematics achievement of the students across Turkey, European Union countries and candidate countries after home educational resources (HER) of students is controlled?
3. How much variance in the mathematics achievement can be explained by the factors related to teacher and class characteristics when HER is controlled?

3.2 Instruments

TIMSS 1999 was designed to measure the trends in student achievement over time by building on the data collected from TIMSS 1995. Therefore, the school, teacher and student questionnaires used in TIMSS 1995 were used in TIMSS 1999 after a thorough review. These background questionnaires allow researchers to investigate the most influential characteristics of the people, practices and policies affecting student achievement. Four background questionnaires were used to gather information at various levels of the educational system: a school questionnaire asked school principals to provide information about school staffing and facilities, as well as curricular and instructional arrangements; teacher questionnaires asked mathematics and science teachers about their backgrounds, attitudes, and teaching activities and approaches; and a questionnaire for students sought information about their home backgrounds and attitudes, and their experiences in mathematics and science classes; curriculum questionnaires which were first used in TIMSS 1999 addressed issues of curriculum design and emphasis in mathematics and science.

In this study, data from student background questionnaire, teacher background questionnaire and mathematics achievement scores of students were used.

Student background questionnaire

For statistical adjustment, “Home educational resources” (HER) which is an index variable present at the database is used as a covariate in the analysis. It is constructed from the questions related with father and mother’s education level, number of books and number of possessions at home by IEA.

Mathematics teacher background questionnaire

In this study, since the focus is on teacher effect, mainly mathematics teacher background questionnaire is analyzed. In each school, a single mathematics class was sampled for the TIMSS 1999 testing. The mathematics teacher of the sampled class was asked to complete a questionnaire that sought information on the teacher’s background, beliefs, attitudes, educational preparation, and teaching load, as well as details of the instructional approach used in teaching mathematics, classroom characteristics, activities and homework practices. The teacher questionnaires were carefully constructed to elicit information on variables thought to be associated with student achievement. Some of the important research questions addressed by the teacher questionnaires were:

- What are the characteristics of mathematics teachers?
- What are teachers’ perceptions about mathematics?

• How do teachers spend their school-related time?

• How are mathematics classes organized?

• What activities do students do in their mathematics lessons?

• How are calculators and computers used?

• How much homework are students assigned?

• What assessment and evaluation procedures do teachers use? (Martin, Mullis and Stemler, 2000).

Mathematics test

In comparative studies, the quality of the test is very important. After a careful study, the TIMSS 1999 mathematics test which contained 162 items representing a range of mathematics topics and skills was developed. Five content areas were covered in TIMSS 1999 mathematics test. These areas and the percentage of the test items devoted to each were fractions and number sense (38 %), measurement (15 %), data representation, analysis, and probability (13 %), geometry (13 %), and algebra (22 %). The performance expectations include knowing (19 %), using routine procedures (23 %), using complex procedures (24 %), investigating and solving problems (31 %), and communicating and reasoning (2 %). About one-fourth of the questions were in the free-response format, requiring students to generate and write their answers. These questions, some of which required extended responses, were allotted about one-third of the testing time. Responses to the free-response questions were evaluated to capture diagnostic information, and some were scored using procedures that permitted partial credit (Garden and Smith, 2000).

3.3 Data collection

Each participating country was responsible for carrying out all aspects of the data collection, using standardized procedures developed for the study. To verify that standardized procedures were followed across all participating countries, the International Study Center (ISC) instituted a program for quality assurance in data collection. In collaboration with the IEA Secretariat, one or more international Quality Control Monitors (QCMs) were recruited in each country to document data collection procedures at both the national and the school level. The observations by the Quality Control Monitors and the interviews with the National Research Coordinators indicate that the data collected in the TIMSS 1999 study met high quality standards, and that as a result there can be a high level of confidence in the findings (O'Connor & Stemler, 2000).

3.4 Population and Sampling

The target population for TIMSS 1999 was all students enrolled in the upper of the two adjacent grades that contain the largest proportion of 13-year-olds at the time of testing.

The basic sample design for TIMSS 1999 is generally referred to as a two-stage stratified cluster sample design. The first stage consisted of a sample of schools, which may be stratified; the second stage consisted of a single mathematics classroom selected at random from the target grade in sampled schools (Foy & Joncas, 2000).

In this study, the data from 12 countries were firstly analyzed in three groups, and then analyzed separately by using a two-level hierarchical linear model. The groups and the countries included in these groups are as follows:

1. Turkey
2. European Union countries: Belgium (Flemish), Italy, Netherlands, Cyprus, Czech Republic, Lithuania, Hungary, Slovak Republic, Slovenia.
3. Other candidate countries: Bulgaria, Romania.

England and Finland were the other European Union countries which attended TIMSS 1999. However, since the sampling procedure used in England was different from the other nations and "home educational resources" index variable was not available for Finnish data, they were not included in this dissertation. Although

Cyprus, Czech Republic, Hungary, Lithuania, Slovak Republic and Slovenia were candidate countries at the time of testing in 1999, since they are now members of EU, they were taken in the group of European Union countries. The rank of these countries in TIMSS 1999 and the number of classrooms and students included in this study are presented in table 3.1.

Table 3.1 Rank and number of classrooms and students in TIMSS for each country

Country	Rank of the country	Number of classrooms	Number of students
Turkey	31	204	7841
Belgium (Flemish)	6	279	5259
Czech Republic	15	142	3453
Cyprus	24	120	3116
Hungary	9	147	3183
Italy	23	180	3328
Lithuania	22	150	2361
Netherlands	7	126	2962
Slovak Republic	8	145	3497
Slovenia	11	149	3109
EU countries	-	1438	30268
Bulgaria	17	163	3272
Romania	25	147	3425
Candidate countries	-	310	6697
Total	-	1952	44806

3.5 Data Analysis

In this dissertation, hierarchical linear modelling (HLM) techniques were employed because of the nested structure of the data and the sampling procedures used in data collection of TIMSS. HLM 6.02 was used in order to build a two-level HLM model which investigated the effects of factors related to teachers' background, teachers' instructional practices and class characteristics on the mathematics achievement of the students. In the analysis, firstly a one-way ANOVA with random effects model was built in order to partition the variance within classes and between classes. Then for investigating the teacher and class characteristics on math achievement of students, means as outcomes model with one level 1 covariate was built by adding different groups of variables successively at level 2.

3.5.1 One-way ANOVA with random effects

Raudenbush and Bryk (2002) state that estimating one-way ANOVA model is often useful as a preliminary step in a hierarchical data analysis. This model is fully unconditional i.e. no predictors are specified at either level 1 or 2.

$$Y_{ij} = \beta_{0j} + r_{ij}$$
$$\beta_{0j} = \gamma_{00} + u_{0j}$$

Intraclass correlation coefficient, which measures the proportion of variance in the outcome that is between the level 2 units, is a useful parameter associated with this model.

$$\rho = \tau_{00} / (\tau_{00} + \sigma^2)$$

σ is the level 1 variance.

τ_{00} is the level 2 variance.

3.5.2 Means as outcome model with level 1 covariate

A means as outcome model with one level 1 covariate (HER) was built by adding different groups of variables successively at level 2 for estimating the relationship between teacher and class characteristics and mean outcome.

Home educational resources (HER), which is an important factor on student achievement, was considered as a covariate in this study for statistical adjustment.

Since the students were not assigned at random to the classes, failure to control for background may bias the estimates of classroom effects. Also, it is known from the literature that HER is strongly related to the mathematics achievement of students. So, controlling it increases the precision of estimates of classroom effects and the power of hypothesis tests by reducing unexplained level-1 error variance.

A two-level model in HLM consists of two sub-models at level 1 and level 2. In the level 1 model, student mathematics achievement is estimated as a function of student's home educational resources. This produces an equation that yields an intercept value for each classroom, which may be interpreted as the average mathematics achievement, across all the classrooms in the groups of countries after adjusting for differences in student's home educational resources. Regression coefficients, called βs, estimated from this equation show the association of achievement with student's home educational background in each classroom (cf. Stemler, 2001).

$$Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + r_{ij}$$

i represents the i^{th} student.
j represents the j^{th} school.
Y_{ij} represents the achievement score of i^{th} student in j^{th} school.
B_{0j} represents the intercept in the j^{th} school.
B_{1j} represents the beta coefficient for HER in the j^{th} school.
X_{ij} represents the HER score of the i^{th} student in the j^{th} school.
r_{ij} is the random error in the j^{th} school.

In the second level model of the HLM analysis, the intercept value estimated at level 1 is used as a dependent variable in the level 2 equation. The variance of this parameter is then modelled using other explanatory variables. γ coefficients produced by the level 2 equation estimate the association of each level 2 explanatory variable with the average math achievement across classrooms.

$$\beta_{0j} = \gamma_{00} + \gamma_{01}W_{01j} + \gamma_{02}W_{02j} + ... + \gamma_{0m}W_{0mj} + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + u_{1j}$$

B_{0j} represents the intercept in the j^{th} school.

B_{1j} represents the beta coefficient for HER in the j^{th} school.

γ_{00} is the average intercept across the level 2 schools.

γ_{10} is the average regression slope across the schools.

u_{0j} and u_{1j} are level 2 random effects.

W_{0pj} is the value of the p^{th} teacher/class level variable in the j^{th} school (Raudenbush and Bryk, 2002).

3.5.3 Centering

Centering the variables is an important concept in HLM analysis. The meaning of the intercept in the level 1 model depends on the location of the level 1 predictors. In order to make sense of models that account for the variation in the intercept, the choice of a metric for all level 1 predictors becomes important. In this study, "home educational resources" variable was centered around its grand mean. So the intercept could be interpreted as the predicted score of an individual whose value for that independent variable was equal to the grand mean.

The choice of location for the level 2 variables is not as critical as for the level 1 variables. It is often convenient to center all of the level 2 predictors around their corresponding grand means (Raudenbush & Bryk, 2002). So all the level 2 variables were centered around their grand means.

3.5.4 Random vs. fixed variables

In hierarchical linear models, it is important to decide whether the variable is fixed or random at level 1. If the variables are fixed in reality and they are taken as fixed, the model is simpler and it yields more precise results. However, if the variables are random in reality and they are taken as fixed, biased estimates are obtained. In the program, variables that are thought as random should include an error term at level

1. Variables that are fixed are considered as essentially the same across classes and they do not need the error term in the equation.

In this dissertation, firstly a two-level model, which includes HER variable at level 1, was built by considering the variable as random. If the result was significant, it was considered as random. Otherwise it was considered as fixed. In the models of Bulgaria, Italy, Czech Republic, Netherlands, Slovenia, Hungary and Lithuania, HER variable at level 1 was considered as fixed. Intercept parameter was considered as random and the variation around it was modelled as function of teacher and class characteristics across the classes.

3.5.6 The use of plausible values

Due to the use of rotated booklet design for testing students in TIMSS-R, special procedures and calculations were necessary when estimating any population parameters and their standard errors. Every student was not tested on the same items, so item response theory (IRT) was used to estimate proficiency scores for each individual student. This procedure estimated a range or distribution of plausible values for each student's proficiency rather than an individual observed score. TIMSS drew five plausible values at random from the conditional distribution of proficiency scores for each student. The measurement error was due to the fact that these scores were estimated, rather than observed(Gonzales and Miles, 2001). In the HLM analysis, the parameter estimates are based on the average parameter estimates from separate HLM analyses of the five plausible values (Raudenbush, Bryk and Congdon, 2000).

3.5.7 Sampling weight

Using sample weight in the estimation of population characteristics is essential due to the sample design of TIMSS. The probability of each student being selected as part of the sample is known. Sampling weight is the inverse of this selection probability. In the data analysis of this dissertation, total student weight (TOTWGT) in the database was used at the first level after it was normalized.

3.5.8 Handling missing data

In HLM computer program, if any of the higher level files contain missing data, units with missing data is automatically deleted when the MDM file is created. Since TIMSS is a survey study, there were some cases with missing data. When these cases were deleted, there was reduction in the sample size which might affect the representativeness of the data. In order to check whether the reduction affected the representativeness; the mean, standard deviation, parameter variance, between-class variance and reliability of the original sample and the reduced sample were compared as in Stemler (2001).

3.5.9 Building Explanatory Models of Teacher Effect

The variables identified from SMSO model and literature were included in this study. Twenty-one explanatory variables were grouped into three blocks to compare four separate hierarchical linear models. The three blocks were named as teacher background characteristics, teachers' instructional practices and class characteristics.

After controlling for HER at the student level, the first model included only the variables of teacher background block. Again after the student level control for HER, the second model included variables related with teachers' instructional practices besides teacher background variables. In the third model, last group of variables, namely class characteristics were added to the second model. In the fourth model, mean of HER of students was added.

3.6 Variables Included in the Study

3.6.1 Level 1 variables

In order to explore the teacher effect, it is critical to control for some student factors before attempting to assess the impact of various variables related with teacher. In this study, "Home educational resources" index variable was used as a control variable. An index variable was used instead of a constructed variable because of high amount of missing data in some variables and an index variable includes more than one variable. Educational level of parents, number of books at home, possessions in the home such as study desk, computer, calculator reflect the educational human and material resources of the home. Past TIMSS secondary analysis revealed that there was a strong relationship between “home educational resources” and achievement of students.

3.6.2 Level 2 variables

Three blocks of variables were analysed in this study. The variables were mostly chosen from teacher background questionnaire data which base on SMSO model. While choosing the variables, theoretical importance of the variables were considered firstly. Response rates of these variables were also important, since HLM does not allow for missing data at the second level. If one case had missing data on one variable, it was deleted from the study. So variables with high ratio of missing data, for example use of computers in math lessons, were not included in the study. It is also necessary that the variables had sufficient variation. Since the level of education variable was uniform across the candidate countries and Lithuania, this variable was not included in the analysis of those countries.

If possible, index variables were used in the analysis. TIMSS sometimes combined information to form an index that was more global and reliable than the component questions (e.g., students’ home educational resources; teachers’ emphasis on reasoning and problem-solving, and confidence in their preparation to teach mathematics or science). According to the responses of students, their teachers, and/or their schools, students were placed in a “high,” “medium,” or “low” category for such an index, with the high level being set so that it corresponds to conditions or activities generally associated with higher academic achievement. These variables were recoded as high equals 1 and medium and low categories equal 0.

Some of the factors were taken directly from the database and some of them were constructed first by standardizing the items with a mean of zero and standard deviation one for each country. Then the factor was formed through summing up the standardized values for each case. Variables associated with each explanatory block, their name in the database and their explanations are given in Appendix A.

Block 1 Teacher background variables

1. Teacher's gender
2. Teacher's experience in years
3. Teacher's level of education

Block 2 Teacher's instructional practices

4. Percentage of time spent on administrative tasks
5. Percentage of time spent on homework review
6. Percentage of time spent on lecture style
7. Percentage of time spent on guided practice
8. Percentage of time spent on reteaching
9. Percentage of time spent on student practice
10. Percentage of time spent on test and quizzes
11. Emphasis on problem solving
12. Emphasis on homework
13. Small group work guided by teacher
14. Percentage of time teaching based on textbook
15. Never or hardly use of calculators
16. Discipline-oriented point of view about mathematics
17. Process-oriented point of view about mathematics

Block 3 Class characteristics

18. Class size
19. Class climate
20. Limitations to teaching in class
21. Mean of home educational resources of students

CHAPTER 4

RESULTS

In this chapter of the dissertation, firstly the proportion of teachers in Turkey, European Union countries and the other candidate countries as a group for the selected teacher related factors are presented. In the second part of this chapter HLM models that were built for investigating the effect of the selected teacher and class related factors on student achievement will be presented.

