# A CROSS-CULTURAL COMPARISON AND MODELING OF INFORMATION AND COMMUNICATION TECHNOLOGIES ASPECTS AFFECTING MATHEMATICAL AND PROBLEM SOLVING LITERACY AND PERCEPTIONS OF POLICY MAKERS

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**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.**

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# ABSTRACT

A CROSS-CULTURAL COMPARISON AND MODELING OF INFORMATION AND COMMUNICATION TECHNOLOGIES ASPECTS AFFECTING MATHEMATICAL AND PROBLEM SOLVING LITERACY AND PERCEPTIONS OF POLICY MAKERS

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The purpose of this study was to compare Turkey and the European Union (EU) regarding aspects (use, self-confidence and attitude) of students' information and communication technologies (ICT), the relationships between ICT aspects and mathematical and problem solving literacy performances, and to understand education policy makers' perceptions on ICT in Turkey. A multimethod (quantitative and qualitative) research design was used in this study. Country groups –an EU member group, a new EU member group and Turkey- were formed on the basis of the status of a country in the EU, and that of having ICT data in the Programme for International Student Assessment (PISA) 2003.

This study has three focuses. The first focus of the present study was to examine similarities and differences in ICT use, self-confidence in ICT and attitudes toward computers in students from Turkey and the EU. The sample of this focus was those students from the EU member group (N=56,610), the new EU member group (N=24,834) and Turkey (N=3,231) who participated in the PISA 2003. Multivariate analysis of covariance -controlling students' economic, social and cultural status (ESCS) and attitudes toward computers- and univariate analysis of covariance -controlling ESCS- were conducted to see whether students' ICT aspects differ across country groups. The first focus of the present study indicated that Turkish students have lower self-confidence in using computer and the Internet and they use the Internet less frequently than students in the EU. Contrary to this, the findings of this focus revealed that Turkish students have relatively more positive attitudes toward computers and they use program/software more frequently than do students in the EU.

The second focus of the present study was to model the relationships among ICT factors and mathematical and problem solving literacy performances of Turkish and the EU students. The sample of this focus was those students from the EU member group (N=57,787), the new EU member group (N=25,359) and Turkey (N=3,590) who participated in the PISA 2003. The proposed path analytic models were separately tested for each country group. The second focus revealed that students' socioeconomic and cultural status and self-confidence in routine computer tasks have positive and medium level relationships with their mathematical and problem solving literacy performances, for all country groups. Furthermore, students' self-confidence in Internet tasks had a positive and low level relationship with these performances for all country groups. On the other hand, it was found that students' frequency of computer and Internet use and their self-confidence in high-level computer tasks have generally negative and small relationships with these literacy performances in all country groups.

The third focus aimed to investigate education policy makers' perceptions of the ICT policy making and implementation process in Turkey, and their evaluations of the findings of the quantitative phase of this study. The participants of this focus consisted of seven education policy makers from the Ministry of National Education and universities in Turkey. The data, collected with interviews, were content-analyzed by coding data, identifying, and relating the categories and sub-categories, that is, open, axial and selective coding were conducted respectively. In the third focus of the present study, participants specified the primary issues of ICT policy making and the implementing process in Turkey and made suggestions on these issues. Participants frequently related the findings of the quantitative phase of this study to the economic, social and cultural status of students.

Keywords: Information and Communication Technologies (ICT) Use, Self-confidence in ICT, Attitudes toward Computers, Mathematical Literacy Performance, ICT Perceptions of Education Policy Makers.

# ÖZ

BİLGİ VE İLETİŞİM TEKNOLOJİLERİ DEĞİŞKENLERİNİN
VE MATEMATİK İLE PROBLEM ÇÖZME OKURYAZARLIĞI MODELLEMESİNİN
KÜLTÜRLER ARASI KARŞILAŞTIRMASI
VE YETKİLİLERİN ALGILARI

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Doktora, Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

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Bu çalışmanın amacı, Türkiye ile Avrupa Birliği'ndeki (AB) öğrencilerin bilgi ve iletişim teknolojileri (BİT) boyutlarını (kullanım, özgüven ve tutum), bu boyutların matematik ve problem çözme okuryazarlık performansıyla ilişkilerini karşılaştırmak, ve eğitim politikası yetkililerinin BİT algılarını anlamaktır. Bu çalışmada çoklu (nicel ve nitel) araştırma yöntemi kullanılmıştır. Ülke grupları, -AB üyeleri, yeni AB üyeleri ve Türkiye- Uluslararası Öğrenci Değerlendirme Programı (PISA) 2003 BİT verisi olan ülkenin AB'deki statüsüne göre oluşturulmuştur.

Bu çalışmanın üç odağı vardır. Araştırmanın birinci odağı, Türk ve AB öğrencilerinin BİT kullanımı, BİT özgüveni ve bilgisayara ilişkin tutumlarındaki benzerlikleri ve farklılıkları incelemektir. Birinci odağın örneklemi, PISA 2003'e katılan AB üyelerinden 56,610, yeni AB üyelerinden 24,834 ve Türkiye'den 3,231 öğrencidir. Ülke gruplarındaki öğrencilerin BİT boyutlarında farklılaşmalarına çok yönlü kovaryans analizleri -öğrencilerin sosyoekonomik ve kültürel durumları -SEKD- ile bilgisayara ilişkin tutumları kontrol edilerek- ve kovaryans analizi -SEKD kontrol edilerek- ile bakılmıştır. Araştırmanın birinci odağı, AB'deki öğrencilere göre Türk öğrencilerin bilgisayar ve Internet kullanımında kendilerine daha az güvendiklerini ve daha az sıklıkta Internet kullandıklarını göstermiştir. Buna karşın bu odağın bulguları, Türk öğrencilerin AB öğrencilerine göre, nispeten bilgisayara ilişkin daha olumlu tutuma sahip olduklarını ve daha sık program/yazılım kullandıklarını açığa çıkarmıştır.

Araştırmanın ikinci odağı, Türk ve AB öğrencilerinin BİT boyutları ile matematik ve problem çözme okuryazarlık performansları arasındaki ilişkilerin modellemesidir. İkinci odağın örneklemi, PISA 2003'e katılan AB üyelerinden 57,787, yeni AB üyelerinden 25,359 ve Türkiye'den 3,590 öğrencidir. Öne sürülen path analizi modelleri her bir ülke grubu için ayrı ayrı test edilmiştir. Çalışmanın ikinci odağı, bütün ülke gruplarında öğrencilerin sosyoekonomik ve kültürel durumu ve rutin bilgisayar kullanım özgüveni ile matematik ve problem çözme okuryazarlık performansları arasında orta düzeyde, İnternet kullanım özgüveni ile bu performanslar arasında düşük düzeyde olumlu ilişki olduğunu ortaya çıkarmıştır. Öte yandan, bütün ülke gruplarında öğrencilerin bilgisayar ve İnternet kullanım sıklığı ve ileri düzey bilgisayar kullanım özgüveni ile bu performansları arasında genellikle düşük düzeyde olumsuz ilişki bulunmuştur.

Araştırmanın üçüncü odağı, eğitim politikasında yetkililerin, bu çalışmanın nicel bulgularını değerlendirmelerini ve Türkiye'de BİT politikası oluşturma ve uygulama süreci ile ilgili algılarını araştırmayı amaçlamıştır. Türkiye'deki üniversitelerden ve Milli Eğitim Bakanlığından eğitim politikasında yetkili yedi kişi bu odağın örneklemini oluşturmaktadır. Görüşmelerle toplanan veriler üzerinde, veriyi kodlama, kategorileri ve alt kategorileri tanımlama ve ilişkilendirme yoluyla içerik analizi yapılmıştır. Bu çalışmanın üçüncü odağında, katılımcılar Türkiye'de BİT politikası oluşturma ve uygulama sürecindeki başlıca sıkıntıları belirtmişler ve bu sıkıntılara yönelik çözüm önerilerilerinde bulunmuşlardır. Katılımcılar, araştırmanın nicel kısmının sonuçlarını genellikle, öğrencilerin sosyoekonomik ve kültürel durumlarıyla ilişkilendirmişlerdir.

Anahtar Kelimeler: Bilgi ve İletişim Teknolojileri (BİT) Kullanımı, BİT Kullanım Özgüveni, Bilgisayara İlişkin Tutum, Matematik Okuryazarlık Performansı, Eğitim Politikası Yapanların BİT Algıları.

*To my darling supportive wife, Hamide*
*and my lovely son, Hamdi Emre*

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**AC:** Academician
**ACER:** Australian Council for Educational Research
**ADSL:** Asymmetric Digital Subscriber Line
**AGFI:** Adjusted Goodness of Fit Index
**ANCOVA:** Analysis of Covariance
**AT:** Austria
**ATTCOMP:** Attitudes toward Computers
**BE:** Belgium
**BE de:** German Community of Belgium
**BE fr:** French Community of Belgium
**BE nl:** Dutch Community of Belgium
**BEP:** Basic Education Project
**BILGEM:** Bilgisayar Eğitimi ve Hizmetleri Genel Müdürlüğü (General Directorate of Computer Education and Services)
**CAE:** Computer Assisted Education
**CAI:** Computer Assisted Instruction
**CD-ROM:** Compact Disk Read Only Memory
**CEIT:** Computer Education and Instructional Technology
**CFA:** Confirmatory Factor Analysis
**CITO:** National Institute for Educational Measurement
**CLS:** Computer Laboratory Schools
**CES:** Computer Experimental Schools
**CZ:** Czech Republic
**DE:** Deutschland
**DK:** Denmark
**EL:** Greece
**ESCS:** Economic, Social, and Cultural Status of Students
**ETS:** Educational Testing Service
**EU:** European Union
**FI:** Finland
**GDP:** Gross Domestic Product
**GFI:** Goodness of Fit Index
**GNI:** Gross National Income
**HIGHCONF:** Self-confidence in High-Level Tasks
**HISEI:** Index of Highest Parental Occupation Status
**HOMEPOS:** Index of Home Possessions
**HU:** Hungary
**ICT:** Information and Communication Technologies
**IE:** Ireland
**ILS:** Integrated Learning Systems
**INTCONF:** Self-confidence in Internet Tasks
**INTUSE:** Internet/Entertainment Use
**IRT:** Item Response Theory
**ISCED:** International Standard Classification of Education
**ISCO:** International Standard Classification of Occupations

**ISEI:** International Socioeconomic Index of Occupational Status
**IST:** Information Society Technologies Programme
**IT:** Italy (only used in tables and figures)
**IT:** Information Technology
**K-12:** Kindergarten through the Twelfth Grade
**K-8:** Kindergarten through the Eighth Grade
**LISREL:** LInear Structural RELationship
**LV:** Latvia
**M:** Mean
**MA:** Master of Arts
**MANCOVA:** Multivariate Analysis of Covariance
**MATHLIT:** Mathematical Literacy Performance of Students
**METU:** Middle East Technical University
**MLO:** Müfredat Laboratuar Okulları (Curriculum Laborotory Schools)
**MONE:** Turkish Ministry of National Education
**NGOs:** Non-Governmental Organizations
**NIER:** National Institute for Educational Research
**NPMs:** National Project Managers
**ODL:** Open and Distance Learning
**OECD:** Organisation for Economic Co-operation and Development
**OKS:** Ortaöğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı (Secondary Education Institutions Student Selection and Placement Examination)
**PARED:** Index of Highest Level of Parental Education in Number of Years of Education
**PGB:** PISA Governing Board
**PI:** Policy Implementer
**PIRLS:** Progress in International Reading Literacy Study
**PISA:** Programme for International Student Assessment
**PL:** Poland
**PM:** Policy Maker
**PRGUSE:** Program/Software Use
**PROBSOL:** Problem Solving Literacy Performance of Students
**PT:** Portugal
**PVs:** Plausible Values
**RMSEA:** Root Mean Square Error of Approximation
**ROUTCONF:** Self-confidence in Routine Tasks
**SD:** Standard Deviation
**SE:** Sweden (only used in tables and figures)
**SE:** Standard Error
**SEM:** Structural Equation Modeling
**SES:** Socioeconomic Status
**SK:** Slovak Republic
**SMEG:** Subject Matter Expert Group
**SPSS:** Statistical Package for the Social Sciences
**S-RMR:** Standardized Root Mean Square Residual
**TBŞ:** Türkiye Bilişim Şurası (Turkish Informatics Council)
**TIMSS:** Third International Mathematics and Science Study
**TR:** Turkey
**TTKB:** Talim ve Terbiye Kurulu Başkanlığı (Authority of the Turkish Education Board)
**UK:** United Kingdom
**UK E:** United Kingdom-England
**UK NI:** United Kingdom-Northern Ireland
**UK SC:** United Kingdom-Scotland
**UK W:** United Kingdom-Wales

**USA:** United States of America
**VET:** Vocational Education and Training School
**WLE:** Weighted Likelihood Estimates
**WWW:** World Wide Web
**YÖK:** Yüksek Öğretim Kurulu (Higher Education Council)

# CHAPTER 1

# INTRODUCTION

Countries have entered the new millennium with such interdependent challenges as insufficient economic conditions, increasing population, huge information explosion, that they lead respectively to low standards of living, inadequate quality in education, and the need to access, process and share information. In order to cope with these challenges, governments have recognized that using new approaches in their education systems plays a key role in educating a large number of citizens, and in this way the other challenges can also be overcome more effectively and efficiently. Information and communication technologies (ICT) with their potential for innovation and change can be considered as a new approach in education systems in order to respond to the changing needs.

Contrary to these challenges, there have been some rapid developments in scientific, industrial, technological and educational areas especially in last three decades. Pelgrum and Law (2003) describe the evolution of computers in education. When the products from these developments, particularly technological ones such as microcomputers, have became affordable for end users in the early 1980s, the concept of 'computers in education' was included in the agenda of education policy makers. This situation was primarily supported by the governments with the fear of loosing the technology race. Then, at the end of the 1980s, the focus shifted from computing technology to storing and retrieving information, thereby the concept of 'information technology' (IT) superseded the concept of 'computers in education'. Later on, in conjunction with the spread of e-mail to the general public, IT was replaced by the new concept of 'information and communication technologies', in the early 1990s (Pelgrum & Law, 2003).