4.1 Proportion of teachers on the teacher-related factors

Age

In all of the groups, the greatest proportion of the mathematics teachers was found to be in the ages between 40-49 years old. Among these three groups, more than half of the teachers in Turkey are in this group. In the EU and candidate countries, this proportion was about 36 %.

Table 4.1 Percentages of teachers for each age range

Age of teacher	Turkey	EU	Candidate
Under 25 years old	5.4 %	2 %	2 %
25-29	17.2 %	7.5 %	6.9 %
30-39	15.8 %	26.3 %	23.5 %
40-49	58.1 %	38.2 %	37.3 %
Older than 50 years old	3.4 %	26 %	30.4 %

Gender

In both EU and candidate countries, female teachers were about three fourth of the teachers. In Turkey, proportion of male teachers was greater, which was 62 %.

Table 4.2 Percentages of female and male teachers

Gender of teacher	Turkey	EU	Candidate
Female teachers	38.4 %	73.6 %	74.2 %
Male teachers	61.6 %	26.4 %	25.8 %

Years teaching

In EU and candidate countries, there were more experienced teachers than Turkey. There was almost no teacher who had more than 30 years experience in Turkey whereas almost 15 % of teachers in EU and 19 % of teachers in candidate countries had been working 30-40 years as a teacher. The proportion of teachers who had less than 10 years experience was greater in Turkey.

Table 4.3 Percentages of teachers for each experience year range

Number of years	Turkey	European Union	Candidate
0-10 years	31.5 %	24.1 %	17 %
10-20 years	45.5 %	29.8 %	36.2 %
20-30 years	23 %	31.1 %	27.8 %
30-40 years	0.5 %	14.9 %	19 %
More than 40 years	-	1.1	-

Level of education

In three groups, almost all of the teachers had at least BA or an equivalent degree. In European Union countries, nearly one-third of the teachers had masters or Ph.D. degrees whereas in Turkey and candidate countries, the percentage of teachers who had further degrees were quite low, 1 % and 0.3 %, respectively,

Table 4.4 Percentages of teachers for each level of education that teachers completed

Level of education	Turkey	European Union	Candidate
Secondary education	2.0 %	1.2 %	6.4 %
BA or equivalent	97.0 %	60.6 %	93.3 %
MA or Ph.D.	1.0 %	33.1 %	0.3 %

Use of textbook

In all groups high percentage of teachers used a textbook in their mathematics classes. However, the percentage of time that weekly mathematics teaching was based on mathematics textbook varies. Teachers in all groups mostly chose 51-75 % of the time. Higher percentage of teachers in EU (30.4 %) and candidate countries (36.2 %) than Turkish teachers (8.9 %) used mathematics textbooks 76-100 % of time in their lessons.

Table 4.5 Mean of percentage of time that teachers base their teaching on textbooks

Percentage of time	Turkey	European Union	Candidate
0-25 % of time	16.8	11.5	5
26-50 % of time	36.8	22.2	15.3
51-75 % of time	37.4	35.8	43.5
76-100 % of time	8.9	30.4	36.2

Class size

Teachers were asked information about the class sizes which was considered as a factor that can affect the instructional activities in class. By summing up the number of boys and girls in classes, average class size variable was constructed. Average class size in Turkey was greatly higher than EU and candidate countries' class sizes. Average class size in EU and candidate countries was very close to each other and nearly half of the average class size in Turkey.

Table 4.6 Mean of class sizes for three groups of countries

Items	Turkey	European Union	Candidates
Mean of class size	42	22	22

Time spent on instructional activities in math class

Table 4.7 Mean of percentages of time that teachers spent on instructional activities

Items	Turkey	European Union	Candidates
Administrative duties	4.6	3.2	3.0
Homework review	9.9	10.4	9.5
Lecture style presentation	49.7	18.7	31.5
Guided practice	14.5	25.4	17.7
Reteaching and clarification of content	13.3	12.5	11.0
Student independent practice	7.8	16.7	12.8
Tests and quizzes	9.8	10.2	12.8

Mathematics teachers were asked how much time that they spent on various instructional activities in mathematics classes. Lecture style presentation and teacher guided practice were the ones that teachers mostly preferred in each group. Turkish teachers used lecturing nearly half of the time and 15 % of the time was used for teacher guided practice. This was different in EU countries in that 19 % of the time was spent on lecturing and 25 % of the time was guided practice. Importance given to student independent practice was higher in EU countries than candidate country and Turkish classes. Percentage of time spent on administrative tasks, homework review and tests and quizzes was almost equal in all the groups.

Being good at mathematics

Table 4.8 Percentages of Teachers Attaching High Importance to Characteristics for 'Being Good' at Mathematics

Items	Turkey	EU	Candidate
Remember formulas and procedures	62.6 %	36.2 %	45.9 %
Think in a sequential and procedural manner	75.8 %	86.6 %	95.1 %
Understand mathematical concepts, principles, and strategies	78.5 %	68.0 %	77.7 %
Be able to think creatively	74.7 %	66.7 %	76.8 %
Understand how mathematics is used in the real world	56.0 %	56.5 %	60.1 %
Be able to provide reasons to support their solutions	58.1 %	69.4 %	79.4 %

Teachers were asked what should be done in order to be successful in mathematics. Turkish mathematics teachers (62.6 %) rated remembering formulas and procedures more highly than the candidate countries' (45.9%) and European Union countries' teachers (36.2%). About 95 % of the candidate country teachers rated thinking in a sequential and procedural manner as very important compared with 87 % of European teachers and 76 % of Turkish teachers. 56 % of Turkish mathematics teachers rated that understanding the use of mathematics in real life as very important, which was slightly lower than EU and candidate country teachers. Greater percentages of teachers in candidate countries (79 %) rated that it was very important for students to be able to support their solutions than EU teachers (69 %) and Turkish teachers (58 %). Teachers' opinion in all the groups on the importance of understanding the concepts and thinking creatively were nearly equal and majority of the teachers believed that these were very important on the achievement of the students.

Conceptions about mathematics and teaching mathematics

Table 4.9 Percentage of teachers who agree/strongly agree with the conceptions about mathematics and teaching mathematics

Items	Turkey	European Union	Candidate
Math is primarily an abstract subject	53 %	30 %	42.8 %
Math is formal representation of world	92.6 %	54 %	54.5 %
Math is practical and structured guide	91.5 %	78.1 %	88.4 %
Students who have natural talent are successful	70.2 %	93.5%	96.1%
Use more than 1 representation	95.6 %	95.1 %	93.1 %
Set of algorithms and rules	70.7 %	46.5 %	65.2 %
Basic computational skills	43 %	29.9 %	14.8 %

A greater proportion of teachers in Turkey than European and candidate country teachers believed that mathematics was primarily an abstract subject. They also believed that mathematics is the formal representation of world. As a result of these conceptions about mathematics, it was natural that most of Turkish teachers thought mathematics should be taught as a set of algorithms and rules and basic computational skills were important in teaching primary school mathematics. In all the groups, teachers believed the importance of using more than one representation in teaching mathematics. More than 90 % of the teachers believed that in order to be successful in mathematics, students should have a natural talent in EU and candidate countries whereas this proportion was 70 % in Turkish teachers.

Student arrangements during the presentation of mathematics topics

It is seen from the analysis that teachers used different techniques and methods in the presentation of math topics. Mostly preferred methods in all the groups were individual work with teacher assistance and teacher teaching the whole class. The least preferred methods were the ones that the teachers had a minimum role. Working in groups were also not preferred much by the teachers.

Table 4.10 Percentages of teachers for each student arrangement

Items	Turkey	EU	Candidate
Individual work with no assistance	18.1 %	29 %	21.4 %
Individual work with assistance of teacher	58 %	70.7 %	71.3 %
Work together—teacher teaches	51.5 %	63.3 %	74.1 %
Work together-students interact	30 %	11.7 %	24.6 %
Work in groups with no assistance	11.5 %	8.5 %	4.9 %
Work in groups with teacher assistance	30.4 %	18.5 %	21.8 %

Limitations to teaching

Turkish teachers reported wide range of backgrounds of students, students with special needs, high student-teacher ratio, low moral among the staff, low moral among the students and threats to safety as limitations to teaching more than the other group teachers. Uninterested students were highly rated as a limitation in mathematics classes in all the groups. Both candidate countries' and Turkish teachers believed that inadequate physical facilities were limitations to teaching. Shortage of computer hardware and software were mostly reported as limitation in candidate countries.

Table 4.11 Percentages of teachers who rated the limitations to teaching a great deal/quite a lot

Items	Turkey	EU	Candidate
Students with different academic abilities	38.2 %	53.6 %	61.3 %
Students with wide range of background	40.5 %	15.6 %	32.5 %
Students with special needs	67.0 %	14.7 %	22.1 %
Uninterested students	68.2 %	60.5 %	65.5 %
Disruptive students	42.5 %	38.1 %	32.1 %
Parents interested	29.3 %	15.4 %	12.0 %
Parents uninterested	54.5 %	34.2 %	51.3 %
Shortage of computer hardware	23.2 %	16.4 %	34.0 %
Shortage of computer software	21.2 %	27.7 %	33.0 %
Shortage of instructional equipment	45.7 %	27.2 %	50.8 %
Shortage of demonstration equipment	39.5 %	27.1 %	49.9 %
Inadequate physical facilities	52.0 %	18.6 %	51.8 %
High student-teacher ratio	58.7 %	36.2 %	37.8 %
Low moral among staff	47.8 %	10.7 %	18.2 %
Low moral among students	61.5 %	33.9 %	34.9 %
Threats to safety	58.2 %	11.2 %	16.8 %

Homework

The amount of homework that teachers gave was quite different from each other. Most of the Turkish teachers gave homework 1-2 times a week. In EU and candidate countries, teachers gave homework more than 3 times a week. The average time needed for completing the homework was mostly more than 30 minutes in candidate countries whereas it was less than 30 minutes in EU countries. In all the groups, teachers mostly gave textbook problems as homework.

Table 4.12 Percentages of teachers according to their homework policy

Amount of homework, Time spent on homework	Turkey	EU	Candidate
< once\week, > 30 min	0.5 %	0.8 %	0.7 %
< once\week, < 30 min	4.0 %	5.3 %	0.3 %
1-2 times\week, > 30 min	37.9 %	3.7 %	5.4 %
1-2 times\week, < 30 min	35.4 %	19.7 %	9.0 %
3 or more times, > 30 min	12.1 %	16.3 %	54.8 %
3 or more times, < 30 min	10.1 %	53.7 %	29.1 %

Use of calculators and computers

In Turkey, teachers mostly did not allow their students use calculators in mathematics lessons. In European and candidate countries, mostly there was a restricted use of calculators. If it was allowed it was mostly used for checking answers and routine computation.

In most of the classrooms, there were no computers. The percentage of teachers in European Union countries who reported that there were computers in other rooms at school was slightly more than the candidate country and Turkish teachers. If there were computers at school, the teachers reported that they almost did not use internet for educational purposes.

Table 4.13 Percentages of teachers on the extent they allow their students use calculators in class

Items	Turkey	EU	Candidate
Unrestricted use of calculators	1.5 %	16.5 %	16.7 %
Restricted use of calculators	37.2 %	68.6 %	48.3 %
Calculators not permitted	61.3 %	14.8 %	35 %

Tasks in class

More than three-fourth of the teachers had their students practice computational skills in most or every lesson. The percentage of teachers who asked their students explain the reasoning behind an idea was higher in EU (79.9 %) and candidate countries (92.8 %) than Turkey (56 %). Turkish teachers asked analyzing relationships by using tables, charts and graphics and writing equations to represent relationships more frequently than EU and candidate countries' teachers. Less than one-fourth of the teachers had their students work on non-routine problems in all groups. The percentage of teachers who were asking students to use computers and graphic calculators to solve problems and exercises was quite low in each group.

Table 4.14 Percentages of teachers rated agree/strongly agree on the items related with problem solving

Items	Turkey	EU	Candidate
Explain reasoning behind an idea	70.6 %	79.9 %	92.8 %
Analyze relationships	56 %	22.2 %	27.2 %
Work on non-routine problems	23.9 %	21.5 %	24.3 %
Use computers to solve problems	5.6 %	1.2 %	0 %
Write equations	60.6 %	48.3 %	35.7 %
Practice computational skills	78 %	78.4 %	78.1 %
Use graphic calculators to solve problems	1.5 %	2.7 %	14.5 %

Assessment practices

Teachers were also asked how much weight they assigned to different assessment techniques. In all the groups it was observed that teachers were using a mix of assessment techniques. In all the groups, students' responses in class was rated highly. Teacher-made reasoning tests were more frequently used in candidate and EU countries' math classes. In Turkey, after student observation and responses in class, teacher-made tests are frequently used.

Table 4.15 Percentages of teachers agree/strongly agree with each type of assessment

Items	Turkey	EU	Candidate
Standardized tests	24.5 %	38.4 %	51.3 %
Teacher-made reasoning tests	52.3 %	79.1 %	80.9 %
Teacher-made objective tests	36.1 %	23.3 %	38.9 %
Homework performance	58 %	35.5 %	77.8 %
Project performance	32.3 %	37.4 %	33.4 %
Observation	51.7 %	54.4 %	77.8 %
Responses in class	95.5 %	76.8 %	98.1 %

4.2 HLM Analysis

In this part of the chapter, the results of HLM analysis will be presented. Four models were built in order to investigate the effects of teacher related factors and classroom characteristics by adding three blocks of variables successively.

4.2.1 Handling missing data at level 2

HLM software program assumes level 2 data files to be complete i.e. it doesn't allow for missing data except for level 1. If any of the higher level files contain missing data, units with missing data is automatically deleted when the MDM file is created. There were missing data in the teacher background questionnaires which were analyzed at level 2 in HLM analysis in this dissertation. So the data was reduced in the analysis as it is presented in table 4.16. In order to check whether this reduction in the sample size affected the representativeness of the data or not, Stemler (2001) compared the mean, standard deviation, between-school variance, reliability and parameter variance of the original data and the data used in HLM analysis. These values were also compared in this dissertation. The mean achievement and standard deviation of the original sample and the reduced sample were similar to each other as it is seen from table 4.17. The greatest difference was in Belgium (Flemish) data which was about 6 points and in Slovak Republic and the other candidate countries, it was about 5 points.

Table 4.16 The number of students and classrooms in the original data in the database and in the data used in HLM analysis

Country	Original data in the database		Data used in HLM analysis	
	Number of classrooms	Number of students	Number of classrooms	Number of students
Turkey	204	7841	105	4048
Belgium (Flemish)	279	5259	195	3665
Czech Republic	142	3453	106	2591
Hungary	147	2872	108	2333
Italy	180	3328	140	2579
Lithuania	150	2361	121	1868
Netherlands	126	2962	90	2082
Slovak Republic	145	3497	104	2474
EU countries	1425	29957	1105	22923
Bulgaria	163	3272	109	2218
Romania	147	3425	118	2737
Candidate countries	310	6697	227	4955

Table 4.17 Mean and standard deviation of mathematics achievement scores of students in the original data in the database and in the data used in HLM analysis

Country	Original data in the database		Data used in HLM analysis	
	Mean	Standard deviation	Mean	Standard deviation
Turkey	427.23	83.72	425.38	82.48
Belgium (Flemish)	573.93	64.46	579.87	63.90
Czech Republic	557.51	88.93	559.39	89.78
Hungary	530.65	84.57	529.13	85.60
Italy	479.34	85.42	478.78	87.14
Lithuania	485.69	76.52	487.15	76.38
Netherlands	544.39	67.63	545.76	69.49
Slovak Republic	550.21	78.69	545.69	77.71
Slovenia	532.14	83.40	532.16	83.33
EU countries	530.16	86.09	531.18	86.65
Bulgaria	508.27	87.79	513.72	86.45
Romania	482.70	93.76	487.68	90.43
Candidate countries	495.19	91.78	499.11	89.63

In the table 4.18, the reliability, the parameter variance and the between-class variance of the original sample and the reduced sample are presented. The differences in the reliability are less than 0.01 in all the countries. The greatest difference in the between-class variance of countries was in Slovak Republic data which was 3 %.

The mean achievement, standard deviation, parameter variance, reliability and between-class variance of the original sample and the reduced sample were similar to each other. So, we can assume that the reduction in the sample did not affect the representativeness of the data. In the preceding sections, the results of the reduced sample are presented.

Table 4.18 Reliability, parameter variance and between-class variance in the original data in the database and in the data used in HLM analysis

Country	Original data in the database			Data used in HLM analysis		
	Reliability	**Parameter variance**	**Between-class variance**	**Reliability**	**Parameter variance**	**Between -class variance**
Turkey	0.94	2153.73	30 %	0.94	2132.81	31 %
Belgium (Flemish)	0.97	4371.71	71 %	0.97	4089.71	71%
Czech Republic	0.91	1766.98	31 %	0.92	2025.34	33 %
Hungary	0.90	2236.29	32 %	0.90	2384.79	34 %
Italy	0.91	2651.45	35 %	0.91	2767.02	36 %
Lithuania	0.91	2646.90	46 %	0.91	2678.52	46 %
Netherlands	0.98	4359.01	72 %	0.98	4985.70	74 %
Slovak Republic	0.92	1804.65	33 %	0.90	1613.94	30 %
Slovenia	0.73	803.13	12 %	0.74	854.73	13 %
EU countries	0.94	3519.33	48 %	0.94	3419.86	47 %
Bulgaria	0.95	3728.42	51 %	0.95	3584.98	51 %
Romania	0.93	3559.68	44 %	0.92	3003.96	40 %
Candidate countries	0.94	3840.68	46 %	0.94	3681.36	47 %

4.2.2 Results of research question 1

The one-way ANOVA with random effects provided information about how much variation in the mathematics achievement of students lies within and between classrooms.

In the table 4.19, between class and within class variances are presented. The variability between classrooms ranged from 9 % in Cyprus to 74 % in Netherlands. In order to develop theoretical models that explain variance between classes in each group, there should be sufficient between-class variability in mathematics achievement. The cut-off point was determined as 10 % in Stemler (2001) and Martin (2000). In this study, this value was also accepted and except for Cyprus which had 9 % of between-class variance, two level hierarchical linear models were developed for exploring teacher and class effects on student achievement for each country separately and for the groups of countries.

Table 4.19 Between- and within-class variance of countries

Country	Between-class variance	Within-class variance
Turkey	31 %	69 %
Belgium (Flemish)	71 %	29 %
Czech Republic	33 %	67 %
Cyprus	9 %	91 %
Hungary	34 %	66 %
Italy	36 %	64 %
Lithuania	46 %	54 %
Netherlands	74 %	26 %
Slovak Republic	30 %	70 %
Slovenia	13 %	87 %
EU countries	47 %	53 %
Bulgaria	51 %	49 %
Romania	40 %	60 %
Candidate countries	47 %	53 %

4.2.3 Results of research question 2

Two-level hierarchical linear models (HLM) were developed to explore teacher and class effects in European Union Countries, candidate countries and Turkey. In tables 4.20, 4.21 and 4.22, the results of HLM analysis of Turkey, European Union countries and candidate countries are presented. The results of each country are presented separately in Appendix B. The variables were accepted as significant at 0.10 level.

In the first model, the block of teacher background variables, namely teacher's gender, level of education and experience in years were included. In Turkey, gender of teacher and the experience of teacher had significant effect on mathematics achievement of the students. In EU countries, experience of teacher in years increased, the mathematics achievement of the students also increased whereas the level of education of teacher had a negative significant effect. In candidate countries as a group, none of the factors had significant effect.

Table 4.20 HLM models of Turkey

Turkey	Model 1	Model 2	Model 3	Model 4
Gender	-19.01(9.79)			-14.06(8.07)
Years teaching	1.53(0.62)	2.12(0.57)	1.87(0.52)	1.56(0.54)
Level of education				
Administrative duties				
Homework review				
Lecture style				
Guided practice				
Reteaching and clarification of content		-1.06(0.47)	-1.18(0.44)	-0.88(0.45)
Independent practice				
Tests and quizzes		2.02(0.78)	2.05(0.75)	1.91(0.72)
Emphasis on prob solving		-20.41(8.96)	-22.24(9.58)	-18.58(8.82)
Emphasis on homework				
Small group work				
Never or hardly use of calculator				
Textbook based teaching		45.62(19.02)	43.95(17.57)	52.30(17.89)
Discipline oriented point of view				
Process oriented point of view				
Class size				
Class Climate			8.46(3.79)	5.75(3.39)
Limitations to teaching				
Mean of HER				58.92(26.39)

Table 4.21 HLM models of European Union countries as a group

EU	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching	0.41 (0.21)		0.38 (0.19)	0.36 (0.19)
Level of education	-13.46 (4.30)	-17.15(4.39)	-13.08(3.93)	-13.83(3.73)
Administrative duties				
Homework review		-0.64 (0.32)	-1.01 (0.28)	-0.98(0.30)
Lecture style				
Guided practice				
Reteaching and clarification of content				-0.52 (0.29)
Independent practice		0.62 (0.28)		
Tests and quizzes		-0.90 (0.44)	-0.71(0.37)	
Emphasis on prob solving		19.06(4.52)	15.76 (4.11)	13.78 (3.74)
Emphasis on homework		-8.36 (4.72)		
Small group work		-14.45 (6.03)	-12.20(4.41)	-11.02 (4.46)
Never or hardly use of calculator				
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view		-11.12 (2.08)	-7.01 (1.88)	-5.37 (2.01)
Class size			2.72 (0.38)	1.55 (0.43)
Class Climate			6.45 (1.20)	4.01 (1.20)
Limitations to teaching			-2.16(0.21)	-1.77 (0.21)
Mean of HER				104.22(12.87)

Table 4.22 HLM models of the other candidate countries as a group

Candidate	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching				
Administrative duties				
Homework review				
Lecture style				
Guided practice				
Reteaching and clarification of content				
Independent practice		3.48 (1.18)	3.14(1.15)	2.65(1.07)
Tests and quizzes				
Emphasis on prob solving				
Emphasis on homework				
Small group work				
Never or hardly use of calculator		-29.05(7.87)	-29.38(8.42)	-19.16(7.80)
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size				
Class Climate				
Limitations to teaching				
Mean of HER				82.77 (19.43)

In the second model, the block of variables related with teachers' instructional practices were added to the first model. In Turkey, experience of teacher, percentage of time spent on tests and quizzes and use of textbook had positive significant effects whereas percentage of time spent on re-teaching and clarification of content and emphasis on problem solving had negative significant effects. In candidate countries, time spent on student independent practice had a positive significant effect, but never or hardly use of calculator in math lessons had a negative significant effect. In European Union countries, the effect of experience of teacher variable was removed after addition of teacher's instructional practices block. In the second model of EU, it was found that time spent on homework review and tests and quizzes, emphasis on homework, small group work and teacher's process-oriented point of view about mathematics had negative significant effects. Emphasis on problem solving and student independent practice had positive significant effects on mathematics performance.

In the third model, the variables in class characteristics were added to the model. In Turkish model, experience of teacher, time spent on tests and quizzes, use of textbook and orderly class environment had positive significant effects while time spent on re-teaching and clarification of content and emphasis on problem solving had negative significant effects. In the third model of candidate countries, nothing was changed. None of the factors related with class characteristics were significant. In the third model of EU, the effects of emphasis on homework and time spent on independent practice were removed after the addition of class characteristics block. It was found that class size and class climate had positive significant effects while limitations to teaching had a negative significant effect in EU countries.

In the fourth model, mean HER of the class was added to the model and it was positively significant in all the group models. In Turkey, the effect of gender was again added to the model. In candidate countries, the positive effect of mean of HER was added to the model, the effect of other variables remained same. In EU model, after addition of mean HER variable, the effect time spent on tests and quizzes was removed. Level of education of teacher, time spent on homework review, re-teaching and clarification of content and limitations to teaching in class had negative significant effects while teachers' experience, emphasis on problem solving, class size, class climate and mean of HER had positive significant effects.

Regression coefficients presented in the tables show the expected increase in y for one unit increase in x, given all of the other variables in the model are held constant.

If it is accepted that the values less than 10 points as low effect, 10 to 30 points as moderate effect and more than 30 points as high effect, it is seen that in the full model of all groups, time spent on various activities had low effect and mean of HER had high effect on students' mathematics achievement. In Turkish full model, gender and emphasis on problem solving had moderate effects while the use of textbook in math classes had a high effect. In European Union countries' model, education level of teacher, emphasis on problem solving and small group work had high effects. In candidate countries, use of calculators had moderate effect on the performance of students in mathematics.

The number of variables that were significant for each country and whether they had a negative or positive significant effect on student achievement are summarized in table 4.23.

Table 4.23 Number of significant variables for each country

Variables	Turkey	Belgium	Slovak Rep.	Czech Rep.	Hungary	Italy	Lithuania	Netherlands	Slovenia	Bulgaria	Romania	Total
Gender	-			-	+			+				4
Years teaching	+		-					+	-			4
Level of education			-									1
Administrative duties		-		+				-				3
Homework review								-				1
Lecture style		+						-				2
Guided practice		+			+		-					3
Reteaching and clarification of content	-		-			-		-				4
Independent practice		+						-		+		3
Tests and quizzes	+				-		-	-				4
Emphasis on prob solving	-			+	+				+		-	5
Emphasis on homework		+	+				+					3
Small group work			-	-								2
Never or hardly use of calculator		-	+					+		-	-	5
Textbook based teaching	+											1
Discipline oriented point of view												0
Process oriented point of view		+		-								2
Class size		+			+	+	+	+				5
Class Climate	+		+			+						3
Limitations to teaching		-				-		-	-			4
Mean of HER	+	+	+	+	+	+	+	+	+	+		10
Total	8	10	8	5	6	5	5	12	4	3	2	

4.2.4 Results of research question 3

Proportion variance explained statistics can be used to evaluate the impact of the addition of the predictors to a hierarchical linear model on the amount of the variation in the outcome that is explained by the model (Raudenbush & Bryk, 2002). Table 4.24 presents the amount of variance explained by each model both across models and within countries.

Table 4.24 Amount of variance explained by each HLM model for the groups of countries and individual countries

Variance explained	Model 1	Model 2	Model 3	Model 4
Turkey	11 %	30 %	38 %	45 %
Belgium (Flemish)	0 %	35 %	59 %	63 %
Czech Republic	5 %	27 %	44 %	62 %
Hungary	3 %	25 %	40 %	69 %
Italy	1 %	24 %	42 %	46 %
Lithuania	3 %	21 %	45 %	63 %
Netherlands	5 %	45 %	70 %	74 %
Slovak Republic	5 %	24 %	38 %	43 %
Slovenia	7 %	19 %	30 %	44 %
EU countries	2 %	14 %	35 %	43 %
Bulgaria	2 %	42 %	46 %	56 %
Romania	0 %	20 %	23 %	26 %
Candidate countries	1 %	25 %	28 %	37 %

While investigating the third research question, four models were built for exploring the effects of teacher and class characteristics on mathematics achievement of students. In the first model, the block of teacher background variables, namely gender, experience and level of education of teachers were considered. This block of variables could explain a small amount of variance. The amount of explained variance ranged from 0 % in Romania and Belgium (Flemish) to 11 % in Turkey.

In the second model, the block of variables related with teachers' instructional practices were added to the first model. The factors that effect mathematics achievement significantly were different in each country. The difference in explained variance ranged from 12 % in Slovenia, to 40 % in Bulgaria and Netherlands. The mean of the difference in explained variance was about 25 %.

In the third model, the block of class characteristics variables, namely class size, class climate and limitations to teaching were added to the model. The difference in explained variance ranged from 3 % in Romania to 25 % in Netherlands. It was observed that the number of countries where class characteristics variables had significant effect were more than the number of countries in other models. The mean of the difference in the explained variance was about 15 %.

In the fourth model, average of home educational resources index variable was added to the third model. In all of the countries, the effect of average home educational resources index variable was positively significant. The differences in the explained variances ranged from 3 % in Romania to 29 % in Hungary. The mean of the difference in the explained variance was 11 %.

4.3 Summary

Three research questions were addressed in order to investigate the effects of teacher and class characteristics on mathematics achievement of students in Turkey, European Union countries and the other candidate countries of EU. Null model provided the information that of the twelve countries, except Cyprus, there was enough between-school variation to develop a theoretical model for explaining the teacher and class effects.

Second research question revealed the information that the factors that had significant effect were different in each country. The directions of these significant factors were also opposite i.e. a factor that had a positive significant effect in one country might have a negative effect in another country. In most of the countries, the variables in the class characteristics block had significant effect on mathematics achievement. Mean of HER was the variable that had significant effect on mathematics achievement of students for every country except Romania.

The proportion-variance explained was examined in the third research question. The block of variables related with teacher background characteristics had low effect on the mathematics achievement of students. The effects of the variables in the instructional practices block were quite different in each country. Most of the variance was explained by the factors in instructional practices block. The third block of variables which was constituted from class size, limitations to teaching and class climate were significant in more number of countries. By adding mean of HER variable, the explained variances increased about 11 % in average.

CHAPTER 5

DISCUSSION AND CONCLUSION

In this part of the thesis, variables included in the study are discussed in compatible with the literature. Implications of the study, limitations of the study and suggestions for further research are presented.

5.1 Discussion of the Results

In this dissertation, the effects of teacher and class characteristics on student mathematics achievement in Turkey, European Union (EU) countries and other candidate countries were examined. There were substantial differences between the groups of countries when teacher and class characteristics were taken into consideration. Mean of home educational resources had positive significant effect in all the groups. Candidate countries are completely different from EU countries and Turkey. Time spent on independent practice and use of calculator had significant effect in candidate countries. There are some similarities and differences between EU countries and Turkey. In both EU and Turkey, experience of teachers and class climate had positive significant effects, but reteaching and clarification of content had a negative significant effect. In Turkey, emphasis on problem solving had negative significant effect, but in EU it had a positive significant effect on student achievement. In Turkey, time spent on tests and quizzes, textbook based teaching had positive significant effects and the classes of male teachers were more successful. In EU countries, time spent on homework review, level of education of teacher, small group work, process-oriented point of view and limitations to teaching had negative significant effects, but class size had a positive significant effect on student performance. The separate analysis of countries did not reflect the results yielded from them as a group. Although, European Union is considered as a whole, each country has its own specific characteristics, especially in the instructional practices of the teachers. Reasons of this difference may stem from the differences in education systems. Information about education systems of the countries is involved in this study was taken directly from the country reports located in Eurybase, which is the information database on education systems in Europe on internet, in Appendix C.

When the results are considered, it is observed that results were consistent with past TIMSS studies, but some results were not consistent with research literature. The reasons of this contradiction are discussed for each variable regarding the educational research literature and information about education systems of countries.

Gender of teacher

The gender of teacher was a significant factor in four countries. However, the effect was not consistent across the countries. In Turkey and Czech Republic, male teachers were more effective and in Hungary and Netherlands female teachers were more effective.

Experience of teachers

The variable asking the experience of teachers in years in the questionnaire was included in the study. It was observed that experience of teacher had a positive significant effect in Turkey and Netherlands, but negative significant effect in Slovak Republic and Slovenia. Literature shows that teachers who have more than five years of experience are more effective teachers (Greenwald, Hedges, and Laine, 1996). However, it is not possible that all teaching is carried out by the experienced teachers. The effects of inexperienced teachers may be reduced if they are evenly appointed to the schools, and proper assistance is given to new teachers (Mullis et.al., 1997). In Turkey, teachers are considered as trainee in their first years and they should prepare a file and work with an experienced teacher. However, they are mostly appointed to the small schools or in the schools in the small cities or villages with one mathematics teacher. So, they do not have the opportunity to work with an experienced teacher. There should be some developments in this first year training program to improve the teaching skills of new teachers and appointment procedure should be revised. Appointing the teachers to the schools where they would have an opportunity to work with an experienced teacher at least for one year could help teachers improve their teaching skills.