Initially, although the expectations about effectiveness and motivation in education were very closely related to the introduction of microcomputers in education systems, a great number of surveys revealed that ICT were used mainly as a supplement to the curriculum and rarely as tools integrated in a traditional learning environment. This led many policy makers to feel great disappointment, whereby the investments in hardware, professional development and research programmes on ICT were diminished between the years 1992 and

1995. However, with the availability of the World Wide Web (WWW), the political focus was once more, and quickly, shifted to ICT (Pelgrum & Law, 2003).

With ubiquitous impact of WWW, and the proliferation and utilization of ICT in goods and services in public and private sectors have become pervasive in almost all areas of life. ICT and its facilities have become increasingly common in peoples' daily activities in their professional, social and cultural lives, as well. Accordingly, people needed to adopt ICT related developments and integrate ICT as a basic functional requirement into their personal and professional lives. On this account, governments as policy makers need to develop successful ICT policies for their national education systems, and to provide and monitor their implementations in order to make their citizens acquire ICT literacy.

Experts from education, government, non-governmental organizations (NGOs), labor, and the private sector, in the international ICT literacy panel convened by the Educational Testing Service (ETS), defined ICT literacy as "using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Kirsch et al., 2007, p.2). Considering this definition and the growing importance, and ubiquity of the ICT concept in almost all aspects of the life, the governments investing in their human capital aim to have their citizens ICT literate in order to transform their society into a 'knowledge society'. Having ICT literacy requires citizens to gain ICT competency, such as knowing how to collect, apply, interpret and represent, evaluate, and generate information. Therefore, inevitably, governments should provide their citizens with ICT competency in compulsory education.

In the research literature, there are many rationales why ICT should be included in education. They can be categorized into three broad groups: (1) economic (or vocational, professional) rationales, (2) social (or public, cultural, personal) rationales and (3) educational (or pedagogical, cognitional) rationales. Firstly, the economic rationale forces employees in many work areas to have ICT competency, which leads to a high quality in employment and employability for the current and future economy. This rationale involves employees in different workforce categories in almost all areas of employment having ICT literacy to some degree. Furthermore, there is a global expectation and trend that nations with ICT literate societies benefit economically from ICT use (OECD, 2001a; Markauskaite, 2006).

Secondly, as to the social rationale, since traditional life and emerging e-activities (e-learning, e-communities, and e-commerce etc.) with ICT facilities have gradually established coherent association, having ICT competency is considered an essential 'life skill', which is both a ‘requirement’ and a ‘right’ in providing full participation in the knowledge society for all citizens. In other words, the members of society with little or no ICT literacy can not independently use any public or private services through ICT (OECD, 2001a; Markauskaite, 2006).

Thirdly, the pedagogical rationale concentrates on the role of ICT in enhancing the breadth and richness of students’ learning. In this respect, governments have been encouraging especially their youths both to be ICT literate and to enhance their learning with ICT facilities within their formal education system, which prepares them for the future of their society. In meeting the basic needs rationalized from economic, social and pedagogical issues, involving ICT literacy in compulsory education seems to be the most reasonable approach in delivering ICT literacy education from the point of view of both citizens and governments. These three rationales are growing in cooperation and convergence and there is an increasing positive interaction between them (OECD, 2001a; Markauskaite, 2006).

In education, there are several ICT use areas, namely, such instructional tasks as preparation of lessons, teaching delivery, measurement and evaluation, and such managerial tasks as databases for students and schools, communication and sharing information. Aşkar and Olkun (2005) classified the major effects of ICT use on education into three areas: (1) when learning to use ICT as instructional tools is considered, it is important in terms of preparing students for life. In this context, ICT as a purpose is an integral part of the school curriculum; (2) using ICT in teaching and learning activities has transformed ICT into an essential tool; (3) ICT has been changing the role of teachers in education; acquisition of ICT knowledge and skills by teachers is now a necessity.

This study aims to understand the relationships between aspects of ICT (ICT use, self-confidence in ICT, attitudes toward computers), the economic, social, and cultural status of students (ESCS), and mathematical and problem solving literacy performance across country groups (an EU member group, a new EU member group and Turkey) through the dataset of the Programme for International Student Assessment (PISA) 2003, conducted by the Organisation for Economic Co-operation and Development (OECD).

## 1.1 Organisation for Economic Co-Operation and Development

The OECD was established in 1961, and located in Paris. The OECD is an organization that it consists of 30 member countries, committed to democracy and the market economy. The mission of the OECD covers: supporting economic growth; boosting employment; raising the standards of living; maintaining financial stability; assisting other countries’ economic development; and contributing to growth in world trade. It is based on three administrative powers: Council (oversight and strategic direction); Committees (discussion and implementation); and Secretariat (analysis and proposals). The Directorate for Education, affiliated to the Secretariat of the OECD, helps the members reach high-quality learning, contributing to personal development, sustainable economic growth and social cohesion. Furthermore, it assists countries in designing, developing and implementing effective educational policies so as to respond to challenges related to education systems. Moreover, it concentrates on outcomes of education in terms of their evaluation and improvement processes. These lead to improved quality of teaching and learning (OECD, 2006a, 2006b, n.d).

The OECD is one of the world's largest and most reliable sources of comparable economic and social statistical data and their related publications. It researches social changes and evolving patterns in trade, environment, agriculture, technology, fiscal policy, and education. Accordingly, the OECD helps governments compare policy experiences; seek answers to common problems; identify good practice; and coordinate national and international policies; and thereby the governments can develop policies and/or adopt strategic orientations through deciphering emerging issues and identifying policies that work. Furthermore, it makes specifically regular peer reviews about the education systems of members and non-members, and presents progress in education and training systems in an annual compendium including statistics and indicators. For example, the Programme for International Student Assessment (PISA) provides information on investigations into long-range trends and innovations in achievement levels of 15-year-old students, every three years, in education (OECD, 2006a, 2006b, n.d).

## 1.2 Programme for International Student Assessment

In 1997, the OECD launched a three-year cycled programme going under the name of the Programme for International Student Assessment (PISA) in order to respond to demands for regular, reliable and valid data on the knowledge and skills of students, educational demographics and the performance of the education systems. The first study (cycle) took place in 2000, the second one in 2003 and the third one in 2006. It will be continued by the same token. Since the PISA surveys provide global and regular data, they allow countries to monitor their progress, to compare their performance with the best practices of the others, and to check whether educational goals are met or not. This leads to improvements in their educational systems, through modeling on more successful ones, if appropriate (Downes, 2005; PISA, n.d.).

Moreover, it is the only international education survey which focuses on 15-year-old students, who are almost at end of compulsory education in schools. In this context, the PISA seeks answers to the following questions, concerned by all stakeholders: Do schools prepare young people for the challenges of adult life? (public policy issue); How do young adults analyze, reason and communicate effectively when they examine, interpret and solve real life problems rather than any discipline in school curricula? (literacy issue); and Do young people know what, why and how to learn knowledge and skills? (lifelong learning issue). It measures not only students' performance in reading, mathematics, and science literacy –not focusing on the curriculum– but also students' motivations, beliefs about themselves, and learning strategies. Therefore, it is considered unique among other international studies. With its student and ICT questionnaire, the PISA also collects contextual data on students' demographics, socioeconomic status (SES), and computer familiarity (PISA, n.d.).

## 1.3 Purpose of the Study

This study has a multimethod research design. It has quantitative and qualitative phases, with separate main purposes. The main purpose of the quantitative phase is three-fold: first to reanalyze the PISA 2003 dataset with respect to aspects of ICT controlling ESCS and attitudes toward computers, across country groups; second to model the relationships between mathematical literacy performance and affecting factors, such as aspects of ICT and ESCS, by using the PISA 2003 dataset across country groups; and third to model the relationships between problem solving literacy performance and those other factors across country groups.

On the other hand, the main purpose of the qualitative phase is to investigate exemplary education policy makers' perceptions of the quantitative phase results of this study and of issues and possible solutions in ICT policy making and implementations in Turkey.

Along with reanalyzing ICT aspects in the PISA 2003 dataset in the quantitative phase, the factors affecting mathematical and problem solving literacy performance of students in PISA 2003 are tested with proposed path analytic models. The proposed models are not only designed on the basis of the previously developed models (Erbaş, 2005; İş Güzel & Berberoğlu, 2005), but also developed through considering the most meaningful modification indexes during testing the models. First of all, the mathematical and problem solving literacy performance of students, endogenous variables, are supposed to be directly affected by ICT aspects (exogenous variables), but then the economic, social and cultural status of students is also regarded as an important factor affecting the literacy performance of students (Yang, 2003). Finally, although students' attitudes toward computers can be considered as an aspect of ICT strongly affecting the ICT literacy of students, it is also considered as both a predictor and a criterion variable, moderating relationships between other ICT aspects, the economic, social and cultural status of students and the literacy performance of students. These models of mathematical and problem solving literacy performance for country groups are given in Figure 1.1. These models are evaluated to interpret similarities and differences in relation to the relationships between ICT aspects, ESCS, mathematical and problem solving literacy performance across country groups. Country groups are formed on the basis of the status of a country in the EU, (i.e., being an EU member, a new EU member or a candidate state -only Turkey is considered- in this study) and that of having ICT data in the PISA 2003 study. In this sense, the partial endeavor of this study is to pursue answers to the following questions "Which path analytic models explain the relationships between ICT aspects and mathematical and problem solving literacy performance of students in PISA 2003 across country groups, considering ESCS?" and "How well do the proposed models explain the variance in student performance of mathematical and problem solving literacy performance in PISA 2003 across country groups, considering ICT aspects and ESCS?".

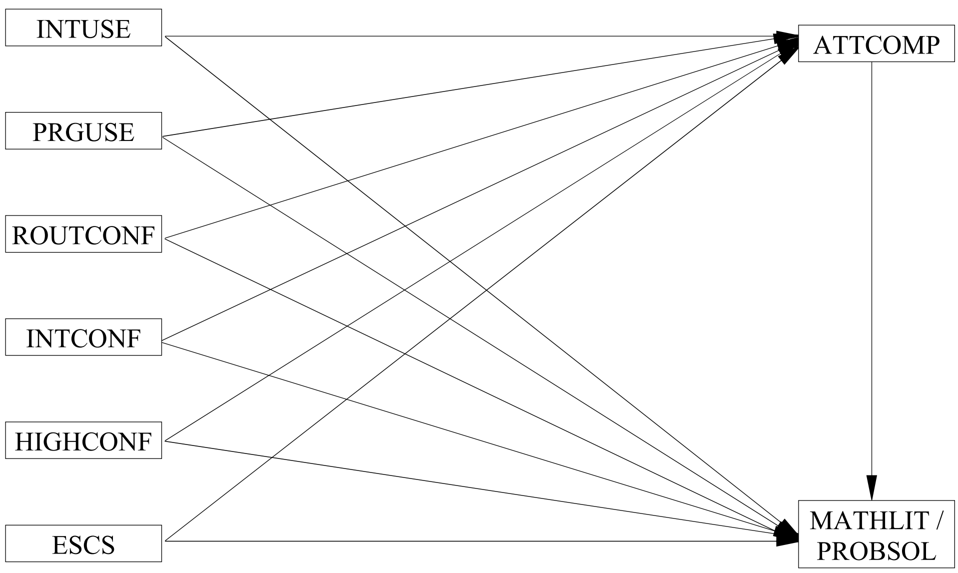



Figure 1.1 Hypothesized Path Analytic Mathematical and Problem Solving Literacy Performance Models for Country Groups

In the modeling part, students' responses to assessment instruments, ICT and student questionnaires in PISA 2003, are used to generate and test path analytic models. Since related items in questionnaires have already been grouped by PISA experts to obtain composite scores (called indexes) for ICT and ESCS, the path analytic models are conceptually and theoretically generated and tested by using these indexes in the PISA 2003 dataset. Consequently, two path analytic models are proposed to give the best explanations of the factors affecting mathematical and problem solving literacy performance across country groups.

With the emergence and demands for ICT and its facilities, particularly educational settings, the ICT related factors, -namely PRGUSE: Programs/software use, INTUSE: Internet/entertainment use, ROUTCONF: Confidence in routine tasks, INTCONF: Confidence in Internet tasks, HIGHCONF: Confidence in high-level tasks, ATTCOMP: Attitudes toward computers-, and students' background variable –ESCS: Economic, Social, and Cultural Status of Students- are considered as factors influencing students' mathematical and problem solving literacy performance (MATHLIT and PROBSOL) in the two proposed models (see Figure 1.1).

## 1.4 Significance of the Study

In this study, a multimethod (quantitative and qualitative) research design is used to explore, compare, and understand the relationships between ICT aspects, mathematical and problem solving literacy performance, and student background information across the EU member group, the new EU member group and Turkey. Thus, this study puts forth some information and suggestions about differences and similarities in terms of students' perceived ICT use, self-confidence in ICT and attitudes toward computers, which may reflect ICT policies and implementations across country groups. In the integration process of Turkey into the EU, this valuable comparison is likely to point out the general status and needs for changes in ICT policy, and its implementations for decision-making powers in the Turkish education system. Correspondingly, in order to compare and understand the relative strengths and weaknesses of students from Turkey and the EU in aspects of ICT, multivariate analyses are conducted to investigate how well the students seem to be prepared to meet today's requirements for basic ICT knowledge and skills.