Level of education

Teachers' level of education, i.e. whether they had a graduate degree or not, was taken into analysis. From literature, in most of the studies it was observed that extra qualifications related with mathematics and mathematics education had positive significant effect on the achievement of students. However, there are also studies that teachers with graduate degrees had negative impact. In this study, when EU countries were taken into analysis as a group, level of education was found to have a negative significant effect, which was moderate, on student achievement. In separate analysis of countries in Slovak Republic, it had a negative significant effect. The difference of scores between the students who had a teacher with a graduate degree and without a graduate degree was about 39 points when all the other variables held constant. In country description of Slovak Republic from Eurybase, it is seen that masters degree is given to the teachers who are specialised in two subject area. In master program, teachers do not get deeper information in their area. They are specialised in another subject area. Probably due to this reason, having master degree had negative effect on student achievement in Slovak Republic and had no effect in the other countries.

Percentage of time spent on administrative tasks

In a typical month of lessons what percentage of time was spent on administrative duties other than teaching was asked in the questionnaire. In Belgium (Flemish) and

Netherlands, time spent on administrative duties other than teaching had a negative significant effect on student performance. Probably since teachers get tired, their performance in their math classes decent and they could not concentrate on the lesson. So the duties other than teaching should be hold at minimum for the teachers. The administrative and clerical work of the schools should be carried out by the supporting staff in these subjects.

Percentage of time spent on re-teaching and clarification of content

In four of eleven countries, namely in Turkey, Slovak Republic, Italy and Netherlands, the percentage of time spent on re-teaching and clarification of content in a typical month of math lessons had negative significant effect on mathematics achievement of students. This may be due to low-achieving students need re-teaching and clarification of content more than the high-achieving students. Low-achieving students need more control and structuring from their teachers, more active instruction and feedback, more redundancy. This means more review, drill and practice and thus more lower-level questions. Across the school year, it will mean exposure to less material and this will lead to low scores in the tests (Brophy and Good, 1986). This does not mean that reteaching or clarifying the content effects the mathematics performance of students in a negative way. Reteaching the content should be done when necessary since mathematics can not be learned without removing student difficulties in prior knowledge.

Percentage of time spent on tests and quizzes

The percentage of time spent on tests and quizzes in a typical month of math lessons had a positive significant effect in Turkey and had a negative significant effect in Hungary, Lithuania and Netherlands, it. Giving tests and quizzes is one type of assessment. They are useful in providing the teacher with feedback about students' progress, motivating the students, assessing the students' readiness for future learning. In Turkey, the education system is test-oriented. Students mostly study their lessons when there is an exam. So giving tests and quizzes make the students study harder. Although giving tests and quizzes may foster the students in studying, teachers should be careful while using them. There is a danger that some of the students may feel disheartened and upset as a result of low scores they got. Also the tests and quizzes should not be too time-consuming. The content of the tests and quizzes should be prepared carefully (Kyriacou, 1997). In Turkey and in the other groups of countries, teacher-made tests were mostly preferred according to the TIMSS results presented in chapter 4. It is important that teachers are informed about test construction and assessment techniques as a result of the reforms in education system.

Percentage of time spent on lecture-style presentation, teacher-guided practice and student-independent practice

There are many teaching methods that can be used in teaching mathematics. Teachers should decide which method is best to use in the activities. Percentage of time spent on lecture-style teaching had a positive effect on student achievement in Belgium (Flemish), but a negative significant effect in Netherlands.

Whatever method is used in mathematics teaching, guided practice followed by independent practice has important impact on student achievement. There is no consistency in the results. The percentage of time spent on teacher guided practice in a typical month of mathematics lessons had a positive significant effect in Belgium (Flemish) and Hungary, but a negative significant effect in Lithuania. The percentage of time spent on student independent practice in Belgium (Flemish) and Bulgaria had a positive significant effect on student achievement, but a negative significant effect in Netherlands. Guided practice and independent practice are two important parts of an effective lesson (Rosenshine and Stevens, 1986). If metacognitive questions, that students can ask themselves or discuss as a whole class, are not considered in guided practice, it becomes routine skills practice and does not improve student learning. The success of guided practice could be understood from the student success in independent practice.

Only in Belgium (Flemish), the teaching method followed by teacher-guided and student-independent practice had all positive significant effect which was a consistent result with the literature. In the education system of Belgium (Flemish), teachers are responsible for choosing the teaching methods and teaching resources. There are no any official guidelines (Eurybase, 2006). They are successful in applying them, since it was the highest achievement country among the countries included in this study. Failing to guide the students in appropriate form does not increase the performance of students.

Small group work

Small group instruction where two or more students work together on a task is endorsed by most of the teachers and researchers. Turkey, Czech Republic, Hungary, Slovak Republic, Slovenia, Bulgaria and Romania emphasize using small groups in class teaching in their education systems (Eurybase, 2006). Although, there is evidence from literature that using small groups within mathematics education in various types of different classroom tasks has positive effects on student learning (Davidson, 1985; Slavin, 1990), in this dissertation, small-group work had a negative significant effect in Slovak Republic and Czech Republic on student performance. The reason of this is probably these are new methods employed in class teaching. In Czech Republic, small group work is used in practical work. During the lesson, lecturing is mostly used. In Slovak Republic, teachers have recently started to use new techniques such as small group work, cooperative learning in their lessons. Ministry of education is testing the efficiency of these methods through projects (Eurybase, 2006).

Since these are new methods, there may be some problems in the practice of small group instruction. There may be difference between theory and practice of using small group work in class. In theory, students are expected to present and test their ideas while working in small groups. However, in practice students often work alone on the task assigned to the group (Gerelman, 1987). In small group instruction, group structure, kinds of tasks presented, the nature of interactions between students and the characteristics of students are important besides teachers' involvement in class. Teacher should monitor students as they work by asking questions, providing clues and offering feedback and explanations (Rosenshine, 1980). In order to use small group work effectively in class, teachers should be informed about how should it be used.

Use of textbooks

The percentage of time that teachers base their lessons on textbooks was asked in the questionnaire. In Turkish data, use of textbooks in mathematics lessons had a positive significant effect on the mathematics achievement of the students in the full model. The results were consistent with the literature that textbooks have positive effect in developing countries but no effect have been reported in the more developed countries (Braswell et al., 2001). Books are important resources in reaching the knowledge when there is no internet and shortage of teachers. Turkish education system is in a transition from a teacher-centered structure to student-centered structure. In order to facilitate the transition, teacher books of textbooks which explain the activities and instructional methods that may be employed in class should be prepared. Although, new textbooks are being prepared in Turkey, the studies point out that they are inadequate in scope (TÜBA, 2005). Olkun and Toluk (2001) examined primary school mathematics textbooks from first to fifth grade with respect to the meanings of operations derived from word problems. Results showed that word problems were widely used in textbooks but problem types were not represented adequately and same type of problems were repeated throughout the textbooks examined. The textbooks used in math classes should be considered and revised in order to be used more effectively. They should provide more problem solving activities, such as non-routine problems, which have more than one answer and more than one solution method, that enable students to think.

Emphasis on problem solving

Problem solving has special importance in the study of mathematics. A primary goal of mathematics teaching and learning is to develop the ability to solve a wide variety of complex mathematics problems. To many mathematically literate people, mathematics is synonymous with solving problems -- doing word problems, creating patterns, interpreting figures, developing geometric constructions, proving theorems, etc. (Wilson, Fernandez and Hadaway, n.d.). The index variable "emphasis on problem solving" which was constructed in TIMSS database, was considered in the analysis. Emphasis on problem solving had a positive significant effect in Hungary, Czech Republic and Slovenia, but a negative significant effect in Romania and Turkey. The negative effect of problem solving on student achievement may be due to the differences between beliefs and practices of teachers in problem solving. The results of descriptive analysis showed that teachers agree with the items in the survey, such as explain reasoning, analyzing relationships, but they may not be able to apply them in their lessons. Also when the meaning of problem solving is asked, people explain it differently (Wilson, Fernandez and Hadaway, n.d.). Mostly, problem solving is regarded as solving routine word problems. Primary school mathematics textbooks in Turkey mostly include routine problems which have one solution method and one answer. Same type of problems were also repeating throughout the book (Olkun and Toluk, 2001). It is not possible to improve students' problem solving abilities with only this type of problems. In order to have successful problem solvers, teachers should also improve themselves in problem solving and in teaching problem solving. This can be satisfied by providing seminars and preparing teacher handbooks for in-service teachers and adding courses which mainly focus on problem solving to the curriculum of pre-service teacher training.

Emphasis on homework

Emphasis on mathematics homework was another factor that had a positive effect on mathematics performance of students in three countries, namely in Belgium (Flemish), Slovak Republic and Lithuania. Time spent on homework review had a negative significant effect in Netherlands. The research suggests that assignments should be varied and interesting enough to motivate student engagement. They should also be new and challenging enough to constitute meaningful learning rather than pointless busy work and easy enough to allow students to achieve high rates of success if they spend reasonable effort. The effectiveness of assignments is enhanced when teachers explain the work and go over practice examples with students before releasing them to work independently and then monitor the students and provide them help when needed (Brophy and Good, 1986).

Descriptive results showed that the amount of homework that Turkish teachers give was less than the European Union countries' and candidate countries' teachers. It is important to develop homework policies. They should be developed regarding the questions; What kind of homework is most effective?, How much homework is appropriate?, At what age level is homework a useful learning tool?, Who is responsible for deciding how much homework to assign?, Who is responsible for monitoring homework? Little attention is paid to the topic of homework in teacher education. (Cooper, 1994). The effectiveness of homework could be increased by giving more emphasis on homework in pre-service and in-service teacher training courses.

Use of calculators

Many researchers in mathematics education advise the use of calculators, especially in the middle school grades (Hembree and Dessart, 1985). In this dissertation, the results were different among the countries. In five countries, the use of calculators had significant effect. In Belgium (Flemish) and candidate countries, the more use of calculators led to the higher scores of students. In Slovak Republic and Netherlands, the use of calculators had a negative effect on the achievement of students. In almost all of the education systems included in this study, there is a tendency to include instructional technologies especially computers and internet in their system. So, teachers are experiencing an unprecedented transition in their role and status: they require further training in the use of new technological tools in ICT. They should be informed about using technological devices in their lessons in appropriate form. If the calculators are mostly used in routine computation and not used for learning number concepts or solving nonroutine problems, they do not have any effect on mathematics achievement of students.

Conceptions about mathematics

Literature states that conceptions about mathematics affect the instructional practices of the teachers (Thompson, 1984). In this dissertation, the effects of two different conceptions about mathematics were considered. These were discipline-oriented point of view and process-oriented point of view about mathematics. First one conceives mathematics as abstract and the other one conceives it as a formal way of representing the world. When mean of HER was not considered, in Belgium (Flemish), discipline oriented point of view had a positive significant effect.

When mean of HER was included in the model, process-oriented point of view had a positive significant effect on mathematics achievement of students in Belgium (Flemish), but a negative significant effect in Czech Republic. Although literature states that there is a strong relationship between beliefs about the subject matter and achievement, probably due to the questionnaires used in TIMSS and the answers of teachers to the survey questions, the effects of teachers' beliefs on student achievement could not be detected in this study.

In Turkey, there was no significant effect of conceptions on mathematics achievement. From descriptive analysis of the data, it was observed that teachers' responses to the items about their beliefs were not consistent, for example, Turkish teachers rated both "Mathematics is an abstract subject." and "Mathematics is formal representation of the world.". These contradictory beliefs of the teachers may also be a factor that affects student success in mathematics.

Class size

Class size which was calculated by summing up the number of boys and girls as reported by the teacher was included in the analysis. In five of eleven countries, namely Belgium (Flemish), Hungary, Italy, Lithuania and Netherlands, it was found that class size had a positive significant effect on the achievement of students like in other secondary analysis of TIMSS (Martin et al., 2000). The reason of this result was stated as the weaker students are assigned in the smaller classes. In Lithuania, Italy and Bulgaria remedial classes are constructed for less able students and disabled students (Eurybase, 2006). In European countries, average of class sizes was 22. In Turkey, the classes were very crowded, almost twice of the number in European countries according to TIMSS data.

Although class size had a positive significant effect on student achievement in many countries, it does not exceed 30 students in class in European countries. In the literature, many studies concluded that smaller classes are better for student achievement. There is much debate about the optimum number of students in a class. Mostly, 15-20 students is considered as the optimum number of students in class. Reducing the number of students in class does not always mean that the success of students will increase. As a result of small classes, there will be a need for more teachers and the quality of the teaching will descent as a result of appointing inexperienced teachers.

Class climate

The classroom climate variable was aggregated from students' responses to three questions; students are orderly and quiet during lessons; students do as the teacher says; and students rarely neglect their work from student background questionnaire. A high score on this factor means that the class is more disciplined. It was a significant predictor of adjusted school achievement in three countries in the full model. In Turkey, Slovak Republic and Italy, it had a positive significant effect. Most of the research showed that more orderly classrooms mostly tend to have higher achievement. In these classes, teachers probably do not spend much time on disciplinary problems. They focus on the content, so instruction is more effective. In order to help the teachers in providing an orderly classroom climate, seminars on classroom management should be given. The course given in lesson management should be improved in pre-service teacher training. Besides giving theoretical knowledge, practice in real classroom settings may also be included in course content. The teacher may also work with the guidance service for satisfying an orderly classroom environment.

Limitations to teaching

There were 16 questions in teacher background questionnaire asking the limitations to teaching. The questions were asking information about the limitations related with the physical conditions of the school, the morale of students and staff, sufficiency of resources, the behaviors of students and parents. In four countries, namely in Belgium (Flemish), Italy, Slovenia and Netherlands, it was observed that limitations to teaching had negative significant effect on mathematics achievement of students.

Although, limitations to teaching was not a significant factor in Turkish data, from descriptive analysis, it was observed that Turkish teachers mostly rated low morale of students and threats to safety at school as limitations to teaching. Low morale of students may be related to their unsuccessfulness in the mathematics lessons which may affect their self-concept in mathematics. Recently, Ministry of Education has put emphasis on threats to safety problem at schools. These should be investigated deeply and precautions should be taken as soon as possible.

Mean of Home Educational Resources (HER)

In all the countries except Romania, mean of HER had a positive significant effect on student achievement. This result is consistent with the literature. It is important to include the mean of the home background in the model, since it has the potential to represent characteristics of the school and its community that are not captured at the individual student level. A school with a high average on the home background index is likely to be located in an affluent community, with all of the advantages that implies, whereas a school with a low average would likely be less advantageously situated (Martin et al., 2000).