This study aims to help academicians, educational curriculum planners, and policy makers amend their perceptions, beliefs, and perspectives, and this leads to suggestions for initiate some changes in ICT policy in Turkish education, either in the short term or in the long run. Since the findings of this study give information about perceived ICT aspects and the relationships between ICT aspects and the mathematical and problem solving literacy performance of international young adults along with their socioeconomic and cultural status, this research provides national education policy makers with a powerful and helpful tool to understand what ICT related factors will probably be effective in explaining students' literacy performances in their contexts. More specifically, this study is important in clarifying relationships between ICT aspects, student background information, and mathematical and problem solving literacy performance at a macro level across different cultural settings in PISA 2003, which sheds light on the question of how to utilize ICT in gaining mathematical and problem solving literacy performance. Furthermore, the results of this study may provide education policy makers and authorized educators with a general guidance and insight -especially with path analytic models- in order to understand how ICT aspects enhance -or impede- the mathematical and problem solving literacy performance of students.

There is a gap, in the accessed literature, on researching the relationships between ICT aspects and mathematical and problem solving literacy performance. In this sense, this study is new and it is expected that it may contribute to the literature on this issue. It is important to note that both working on a robust, reliable and valid dataset and the scope of this research are likely to increase the significance of this study. In addition to these, it is hope that this study will stimulate further studies to investigate and model ICT related variables in cross-cultural settings.

## 1.5 Research Questions

More specifically, the following research questions have been investigated in the present study.

### 1.5.1 Quantitative Research Questions

1. How does ICT use –Internet/Entertainment Use and Program/Software Use– differ among students in PISA 2003 across the EU member group, the new EU member group and Turkey (country groups) when the effects of students' attitudes toward computers and economic, social and cultural status are controlled?
2. How does the self-confidence in ICT –Confidence in Routine Tasks, Confidence in Internet Tasks and Confidence in High Level Tasks– differ among students in PISA 2003 across country groups when the effects of students' attitudes toward computers and economic, social and cultural status are controlled?

3. How do attitudes toward computers differ among students in PISA 2003 across country groups when the effect of students' economic, social and cultural status is controlled?
4. How well do ICT related factors and student family background explain variances of the PISA 2003 students' mathematical literacy performance across country groups?
5. How well do ICT related factors and student family background explain variances of the PISA 2003 students' problem solving literacy performance across country groups?

### 1.5.2 Qualitative Research Questions

1. How do Turkish education policy makers evaluate the quantitative findings of this study across Turkey and the EU?
2. According to Turkish education policy makers, what are the issues in developing and implementing an ICT-in-education policy in Turkey?
3. What are the Turkish education policy makers' suggestions for developing and implementing an ICT-in-education policy in Turkey?

## 1.6 Definition of Important Terms

***ICT in PISA:*** "The use of any equipment or software for processing or transmitting digital information that performs diverse general functions whose options can be specified or programmed by its user" (OECD, 2005a, p. 239).

***Literacy in PISA:*** "The capacity of students to apply knowledge and skills and to analyze, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations" (OECD, 2004b, p. 23).

***ICT Literacy in PISA:*** "ICT literacy is the interest, attitude, and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in society" (Lennon, Kirsch, Davier, Wagner & Yamamoto, 2003, p. 8).

***ICT indexes (variables):*** ICT indexes are Internet/Entertainment Use (INTUSE), Programs/Software Use (PRGUSE), Self-confidence in Routine Tasks (ROUTCONF), Self-confidence in Internet Tasks (INTCONF), Self-confidence in High-Level Tasks (HIGHCONF), and Attitudes toward Computers (ATTCOMP). Each ICT index is a composite score derived from related observational data collected via an ICT Questionnaire. These indexes are called scale indexes. The key objective in generating the scale indexes is to make internationally valid comparisons (OECD, 2005b, p. 272). Detailed explanations about the ICT indexes are given in the Chapter 3.

***Economic, Social, and Cultural Status of Students (ESCS):*** The ESCS index for PISA 2003 was derived from three variables related to family background: highest level of parental education (in number of years of education), highest parental occupation and number of home possessions (OECD, 2005b, p. 316). Detailed explanations about the ESCS index are given in Chapter 3.

***Mathematical Literacy Performance (MATHLIT):*** "An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen" (OECD, 2003a, p. 15, 2005b, p. 14). Detailed explanations of MATHLIT are given in Chapter 3.

***Problem Solving Literacy Performance (PROBSOL):*** "An individual's capacity to use cognitive process to confront and resolve real, cross-disciplinary situations where the solutions path is not immediately obvious and where the literacy domains or curricular areas that might be applicable are not within a single domain of mathematics, science or reading" (OECD, 2003a, p. 15, 2005b, p. 14). Detailed explanations of PROBSOL are given in Chapter 3.

***Basic Education School (K-8):*** Schools offering primary education and lower secondary education.

***Optional Computer Course:*** Provided that schools have IT room and computer teacher, Optional Computer Course is offered to students. It is not included in compulsory or core curriculum of K-12.

# CHAPTER 2

# LITERATURE REVIEW

Considering the research questions, a comprehensive literature review is conducted and presented in this chapter. Firstly, ICT-in-education policies and implementations in Turkey and studies about integration of ICT into education in Turkey and integration issues from other countries are given. Then, studies on ICT and attainment are gathered under the following titles: meta-analysis studies on ICT and attainment, international ICT and attainment studies on TIMSS and PISA, and studies on the PISA 2003 dataset. Afterwards, the SES of students and achievement is given. ICT-in-education policies and implementations in the EU are then presented. ICT in education in the EU is also given. Finally, information on some demographics, education systems and ICT policy and implementations for each member in the EU groups is also presented.

## 2.1 ICT-in-Education Policies and Implementations in Turkey

Computers have had more priority than any other educational technology in the Turkish education system (Akkoyunlu & Orhan, 2001). This is mainly due to the fact that computer literacy is one of the most important abilities that students need in their future social and professional life. Indeed, since 1984 the national policy of the Turkish Ministry of National Education (MONE) on information technology (IT) had been stated as "to equip all levels in the education system with technology to catch the information age, to be a knowledgeable and technological society, to educate people who think nationally and universally; and to increase competition of our people and society continuously" (MONE, 2002, para. 1).

In a 1999 policy paper, MONE "views IT as a tool that children, teachers and administrators can use comfortably in their daily routines and as an integral part to and supportive of the curriculum offered to the children" (MONE, 1999, p.4). More specifically, MONE claims that technology should be an integral part of basic education due to the following three rationales:

- Widespread use of technology in almost all professional areas in society in the 21st century necessitates students acquiring computer skills.
- Since one of the tasks of a school is to prepare the individuals for the community, integration of changing and developing technologies into education will both improve the quality of education and support economic and social development.
- Technology as an effective tool leads to enhancing learning environment, increasing students' motivation, retention, and increasing problem solving and critical thinking skills (MONE, 1999, p. 5).

It could be said that in the earlier ICT policy statement of MONE, the hardware issue was more emphasized than software and curriculum integration issues like teacher training, curriculum and technical and pedagogical support. Even though integration of ICT into the whole basic education curriculum was stated in a 1999 policy paper, the curriculum was not changed; thus, by 2003 the expected ICT integration had not come out in practice.

In order to integrate ICT into education, some initiatives and projects had been conducted within the framework of National Education Development Project and Basic Education Project phase I up to 2003. The following ones were been launched after that: Basic Education Project phase II, MONE Project for Accessing Internet, Education for the Future (in Co-operation with Intel Company), Learning Centres, Foreign Language Teaching Through Distance Learning at International Standards, Vocational Training Through Distance Learning at International Standards, and E-learning - Education Portal (UNESCO, 2004). Projects only directly related to ICT integration in primary and secondary education schools are given below.

### 2.1.1 ICT-in-Education Initiatives and Projects

Use of information technologies in education began with establishing the Specialized Commission on Computer Education at Secondary Schools in 1984 (MONE, 2003). In that year, the Computer Aided Instruction Project was initiated and 1,100 microcomputers were bought for secondary schools. In the 1985-86 school year, 1,111 computers were bought for an additional 101 secondary schools (10+1 computers for each school). In-service training was provided for two teachers from each of these schools (MONE, 2003). Additionally, with a project started in the 1985-86 school year, 130 computers were sent to 13 vocational high schools related to commerce and tourism. After in-service training of teachers, an optional computer course was added to the curriculum of secondary schools in the 1987-1988 school year (MONE, 2003). MONE decided and planned to equip 500 secondary and vocational schools with a computer laboratory linked to a local area network in the year 1988-1989 (MONE, 1999).

By 1998, with these experiences until 1988, it was realized that computers should be used as an instructional media for more than just educating students about computers (Akkoyunlu & Orhan, 2001). Therefore, MONE invited firms to develop software and to implement it within computer aided instruction at a selected 160 secondary schools in 1988. Along with firms, universities also supported this project. After conducting pilot projects in the 1988-89 school year, nine firms were selected for this project from 28 participating firms working on software and hardware. In the 1989-90 school year, the firms developed courseware for 2,000 hours in total, covering 37 different courses. In 1989, 750 teachers had been trained on basic computer skills in cooperation with 24 universities (MONE, 2003). In the next school year, they developed courseware for 141 different courses, each of which lasted from 25 to 70 hours, all of which lasted 5,000 hours in total (Akkoyunlu & İmer, 1998). At the end of this project, the importance of training teachers was recognized as an important issue in the computer integration process (Akkoyunlu & Orhan, 2001).

By 1990, 3,158 computers had been provided to primary and secondary education schools -170 computers to 55 primary schools, 1,461 computers to 196 general high schools, 1,095 computers to 88 technical high schools, and 432 computers to 43 commercial vocational high schools (Akkoyunlu & İmer, 1998). Afterwards, MONE went on to purchase computers especially for secondary schools. In 1991, additional to the aforementioned computer provision, 5,121 computers were bought. These computers were generally used for optional, introduction-oriented computer courses, focusing on use of available software. It should be noted that the computers were put into upper secondary schools at first. In fact, there were only 2,064 computers in state-run primary schools in 1998 (Akkoyunlu & İmer, 1998).

As the number of computers increased in schools, so did the need to a directorate for the purpose of coordinating and implementing activities related to the use of computers in schools. Therefore, a general directorate of computer education and services (BILGEM - Bilgisayar Eğitimi ve Hizmetleri Genel Müdürlüğü) was established in 1992. Since the computer technology was growing very fast in 1998, MONE founded a new general directorate named the General Directorate of Educational Technologies, concerning to the use of information technology in schools, through unifying BILGEM and the Film Radio Television Center (MONE, 1999).

Using computers for Computer Assisted Instruction (CAI) at schools lasted between the years of 1990 and 1999 (MONE, 2005a). In those years, the “Project on the Development of National Education" was implemented with the support of the World Bank. Within this project, a Computer Experimental Schools (53 CES) project which covered 53 secondary schools, and a Computer Laboratory Schools (182 CLS) project which covered 182 primary and secondary schools were conducted to expand CAI and computer education (MONE, 2003). IT rooms were established in the 53 CES project schools in 1993. Use policies of IT rooms in project schools were specified as follows: 20 hours for computer education, 10 hours for computer assisted education and 10 hours for free use. Teachers were trained in computer literacy in project schools (MONE, 2003). Then, one or two teachers were selected to be trained as "formator teachers" in those schools. Various in-service training opportunities were offered to project schools' principals, formator teachers and province coordinator teachers. In 1995, MONE wanted schools to do some activities increasing computer awareness and skills, such as giving computer literacy courses after school, conducting projects, and founding computer clubs (MONE, 2003). Since the evaluation studies revealed positive results from computer assisted education in the 53 CES, IT rooms were established in 182 schools within the 182 CLS project in 1996. Successful implementations in the 53 CES project were exactly extended to the 182 CLS schools. Some courseware was selected and bought by a committee in MONE, to be used in the 182 CLS (MONE, 2003).

The primary education system was considerably changed with a series of initiatives toward the 2000s. Firstly, the 7$^{th}$ Five Year Development Plan included the aim of increasing the duration of compulsory education from five to eight years. Then, the 15$^{th}$ National Education Council, convened in 1996, also supported the implementation of eight-year compulsory education, with its resolutions. Afterwards, MONE prepared the long-term "Master Plan on Education: 1996-2011" regarding the Turkish education system. Within this master plan, the "Project 2000 for Keeping Pace with the Age in Education" included short-term objectives and strategies. In this process, the Basic Education Law was accepted in 1997, which led the extension of compulsory education to eight years, and to addressing financial resources for this change. In order to implement this law, a long-term Basic Education Project (BEP) was put into practice in 1998 (Eurydice, 2007a).

#### 2.1.1.1 Basic Education Project - Phase I

The aim of Basic Education Project (BEP) was to make primary education universal in Turkey, to enhance the quality of primary education and to convert schools into the learning centres of the community (Eurydice, 2007a). The objectives contained within the framework of these aims are, briefly, as follow:

- Increase the rate of attendance to schools in eight-year primary education from 86% to 100%,
- Increase the rate of attendance in pre-school education from 7% to 16%,
- Create additional capacity at schools (additional capacity for 3,5 million pupils)
- Reduce the numbers present in classrooms to 30,
- Abolish dual education in time,
- Teach at least one foreign language to each pupil,
- Generalize usage of computer technologies in education (Establishing computer labs in every primary education school)
- Improve the conditions of all schools in rural areas (35,000 schools) (Eurydice, 2007a, p. 98).

Expenditure for BEP was estimated at 11.3 billion dollars. The majority of this money was met by Turkey's own resources. Nevertheless, Turkey requested the World Bank for loans for this project in 1997. The World Bank and MONE signed a contract for a 600 million dollar credit in 1998, half of which is for BEP I and the other for BEP II (Eurydice, 2007a). The first phase of BEP was implemented in 1998-2003.

In accordance with the given objectives aforementioned above, MONE aimed to establish and equip learning centres named Information Technology Rooms (IT rooms) in all primary schools and to utilize information technologies tools for productivity. MONE reports that the following actions were taken to achieve IT related objectives in BEP I:

- The infrastructure for 3188 information technology (IT) classes in 2802 primary schools was completed and IT classes were opened;
- 56605 computers and other related pieces of equipment were distributed to 26244 village primary schools in rural areas;
- 1500 laptops were purchased and distributed to primary education inspectors;
- 130 laptops and 1 server were purchased for Board of Inspection/inspectors of MONE (MONE, 2005a, pp. 53-54).