5.2 Implications of the Study

The results of this study is associative in nature, but it provides some suggestions for improving the mathematics education in Turkey as result of the comparison with the countries. The following are the suggestions for the factors identified as significant in this dissertation;

1. New teachers should be appointed to the schools where they would have the opportunity to work with an experienced teacher. The first year training program of the teachers should be more effective in improving the teaching skills of the new teachers. There should be more emphasis on the classroom management and subject specific teaching methods in the training courses.
2. Using textbooks had positive significant effect on mathematics achievement of students in Turkey. They should be revised in a way that includes problem sets improving meta-cognitive skills of students. The tasks in the textbooks should also support guided practice and independent practice of students. Textbooks also could be prepared with their supplementary material.
3. Problem solving is accepted as very important in mathematics education. It is important that students learn problem solving. In order to have the students as successful problem solvers, teachers should be models. Therefore, it is important to develop teachers' problem solving skills in teacher training programs.
4. The number of students in classes should be reduced. Although the optimum number is determined as 15-20 students per class, the optimum number of students could be decided regarding the economic indicators of Turkey. The class size should not exceed 30 students, like in other European countries.
5. Disciplined class environment is important in student learning. In order to satisfy a disciplined class, teachers should be prepared in class management theoretically and practically through seminars in in-service training and courses in pre-service training.
6. Turkish teachers mostly rated low morale of students and threats to safety at school as limitations to teaching. Teachers could work with the guidance

service of the schools in order to increase the morale of the students. Precautions for satisfying a safe school environment should be taken as soon as possible.

7. Tests and quizzes had positive impact in Turkish education system. The teachers should be informed about assessment techniques and test construction in pre-service and in-service teacher training courses.
8. Administrative duties not related with the lesson, affect the achievement of students in a negative way. So, it is recommended that teachers should not be given administrative duties, but if it is necessary, the amount of work should be kept at minimum. It is more appropriate that headmaster of schools do not have any duty in class teaching.
9. Homework is an important factor on student learning. Homework policies should be developed. In both pre-service and in-service teacher training courses, features of effective homework should be discussed.
10. Ministry of Education in Turkey emphasise the importance of use of technology in the schools in mathematics like in the other countries. In order to have widespread use of technological devices, courses that present the use of calculators, computers and internet in mathematics education by giving examples from subject area should be organized for teachers.
11. Besides teacher training courses, a series of books for improving the subject specific teaching skills of teachers should be prepared by mathematics educators.

5.3 Limitations of the Study

1. Although this study provides some conclusions about the effects of teacher and class characteristics on mathematics achievement of students, it is associative in nature. It does not give much information about the causes of problems in the education system.

2. In this study, a significant amount of parameter variance was remained to be explained in all the groups of countries. The reason of this may be the fact

that it was a secondary analysis and many of the variables necessary for building a more accurate specified model were not included in the TIMSS questionnaire.

3. Most of the factors related to teacher background and approaches to teaching mathematics did not have significant effect on students' performance. The reason of this may be the difficulty of determining the details of what happens in classrooms from the teachers' answers to the questionnaires.
4. In TIMSS sample design, one class from each school was selected. So it was not possible to build three-level hierarchical linear models. It was impossible to distinguish the class and school level factors.
5. The prior achievement of students is an important background factor. There was no information about students' prior achievement in TIMSS database. So only home educational resources was taken as a control variable in this study. An intelligence test to determine the ability of students could be added.
6. Exploring the teacher effects in a longitudinal study would be more appropriate. However, the data collection in TIMSS project was cross-sectional.
7. Importance has been given to use of technology in the lessons in recent years. However, the effect of technology on mathematics achievement of students could not be investigated due to the high amount of missing data in the related variables in the questionnaire.

5.4 Suggestions for Further Research

This study is a associative study rather than explaining the causes. Experimental studies should be carried out in order to explain the effects of factors, namely homework practices, textbook usage, problem solving skills of teachers and students, tests and quizzes, on student achievement.

Turkey will participate in TIMSS 2007. Exploring the data of that study will provide us the opportunity to examine the trend in mathematics education.

5.5 Conclusion

In conclusion, besides the limitations, this study contributed to the literature by giving information about Turkish mathematics teachers while comparing them with their colleagues in European Union countries and the other candidate countries. Although the study did not provide clear-cut, causal explanation of the selected variables and mathematics achievement, it provides a picture of mathematics teachers in Turkey. This information is important due to the limited number of study on teachers.

When the education systems of Turkey, European Union countries and other candidate countries are examined from Eurybase, which is a database of educational systems, it is observed that there is a transition to student-centered teaching. The teaching methods that are advised to be used in classes mostly have students participate actively in learning process. Group-work, problem solving, use of technological devices are important. Because of reforms in educational systems, teachers need more training in order to apply the methods in appropriate form.

By developing two-level hierarchical linear models, the effects of variables related with teacher and class characteristics on mathematics performance of students were investigated. When we compare Turkey, European Union and candidate countries as group, there are substantial differences, especially in the teachers' instructional practices. Although European Union is a whole, there are great differences among the factors affecting student outcomes in each EU country when analyzed separately. The other two candidate countries were also different from each other on some factors.

The results were mostly same with the past TIMSS secondary analyses. However, they were sometimes not parallel with the results in educational research literature. For example, it was found that reteaching and clarifying content and small group work which are considered as effective techniques in mathematics education literature had negative or no effect on student perfomance. In experimental settings since the class setting is controlled, it is possible to reveal the positive effects of these variables. However, in real classes because of difficulty in applying or the inadequate knowledge of teachers on these methods, their effects could not be detected. In reality, teachers may not have the knowledge of teaching methods or have the necessary skills to apply them in class. The fallacies of the questionnaires used in the TIMSS Project may also be the reason of low amount of explained variance and contradictory results to the educational literature. However, the study is still significant as it explains the real classroom situation from the teachers' point of view in a large number of countries.

REFERENCES

Bay, J., (2000). Linking problem solving to student achievement in mathematics: issues and outcomes. *Journal of School Improvement*, Volume 1(2).

Baydar, S.C. & Bulut, S., (2002). Öğretmenlerin matematiğin doğası ve öğretimi ile ilgili inançlarının matematik eğitimindeki önemi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 23.

Beaton, A., Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1996). *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study. Chestnut Hill, MA: Boston College.*

Beaton, A. E., & Robitaille, D. F. (1999). An Overview of the Third International Mathematics and Science Study. In G. Kaiser, E. Luna, & I. Huntley (Eds.), *International comparisons in mathematics education*. 30-47. London: Falmer Press.

Bos, K. and Kuiper, W., (1999). Modelling TIMSS data in a European comparative perspective: Exploring influencing factors on achievement in mathematics in grade 8. *Educational Research and Evaluation, 5*(2), pp.157-179.

Bracey, G. W., (2003). Teachers around the world. *Phi Delta Kappan*, 85(3), pp.253-254.

Braswell,J.S., Lutkus, A.D., Grigg, W.S., Santapau, S.L., Tay-Lim, B., Johnson M (2001). *The Nation's Report Card: Mathematics 2000*. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2001517

Brophy, J, & Good, T.L., (1986). Teacher behavior and student achievement. In M.C. Wittrock (Ed), *Handbook of Research on Teaching*, (3rd ed.). New York: Macmillan.

Clark, C.M. & Peterson, P.L. (1986). Teachers' thought processes. In M.C. Wittrock (Ed), *Handbook of Research on Teaching*, (3rd ed.). New York: Macmillan.

Cockroft, W.H., (1982). *Mathematics counts*. London: Her Majesty's Stationery Office.

Cogan, L.S. & Schmidt, W. H., (1999). An examination of instructional practices in six countries. In G. Kaiser, E. Luna, & I. Huntley (eds). *International Comparisons in Mathematics Education.* London: Falmer Press.

Cooper, H., (1994, Summer). Homework research and policy: A review of literature. *Research/Practice, 2 (2*). Retrieved from http://education.umn.edu/CAREI/Reports/Rpractice/homework.html

Davidson, N. (1985). Small group cooperative learning in mathematics: A selective view of the research. In R. Slavin (Ed.), *Learning to cooperate: Cooperating to learn* (pp.211-30) NY: Plenum.

Doğan, M., (2000). Eğitim fakültelerinde okuyan öğretmen adaylarının matematiğe karşı tutumları. Paper presented at IV. Fen Bilimleri Eğitimi Kongresi. Hacettepe Üniversitesi: Ankara.

Ernest, P., (1988). The impact of beliefs on the teaching of mathematics. Paper presented at ICME VI, Budapest, Hungary.

Europa: The European Union at a Glance. (n.d.). Retrieved October 9, 2005, from http://europa.eu.int/abc/index_en.htm

Eurybase: The information database on education systems in Europe, (2006). Retrieved 3 July, 2006, from Eurydice: The information network on education in Europe Web site: http://oraprod.eurydice.org/portal/page?_pageid=197,161439&_dad=portal&_schema=PORTAL

Foy, P., Joncas, M., (2000). TIMSS Sample Design. In M.O. Martin, K.D. Gregory & S.E. Stemler (eds.) *TIMSS 1999 Technical Report*. Boston College, Lynch School of Education.

Fullarton, S., Lokan, J., Lamb, S. & Ainley, J. (2003). *Lessons from the Third International Mathematics and Science Study*, TIMSS Australia Monograph No. 4. Melbourne: Australian Council for Educational Research.

Garden, R.A., Smith, T.A., (2000). TIMSS Test Development. In M.O. Martin, K.D. Gregory & S.E. Stemler (eds.) *TIMSS 1999 Technical Report*. Boston College, Lynch School of Education.

Gerelman, S. (1987). An observational study of small-group instruction in fourth grade mathematics classrooms. *Elementary School Journal,* 88, 4-28.

Getting started with HLM for windows. (2004). Retrieved December 2, 2005 from The University of Texas at Austin, Information Technologies Services website: http://www.utexas.edu/its/rc/tutorials/stat/hlm/#1.%20Levels

Goldhaber, D.D. & Brewer, D.J., (1997). Evaluating the effect of teacher degree level on educational performance. In W.J. Fowler (ed), *Developments in School Finance, 1996.* Washington DC: National Center for Education Statistics, US Department of Education.

Gonzales, E.J. & Miles, J.A., (2001). *TIMSS 1999:User Guide for the International Database*. Boston College, Lynch School of Education.

Greenwald, R., Hedges, L., and Laine, R. (1996). The effect of school resources on student achievement. *Review of Educational Research,* 66(3), 361-396.

Grouws, D.A., (1991). Improving research in mathematics classroom instruction. In E. Fennema, T.P. Carpenter & S.J. Lamon (eds) *Integrating research on teaching and learning mathematics*. Albany: State University of New York.

Grouws, D. A. & Cebulla, K. J. (2000). Improving Student Achievement in Mathematics. Part 2: Recommendations for the classroom. *ERIC Digest* ERIC Clearinghouse for Science, Mathematics and Environmental Education: Columbus OH. (ED463953)

Hembree, R. and Dessert, D.(1986). Effects Of Hand-Held Calculators In Precollege Mathematics Education: A Meta-Analysis. *Journal For Research In Mathematics Education.* 17(2) , p83-99.

Howie, S. J., (2003). Conditions of schooling in South Africa and the effects on mathematics achievement. *Studies in Educational Evaluation, 29*, pp.227-241.

Indicators on quality of school education, (2006). Retrieved July 3, 2006, from http://europa.eu/scadplus/leg/en/cha/c11063.htm

Kaiser, G., (1999). International comparisons in mathematics education under the perspective of comparative education. In G. Kaiser, E. Luna and I. Huntley (eds). *International Comparisons in Mathematics Education*. London: Falmer Press.

Keeves, J. P., (2001). Comparative research in education: IEA Studies. *International Encyclopedia of the Social and Behavioral Sciences.* In N.J. Smelser and P.B. Baltes (eds.). Oxford: Pergamon Press.

Koehler, M., and Grouws, D.A., (1992). Mathematics teaching practices and their effects. In D.A.Grouws (ed) *Handbook of Research on Mathematics Teaching and Learning.* New York: Macmillan.

Kupari, P., (2003). Instructional practices and teachers' beliefs in Finnish mathematics education. *Studies in Educational Evaluation, 29,* 243-257.

Kyriacou, C., (1997). *Effective Teaching in Schools*. Cheltenhem: Stanley Thornes.

Martin, M.O., Mullis, V.S. & Stemler, S.E., (2000). TIMSS Questionnaire Development. In M.O. Martin, K.D. Gregory & S.E. Stemler (eds.) *TIMSS 1999 Technical Report.* Boston College, Lynch School of Education.

Martin, M.O., Mullis, I.V.S., Gregory, K.D., Hoyle, C and Shen, C., (2000). *Effective schools in science and mathematics: IEA's Third International Mathematics and Science Study*. Boston College, Lynch School of Education.

Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzales, E.J., Kelly, D.L., Smith, T.A., (1997). *Mathematics achievement in primary school years: IEA's Third International Mathematics and Science Study*. Boston College, Center for the Study of Testing, Evaluation and Educational Policy.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: author.

Neville, T., (1988). Preface in *International Encyclopedia of Comparative Education and National Systems of Education.* In T.N. Postlethwaite(ed). Oxford, Pergamon Press.

O'Connor, K. & Stemler, S.E., (2000). Quality control in the TIMSS data collection. In M.O. Martin, K.D. Gregory & S.E. Stemler (eds.) *TIMSS 1999 Technical Report*. Boston College, Lynch School of Education.

Olkun, S. ve Toluk, Z. (2001). *İlköğretim 1-5 sınıfları matematik ders kitaplarının incelenmesi*, Abant İzzet Baysal Üniversitesi'nce düzenlenen X. Eğitim Bilimleri Kongresi'nde sunulmuş bildiri, Bolu.

Özgün Koca, A., (2002). Hizmet öncesi matematik öğretmenlerinin matematiğe karşı tutumları ve matematiğin öğretilmesine ve kendi öğretmen yetiştirme programlarına ilişkin inançları nelerdir?. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 22*.

Philippou, G.N. & Christou, C., (1999). Teachers' conceptions of mathematics and students' achievement: A cross-cultural study based on results from TIMSS. *Studies in Educational Evaluation,* 25, 379-398.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical Linear Models: Applications and Data Analysis Methods, Second Edition.* Newbury Park, CA: Sage.

Raudenbush, S. W.,Bryk T. and Congdon R. (2000). *HLM 5: Hierarchical, Linear and Nonlinear Modeling*, Chicago, IL: Scientific Software International.

Rivkin, S.G., Hanushek, E.A., & Kain, J.F. (2005). Teachers, schools, and academic achievement. *Econometrica*, 73(2), 417-458.

Robitaille, D.F. & Beaton, A.E., (2002). TIMSS: A brief overview of the study. In D.F. Robitaille & A.E. Beaton (eds) *Secondary Analysis of the TIMSS Data*. Dordrecht: Kluwer Academic Publications.

Robitaille, D.F. & Garden, R.A., (1989). *The IEA Study of Mathematics II: Contexts and outcomes of school mathematics*. New York.

Rodriguez, M.C., (2004). The role of classroom assessment in student performance on TIMSS. *Applied Measurement in Education,*17(1),1-24.

Romberg, T.A. & Carpenter, T.P., (1986). Research on teaching and learning mathematics: Two disciplines of scientific inquiry. In M.C. Wittrock (Ed), *Handbook of Research on Teaching*, (3rd ed.). New York: Macmillan.

Rosenshine, B.V. (1980). How time is spent in elementary classrooms. In C. Denham and A. Lieberman, *Time to learn.* Washington, DC: National Institute of Education.

Schmidt, W.H., McKnight, C.C., Cogan, L.S., Jakwerth, P.M., Houang, R.T. (1999). *Facing the Consequences: Using TIMSS for a Closer Look At U.S. Mathematics & Science Education.* Kluwer Academic Publishers.

Simon, M., (1997). Developing new models of mathematics teaching: An imperative for research on mathematics teacher education. In E. Fennema & B.S. Nelson (eds). *Mathematics Teachers in Transition*, pp.55-86.

Slavin, R.E. (1990). Student team learning in mathematics. In N. Davidson (Ed.), *Cooperative learning in math: A handbook for teachers*. Boston: Allyn & Bacon, pp. 69-102.

Steinberg, R., Haymore, J. & Marks, R., (1985). Teachers' knowledge and structuring content in mathematics. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Stemler, S.E. (2001). *Examining School Effectiveness at the Fourth Grade: A Hierarchical Analysis of the Third International Mathematics and Science Study (TIMSS)*. Dissertation Abstracts International, 62 (03A), p. 919.