Almost all of the IT rooms were equipped and in operation by the end of the 1999-2000 school year (World Bank, 2001).

As for the training component of BEP I, along with in-service training in other fields, basic and advanced training in computer hardware and educational software was offered to supervisors, administrators, teacher trainees and teachers, in order to utilize IT rooms in primary schools in the most efficient way (MONE, 2005a). The ICT related training events announced by MONE were:

- In-service training provided for 3000 primary education inspectors in the areas of Educational Management, Computer Literacy, Active Learning and Teaching Strategies together with Material Usage, Active Learning and Special Teaching Methods;
- In-service training on computer literacy provided for 25000 teachers in the schools where IT classes were established by computer teacher trainers;
- 250 computer teacher trainers selected from schools with IT classes trained in 3 periods on various subject areas in order to make them gain the necessary qualifications for training computer teacher trainers in provinces;

- 15928 teachers in the schools where IT classrooms were built given basic (computer literacy) and advanced (Windows NT, Proxy, MS Office, Internet, Windows 98) education by the firms providing hardware and software (MONE, 2005a, pp. 54-55).

According to the Turkish Informatics Council (Türkiye Bilişim Şurası-TBŞ) education report of 2002, in spite of large investments in hardware within BEP I, only 17% of primary and secondary schools in Turkey had computers in 2002. The ratio of computer to students was 1 to 81 among primary and secondary students, which was considerably lower than the world average of 1 to 45 students. Furthermore, it is assumed that most of these schools had no or limited Internet connections (TBŞ, 2002).

In 2005, based on the experiences of BEP I, MONE declared its objectives related to ICT integration into the Turkish education system in the 2000s as:

- IT hardware and software will be provided for every school including primary education schools;
- Secure and fast Internet connection will be provided to all schools;
- All students, teachers, directors, parents and school staff will be able to access IT;
- An IT class with 20+1 computers per 500 students, at least 2 computers with Internet and intranet connection per teachers' room and at least 1 computer will be provided with the same specs for guidance services, libraries and administration offices;
- Necessary software and in-service training courses will be provided in order to ensure that teachers, students, directors and the school staff are able to use IT and successfully take advantage of it during the educational processes;
- Current curriculum will be transformed into a student-centered one and students will be able to access information by using IT tools by themselves during their educational processes;
- Work will be undertaken in order to avoid the digital divide, and IT at schools will be at all citizens' service;
- Technical support centres for schools will be established in order to provide the necessary technical support for the update and continuous maintenance of the IT hardware at schools (MONE 2005a, pp. 70-71).

It is understood from these policy objectives that MONE recognized the importance of not only installing IT rooms, but also providing software, internet connections, hardware for school staff, technical support, and in-service training for all staff, and of transforming the curriculum into a student-centered curriculum. Parallel to these, the last curriculum reform beginning in 2004 also involves integrating ICT into primary and secondary school curricula. It is likely that ICT will be utilized in all subjects as teachers adopt and use the new curriculum. The projects hereafter are designed, developed and implemented in the light of these policy objectives.

ICT related major policies, initiatives, and projects underway in primary and secondary education until the PISA 2003 data collection have been mentioned so far. It should be noted that only Computer Experimental Schools, Computer Laboratory Schools and BEP I projects were initiated and/or finished by 2003. Hence, the major initiatives and projects stated below do not have any impact on the PISA 2003 data. They are described in order to illustrate the context and trend of ICT integration into education settings after 2003 in Turkey.

#### 2.1.1.2 Basic Education Project - Phase II

The World Bank's Board approved the second loan of 300 million dollars to continue to support the Government's Basic Education Project in 2002, in the second phase (BEP II). According to the official website of the World Bank, BEP II was conducted in 2002-2007. However, in reality the project was activated by the government in 2005 (World Bank, n.d.). The general aims of BEP I were kept in the second phase, too. Additionally, pre-primary education and special education were emphasized in the second phase (MONE, 2005a). In order to increase access to ICT in basic education schools within this phase of the project, 4,002 IT rooms were to be established in 3,000 additional basic education schools throughout Turkey. Installing an education portal was also among the aims of BEP II (World Bank, 2002; MONE, 2005a).

#### 2.1.1.3 MONE ADSL Connection Project

In December 2003, a protocol between the Ministry of Transport and MONE was signed to provide high speed Internet connection to approximately 40,000 schools including most of the primary schools and all secondary schools, for educational and administrative purposes (World Bank, 2004). The main goal of this project was to improve the students' skills in accessing, using, producing and sharing information through providing schools an appropriate Internet bandwidth for using e-learning methods (UNESCO, 2004).

According to the protocol, high speed Internet connections would be provided to these schools for a 3-year period of 2004 and 2006. The cost of the Internet connection would be covered under MONE's budget (World Bank, 2004). The project consists of four phases: in the first three phases Asymmetric Digital Subscriber Line (ADSL) Internet access was completed for approximately 20,000 schools, and then it was planned that ADSL Internet access for the rest of schools would be completed by 31 October 2005 (MONE, 2005a). With this project, an important step has been taken in the way of e-education application at every level of education and training (UNESCO, 2004).

### 2.1.1.4 Campaign for Supporting Computer Aided Education

This project was launched by MONE and Turkish Informatics Industry Association in 2005. The main goal of the project is to catch up with world informatics standards with a new technology boom in the Turkish education system. The objective of the project is to gain one million computers for primary and secondary education schools with donations from the private sector and community (BEDK, 2008). Up to 2007, 294,000 computers have been put into schools, IT rooms have been established in 19,000 schools, and Internet connections (as ADSL) have been provided to 25,000 schools (Eurydice, 2007a).

### 2.1.1.5 Education for the Future (in Co-operation with Intel Company)

With this project, it was aimed to enable 50,000 teachers to acquire computer literacy in three years through expert teacher trainers who would be trained with a specific program by 2006. Computer teachers determined by MONE have 40 hours training about teaching computer use. These teachers -as the main instructors- will undergo special education about the curriculum and be responsible for the training of the expert teachers. The expert teachers will train other teachers, determined by MONE. During this process, the aim was to train 5,000-8,000 teachers in the first year, and the estimated number of trained teachers would be 50,000 by the end of the third year. A protocol was signed with the Intel Company (UNESCO, 2004).

### 2.1.1.6 E-learning - Education Portal

As aforementioned, one of the stated aims of BEP II was that MONE would install an educational portal. The following services are to be offered with the education portal:

- Software which suits and supports the curriculum,
- A rich, continuous, up-to-date and reliable educational content in Turkish which meets the requirements of students, teachers, parents and directors,
- Distance synchronized and desynchronised educational services,
- Foreign Language teaching through distance learning at international standards,
- Vocational training through distance learning at international standards,
- The training of teachers, students and administrators,
- Mutual communication of the students, teachers, administrators and parents; services such as providing e-mails, web pages and etc,
- Necessary web page orientations through search engines and links,
- Preparation of the continuous education environment so as to provide all necessary educational information and allied services for individuals at all ages and the target audience remaining out of the formal education (UNESCO, 2004, p. 30-31).

Major projects related to ICT integration into primary and secondary schools have been mentioned so far. In summary, ICT investments started at first in secondary schools in

1984. These investments continued, especially in upper secondary schools, in the years of 1984-1991. Attempts to develop instructional software for CAI in collaboration with MONE, the private sector and universities were seen in 1988-1991. In the late 1980s and early 1990s, a few in-service-training activities were also held on basic computer skills for teachers, with the support of universities. In the 1990s, within the framework of a National Education Development project, 53 CES and 182 CLS projects were started in selected secondary and basic education (K-8 -Kindergarten through the Eighth Grade) schools, in 1993 and 1996 respectively. The main aim of these two projects was to investigate ways to integrate computers into the Turkish education system.

The Education Master Plan 1996-2011 was formed on the basis of policy recommendations from the Seventh 5$^{th}$ Year Development Plan and the 15$^{th}$ National Education Council. Within this master plan, Project 2000 for Keeping Pace with the Age in Education was launched as a short-term project. Afterwards, compulsory education was expanded from five to eight years in 1997. The long-term plan BEP was initiated in 1998, which was one of the largest education projects in the world in terms of its scope, affected population, and budget. The main purpose of this project was to generalize basic education throughout Turkey, to enhance the quality of basic education and to convert schools into community learning centers. One of the objectives was directly related to ICT: generalizing the use of computer technologies in education through establishing IT rooms in every basic education school. The government had a loan of 300 million dollars from the World Bank for the first phase of this project, that was implemented in 1998-2003, and an additional 300 million dollar for the second phase, in 2002-2007. Since the government in Turkey and project leaders in the World Bank changed, the second phase of BEP actually started in 2005. In the second phase, the main aims and goals were kept. Additionally, pre-primary school education and special education were also planned to be improved in this phase.

It could be concluded that hardware investments were more dominant in the ICT integration process up to 2003. Those investments for basic education schools were actually implemented in 1998-2000 within BEP I (3,188 IT rooms in 2,802 primary schools). Yet, the Internet connections at schools were limited and slow until the end of 2003 (Akbaba-Altun, 2006). However, it appears that with MONE ADSL Connection Project signed at the end of 2003, schools started to access the Internet through broadband. E-learning - Education Portal (one of the objectives of BEP II), Education for the Future (in Co-operation with Intel for training teachers on ICT), and the Campaign for Supporting Computer Aided Education Project are other major projects that are directly related to ICT integration into compulsory education implemented after the PISA 2003 data collection.

### 2.1.2 ICT in Primary and Secondary School Curriculum

Parallel to the priority given to upper secondary schools in providing computers, computer courses were planned and implemented in upper secondary schools earlier than in primary schools. A three-credit computer course was added as an optional course to the curriculum of secondary schools in the 1987-1988 school year (MONE, 2003). MONE Authority of the Turkish Education Board (Talim ve Terbiye Kurulu Başkanlığı-TTKB) accepted the curriculum of a Computer 1 course for ninth and tenth grades in secondary schools in 1992. Afterwards, in line with developments in computer hardware and software, this program was cancelled and a new updated program was accepted for the Computer 1 course in 2000 (MONE, 2000). This course was intended to provide basic computer knowledge and skills. A Computer 2 course was also offered in upper secondary schools. This course focused on providing basic programming concepts and skills through the BASIC or PASCAL languages. In addition to these courses, the curriculum of Information Technology I-II courses, each lasting one semester, were accepted by the TTKB and launched in the 1995-1996 school year (MONE, 1994). These courses were offered either to $10^{th}$ or to $11^{th}$ grades as optional courses.

The aim of Information Technology courses is to teach students the ways of accessing information and the developments in information technologies. In this sense, students will be able to learn to the ways of accessing knowledge resources, to compile various data, and to collect data for their own needs. The main areas included in the Information Technology I course are (1) the concepts of information society and information technology (40% of the course), (2) information systems (data and information concepts) (40%), and (3) protection of individual and institutional rights in communicating information (20%) (MONE, 1994). As to Information Technology II, it teaches students to apply what they have learned in the Information Technology I course. Information Technology II covers computer hardware (10% of the course), introduction and basic use of general purpose software (word processing, spreadsheet, database, graphic programs) (50%) and data processing methods (40%) (MONE, 1994).

The curriculum of the “Information and Communication Technology” course for upper secondary education is accepted by TKKB, and the “Computer 1” course was abolished in 2005 (MONE, 2005b) within the restructuring of secondary education and curriculum reform. This two-semester course is compulsory for vocational education and training schools (VET) and optional for all other upper secondary schools, in $9^{th}$ grade, as of 2005-2006 school year. This course covers basic ICT concepts, basic computer skills, word processing, spreadsheet, database, and presentation program as well as Internet and communication (MONE, 2005b).

As to basic education schools, the program of optional computer courses from 4th to 8th grades was accepted by MONE in August 1998 (MONE, 1998). It started to be implemented in the 1998-1999 school year. This program had a spiral content organization, that is, the content of one grade was included in the next grade with additional knowledge and skills. This program was too repetitive in content organization across grades, so teachers did not actually follow it (Kural Er & Güven, 2008).

In 1999, MONE declared that its main policy on ICT was to spread IT skills across grades 1 through 8 in order to give students the necessary computer competencies for the 21st century workforce. Thus, MONE aimed to integrate basic computer skills into the whole primary education curriculum rather than introducing them in a separate computer course (MONE, 1999). The World Bank also indicated that BEP aimed to integrate ICT into other subjects in primary education, beginning from fourth grade, along with improving the computer literacy of teachers and students (World Bank, 2002). Accordingly, in a 1999 policy paper, MONE defined computer competencies for each grade level, as seen in Figure 2.1 (MONE, 1999). Although computer competencies of the first three grades were also defined, the curriculum of the optional computer course was accepted for students in the 4th to 8th grades in 1998. This could be evaluated as a contradiction between policy and practice. Indeed, the first three grades were permitted to take optional computer course as of the 2005-2006 school year.

Afterwards, within the framework of the education reforms that started in 2004, a new curriculum for all grades in basic education was designed and accepted by the TTKB in 2006. This new curriculum began to be implemented in 2006-2007 for the first three grades, and in 2007-2008 for the 4th - 8th grades.