Thompson, A., (1984). The relationship of teachers' conceptions of mathematics teaching to instructional practice. *Educational Studies in Mathematics, 15*, pp.105-127.

Thompson, A., (1992). Teachers' beliefs and conceptions: A synthesis of the research. *Handbook of research on mathematics teaching and learning*. NCTM: Reston VA.

TÜBA:Türkiye Bilimler Akademisi'nin Program İle İlgili Genel Görüş Ve Önerileri, (2005). Retrieved July 4, 2006, from http://www.tuba.gov.tr/files_tr/haberler/mufredat.doc

Van den Broeck, A., Opdenakker, M.-C., & Van Damme, J. (2005). The effects of student characteristics on mathematics achievement in Flemish TIMSS 1999 data. *Educational Research and Evaluation*, 11(2), 107-121

Wagemaker, H., (2002). TIMSS in context: Assessing, monitoring and moving targets. In D.F. Robitaille & A.E. Beaton (eds) *Secondary Analysis of the TIMSS Data*. Dordrecht: Kluwer Academic Publications.

Wayne, A. J. & Youngs, P., (2003). Teacher characteristics and student achievement gains: A review. *Review of Educational Research, 73* (1), pp.89-122.

Willms, J.D. (1999). Basic Concepts in Hierarchical Linear Modeling with Applications for Policy Analysis, in Gregory J. Cizek (Ed.) *The Handbook of Educational Policy*. San Diego: Academic Press, 473-490.

Wilson, J.W., Fernandez, M.L., Hadaway, N., (n.d). *Mathematical problem solving*. Retrieved July 3, 2006, from The University of Georgia, Department of Mathematics Education Web site: http://jwilson.coe.uga.edu/EMT725/PSsyn/PSsyn.html

APPENDIX A

VARIABLES INCLUDED IN THE STUDY

The variables included in HLM analysis and the explanations about the changes made on these variables are presented.

Level 1 variable

Home Educational Resources (HER)

BSDGHERI Students' reports of home educational resources
HER, which was a derived variable in the database, was taken as a control variable. The index variable was constructed basing on student's responses to the following variables:
1. Number of books in the home
2. Educational aids in the home: computer, study desk/table for own use, dictionary
3. Father's and mother's education
Index variable was assigned to three levels in the database:
High (3) = Have more than 100 books in the hom; Have all three educational aids; and EITHER parents' highest level of education is finished university.
Low (1) = Have 25 or fewer books in the home; Do not have all three educational aids; and BOTH parents' highest level of education is some secondary or less or Don't Know.
Medium(2) = All other combinations.
In this study, HER was recoded as high=1, medium=0 and low = 0

Level 2 variables:

Teacher background variables

Gender

BTBGSEX Teacher's gender

It was recoded as male = 0.

Experience

BTBGTAUG Teacher's experience in years

Level of education

BTBGEDUC Teacher's level of education

It was recoded as MS/Ph.D.= 1, BA or less = 0. Level of education could not be taken into HLM analysis in Lithuania, and the other candidate countries, namely in Romania and Bulgaria due to zero variance of the variable.

Teacher instructional practices

Administrative duties

BTBMACT1 In a typical month of lessons, what percentage of time is spent on administrative tasks?

Homework review

BTBMACT2 In a typical month of lessons, what percentage of time is spent on homework review?

Lecture-style presentation

BTBMACT3 In a typical month of lessons, what percentage of time is spent on lecture-style presentation by the teacher?

Teacher guided practice

BTBMACT4 In a typical month of lessons, what percentage of time is spent on teacher-guided student practice?

Reteaching and clarification of content

BTBMACT5 In a typical month of lessons, what percentage of time is spent on re-teaching and clarification?

Independent practice

BTBMACT6 In a typical month of lessons, what percentage of time is spent on student independent practice?

Tests and quizzes

BTBMACT7 In a typical month of lessons, what percentage of time is spent on tests and quizzes?

Emphasis on problem solving

BTDMERPS Index of teachers' emphasis on mathematics reasoning and problem solving.

It was based on numerically recoded responses to the following questions:
In your mathematics lessons, how often do you usually ask students to do the following?

a) explain reasoning behind an idea;

b) represent and analyze relationships using tables, charts, graphs;

c) work on problems for which there is not immediately obvious method of solution;

e) write equations to represent relationships.

Computed average across the 4 items based on:

1 = never or almost never (option 1);

2 = some lessons (option 2);

3 = most lessons (option 3);

4 = every lesson (option 4).

Index assigned to three levels:

High (3): Average => 3.0;

Medium (2): Average => 2.25 - <3.0;

Low (1): Average < 2.25.

In this study, BTDMERPS was recoded as high = 1, medium = 0 and low = 0.

Emphasis on homework

BTDMEMH Index of teachers' emphasis on mathematics homework

Index of emphasis on mathematics homework based on teachers' responses to the following questions:

i) How often they usually assign mathematics homework;

ii) How many minutes of mathematics homework they usually assign students.

Index assigned to three levels:

High (3):At least once or twice a week ; More than 30 minutes;

Low (1): Never or Less Than Once a Week; Less Than 15 Minutes or 15-30 Minutes;

Medium (2) : all other combinations.

In this study, BTDMEMH was recoded as high = 1, medium = 0 and low = 0.

Use of calculators

BTDMCALC Teachers' reports of students never or hardly ever using calculators in class.

Based on teachers' responses that students 'Never or Hardly Ever Use Calculators" to five questions about different classroom activities:
1 = Yes (ALL of the questions are marked as never or hardly ever);
2 = No (ANY or NONE of the questions are marked as never or hardly ever).
In this study, no was recoded as 0.

Use of textbook

BTBMTXBR What percentage of your teaching time is based on the textbook?

Small group work

BTBMLES6 In mathematics lessons how often do students work in pairs with assistance.

It was recoded as most or every lesson as 1 and never or almost never or some as 0.

Teachers' beliefs about mathematics and mathematics education

Principal component analysis was carried out and two factors were extracted by varimax rotation. These factors were named as process-oriented point of view and discipline-oriented point of view and used in HLM.

Process oriented point of view

BTBMIMP3 To be good in mathematics how important is it to understand mathematical concepts?

BTBMIMP4 To be good in mathematics how important is it to think creatively?
BTBMIMP5 To be good in mathematics how important is it to understand real world use?
BTBMIMP6 To be good in mathematics how important is it to be able to provide reasons to support solutions?
BTBMAGR3 Mathematics is primarily a practical and structured guide for addressing real situations.
BTBMAGR6 More than one representation should be used in teaching a mathematics topic.
BTBMAGR9 A liking for and understanding of students are essential for teaching mathematics.

Discipline oriented point of view

BTBMIMP1 To be good in mathematics how important is it to remember formulas and procedures?
BTBMIMP2 To be good in mathematics how important is it to think in a sequential and procedural manner?
BTBMAGR1 Mathematics is primarily an abstract subject.
BTBMAGR4 If students have difficulty they should be given more practice by themselves.
BTBMAGR5 Some students have a natural talent for mathematics and others do not.
BTBMAGR7 Mathematics should be learned as sets of algorithms that cover all possibilities.
BTBMAGR8 Basic computational skills are sufficient for teaching primary school mathematics.

Class characteristics

Class size

BTDMSIZE Teachers' reports of mathematics class size
Total mathematics class size was computed from sum of boys and girls.

Class climate

The items included for this variable were aggragated from the student questionaire data. They were standardised and summed up. The items are;
BSBMCLS1 In my mathematics class students often neglect their schoolwork. (reverse coded)
BSBMCLS2 In my mathematics class students are orderly and quiet during lessons.
BSBMCLS3 In my mathematics class students do exactly as the teacher says.

Limitations to teaching in class

The items included for this variable were standardised and summed up. The items are;
BTBMLM01 Is your teaching limited by students with different academic abilities?
BTBMLM02 Is your teaching limited by students from a wide range of backgrounds?
BTBMLM03 Is your teaching limited by students with special needs?
BTBMLM04 Is your teaching limited by uninterested students?
BTBMLM05 Is your teaching limited by disruptive students?
BTBMLM06 Is your teaching limited by parents interested in their children's progress?
BTBMLM07 Is your teaching limited by parents uninterested in their children's progress?
BTBMLM08 Is your teaching limited by shortage of computer hardware?
BTBMLM09 Is your teaching limited by shortage of computer software?
BTBMLM10 Is your teaching limited by shortage of other instructional equipment for student use?
BTBMLM11 Is your teaching limited by shortage of equipment for demonstrations?
BTBMLM12 Is your teaching limited by inadequate physical facilities?
BTBMLM13 Is your teaching limited by high student/teacher ratio?
BTBMLM14 Is your teaching limited by low morale among fellow teachers/administrators?

BTBMLM15 Is your teaching limited by low morale among students?
BTBMLM16 Is your teaching limited by threats to personal safety or students' safety?

Mean of HER

Class mean of the home educational resources variable which was taken as the control variable in HLM analysis was analysed at the second level of analysis.

APPENDIX B

HLM MODELS OF EACH COUNTRY

Table A.1. HLM models of Czech Republic

Czech Republic	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Gender	-20.26(12.11)	-20.48(10.12)	-35.67(10.78)	-29.34(9.98)
Years teaching				
Level of education				
Administrative duties			3.32(1.53)	2.47(1.47)
Homework review		3.82(1.70)	3.26(1.66)	
Lecture style				
Guided practice		1.76(1.04)		
Reteaching and clarification of content				
Independent practice		1.97(1.03)		
Tests and quizzes		2.91(1.26)		
Emphasis on prob solving		27.79(13.72)	20.68(12.37)	20.72(9.50)
Emphasis on homework				
Small group work				-36.39(14.83)
Never or hardly use of calculator				
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view		-10.14 (5.08)		-8.82(4.35)
Class size			2.39(0.88)	
Class Climate				
Limitations to teaching			-1.97(0.56)	
Mean of HER				163.63(31.44)

Table A.2 HLM models of Hungary

Hungary	Model 1	Model 2	Model 3	Model 4
Gender		23.90(11.99)	20.85(11.06)	14.03(8.29)
Years teaching				
Level of education				
Administrative duties				
Homework review				
Lecture style				
Guided practice				0.33(0.18)
Reteaching and clarification of content		-1.21(0.65)		
Independent practice				
Tests and quizzes			-1.79(0.80)	-1.13(0.59)
Emphasis on prob solving		30.43(11.42)	36.07(9.69)	30.59(7.76)
Emphasis on homework				
Small group work				
Never or hardly use of calculator				
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size			3.14(0.76)	1.48(0.70)
Class Climate				
Limitations to teaching				
Mean of HER				117.47(17.96)

Table A.3 HLM models of Italy

Italy	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching				
Level of education	30.46(13.01)	46.82(14.36)		
Administrative duties		-4.43(1.85)		
Homework review				
Lecture style				
Guided practice				
Reteaching and clarification of content		-3.21(1.30)	-2.36(1.21)	-2.42(1.27)
Independent practice				
Tests and quizzes				
Emphasis on prob solving		23.33(8.90)	20.16(8.64)	
Emphasis on homework				
Small group work		-22.77(13.33)		
Never or hardly use of calculator				
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size			2.23(0.88)	2.02(0.85)
Class Climate			11.07(2.99)	8.81(3.00)
Limitations to teaching			-1.56(0.51)	-1.34(0.50)
Mean of HER				72.17(27.31)

Table A.4 HLM models of Lithuania

Lithuania	Model 1	Model 2	Model 3	Model 4
Gender	22.00(12.37)			
Years teaching				
Administrative duties				
Homework review				
Lecture style				
Guided practice				-0.74(0.30)
Reteaching and clarification of content				
Independent practice			0.73(0.43)	
Tests and quizzes			-1.56(0.73)	-1.24(0.66)
Emphasis on prob solving		33.75(13.04)		
Emphasis on homework		26.38(10.41)	25.30(8.77)	17.05(7.64)
Small group work				
Never or hardly use of calculator				
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size			3.87(0.68)	2.64(0.57)
Class Climate				
Limitations to teaching			-1.24(0.58)	
Mean of HER				118.30(23.35)

Table A.5 HLM models of Netherlands

Netherlands	Model 1	Model 2	Model 3	Model 4
Gender	40.24(21.47)		24.83(13.90)	27.27(14.18)
Years teaching			1.47(0.71)	1.65(0.75)
Level of education				
Administrative duties		-7.15(2.51)	-3.00(1.60)	-2.98(1.43)
Homework review		-4.50(1.37)	-3.44(1.04)	-3.46(0.93)
Lecture style		-2.39(2.01)	-3.00(1.64)	-3.76(1.49)
Guided practice				
Reteaching and clarification of content		-3.09(1.46)	-2.74(1.18)	-3.33(1.05)
Independent practice		-3.62(1.48)	-2.47(1.21)	-2.95(1.14)
Tests and quizzes		-8.14(2.99)	-4.06(1.77)	-4.87(1.85)
Emphasis on prob solving				
Emphasis on homework		48.67(22.85)		
Small group work				
Never or hardly use of calculator			50.16(29.05)	64.71(29.34)
Textbook based teaching		45.51(22.20)		
Discipline oriented point of view				
Process oriented point of view		-17.73(9.83)		
Class size			5.72(1.16)	4.79(1.30)
Class Climate			15.50(5.74)	
Limitations to teaching			-2.78(0.93)	-2.41(0.84)
Mean of HER				165.76(46.22)

Table A.6 HLM models of Slovak Republic

Slovak Republic	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Gender	17.31(9.87)			
Years teaching			0.79(0.36)	0.66(0.34)
Level of education		-31.63(14.42)	-34.88(19.42)	-39.08(19.89)
Administrative duties				
Homework review		2.36(1.15)		
Lecture style				
Guided practice		1.07(0.58)		
Reteaching and clarification of content		-1.32(0.58)	-1.77(0.63)	-1.83(0.60)
Independent practice				
Tests and quizzes				
Emphasis on prob solving				
Emphasis on homework			37.70(16.90)	35.20(15.45)
Small group work		-23.72(10.67)	-25.18(11.42)	-24.77(12.57)
Never or hardly use of calculator		41.54(12.37)	45.24(11.61)	45.73(11.56)
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size			2.09(1.23)	
Class Climate			7.72(2.59)	5.85(2.57)
Limitations to teaching			-1.10(0.55)	
Mean of HER				86.31(38.17)

Table A.7 HLM models of Belgium (Flemish)

Belgium (Flemish)	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching				
Level of education	-49.09(16.52)	-35.57(19.25)		
Administrative duties		-2.83(1.14)	-2.69 (0.92)	-1.91(0.94)
Homework review		2.19(0.95)		
Lecture style		1.13(0.42)	1.02 (0.35)	0.87(0.34)
Guided practice		1.69(0.39)	1.23(0.31)	0.73(0.33)
Reteaching and clarification of content				
Independent practice		2.04 (0.54)	1.84(0.41)	1.48(0.44)
Tests and quizzes				
Emphasis on prob solving				
Emphasis on homework		25.44(9.44)	27.82(10.12)	19.35(9.22)
Small group work				
Never or hardly use of calculator		-52.06(27.07)		-36.71(17.34)
Textbook based teaching		-17.62(9.96)		
Discipline oriented point of view		11.11(6.43)	12.03(5.59)	
Process oriented point of view				5.89(3.55)
Class size			4.37(0.99)	3.17(1.10)
Class Climate				
Limitations to teaching			-2.73(0.52)	-2.36(0.53)
Mean of HER				99.34(25.20)

Table A.8 HLM models of Slovenia

Slovenia	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching	-0.80(0.39)	-0.83(0.41)	-0.96(0.39)	-0.79(0.38)
Level of education				
Administrative duties			0.71(0.43)	
Homework review				
Lecture style				
Guided practice				
Reteaching and clarification of content			0.96(0.55)	
Independent practice				
Tests and quizzes				
Emphasis on prob solving		16.57(7.89)	22.82(7.44)	26.25(7.05)
Emphasis on homework				
Small group work				
Never or hardly use of calculator				
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size				
Class Climate			4.85(2.44)	
Limitations to teaching			-0.95(0.34)	-0.92(0.35)
Mean of HER				90.53(22.40)

Table A.9 HLM models of Bulgaria

Bulgaria	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching				
Administrative duties				
Homework review				
Lecture style				
Guided practice				
Reteaching and clarification of content				
Independent practice		3.96(1.78)	4.15(1.81)	3.47(1.53)
Tests and quizzes				
Emphasis on prob solving				
Emphasis on homework				
Small group work				
Never or hardly use of calculator		-40.92(10.91)	-41.45(10.70)	-32.77(10.23)
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view				
Class size				
Class Climate				
Limitations to teaching				
Mean of HER				139.42(30.76)

Table A.10 HLM models of Romania

Romania	Model 1	Model 2	Model 3	Model 4
Gender				
Years teaching				
Administrative duties				
Homework review				
Lecture style				
Guided practice				
Reteaching and clarification of content				
Independent actice				
Tests and quizzes				
Emphasis on prob solving		-23.79(12.41)	-23.87(12.46)	-22.02(11.71)
Emphasis on homework				
Small group work				
Never or hardly use of calculator		-29.91(11.09)	-29.45(12.61)	-23.01(12.51)
Textbook based teaching				
Discipline oriented point of view				
Process oriented point of view		11.69(6.30)	11.87(6.29)	
Class size				
Class Climate				
Limitations to teaching				
Mean of HER				

APPENDIX C

COUNTRY DESCRIPTIONS

The following country descriptions are taken directly from website of Eurybase, which is information database on education systems in Europe, for the age level included in this study.