In order to understand to what extent the content of optional computer courses covers the aspects of ICT focused on by PISA 2003, a curriculum analysis of each computer course given in Turkey until 2003 was done and is presented in Table 2.1. First, the most striking deficiency is a lack of Internet-related objectives and content. Second, programming skills do not take place in the curricula, except for in that of Computer 2. Third, no educational software or content/activity to enhance other subjects exists within the curricula. Finally, creating a web page, multimedia presentation, and using antivirus software are not included in the curricula at all. The curricula of those courses are largely focused on basic computer skills, such as opening, deleting and copying a file, playing games and drawing pictures with the mouse.

| Grades 1 Through 3 | Grades 4 Through 8 |
|---|---|
| **Grades 1 Through 3:** The students of these grades will have the following skills:<br><br>***Operating System***<br>Have necessary motor skills<br>Have eye-hand coordination<br>Use computer mouse<br>Identify components of a computer (e.g. monitor, hard-drive, keyboard)<br>Turn on and off the computer and its peripherals<br>Launch and exit an application program<br>Use a scroll bar and keyboard<br><br>***Desktop Publishing***<br>Enter a text<br>Change text font, style, alignment and size<br>Use copy, cut, and paste functions<br>Insert an image<br>Insert a table<br>Move images and text frame<br>Open an existing document<br>Insert date, time, page number<br>Name a document and save it<br>Print a document<br><br>***Instructional Software***<br>Open an instructional game, drill & practice program, and simulations<br>Use keyboard and mouse to use the application<br>Exit the application<br><br>***On-Line Communication Programs***<br>Connect to Internet and/or an on-line services<br>Use Electronic Mail (compose, send, retrieve, read, respond)<br>Access and use resources on Internet and World Wide Web<br>Use effectively distance learning, desktop video conferencing, and tele-teaching technologies. | **Grades 4 Through 8:** The students of these grades will have the following skills:<br><br>***Operating System***<br>Identify operating system<br>Change a window size<br>Identify different drives<br>Select and use tools from a toolbar<br>Rename a file<br>Delete a file<br>Navigate from one folder to another<br>Navigate from one window to another<br>Use the keyboard to select commands<br>Customize the desktop<br>Use a find function to locate folders and files<br>Organize files and folders<br><br>***Desktop Publishing***<br>Customize rulers<br>Rotate text and images<br>Create a border around a text or graphics<br>Customize positioning guides<br>Customize layout guides<br>Adjust page margins<br>Adjust page layout<br>Insert a spreadsheet document<br>Insert a picture, object or file from a different source<br>Select several objects at a once<br>Alter the shading of a text or graphics frame<br>Use the print preview function<br>Use the zoom function<br>Create a desktop publishing template<br><br>***Online Communication Programs***<br>Connect to Internet and/or an on-line services<br>Use Electronic Mail (compose, send, retrieve, read, respond)<br>Access and use resources on Internet and World Wide Web<br>Use effectively distance learning, desktop video conferencing, and tele-teaching technologies |

Source: MONE (1999)

Figure 2.1 Computer Competencies that should be gained at each grade in primary education

Table 2.1 Analysis of Computer  Courses' Curriculum Content until 2003 in Turkey

| ICT Aspects | Items | Optional Computer Course (1998-2006) | | | | | Computer-1 (1992-2005) | Computer-2 | Information Technology - 1 (1994-) | Information Technology - 2 (1994-) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 4th | 5th | 6th | 7th | 8th | 9th – 10th grades | | 10th – 11th grades | |
| INTUSE | The Internet to look up information about people, things, or ideas | | | | | | + | | | |
| | Games on a computer | | | | | | | | | |
| | The Internet to collaborate with a group or team | | | | | | | | | |
| | The Internet to download software | | | | | | | | | |
| | The Internet to download music | | | | | | | | | |
| | A computer for electronic communication (e.g. e-mail or "chat rooms") | | | | | | + | | | |
| PRGUSE | Word processing (e.g. Microsoft Word or Word Perfect | | | | + | + | + | | | + |
| | Spreadsheets (e.g. Lotus 1-2-3 or Microsoft Excel) | | | | | | + | | | + |
| | Drawing, painting or graphics programs on a computer | | | + | + | + | | | | + |
| | Educational software such as mathematics programs | | | | | | | | | |
| | The computer to help you learn school material | | | | | | | | | |
| | The computer for programming | | | | | | | + | | |

Table 2.1 Continued.

| ICT Aspects | Items | Optional Computer Course (1998-2006) | | | | | Computer-1 (1992-2005) | Computer - 2 | Information Technology-1 (1994-) | Information Technology-2 (1994-) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $4^{th}$ | $5^{th}$ | $6^{th}$ | $7^{th}$ | $8^{th}$ | $9^{th}$ – $10^{th}$ grades | | $10^{th}$ – $11^{th}$ grades | |
| ROUTCONF | Start a computer game. | + | + | + | + | + | | | | |
| | Open a file. | | | | + | + | + | | | |
| | Create/edit a document. | | | | + | + | + | | | |
| | Scroll a document up and down a screen. | | | + | + | + | | | | |
| | Copy a file from a floppy disk | | | | | | + | | | |
| | Save a computer document or file. | | | + | + | + | + | | | + |
| | Print a computer document or file. | | | | + | + | | | | + |
| | Delete a computer document or file. | | | + | + | + | + | | | |
| | Moves files form one place to another on a computer. | | | | | + | | | | |
| | Play computer games. | + | + | + | + | + | | | | |
| | Draw pictures using a mouse. | + | + | + | + | + | | | | + |
| INTCONF | Get on to the Internet. | | | | | | + | | | |
| | Copy or download files from the Internet. | | | | | | | | | |
| | Attach a file to an email message | | | | | | | | | |
| | Download music from the Internet. | | | | | | | | | |
| | Write and send emails. | | | | | | + | | | |
| HIGHCONF | Use software to find and get rid of computer viruses. | | | | | | | | | |
| | Use a database to produce a list of addresses. | | | | + | + | + | | | + |
| | Create a computer program (e.g. in Logo, Pascal, Basic) | | | | | | | + | | |
| | Use a spreadsheet to plot a graph | | | | + | + | + | | | + |
| | Create a presentation (e.g. using Microsoft PowerPoint). | | | + | + | + | + | | | |
| | Create a multi-media presentation | | | | | | | | | |
| | Construct a Web page. | | | | | | | | | |

At this point, it is worth mentioning both the place of ICT in the curriculum reform initiated in 2004 and the relationship of curriculum reform with the PISA 2003 study. Within the 2004 curriculum reform, TTKB studied curriculum change for primary and secondary education with a holistic view in accordance with developments in Turkey and in the World (TTKB, 2004). In the 8th Five Year Development Plan, MONE was advised to develop the curriculum according the following points: (1) Continuity of Turkish Republic project founded by Atatürk through development, (2) Changes and developments in the world-especially in curriculum, (3) the EU norms, goals, and insight of education, and (4) assessing the existing education properties, evaluating success and failures and raising consequences. The findings of international studies such as PISA, the Third International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS) are considered in the fourth point (TTKB, 2004).

One of the basic components of new curricula is “to use informatics technology in an efficient and productive way for a certain purpose” (TTKB, 2004, p. 14). TTKB also stresses that the aim of the new programs is not to use ICT, but to utilize ICT effectively and efficiently in order to reach a specific goal. Parallel to this aim, the new curricula include systematic arrangements related to where ICT will be embedded in courses (TTKB, 2004, p. 14).

In summary, there was no formal computer education curriculum for basic education until 1998. Computer education started from the 4th grade, in the curriculum accepted in 1998. This development could be attributed to ICT objectives in BEP I. Within the curriculum reform of 2004, this curriculum was cancelled and a new curriculum for 1st – 8th grades was accepted. The new curriculum is more student-centered than the previous one. As of 2005, students in the first three grades were allowed to take optional computer courses. When the integration of ICT into other subjects is considered, it could be said that the curriculum reform that started in 2004 is the first apparent curricular evidence of integrating ICT into whole primary and secondary school curricula. In fact, hardware and in-service training are provided within BEP I, but only one optional computer course is added to the basic education curriculum. Göktaş (2003) also stresses that there is little evidence any effort to change the curriculum in basic education until 2003.

As to upper secondary education, optional courses, named Computer 1-2 and Information Technology 1-2, were added to the curriculum, but they are still optional courses. In 2005, the Computer 1 course was replaced with a new course, called Information and Communication Technologies, for the 9th grade (MONE, 2005b). Note that offering computer courses depends on the existence of IT rooms and computer teacher in primary and secondary schools.

## 2.2 Studies about the Integration of ICT into Education in Turkey

There is an agreement in the literature that nations should find ways to transform themselves into knowledge societies, in order to become competitive with others (Akkoyunlu, 1992; Aydın & McIsaac, 2004). Aydın and McIsaac (2004) deduce that if ICT is utilized in the best way, information technology can form the foundations for economic, social and educational transformation; can increase production of knowledge; and can be developed to meet local needs rather than using developed nations' own solutions.

MONE continues to purchase computers for primary and secondary schools, to train staff with in-service training through various projects, and to make attempts to increase available instructional software. Meanwhile, researchers have conducted a variety of studies to identify issues or problems in ICT integration, and have suggested strategies or possible prescriptive solutions to those problems. These studies focused on challenges faced by such different stakeholders as key policy makers, formator teachers, subject teachers, school principals, and inspectors. The issues and problems of ICT integration into K-12 schools in Turkey, and possible solutions recommended by the literature are presented in this section.

The need to integrate computers into Turkish primary schools as part of the country's transformation from an agricultural and industrialized society to a knowledge society was stressed by Akkoyunlu in early 1990s (Akkoyunlu, 1992), even though there was no significant ICT investment in primary schools at that time. In terms of the integration of computers into primary school curricula, Akkoyunlu (1992) also underlines the importance of very careful planning on many issues, such as selection of hardware and software compatible to each other and to the curriculum, integrating computers into other learning activities, and the training of teachers (p. 324).

Opinions of key policy makers were also a topic of research in ICT integration studies. Özar (1996) conducted a qualitative study to identify the opinions of key policy makers in MONE in terms of present and future uses of IT in Turkey. He interviewed fifteen key policy makers in the headquarters of MONE. Özar (1996) reports that almost all of the participants expressed that the Turkish education system as a whole was not ready for IT integration, due to a classical understanding of curriculum, teaching methods and the content of the courses in the educational system; teachers' lack of IT skills; and a lack of educational courseware. Issues that emerged from his study are a lack of good planning, a lack of curriculum revision and change, and the need for cooperation between the private sector and universities with MONE.

Özar (1996) inferred from his data three important mistakes in IT integration into schools, and he saw that these had led to the failure of IT integration planning up to 1996. The first is lack of well-planned IT implementation. The existing education system, in terms of physical and human resources, was not really well considered and evaluated before IT was introduced into the Turkish education system (10 out of 15 participants). Second, since the 1980s, the emphasis has been on hardware issues rather than on software (4 out of 15). This led to inefficient use of IT in schools. Third, in many schools computers seem to have been locked away (2 out of 15) due to teachers not understanding the fact that technology is changing rapidly and therefore these technological products will be outdated soon. Özar (1996) attributed these mistakes in IT policy to policy makers not understanding IT and to a lack of well-planned activities. The biggest obstacle to IT integration is teachers' lack of appropriate knowledge and skills, according to participants (8 out of 15). Lack of communication and cooperative work on ICT integration in MONE was another issue among his findings. Based on these results, Özar addressed some common areas that need to be considered in the integration of IT. These can be summarized as the needs for teacher training (8 out of 15), improvement of physical conditions, management of finance, preservation of national unity while giving autonomy to local authorities, and the necessity for contributions from the private sector and the universities (Özar, 1996).

In order to increase the number of computer teachers, selected voluntary subject teachers have been trained and given some special rights under the name of formator teachers or computer coordinator teachers, since the mid 1980s. These formator teachers were expected to train other teachers and students in computer literacy and to be agents of change for utilizing computers in educational purposes in schools. Various studies were conducted to investigate formator teachers' use of computers and the problems they encountered in schools (Akkoyunlu, 1995; Akbaba-Altun, 2006). For instance, in the months of July and September, between the 1991 and 1993, there were in-service training sessions for formator teachers. Along with this in-service training sessions, Akkoyunlu (1995) asked the 160 formator teachers to answer an open-ended question asking which obstacles they encounter when using computers in schools. Most of the respondents stated inadequate hardware; insufficient and low-quality software; inadequate number of teachers trained in computer skills, not having a computer laboratory in school; and the computer laboratory being kept locked. In the other study conducted between March 2003 and July 2004, Akbaba-Altun (2006) reported the problems of IT coordinators as insufficient in-service training (rare training sessions, problematic training in terms of quality of trainers and training not addressing the needs of adult learners), the ambiguity of their basic rights as State employees (conflict in their roles as subject teacher and formator teacher, retrenching of salary, supervision problems, lack of incentives for being formator teachers) and heavy workload (planning IT room schedule, being responsible for IT rooms' maintenance, helping subject teachers use computers for their courses, preparing in-service training for teachers and the public) (Akbaba-Altun, 2006).

There is no doubt that without teachers internalizing new technology as a tool in their instructional activities, all ICT investment would be a waste of time and money. Teachers' computer competency levels, the purposes and extent of their computer use, and the problems they face in ICT integration were described and analyzed by many studies. Çağıltay, Çakıroğlu, Çağıltay and Çakıroğlu (2001) conducted a survey study to investigate how teachers use computers in education and how they perceive the use of computers in education in Turkey. In 1998 spring, a questionnaire with 95 items was distributed to 202 teachers from a randomly selected 27 schools in three cities in the middle and western part of the country. The most frequently selected purposes for computer use are preparing examination questions, calculating student grades and administrative tasks. From a given list of problems which they may face in integrating computers in the curriculum, teachers selected the following three problems: (1) lack of access to a computer, (2) their own insufficient experience in computer use, and (3) inconvenience of curriculum structure for integration of computers. Only 21% of the teachers in the sample had taken in-service training in computer skills. Based on the results of this study, the authors identify the needs of teachers is access to computers and in-service training on computer skills and on how to use computers in the curriculum (Çağıltay et al., 2001).