Turkey

Primary education in Turkey is compulsory for children of ages 6 - 14. The compulsory education in Turkey is executed in primary education schools. The primary education schools offer coeducation. The number of pupils per teacher in primary education schools, including the unified classes cannot exceed 40. The number of pupils per teacher in 2004 - 2005 academic year was determined to be 26.4.

The education in primary education institutions aims to provide the pupils with fundamental knowledge and skills and implements pupil-oriented education for ensuring the pupils develop as creative, critical thinking individuals learning to learn and in turn, grow as individuals able to solve problems encountered. In an constructivist approach, contemporary education methods, techniques and strategies such as active learning, individualized teaching, group learning, etc. are employed in the course of lessons (New Primary Education Curriculum Introduction Guidebook)

The methods of teaching in primary education institutions are determined by teachers. Every teacher is responsible from making necessary preliminary studies based on the curriculums related with their course. Teachers teaching in primary education institutions implement the plans prepared on the basis of curriculums.

Teachers are allowed to employ visual tools such as video, slide, tape - radio, overhead projector, television etc. Most of the schools must be fitted with internet and information technology tools for the use of teachers and pupils. For this purpose, the studies on establishment of information technology classrooms are intensified within recent years.

The function of researching and developing all educational tools and devices in Turkey and drafting or procurement of textbooks and auxiliary textbooks according to the curriculum is assigned to Department of Turkish Board of Education

Upon renovation of the primary education curriculums, the textbooks are also subjected to an innovation process. In this context; the textbooks are designed and drafted with an innovative insight in accordance with the content of the new curriculum and more contemporary textbooks are produced. Under this scope; as a major innovation, the education materials are produced in triple sets (Textbook, Teacher's Guidebook, and Pupil Workbook). In addition, Ministry of National Education distributed all textbooks of primary education as gratis in last three years.

European Union Countries

Belgium (Flemish)

Theoretically, class composition is linked with age grouping: the year-class system. Because of school failures and repeats, the classes sometimes become heterogeneous. Each subject is taught by a specialised teacher. The teacher's teaching qualification depends on his/her competence certificate: the teacher may teach all subjects for which he/she owns an adequate competence certificate.

Teachers teach in different school years and children are taught by different teachers.

The decision on teaching methods and teaching aids belongs to the freedom of the organising bodies. Consequently, there are no official guidelines. In general, it can be stated that teaching is subject-oriented. Schools within accredited and grant-aided education are inspired by the ideas and methods of Steiner, Freinet, Montessori and other important figures of educational history. There are no official guidelines concerning duration and amount of homework. The Flemish Community delegates this responsibility to its school boards and teachers.

Cyprus

Pupils attend a common programme of studies at the Gymnasium with no differentiation. The age of pupils ranges between 12 and 15, except for instance when the pupil is obliged to repeat a year. Classes are heterogeneous concerning level, with a maximum of 30 pupils in each class.

At the beginning of the school year special directions are sent or given to teachers in special seminars by the Inspectorate about the goals of the subjects they teach, together with general and particular methodological teaching instructions.

An essential principle that has been adopted by the Cyprus education system is the teaching to mixed ability classes. Teachers are responsible for assessing the abilities of their pupils and modifying their teaching accordingly. They must take into account that they have to do with mixed ability classes, giving each pupil the opportunity to develop. All methods in modern pedagogy are applied according to the subject and a variety of teaching materials and technological aids are used. Group activities are encouraged.

Czech Republic

Pupils are grouped into classes by age. Number of pupils in one class is maximum 30. The regular classes can be divided into groups for teaching of practical skills. (languages, practical and laboratory work, part of lessons of mathematics).

A specialised teacher teaches the subject. Regarding proposals or recommendations articulated in the educational programme, it is up to the teacher to choose methods. A part of the educational programme Národní škola is a catalogue of forms and methods that comprises and permanently extends the didactics useful for implementation of the programme.

Different educational technologies (television, video) are in common use and under the project Internet to schools the information technology are used more and more often.

As for theoretical teaching, classic teaching methods (teacher lecturing in the classroom) prevail. The practical part of instruction includes practical exercises and work in laboratories, which is usually a part of subjects. During such exercises the class is divided into groups. There are no regulations for pupils' homeworks.

Teachers at the second stage are educated in faculties of education in four to five-year Master′s studies. Teachers of general subjects at upper secondary schools can also gain their qualification at faculties of philosophy, of natural sciences, mathematics and physics, or at faculties of physical education and sports. The studies at these faculties can be both concurrent and consecutive, and are usually 5 years in duration.

Hungary

Primary education/teaching in the Hungarian education system is ensured by the single structure arrangement. It begins in the first form of the ["általános iskola"], and lasts until the end of the eighth form. That phase is divided in two parts: one begins in the first form, and last until the end of the fourth, and the second from the fifth form, and lasts until the end of the eighth form. The objective in both phases is to teach the essentials of general culture, to provide a basis for later studies, and to facilitate the choice of career. Uniformity of content and cross-over options among schools is ensured by the National Core Curriculum.

From grade 5 onward education is allocated in more specialised subjects, which means that the individual subjects are taught by different teachers with the specific qualification required by that subject. The Act on Public education provides maximum and recommended class sizes and group sizes. The more important is the maximum number as that may only be exceeded under restricted statutory conditions. Class sizes over the maximum may be authorized – in cases regulated by legislation – by the head of institution, the maintainer or the National Public Education Evaluation and Examination Centre. Offending institutions may be fined.

Teaching is conducted in lessons of 45 minutes spent on one subject. Integrated or cross-curricular structuring of the teaching material happens only rarely. Teachers enjoy total methodological freedom concerning the achievement of the educational and teaching objectives. Most do not subscribe to any one methodology, but employ a set of methods. Research tends to prove, however, that the methodological repertoire of teachers is rather limited. Teachers following traditional methods do chiefly frontal classwork, their lessons are predominantly a period of transferring new knowledge, and the explanation is complemented by traditional and more modern demonstration tools. Hungarian teachers attach major significance to homework, regular testing, thus the lessons will invariably have a part when pupils are tested orally and/or in a written form.

Small group sessions are becoming increasingly popular under the influence of alternative pedagogical principles. Classes are frequently divided into two-three groups for foreign language, technology, IT, or maths lessons. In such cases there are two teachers working with the pupils simultaneously but in different rooms. In some schools there is a slot in the daily timetable when they bring together children from each class of the various grades with identical levels of proficiency in – typically – mathematics, and foreign language. Teachers apply the method of groupwork even in full classes. The aspects of splitting a class into groups varies according to the pedagogical aim to be achieved: sometimes children similarly motivated and at identical rates of progress are brought together in groups, while on other occasions group compositions may be entirely heterogeneous. The simple re-production of the teaching material is gradually replaced by methods aiming at increased activity of pupils, focussing on action, preferring creativity. In some classes, primarily at private schools teaching takes place almost exclusively in individual and cooperative groups, substituting the rigid separation of subjects by integrated subjects, and project-work, processing the teaching material in an epochal framework. The most widespread schools in Hungary are Waldorf-Steiner ones, but Freinet Gordon, Rogers and Montessori methods are also popular. Computers at school are used almost exclusively in IT teaching. The main obstacle in using them in the other subjects is the relatively low number of computers, and shortage of good quality multimedia teaching programmes, compounded by deficient skills of part of the teaching staff. The Ministry of Education started a grand scale content development programme titled "Schoolnet Digital Knowledge Base" using EU funds in 2003/4. A considerable part of this programme is focused on the improvement of digital teaching aids in grades 5-8 of ["általános iskola"]. Teachers are free to choose the textbooks, workbooks, maps, audiovisual aids in line with the principles laid down in the local curriculum. The Minister of Education publishes annually the updated list of textbooks of public education, where only quality controlled (approved) books not exceeding a certain price are listed year on year. The quality control process concentrates on whether the particular book is capable of transferring the teaching content of the given subject to the intended age group with the help of the appropriate methods in accordance with the requirements of the National Core Curriculum . Books are evaluated from the point of view of scientific accuracy, objectivity, style, language, compliance with standards of reading hygiene, and technical appropriateness. The process includes the investigation of how useful the book proves to be in practice from the point of view of teaching and learning. When the evaluation/investigation is complete, a special committee, the Committee of Textbooks and Teaching Accessories, which is a subdivision of the most prestigious body or experts of Hungarian public education, the National Council of Public Education, make a proposal to the minister on approving or refusing the textbook.

Italy

Lower secondary education lasts 3 years and is subdivided into a two-year period and a third year aimed at consolidating the disciplinary path and strengthening guidance and connection with the secondo ciclo in order to permit a reasoned choice by pupils as regards their study prosecution. Lower secondary ducation (The scuola secondaria di I grado) can now be attended by pupils aged 10 years onwards. Normally every class should have not more than 25 (20 if there are students with disabilities) and not less than 15 students, with the exception of mountains villages, little islands, areas at the risk of juvenile delinquency, geographic areas inhabited by linguistic minorities. These are, however, approximative numbers which can be overlooked in order to respect the limit of the budget established by the regional school office.

Legislative Decree 59/2004 foresees that teachers work in the same class for at least the two-year period, in order to foster teaching continuity and the quality of pupils' learning processes. It will be necessary to change the teachers' legal status to make this rule effective; this will imply a union negotiation.

The obiettivi specifici di apprendimento aim at indicating clearly in the details the basic performance levels that public schools should ensure to the citizens to keep the unity of the national education system and to prevent breaking up and polarization; furthermore, it aims, above all, at allowing pupils to mature in all the dimensions outlined in the Profilo educativo culturale e professionale foreseen at the end of the primo ciclo Teachers and the single schools, on the basis of their history and the reality of the territory, are responsible to mediate, interpret, organise and distribute the obiettivi specifici di apprendimento within the formative objectives, in the contents, methods, learning units assessment, taking into consideration, on the one hand, the general abilities of each pupil and, on the other hand, the teaching practices more suitable to transform these abilities into personal competencies. However, at the same time, each school and its teachers are responsible to account for their choices and to inform pupils, their families and the territory about them.

Netherlands

There are no detailed regulations with regard to the curriculum (content, teaching methods and materials), although the attainment targets for basic secondary education covering the period from 1998 to 2003 do, however, stress the importance of information and communication technology (ICT). Schools select their own textbooks and course materials. The school plan must describe the subject matter covered and the teaching methods used. The leaving examination regulations provide guidance as to the content of the various curricula. The National Teaching Materials Information Centre (NICL) produces a guide to teaching materials which schools can use to compare existing and new products.

The organisation of teacher training courses is regulated in the teaching and examination regulations of the HBO institution or university concerned. Only the principles, structure and procedures underlying the teaching and examination regulations are prescribed by law. There are no statutory requirements relating to curriculum content. In the case of HBO courses there is a common curriculum that is used by many of the institutions. It is not however compulsory by law. The government does not lay down regulations concerning the organisation of teaching. The standards of competence for teachers which are shortly to be introduced will of course influence curriculum content.

HBO teacher training courses are in general subjects, arts subjects, technical subjects and agricultural subjects. Since 1990, students qualify to teach one subject rather than two, as was previously the case. The courses cover both subject training and aspects of teaching in general, including: teaching methods, teaching practice, command of language, communication and educational theory. Teaching practice is an important component of every course. Courses leading to a grade two qualification, both full-time and part-time, have a study load of 240 ECTS credits under the bachelor-master system. Courses consist of a propaedeutic part (60 ECTS credits) and the main part (180 ECTS credits). Qualified teachers with a bachelor's degree may then carry on studying for a grade one qualification in the same subject. These courses have a study load of 120 ECTS credits. Courses in technical and agricultural subjects lead to a grade two qualification only. The study load for both full-time and part-time courses is 240 ECTS credits.

University-based teacher training courses lead to a grade one qualification in one subject, sometimes with an extra qualification to teach a subject like general science or culture and the arts. Courses have a study load of 60 ECTS credits (equivalent to one year of full-time study or two years of part-time study). As a rule, half the course consists of teaching practice while the rest is devoted to theory (teaching methods). On 1 May 1998 the government and the Association of Dutch Universities (VSNU) concluded a covenant, the aim of which is to attract more students into the teaching profession by offering more options within teacher training. A number of new variants are now offered alongside the existing postgraduate teacher training course, including a dual training course combining working and learning, teacher training options at undergraduate level and tailored courses. The 1998 covenant on exact sciences stated that all new-look science degrees would include a teacher training option to be incorporated, as far as possible, in the regular five-year undergraduate course. These will remain under the bachelor-master system.

Lithuania

In grades 5-10, pupils from the age of 10/11 to 16/17 are taught. Remedial classes are established for pupils that have learning or interpersonal difficulties. In the remedial classes, maximum number of pupils per class is 16 learners. The minimum number of pupils per class or group providing additional education is determined by the founder.

In pursuing general education goals, every teacher is free to select what she or he deems adequate educational methods, combine several of them and create their individual style of instruction. Specific education methods should reflect the actual situation: the needs and abilities of pupils; skills and faculties of each individual teacher as well as the changing socio-cultural context. The teacher has a right to propose his/her individual programmes and choose various ways and forms of pedagogical activities. The General Curriculum Framework and Education Standards provide favourable conditions for teachers' individual engagement in the development of the curriculum content by tailoring it to the individual needs and aptitudes of their learners, aligning the curriculum content with the school's objectives and also the teacher's experience and resources available. Teachers apply such teaching methods which encourage pupils' activity and independence, stimulate critical, creative and constructive thinking, foster problem solving abilities, situational awareness and responsibility for their actions. Project development method is a good means of integrating formal and non-formal educational content. In teaching, teachers apply new computer and information technologies. The educational process is based on interpretative rather than reproductive methods.

Schools apply differentiated and individualised teaching methods. Teachers adjust their teaching practices according to the individual character of a pupil or a mobile group they are working with. Individual teaching methods are designed for the best and worst performing pupils. Teachers apply non-traditional methods and a wide variety of them. Lessons can be given not only in the classroom or school, but also out-of-doors, in libraries, museums or exhibition halls.

Youth school teachers apply individual forms, methods, ways and content in their teaching as well as innovative teaching (learning) technologies, which serve to restore and stimulate motivation in their pupils. The main methods are teaching practices that seek to turn pupils into active, life-long learners, stimulate their involvement and initiative in the learning process. One of the practices is organisation of long-term integrated projects. Teachers apply interpretative, communicative, integrated, cooperative, learning to learn methods, which encourage abstract and conceptual thinking and independent work. Gymnasium teachers choose teaching methods which are focused on problem solving level, independent learning, theoretical thinking skills and research principles, the use of a wide variety of resources, IT literacy and original, non-standard tasks. On recommendations from expert panels, the Ministry of Education and Science prepares a list of currently used textbooks and that list can be upgraded every three months. The list includes only approved textbooks and parts of their sets that were published in Lithuania and also those foreign-published textbooks and parts of their sets that have been recommended by the expert panels. The founder of the school or its authorised institution establishes the procedure for provision of schools under its control with textbooks or parts of their sets, teaching materials and reference literature for all general education school subjects and sends it to the Ministry's Education Resource Centre.

Colleges train teachers of modern languages, music, art, technologies, dancing, Catholicism and religion for basic and secondary schools of general education. Most of the study programmes offered provide a combination of two specialities, e.g. English-German, art-technologies, etc. The duration of training is 3-4 years in full-time (daytime) studies and 4-5 years in extramural (distance) studies. Upon completion of the programme in a certain study field at university basic studies, graduates may work as subject specialists in general education and special schools or lecturers in colleges, advanced vocational schools and higher educational institutions as well as continue studies for Master's degree by following didactic or educational programmes.

Slovak Republic

The instruction of subjects is conducted by teachers with the required qualification. The teachers have, as a rule, the certification to teach two subjects. The class-teacher, who is appointed by the headmaster, coordinates teaching in the classroom. The class-teacher along with other teachers monitors pupils' achievements, helps him solve problems, keeps the class documentation. He uses the gathered information about the pupil for preparation of his records applied at transition to secondary school. The class-teacher controls hygienic conditions of instruction and work load of pupils, especially the volume of homework, and pays adequate attention to the impaired and those with chronic diseases. He closely co-operates with the pupils' parents, the paediatrician and psychologist. In the absence of the class-teacher his work is taken over by another teacher appointed by the headmaster. The highest number of pupils per class in the second stage of is 34.

In the Slovak Republic, the methods dynamizing the content of learning and teaching, accelerating the pupil's and teacher's activities, and influencing the processual aspect of pupil - teacher relationships are used. Both traditional and non-traditional techniques are used in the teaching process. Teachers use various combinations of teaching methods. Each of the teaching method is applied depending on the aim of the lesson, the content of subject matter, and age peculiarities, etc. From among common, traditional methods including oral, object-demonstrative, practical, productive, motivational, exposition, fixation, diagnostic and application methods are used. Recently, the following techniques have been much used in schools: co-operative learning, group work, work at the round table, brainstorming, face-to-face work and jigsaw groups. The use of non-traditional, special methods (e.g., Freneit's, Piaget's model) is being experimentally verified under the projects approved by the Ministry of Education. The object of experimental verification are especially alternative education programmes, the concept of working with the gifted, etc. The elements of Waldorf pedagogy, the system of M. Montessori, and the integrated thematic teaching of S. Kovalik and K. Olsen are verified. The verified alternative education programmes are regularly evaluated from the point of view of relationship of the pupil and school, adaptation of the pupil at his transition to another school, motivation of pupils, social climate in the classroom, and other aspects which have an effect on the teaching process in these classes.

Faculties of education provide training for teachers and educators of secondary schools. The length of study is six semesters (instructor of practical training), it is the first level of higher education study – to be completed by bachelor examinations. Further, it is eight semesters (teacher training for the first level, preschool pedagogy, teacher training with one subject specialization) or ten semesters (teacher training with two-subject specialization, teacher training for the first stage of primary schools, in combination preschool pedagogy and in combination teacher training for special schools and teacher training for vocational subjects).

In the subject and pedagogical practice of teachers the training teacher plays a principal role. He is the main feedback adviser of the practising student. Quality of his consultations is an important impulse at practical, personality and professional profile of the future teacher.

In addition, the teachers and educational staff are trained in other higher education institutions and universities, e.g., faculties of arts, faculties of the humanities and natural sciences, faculties of mathematics and physics, faculties of physical education and sports, etc. These faculties usually train teachers for secondary schools.

Slovenia

Pupils of the same cohort attend the same grade. The eight-year elementary school is not formally divided into levels. In practice, however, it consists of the class level, including grades 1 to 4 and subject level, grades 5 to 8. This division concerns primarily the organisation of teaching. In grades 1 to 4, all subjects are taught by a single teacher. These teachers could be called *class teachers*. They are qualified to teach all subjects of the curriculum and also carry out the duties of the home class teacher, responsible for the class. From the fifth grade, specialised teachers teach individual subjects. They are qualified to teach either one or two subjects. A home-class teacher who is responsible for the class is assigned to each class. Home-class teacher stay with the same class for several years, preferably all the time from the fifth to eighth grade.

In Slovene elementary schools, teaching is structured by disciplines. Various forms of cross-curricular teaching can be found in practice. One of such forms at the class level is integrated learning. Project work is also gaining in importance. It is offered at both levels. Cross-curricular teaching is typical for activity days organised by schools in all grades as part of the compulsory programme. In addition to traditional teaching methods, work is carried out in small groups and in pairs. In the past ten years, new teaching models have been implemented and evaluated within the framework of numerous projects. The SOROS programme is quite common, and some schools use the Wambach method. Elementary schools are fairly well equipped with modern teaching technology. The Ministry of Education, Science and Sport has systematically invested in the development of computer supported learning in recent years. There is practically no elementary school without a computer classroom. Many have installed small computer laboratories in school libraries and multimedia equipment in at least one classroom.

Academic four-year study programmes for subject teachers of two subjects are offered either by the faculties of education or jointly through co-operation between the Faculty of Education and other faculties, or by multidisciplinary faculties (such as the Faculty of Arts). The study programmes in the faculties of education are based on the concurrent model of teacher training. Educational science, psychology and subject-specific didactics are offered throughout the study period, with emphasis in the second half of the studies, while the continuous practical course lasts just 14 aggregated days. The teacher training programmes offered by the multidisciplinary faculties consist primarily of one or two disciplines, few professional courses offered in parallel to the study of academic disciplines, and the two-week practical course. Practical experience is mostly acquired by the future teacher during their traineeship period. Teaching qualifications can also be obtained through a supplementary post-graduate teacher-training course. Such a course is offered by the Faculty of Arts and by both Faculties of Education. In recent years, a few more supplementary courses have been introduced: courses for new teaching subjects, upgrading training courses for the reception teachers in nine-year elementary school, courses for the early learning of foreign languages, etc.

Bulgaria

Basic education has two levels: primary stage – from I to IV grade and pre-secondary stage – from V to VIII grade. school education starts at the age of 7 years completed in the year of enrolling in first grade. The primary stage includes pupils from 7 to 11 years of age, and the pre-secondary stage – from 11 to 15 years. At lower-secondary stage each subject is taught by a separate teacher, who teaches several classes of pupils of V through VIII grade. Pupils of the same age belong to the same class. The number of pupils in one class can be between 16 to 22 from I to IV grade and 18-26 from V to VIII grade. In the state and municipal schools 5 pupils can form a separate class for children with chronic disease and/or special educational needs.

Various teaching methods and techniques and academic activities are employed in the process of education in the basic schools. In basic education, teaching is done by combining the traditional methods: narrative, explanation, demonstration, interaction, etc. with the contemporary ones: research, dialogue, conting on pupils' participation through presentations, reports, essays. Seminar lessons with brainstorming, binary lessons, etc are held. Small group activities are organised and an emphasis is laid on the independent creation of products according to the specific subject that is taught (essays, projects, models etc.)

From 2002/2003 new textbooks were introduced along with the new curriculum. They were commissioned on the principle of competuition. Several types of textbooks were offered from which teachers could choose. The teaching community reacted neqivocally to these new ideas. The debate about the textbooks continues with the prospect of creating really up to date instruction books with good design for basic education. In the system of national education can be used only textbooks and teaching aids that have been approved by the Ministry of Education and Science. More than one textbook can be approved for one and the same subject for each grade. Every teacher and every school can choose one of the textbooks approved. The basic criterion for approving a textbook is its compliance with the curricula of the studied subjects and with the State education requirements, which guarantees that in spite of the variety of offered textbooks, the common requirements are met.

If the necessary technical basis is available, audio-visual means and various visual materials are used in teaching. After 1989 the overall review of goals, study content, strategies and technology of education began. Modern methods of education point to a new type of pedagogical influence in which the child takes an active position, he/she is motivated to learn, has a creative contribution and readiness to transfer what has been learned in real life situations.

The training for acquiring the professional qualification of a teacher is both theoretical and practical. The theoretical education of teachers consists of compulsory, optional and extra subjects. Current pedagogic practice consists of visits to schools, observation of lessons and other forms of education in preparation for the pre-graduate pedagogic practice; Pre-graduation pedagogic practice consists of personal participation in the educational instructive process, the supervision of a teacher and a professor from the high school. Students must deliver personally between 10 and 22 lessons during the practice. Various methods are applied in the course of training students for acquiring the professional qualification of teacher. during the theoretical courses, mainly lectures and dialogues are used as educational methods as well as various methods of self-training: analysis of literature sources, document research, development of topics and projects, etc. During the practical courses, observation and analysis of lessons, the supervision of a professor, are used, aiming at obtaining knowledge on the good pedagogic practices and on the process of running the lesson; during the pre-graduation pedagogic practice, students participate on their own in the education process, the supervision of a school teacher.

Romania

The classes are in general homogenous regarding the age of the pupils. The gimnaziu is organised for pupils aged 10(11)-14(15) and includes grades from V to VIII. The number of pupils per class depends on the educational level and is established by the Education Law. In Gimnaziu (grades V to VIII) – in average 25 pupils per class, but no less than 10 and no more than 30.

The teaching methods applied in secondary and post-secondary non-tertiary education are carefully chosen so as to meet the finalities and the educational objectives set for the educational levels. General Objectives and, most of all, the pupils' age and individual particularities. The teacher is fully responsible for choosing the methods, taking the structure of the class into consideration, the teaching aids available in the school and following the methodological guidelines provided by the National Curriculum and the teachers' guides for each subject.

During secondary and post-secondary non-tertiary education each subject is taught by a different teacher. According to the "principle of continuity", usually the same teacher works with a given class throughout all the grades during which the respective subject is studied within a given educational cycle/level. During a given lesson, the class management is entirely the responsibility of the teacher. In consequence, teachers can decide per se to organise the activities with all the pupils (frontal activities), in smaller groups or individually (differentiated activities) – depending on the specific objectives of the lesson and the level of the pupils. The oral communication methods utilized can be classified as expository methods (description, explanation, etc.) and conversational methods (conversation, heuristic conversation, questioning on a special subject, etc.). Teachers also use exploratory learning methods: direct exploration of objects and phenomena (systematic and independent observation, experiments, practical work, etc.) and indirect exploration (problem solving, demonstration through pictures, films, etc.). For teaching most subjects, teachers use extensively methods based on the pupils' direct voluntary action (exercises, practical work, etc.) and simulated action (didactic games, learning through dramatisation, etc.). At the end of each lesson teachers usually assign the homework for the next class – foreseeing both further understanding of the knowledge acquired and exercise of the competences developed. The homework consists of exercises, activities, etc. chosen either from the textbooks or from other printed teaching aids (pupils' textbooks, texts anthologies, problems and exercises collections, etc.). In some cases, pupils are also requested to perform as their homework specific practical activities – like measurements, observations, small practical projects, etc. At the beginning of each lesson teachers usually check with the pupils the homework and, as the case may be, help them in accomplishing it, giving supplementary explanations. As a general rule, the Ministry of Education and Research recommends that time dedicated for homework should take into consideration the need of the youngsters to socialise and perform sports and other leisure activities. The Education Law also stipulates that teachers are allowed to use only textbooks and printed teaching aids that are approved by the Ministry of Education and Research. For most subjects taught during secondary education there are three or more alternative textbooks approved by the Ministry of Education and Research for each grade. According to the level of pupils, each teacher decides and recommend at the beginning of the school year the textbooks to be used for each subject. The teaching aids used in secondary and post-secondary non-tertiary education depend on the educational level and subject and may consist of various natural materials (plants, insects, rocks, etc.), technical objects (measurement instruments, equipments, home appliances, etc.), intuitive materials (various models), figurative aids (pictures, photographs, atlas books, maps, albums, audio-video images, software, etc.) and printed teaching aids (pupils' textbooks, texts anthologies, problems and exercises collections, etc.). Printed teaching aids can be acquired by the schools' libraries or recommended by the teacher and acquired by the pupils. Teaching through ICT has gain an important momentum with the implementation of the *e*Learning initiative. Nevertheless, further development of the infrastructure and in-service training for the teachers are required.

Regarding the auxiliary publications for the teachers, most of the textbooks, especially those published lately, are supplemented by a teacher's book – offering teaching-learning activities examples and broad explanations on the methods to be used so as to cover the educational objectives of the syllabus. By the care of the Ministry of Education and Research, the National Council for Curriculum, Universities' pedagogical departments, professional associations of the teachers and other bodies an important number of publications have been also made available for supporting teaching activities: general or specific teacher-training publications, methodological guides for specific subjects, textbooks for teachers, etc.

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Akyüz, Gözde
Nationality: Turkish (TC)
Date and Place of Birth: 22 March 1976, Balıkesir
Marital Status: Married
Phone: +90 266 239 34 27
Fax: +90 266 241 09 64
email: akyuzgozde@gmail.com

EDUCATION

Degree	**Institution**	**Year of Graduation**
MS	Balıkesir University Mathematics Education	2001
BS	METU Mathematics Education	1999
High School	Zühtü Özkardaşlar Lisesi, Balıkesir	1992

WORK EXPERIENCE

Year	**Place**	**Enrollment**
2003- Present	Kız Meslek Lisesi, Balıkesir	Mathematics Teacher
2001-2003	METU Department of Secondary Science and Mathematics Education	Research Assistant
2000-2001	Balıkesir University	Research Assistant
1999-2000	Balıkesir Özel Altuğ Yurdakuloğlu Lisesi	Mathematics Teacher

FOREIGN LANGUAGES

English

PUBLICATIONS

1. Çömlekoğlu, G., (2001). *Öğretmen adaylarının problem çözme becerilerine hesap makinesinin etkisi.* Yüksek Lisans Tezi. Fen Bilimleri Enstitüsü, Balıkesir Üniversitesi.

2. Çömlekoğlu, G., Gür, H., (2001). Ortaöğretim matematik eğitiminde VEE diyagramlarının değerlendirme aracı olarak kullanımı. *X. Ulusal Eğitim Bilimleri Kongresi.* Abant İzzet Baysal Üniversitesi, Bolu.

3. Gür, H., Çömlekoğlu, G., Ersoy, Y., (2002). Teknoloji destekli matematik etkinlikleri: Öğretmen ve öğretmen adaylarının görüşleri. *Matematik Sempozyumu 2001 Bildiriler Kitabı.* MEB: Ankara.

4. Yıldırım, H.H., Çömlekoğlu, G., Berberoğlu, G., (2003). Milli Eğitim Bakanlığı Özel Okullar Sınavı verilerinin madde tepki kuramı modellerine uyumu. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 24.