In a similar study, Usluel and Aşkar (2002) aimed to identify the purposes of teachers in using ICT. The study's sample covers 638 teachers from 27 primary schools, and data were collected with a questionnaire. Based on the findings, they reported that computers in schools have become widely used for administrative purposes, such as preparation of lesson plans and unit plans, organizing students' scores and reports, and writing official letters. Computer use in instructional activities is not observed more frequently than in managerial tasks. The major computer uses reported in instructional activities were as a presentation tool during lessons and for experiments. Thus, it could be inferred from the results of Çağıltay et al. (2001) and Usluel and Aşkar (2002) that teachers were using computers mostly for administrative tasks until the early 2000s.

Çağıltay et al. (2001) also asked teachers to identify what their schools needed in order to integrate technology into the curricula. The teachers who worked in schools with IT rooms gave priority to the following needs: (1) computer training for teachers, (2) opening the IT rooms for general use, (3) technical support personnel trained in computers, (4) a computer that teachers can use. The other teachers, who worked in schools without IT rooms gave priority to the following needs: (1) computer training for teachers, (2) at least one computer for each classroom, (3) technical support personnel trained in computers. According to these results, the most urgent need for integration of computers into the curriculum is increasing teachers' knowledge about and experience with computers. This is an important issue that also emerged in Özar's study (1996). The second most common need recommended for schools by the two groups of teachers is technical support personnel trained in computers.

Aşkar, Usluel and Mumcu (2006) conducted a causal-comparative study to predict ICT use in teaching preparation, teaching, and administrative tasks from teachers' perceptions about the innovation characteristics of ICT. Innovation characteristics are relative advantage, compatibility, complexity, trialability and observability, which hinder or facilitate diffusion of innovation (Rogers, 1995). The sample was 416 secondary school teachers in Ankara. The data was analyzed with logistic stepwise regression. The results of the study show that complexity -i.e. ease of use- is a common by perceived innovation characteristic of computers for teaching preparation, teaching delivery and managerial tasks in schools. Observability of computer use was a perceived attribute in teaching delivery in some specific tasks during lessons, whereas the relative advantage and compatibility of computers are for teaching preparation tasks. Aşkar, Usluel and Mumcu (2006) state the importance of employing new strategies to decrease the perceived complexity of ICT, for the diffusion of ICT in schools. For this aim, besides nationwide solutions, they propose school-based solutions as more realistic in the diffusion of computers for instructional purposes, such as ongoing and immediate technical and educational support, and early familiarity with ICT. Remember that Çağıltay et al. (2001) arrive at such a conclusion.

Aşkar, Usluel and Mumcu (2006) also suggest some strategies to exploit the observability feature of ICT for the diffusion of ICT in teaching delivery, such as giving teachers the opportunity to observe ICT integration done by their colleagues in the classroom, and demonstrating use of instructional technology in in-service training.

Within the framework of the National Education Development Project implemented in 1990-1999, the Higher Education Council (Yüksek Öğretim Kurulu-YÖK) made some significant efforts to raise the quality of teachers. In order to respond to the changing needs of the society and to increasing problems in the education system, teacher training programs were restructured in 1998 to produce more teachers for basic education. Within this restructuring, a program and departments of Computer Education and Instructional Technology (CEIT) in schools of teacher education were opened, to meet the need of computer teachers in primary education (YÖK, 1998). On the other hand, a compulsory computer course was added to all teacher education programs (including classroom and subject teacher programs) to improve teachers' computer literacy. In addition, as an extension of this computer course, an Instructional Technology and Material Development course was added to new formation courses with the aim of raising teachers' utilization of advanced instructional technologies in the teaching and learning environment (YÖK, 1998). It is noteworthy that there is a parallelism in TTKB's acceptation of computer courses for 4th – 8th grades and YÖK's opening of CEIT programs, both being implementations within the National Education Development Project. Of course, such synchronization among institutions in policy implementation is needed for more successful results.

In his comparison of teacher training schools in terms of ICT inclusion across the EU and Turkey, Göktaş (2003) comments that a pedagogical use of ICT is needed in both preservice and in-service training of teachers, in addition to basic ICT skills for successful integration of ICT into education (Göktaş, 2003). It appears that either the impact of the restructuring of programs in faculties of education by YÖK in 1998 could not be felt, or there are problems in the implementations of the programs. However, Göktaş (2006) investigated the current status of ICT integration into preservice teacher education programs in Turkey and arrived at a conclusion supporting the 1998 restructuring of teacher education programs by YÖK.

Towards the completion of the first phase Basic Education Project (BEP I), some studies were conducted to assess the ICT component of BEP I (e.g. Yıldırım, 2007; Akbaba-Altun, 2006; MONE, 2005a; & Bhullar, 2005). Yıldırım (2007) examined teachers' use of ICT in Turkish basic education schools and investigated the barriers to effective technology integration. The data on extent and type of ICT use and ICT competency perception were obtained from 402 (97 female, 305 male) basic education teachers, through questionnaires. Afterwards, as a follow-up study, 72 of these teachers responded to open-ended questionnaire designed to investigate the barriers to technology integration. Results indicated that teachers use computers most frequently for preparing handouts and tests, and, parallel to this, feel most competent in word processing. Contrary to these, the least frequent use of computers was with instructional software and, naturally, they felt least competent in the use of instructional software. As to the barriers to effective technology integration, Yıldırım

(2007) infers that the most detrimental factors to successful technology integration in schools were overcrowded classes, inadequate in-service training, lack of timely technical and pedagogical support, inflexible school curricula, lack of incentives, lack of sound leadership, lack of clearly stated goals and expectations from ICT, and lack of collaboration among teachers. Based on these findings, Yıldırım (2007) stated that most teachers did not use ICT to promote students' attainment in areas across the curriculum, in basic education schools in the 2002 conditions of Turkey. In order to be successful in educational reforms, he proposes that the teachers should be empowered through appropriate preservice and in-service training, led by a powerful leadership, provided with necessary incentives, and continually provided with technical and pedagogical support. Otherwise, ICT investments will fail and new issues will be added to the existing ones in the education system (Yıldırım, 2007).

In another study, Akbaba-Altun (2006) investigated issues in integrating computers into the Turkish school system (which is highly centralized) from the perspective of formator teachers, school principles and inspectors. Fifteen IT coordinators, and 17 school principals in one city in the Western Black Sea Region were interviewed and 151 elementary school inspectors from eight different cities responded to a survey. Data was analyzed with content analysis. Infrastructure, personnel, curriculum, administration, and supervision were found as ICT implementation issues. The infrastructure issue addresses physical settings -buildings and classrooms, equipment- security, breakdowns, and maintenance; personnel issues were related to formator teachers and other teachers; curricular issues were design, development and implementation of curriculum, materials, assessment, and delivery of instruction; administrative issues were responsibility and anxiety at school level and conflicting roles and communication breakdowns at national level; and finally, the supervision issue was a lack of standards in supervision of IT rooms and the limited or non-existent computer experience of inspectors. Although formator teachers and inspectors mentioned all those issues, school principles only mentioned on infrastructure and personnel as problems and issues with IT rooms. More specifically, the following implications could be drawn from the findings of her study:

- The more problems in the education system, the more challenges in integration of ICT into that education system. Thus, a collaborative organizational approach should be adopted and each unit in the headquarters of MONE should perform a collaborative effort towards this aim.
- Hardware, software, especially in the native language, Internet access and computer peripherals at schools are insufficient.

- There are design faults in the establishment of IT rooms in terms of cabling, ergonomics and security.
- Teacher's in-service training is insufficient and of a low quality. Given by badly-qualified trainers, the training sessions do not address teachers' needs and knowledge levels and do not involve hands-on activities.
- The computer curriculum for grades 4-8 is nearly the same, the design is far too spiral.
- The software sent to schools is not appropriate to the level of students. Except for English courses, other content teachers do not use multimedia or videotapes in their courses. No needs analyses were conducted at schools before sending instructional software to the schools. Schools cannot purchase software.
- Lack of leadership at schools in ICT integration. School principals do not support ICT integration at schools (Akbaba-Altun, 2006).

Akbaba-Altun (2006) deduces that investment in human capital is as important as investment in technology. Thus, she proposes well-planned and up-to-date training to be conducted not only for teachers, but also for supervisors, school principals and formator teachers for successful ICT integration. She underlines the necessity of developing and implementing vision and mission to minimize problems and issues at school and at national level (2006).

MONE and the World Bank reported their evaluation of BEP I. MONE conducted an impact study of BEP I, analyzing the effect of IT rooms in 2004 (MONE, 2004). According to MONE, the results show that IT rooms enable administrators, teachers and especially students to have access to ICT. Furthermore, two-thirds of students are provided with computer access and more than half of the students have computer access only in school. When schools are considered, almost one-third of schools have their own web pages or they have started to develop them. Another noteworthy finding was that all teachers perceive IT rooms as laboratories established for computer lessons rather than as an environment that they can use in their own lessons; thus, teachers who have taken in-service training on computer literacy need to be well informed on the goals of IT rooms. This report also pointed out inadequacies in educational software and technical support, a lack of any factor encouraging or compelling teachers to use computers for educational purposes with the exception of preparing annual course plans, the non-existence of computers in teacher's room at half of the schools, generally keeping IT rooms under lock and key, and the limitedness of Internet opportunities (MONE, 2004). MONE proposes that establishing ADSL connections to IT rooms is an important step toward solving the Internet problem. It was seen that school administrators do not open IT rooms for the use of students and public out of school hours because of security and management problems (MONE, 2004). This drastic finding was also mentioned in several studies (Özar, 1996; Akkoyunlu, 1995), and indicates that not much has changed about keeping IT rooms locked from the point of most principals since 1984.

After completion of BEP I, the World Bank also reported some mistakes of MONE and made a self-criticism related to the ICT components of the project (World Bank, 2004). It criticizes MONE for not preventing administrative and purchase delays in educational material provision, for not writing a policy on how to integrate ICT into the curriculum, and for not completing ICT impact study before BEP I completion date. The World Bank wanted the Government to prepare and update the IT policy paper and formulate a strategy "to integrate IT into the curriculum and teacher training" (pp. 8-9). The IT policy paper and ICT impact study were not completed before the project closing date. The World Bank also pointed out that subject teachers were not trained in "how to integrate computers into their lessons". On the other hand, the World Bank made a self-criticism in the same report, for placing extensive emphasis on solving problems related to procurement and financial issues instead of focusing on outcomes, and for not to synchronizing training of formator teachers and computer provision to schools. In addition, it note that it had not continuously sought opportunities, or entry points, to engage in dialogue with the Government on other aspects of education quality, such as review of the curriculum and content of teacher training (World Bank, 2004). It is understood that the World Bank discerned that solely providing of educational materials in terms of hardware and software will not lead to increased educational quality without considering the other parts of the education system, such as curriculum and teacher training at the end of BEP I.

The World Bank states that there is no evidence of improvement in the quality of basic education or of improvement in computer literacy penetration through BEP I (World Bank, 2004). Nevertheless, this organization admits that the potential uses of computers in schools are many and implementation processes are long-term (World Bank, 2004). In this sense, the World Bank claims that the ICT investments in BEP I could set the preconditions to achieve more ambitious goals for the future, which include radical change of school culture. Thus, the World Bank does not draw final conclusions about the efficiency of ICT investments in BEP I, rather, they only report their formative evaluation (World Bank, 2004).

In order to propose suggestions for issues of ICT integration in Turkey raised in the reports of MONE (2004) and the World Bank (2004), Bhullar (2005) conducted a document analysis on ICT policies and implementations in 15 countries, from North and South

America, Europe and Asia. Based on the experiences of these countries, Bhullar proposes ICT-in-education policies and strategies. At the end of her analysis, Bhullar concludes with the following four policies and related strategies at a national level for Turkey:

**Create a responsive educational system:** The critical success factor for ICT integration into schools in Europe, North America and Asia is the creation of an education system responsive to the needs of a knowledge society.

Creating new knowledge and information should be emphasized, rather than rote learning.

There should be a focus on more individual learning in the education system (Differentiate approaches used in teaching and learning considering students' different aptitudes and learning habits).

More creative and self-directed education methods should be introduced (employ real life problems and solutions)

**In order to optimize the value of new technologies in schools, IT resources should be given directly to the teachers and students so that they may find new ways of using these technologies:** While technology advances, an attitude shift in instruction towards learning is necessary. Traditional teaching and learning do not fit with ICT integration.

**A holistic approach beyond the technological dimension is needed to effectively integrate ICT into education policy:** Successfully utilizing the potential of new technologies (multimedia, and Internet etc.) in education depends far more on pedagogical and organizational issues than on technologies themselves. The ICT-in-education policy should consider other aspects, such as curriculum assessment, the professional development of teachers, research and development, ICT resources and fund generation.

**Accumulation of capital and workforce is not sufficient in competition between countries:** The capacity of the workforce to generate knowledge must be continuously promoted. For this aim, an ICT-in-education policy should be implemented so as to complement and support other development strategies, instead of being formulated in isolation (Bhullar, 2005, pp. 112-113).

Bhullar (2005) explains the importance of arrangements in policy and the regulatory environment, such as clearly defining the roles and responsibilities of all departments in the ICT integration process, transforming education policy into action, educating students regarding the use of Internet, and improving access and equity to narrow the digital divide.

As to policies at school management level for successful integration of ICT into education, Bhullar (2005) proposes that optimization of the potential of ICT in education necessitates a shift in the learning paradigm. ICT provides possibilities for changing both the ways students learn and teachers teach (Bhullar, 2005); thus, curriculum, learning objectives, teaching strategies and activities in the classroom should be changed in the light of a paradigm shift in the concept of learning. For successful ICT integration, Bhullar (2005) suggests three policies at school management level:

1. Creating ICT vision and strategy in schools
   - Top-down strategies will not work
   - Create a shared vision and decide strategies together with all stakeholders affected from the outcome of ICT integration (teachers, students, parents and the community)
2. Putting together an ICT integration plan
   - To promote use of ICT in schools, MONE should set guidelines, rather than imposing rules or regulations.
   - To promote ICT use in schools, school managerial staff should initially adopt strategies that make ICT a part of the daily routine of teachers.
   - Schools should have a master ICT integration plan customized to their own school culture and environment.
   - An ICT integration plan should detail how teachers are expected to use technology in lessons.
   - Making such a plan is complex and time consuming, but worthwhile.
3. Giving schools some autonomy to select ICT resources that are most suitable to the needs of students and teachers
   - MONE should provide basic technological infrastructure
   - MONE should let schools decide on the kind of ICT resources and tools that they need, based on their own vision and analyses of students' learning needs
   - Better ICT integration in the curriculum is ensured only if the fact that every school is different is recognized
   - There is a need for strong and committed leadership of technology integration (Bhullar, 2005, pp. 112-115).

The suggestions of Bhullar (2005) for successful technology integration at school level could be summarized as follows: schools should create their own vision and strategy based on a comprehensive needs analysis about teaching and learning at school, and should make an ICT integration plan together with all stakeholders. Another important point is that schools should have some autonomy to decide an ICT equipments based on their own needs.

Şahinkayası and Şahinkayası (2004) also emphasize a lack of regional or school level instructional technology planning in Turkey. In their study, they attached importance to the integration of ICT into schools within instructional technology planning. Based on Anderson (1996, 1999) and Anderson and Perry (1994), they give the definition of an instructional technology plan, comment on its indispensible components and provide suggestions for developing and implementing a successful instructional technology plan. They point out that a well-prepared instructional technology plan should be developed by all stakeholders for the proper integration of ICT into school, and it should include student, teacher and school characteristics and the components of the instructional technology plan such as: vision and mission statements, needs analysis, implementation and working schedule, professional development, maintenance and support, budget and financial resources, standards, instructions, security, moral issues, and evaluation. Özar (1996) indicates the need to develop a policy document to be used in schools, as well. This document should address long and short-term goals, resource management, technical support, staff development, and student entitlement etc. Furthermore, as he states, this policy document should be revised regularly to keep up with recent developments. Aşkar (2004) also states that for an efficient use of ICT facilities, schools should have a vision about the use of ICT, a technology plan, a support mechanism for teachers, technology integration plan for each subject, collaboration with computer teachers, and evaluation works (as cited in Tuti, 2005).

Gülbahar (2007) presented the process of conducting the technology planning and indicated the important components of technology planning by reporting the technology planning process for a private school. In this private school, she collected data from 105 teachers, 25 administrative staff, and 379 students through questionnaires. Besides, she conducted unstructured interviews with the administrative staff and teachers to validate the questionnaire results. She descriptively analyzed the data to investigate the administrators' and teaching staff's perceived computer literacy, and issues related to ICT use. She also investigated students' perceptions about the current utilization of ICT in their school. In her study, she illustrated how these obtained data could be used in technology planning. For a successful technology integration in schools, Gülbahar (2007) suggests the technology plan should especially guide the school staff in the following aspects: (1) maintenance and continuous update of the technology plan, (2) hardware and software maintenance and update, (3) equity of access to technological resources, (4) providing support services for teachers and administrative staff, (5) reward systems that encourage teachers and administrative staff to use technology, (6) integration of instructional technologies into the curriculum, and (7) in-service training. Gülbahar (2007) concluded that teachers and administrative staff felt themselves competent in using ICT available at school, but they reported a lack of guidelines that would lead them to successful technology integration. Students reported that ICT is not utilized sufficiently in their classes.

### 2.2.1 ICT Use, Competency and the Feelings of Students in Turkey

Yalçınalp and Yıldırım (2006) conducted a descriptive study on Turkey's ICT data in PISA 2003 to analyze ICT demographics, the perceived frequency of ICT use, perceived ICT competency, and feelings about ICT. They also analyzed the differences between males and females in these aspects, with t-test. Firstly, for ICT demographics, they report location of computer access, how long the students have used computers, and from whom they learned computers and Internet. Most of the students have access to computers from other sources (73.4% of 3,458 students), while more than half of the students use computers (53.6% of 3,488 students) at school and only 37.2% of students at home (N= 3,367). Two thirds of the students had been using computers for three years or less. Almost one third of the students reported that they learned to use the computer and Internet by themselves. Only 29.2% students stated that they learned to use computer at school. It is noteworthy that around half of the students who have computer access at school reported that they learned to use computers at school. As to Internet, only 9.7% of students stated that they learned to use Internet at school. The lower proportion of students who had learned Internet at school than those who learned computer at school could be due to the existence of IT rooms with lack of or slow Internet access in the 2003 school conditions. Secondly, for frequency of computer use and computer competency levels, Yalçınalp and Yıldırım (2006) report that 41.1% of students used computers at school a few times each week. They claim that ICT was used more actively with the employment of more computer teachers in schools in recent years. Thirdly, the results indicate that students feel most confident in playing games (79.7%), starting games (78%) and drawing pictures with the mouse (76.8%), while they feel least confident in using antivirus programs (20%), designing web pages (27%) and programming (28%). Finally, the majority of students had positive attitudes towards ICT (85.6% of them saying they agreed or strongly agreed to four positively stated attitude items).

Tuti (2005) conducted a descriptive and correlational study to investigate the use of ICT, according to the performance indicators in the use of ICT in education, students' computer self-efficacy and students' opinion of ICT at lower secondary schools. Her sample was 1014 seventh grade students in 24 basic education schools (19 public, 1 private, 2 BEP, and 1 MLO - Müfredat Laboratuar Okulları) in Çankaya region of Ankara. She administered a survey consisting of an ICT questionnaire, computer self-efficacy measures and opinion of ICT measures. The performance indicators were access to computers, use of computers, use of Internet and use of ICT in education.

Her study also indicated that students' self-efficacy towards computer is high (its mean is 3.8 out of 5) and their opinions about the ICT use in education are positive. However, when the school type is taken into consideration, students who have the lowest self-confidence are from public schools, while students who have the highest self-confidence are from the private school. She stated that the access and use of ICT varies according to school type. That study also showed that computer self-efficacy of students who attend a school with IT room and had taken computer courses is significantly higher than that of students who attend a school without IT room. Tuti (2005) concluded that ICT facilities available for students at school positively influence students' computer self-efficacy.

According to the results, 56.6% of the students have computer access at home. Students use computer at school mostly in IT rooms (46.4%). Very few students stated that they use computers in such different places as, multimedia room (6.5%), library (6%), science laboratory (5.6%), and the classroom (2.3%). However, 60.8% of students reported that they do not use computer in the school. She detected a dramatic difference between students of public school (other than BEP or MLO) and students of private schools in access to ICT. Access to ICT is widespread for the private school students, while it is almost none for the public school students. Furthermore, 22.8% of the students stated that they have never used computer before and 67.8% of them stated that they have never used the Internet. From computer users, 29% of them also reported that they never use computer for educational purposes. Only 38% of students stated that they use computer for educational purposes once a week. If teachers and families guide students about how to use computers and Internet, then these tools can become useful and appropriate (Tuti, 2005).

She deduced that families have an important role in students' using computers, since most of the students reported that they had learned using computers from their family or by themselves. ICT use out of school generally occurs at home and in Internet cafes. The results also indicated that very few students use educational software (less than %2).

When she examined the use of ICT in lessons, she concluded that science is the course in which ICT is mostly used. Thirty percent of the students stated that they use ICT in science courses, while 22% in social science, 19% of them in Turkish Literature courses, 17% of students stated that they use ICT in mathematics courses, 14% in foreign language courses and 7.5% in painting and 6.8% in music courses.

### 2.2.2 Comparison of Turkey and the EU in Integration of ICT into K-12 Schools

There are studies and documents comparing and contrasting education systems, particularly ICT facilities and utilization in primary and secondary schools in Turkey and in the EU (Göktaş, 2003; Uşun, 2004; Yıldırım, 2006).

Göktaş (2003) conducted a document analysis to identify similarities and differences between the education systems of Turkey and 15 EU member states regarding integration of ICT into primary education curricula and teacher education programs. In his thesis, Göktaş (2003) outlines the relationship between Gross National Income (GNI) per capita, population, and possession and utilization of ICT. As GNI per capita increases, the ICT possession rate also increases. On the other hand, there is an inverse relationship between size of population and ICT utilization. Countries with smaller populations have more ICT possession and ICT utilization.

As to a comparison of the EU member states and Turkey in terms of ICT inclusion in primary education, ICT at primary education has become an integral part of the compulsory curriculum in many EU countries (Eurydice, 2001a). Furthermore, ICT is seen as a tool to be used throughout the whole curriculum, which is reflection of the policies and initiatives in most EU countries. In Turkey, on the other hand, primary school curricula include only an optional computer course, and offering that course generally depends on school conditions or students. Göktaş (2003) reports that at the time of his research there is little evidence of conducting a serious revision of that curriculum to increase the use of ICT. On this basis, he suggests that primary education curricula should include ICT as a must course whose objectives are more applicable and relevant to daily life. Turkey has to take measures to meet the EU standards for ICT integration into her education system (Göktaş, 2003). Note that the curriculum reform in 2004 still includes ICT courses as optional, not must courses.

Uşun (2004) conducted a document analysis in order to review, compare and contrast the applications of instructional technologies in Turkey and developed countries. He focused on distance education, use of Internet, and Computer Assisted Education (CAE) as methods and media in his study. First, although the number of computers is increasing at schools, Turkey is still at the very early stages in CAE projects, applications and studies compared to developed countries (Uşun, 2004). According to Uşun (2004), in spite of initiatives taken by MONE to promote computer literacy and the use of CAE in schools, from 1984 through 2002, unfortunately, computer education and CAE were still in the early stages of development. As he points out, even the main components and aims of the first project (CAE project) launched in 1984, couldn't be realized. In the other projects, supported by the World Bank in 1998, the 53 CES project in 1993 and BEP I, the main components and aims had also not been realized. However, according to Uşun (2004) these projects appear to be very important steps for the Turkish education system. He infers the major problem areas of CAE in Turkey as effective planning and administration of CAE projects, insufficient financial resources, lack of adequate software, hardware and teacher training for CAE, and the lack of the projects and experimental studies on the computer education and CAE (Uşun, 2004).

Second, despite some extensive initiatives and projects to integrate Internet into the Turkish education system since 1990 (e.g. computer experimental schools and computer laboratory schools), Uşun (2004) draws attention to the nonexistence of an infrastructure of computer networks in primary and secondary education schools, due to the highly bureaucratic and centralized nature of MONE. The educational uses of the Internet were still in their infancy compared to developed countries (Uşun, 2004). After his comprehensive literature review on instructional technology utilization, Uşun (2004) concluded, "Although Turkey considers itself part of the European community, its educational problems place it rather with its Asian neighbors" (p. 270).

Uşun (2004) accounts for the rapid development of the technology access rate at schools in developed countries, as well. According to him, this could be due to the relative advantaged position of developed countries in the following factors: locally achieving technological advancements -no import cost, capable of producing products meeting local needs, quick delivery, and support services-; support to schools by individuals besides the government; existence of clearly specified policy documents supporting teachers in using technology for teaching and learning; and available research funds for evaluation of media effects, the results of which are a base for future planning (Uşun, 2004, p. 250-251).

Yıldırım (2006) compares and contrasts Turkey and the EU member states in terms of the role of ICT in education. According to Yıldırım, the number of students in the education system, economic indicators and budget allocation per student are the most detrimental factors for the role of ICT in education. Serving a large population increases the problems in the Turkish education system compared to the EU member states. Turkey's economic indicator of per capita was around $6,900 in 2005 while that of the EU member states with similar populations are above $27,000. Similarly, although 3.8% of the budget was allocated to education, educational expenses per student were below $700 in Turkey. This amount is much lower than the EU member states that allocated around $5,000-7,000 to education. Turkey allocates only 15% of the average budget allocation of the EU to education per student. ICT investments are also met from this budget. Schools offering high quality education are very few compared to schools offering low quality education.

According to Yıldırım (2006), the primary goal should be spreading the standards of those schools offering high quality education to those offering low quality educations. ICT plays an important role in sharing limited resources to spread quality. In this sense, Yıldırım (2006) suggests that:

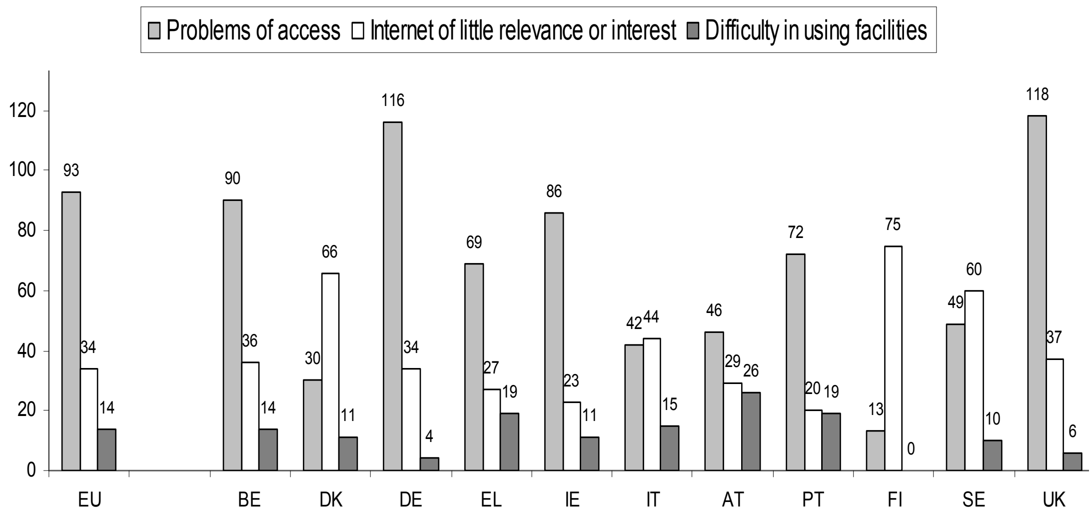
- In order to digitize and share high quality educational content, Turkey has to invest in ICT
- Successful teaching methods have to be shared with other teachers via ICT to increase quality of education.

Putting ICT into schools, maintenance of those ICT at schools and employing teachers in such a profile that he/she leads other staff in using ICT at schools are crucial for Turkey as a candidate for EU membership (Yıldırım, 2006).

## 2.3 ICT Integration Issues from Other Countries

Eurydice (2001a) concludes that non-use of the Internet by teachers in their classes is largely attributable to difficulty in accessing the Internet in European countries. The teachers lay down three major reasons. Firstly, problems of Internet access at schools because they are not equipped with computers or have no Internet connection, or because classrooms themselves do not provide for an Internet connection. Secondly, and much less frequent, are reasons concerned with the lack of relevance of the Internet to their teaching, either because teachers consider that there is no need to turn to the Web for one or more subjects on which they work with their students, or because they believe that information available on the Internet is difficult to use because it is in a foreign language. Finally, the least commonly cited reasons are those related to lack of familiarity with the Internet on the part of students or the inability of teachers to use it. The foregoing ranking of factors is the same in the majority of the cases in the EU member group (see Figure 2.2).

Mumtaz (2000) conducted a review of literature about factors influencing teachers' decisions to use of ICT in the classroom. The review indicates three interlocking factors that affect teachers' use of ICT: institution (school), resources, and the teacher. More specifically, access to resources, quality of software and hardware, ease of use, incentives to change, support and collegiality in their school, school and national policies, commitment to professional learning and background in formal computer training are the factors affecting teachers' decisions (Mumtaz, 2000). Based on this review, Mumtaz (2000) underlines the role of pedagogy and suggests that teachers' beliefs about teaching and learning are central to ICT integration.




Note: The percentages shown are sometimes over 100, because teachers were able to give several reasons for not using the Internet.

Figure 2.2 Reasons given by teachers for not using the internet with students, represented in percentages. Secondary education (ISCED 2 and 3), 2001

Reynolds, Treharne and Tripp (2003) conducted a survey study in secondary schools in the UK to asses to what extent ICT facilities exist and how they are used by teachers. They selected twenty schools by stratified sampling, representing all social backgrounds. They visited schools for half a day. At each school, they interviewed the ICT coordinator (to get an overview of the school's ICT resources and how they are used), subject teachers using ICT in different ways to teach (how they use ICT and their opinions about the most effective use of ICT for teaching their subjects) and students. If possible, a lesson illustrating the use of ICT was observed as well.

Reynolds, Treharne and Tripp (2003) compared their results with the standards specified by the Office for Standards in Education, Children's Services and Skills in England (the non-ministerial government department of Her Majesty's Chief Inspector of Schools in England) for secondary school ICT provision. The first requirement is ICT provision. Almost all of the school staff said that their ICT needs were not fully met. The second requirement is provision of good Internet access. Most schools achieved this, but computer crashes or network problems were the most significant factor discouraging teachers from using computers. Only the existence of an ICT technician during lessons increased the confidence of teachers in using ICT. Standards related to IT rooms were also met by most schools, such as good lighting, being comfortable with sufficient space for students to work away from computers, and for teacher to move around and talk to individual students. Only IT rooms converted from existing classrooms had some accommodation problems. Another finding was a lack of comprehensive provision of digital projectors, and a need for further training of teachers in using this equipment, a need for an efficient and equitable reservation system for IT rooms, and a lack of increase in ICT facilities parallel to in-service training of the staff on ICT.

Reynolds, Treharne and Tripp (2003) conclude that if a school has a strong whole-school ICT policy, lead by an expert in ICT, its teachers are more confident in using ICT for teaching because of feeling that the necessary support exists. The other essential factor for ICT use in schools is that teachers need to believe that ICT will improve their teaching and their students' learning. According the results of their survey, 83% of teachers said that they believed ICT in raising learning standards. The researchers argued, "Yet, we wonder, why is it a belief instead of a reality after the investment of so much in terms of both money, time, commitment and energy in ICT over the past twenty years?" (p. 166). Based on this issue, they claim that acceptance of the human factor besides the financial, social and organizational costs of using ICT is still lacking. At this point, that teachers' beliefs about teaching and learning play a crucial role in integrating ICT into schools is stressed by Reynolds, Treharne and Tripp (2003), like Mumtaz (2000).

It is intriguing that teachers' need for in-service training in using computers or utilizing computers in their teaching is not an issue in the study of Reynolds, Treharne and Tripp (2003). The reverse is the case in Turkey, where almost all studies on ICT integration indicates urgent need for better professional development system for teachers on ICT literacy and ICT integration.

Addo (2001) puts forth a number of factors as barriers to utilization of IT for education and development in developing countries, especially in Africa. These are lack of good, reliable and adequate infrastructural system including the supply of electricity, a conducive computer environment and telecommunications; a non-literate population; lack of finance (foreign exchange); multiplicity of languages (whether IT alone could enable sharing of information); lack of national information technology policies; and rapid and technological advances and changes (Addo, 2001). He concludes that developing countries need to develop a strong commitment to research and take advancement of local knowledge through its own research. Otherwise, as Addo claims, developing countries will always have to rely on and follow the developed nations for knowledge and development.

## 2.4 ICT and Attainment

### 2.4.1 International Studies Comparing Student Achievement across Turkey and the EU

Berberoğlu (2005) examined various international and national student achievement assessments to examine student performance levels across Turkey and the EU countries. He analyzed the TIMMS 1999, PIRLS 2001, the 2000 National Assessment Program for lower secondary schools and PISA 2003 data. The PISA mathematics scale uses six proficiency levels to describe student performances, Level 1 is the lowest and Level 6 is the highest. The mean score of Turkish students corresponded to level 2 (423), while students from most OECD countries performed at level 3. Then, Turkish students can make direct inferences and extract relevant information from a single source, use single representations, carry out algorithmic calculations, and their reasoning skills are limited to direct procedures (Berberoğlu, 2005). He (2005) points out that almost 28% of 15-year-old students in Turkey performed at the bottom proficiency level (Level 1), and over 50% performed at level 1 or 0 on the PISA 2003 mathematics scale. The proportion of students in these two bottom categories is larger than the average proportions of students in these categories in the OECD and the EU countries. Ironically, 2.4% of Turkish students performed at sixth proficiency level (Berberoğlu, 2005). He underlines that this proportion is larger than some EU member states like Italy (1.5%), Portugal (0.8%), Greece (0.6%), Spain (1.4%), and Latvia (1.6%). He (2005) concludes that Turkish students on average do not perform beyond certain basic computational skills and demonstrate only a basic understanding of concepts in mathematics and science, considering the results of both TIMSS and PIRLS in terms of student learning achievement. As to reading skills, they generally can only retrieve explicitly stated information from a text.

Berberoğlu (2005) also investigates how differences in region, gender, and school type affect learning outcomes in Turkey. He detected striking differences in student achievement between two groups of schools: (1) Schools having very low student performance: general high schools, vocational high schools, Anatolian vocational high schools and basic education schools, (2) Schools having high achievers: science lycées, Anatolian high schools, and police colleges. He (2005) states that the differences between types of schools in terms of student achievement are significant and have a large impact, but still they are not as severe as the differences between regions. Further analyses indicated that the difference between two groups of schools could be due to student-related characteristics, such as mathematics self-concept and mathematics efficacy, anxiety about mathematics, and climate in mathematic lessons (Berberoğlu, 2005). Based on these results, he (2005) proposes that more emphasis should be placed on reducing the achievement gap between different school types, particularly by providing more resources and spending greater effort in raising students' learning achievement in general secondary and vocational schools.

### 2.4.2 Meta-analysis Studies

There are many meta-analysis and literature review studies designed to measure the overall effect of ICT use on student achievement. However, the literature on the effect of ICT on achievement is still inconclusive and leading to merely tentative conclusions (Kulik, 2003). Yet, as a field, IT is newly developed with around 50-years of study in the field at most. So, the field is still transforming, based on lessons learned from its past. In the field professionals go on to study the interaction between learner characteristics, learning tasks and media attributes for designing better learning environments.

Two recent studies, one from the USA and one from the EU are reported in this section. Kulik (2003) conducted a meta-analysis on studies conducted in American elementary and secondary schools published since 1990 and on reviews of studies published before 1990. Effect size measures were used to summarize his findings. Kulik (2003) contends that schools have become more successful in utilizing instructional technology in teaching and learning in the 1990s compared to earlier years. He relates this improvement to two reasons. First, computer technology has become more user-friendly, faster, and more sophisticated than it was three decades ago. Second, students are more familiar with the use of ICT and many teachers have comfortably been able to use instructional technology. Based on his meta-analysis results, he comes up with tentative conclusions related to the use of instructional technology to improve instruction in reading, writing, mathematics and natural sciences. Related to mathematics, he claims that ICT often improves student achievement in mathematics with a .40 median effect size in seven studies. He states that especially Integrated Learning Systems (ILS) software has been producing positive results in mathematics programs for decades. ILS comprises software programs that provide sequential instruction for students over several grades, while keeping extensive records of student progress. Most ILS programs use tutorial instruction as a basic teaching methodology, and most of them provide instruction in the basic skill areas of reading and mathematics (Kulik, 2003).

The other review of literature about the impact of ICT on schools was conducted in the European context by Balanskat, Blamire and Kefala (2006). In their study, the six studies they reviewed are more quantitative based, and tried to establish a causal link between use of ICT and students' outcomes based on analyzing the statistical relationship between use of

ICT and students' results in exams or tests. They conclude with the following statements, based on those quantitative studies about learning outcomes:

> 1. ICT impacts positively on educational performance in primary schools, particular in English and less so on science and not in mathematics.
>
> 2. Use of ICT improves attainment levels of school children in English- as a home language- (above all), in Science and in Design and technology between ages 7 and 16, particularly in primary schools.
>
> 3. In the OECD countries there is a positive association between the length of time of ICT use and students' performance in PISA mathematics tests.
>
> 4. Schools with higher levels of e-maturity demonstrate a more rapid increase in performance scores than those with lower levels.
>
> 5. Schools with good ICT resources achieve better results than those that are poorly equipped.
>
> 6. ICT investment impacts on educational standards most when there is fertile ground in schools for making efficient use of it.
>
> 7. Broadband access in classrooms results in significant improvements in pupils' performance in national tests taken at age 16.
>
> 8. Introducing interactive whiteboards results in pupils' performance in national tests in English (particularly for low-achieving pupils and for writing), mathematics and science, improving more than that of pupils in schools without interactive whiteboards (Balanskat, Blamire & Kefala, 2006, p. 3).

ICT is effective in improving achievement in English, Science, and Design and Technology courses, but not in Mathematics for, particularly, primary schools. It is drawn as a conclusion that students with rich ICT facilities at school are more successful than students with poor ICT facilities at school. However, it is not enough to have ICT facilities at school, productive and supportive arrangements are also required to use these facilities efficiently (Balanskat, Blamire & Kefala, 2006).

In addition to quantitative studies, they also reviewed qualitative studies and made a further four, more qualitative-based, statements about the impact of ICT on learning outcomes. These are mainly based on opinions of teachers, students and parents:

> 1. Pupils, teachers and parents consider that ICT has a positive impact on pupils' learning.
>
> 2. Pupils' subject-related performance and basic skills (calculation, reading and writing) improve with ICT, according to teachers.
>
> 3. Teachers are becoming more and more convinced that the educational achievements of pupils improve through the use of ICT.
>
> 4. Academically strong students benefit more from ICT use, but ICT serves also weak students (Balanskat, Blamire & Kefala, 2006, pp. 3-4).

In summary, ICT is perceived as a contributor to achievement by students, teachers, and parents. Teachers are getting convinced that student attainment improves through ICT use. ICT is utilized wisely by high achieving students, but it can also be used to improve low achieving students' attainment level (Balanskat, Blamire & Kefala, 2006).

### 2.4.3 ICT and Attainment: International Studies on TIMSS and PISA

Some studies investigating the relationship between ICT and attainment (Pelgrum & Plomp, 2002; Fusch & Woessmann, 2004; Sweet & Meates, 2004) reanalyze international student assessment studies, such as TIMSS 95-99 and PISA 2000. These studies are presented in this section.

Pelgrum and Plomp (2002) conducted a study on TIMSS 95 and TIMSS 99 data to describe general trends in indicators related to ICT and mathematics education. Their major finding was that ICT use in mathematics education was minimal, except for some countries, and the finding remained the same between 1995 and 1999. They selected fourteen countries from TIMSS-95 data which has at least 150 high ICT-using and low ICT-using students in their mathematics lessons. When those two groups' mathematics achievement scores are compared within each country, it is found that students who used ICT frequently for mathematics learning had much lower achievement score than students who hardly ever used or did not use ICT for all countries. They relate this finding to the fact that focus on drill and practice exercises for lower ability students is more common than other types of ICT use in mathematics courses, which yields a sample selection-bias, as they admit. This means, high ICT-using group and low ICT-using group are already different from each other in achievement before the ICT intervention. They also compared home background indicators of these groups. They conclude that these two groups did not seem to differ in home background variables.

However, Kroesbergen and Van Luit (2003) made a meta analysis of 58 studies of mathematics interventions for elementary students with special needs. Interventions in three different domains were selected: preparatory mathematics, basic skills, and problem solving strategies. They state that interventions involving the use of CAI and peer tutoring showed smaller effects than interventions not including these supports. They conclude that the use of CAI can be very helpful when students have to be motivated to practice with certain kinds of problems. With the use of a computer, it is possible to let children practice and automate math facts and also to provide direct feedback. Yet, the computer cannot remedy the basic difficulties that children encounter. In general, the results of their study show that, traditional interventions by teachers are the most effective among all types of interventions, including

CAI. Whereas the literature states that ICT intervention is used for remedial purposes with low achieving students (Pelgrum & Plomp, 2002), the meta-analysis of Kroesbergen and Van Luit (2003) on mathematical interventions for elementary students indicates that CAI and peer tutoring are less effective than traditional teacher-centered interventions especially for the basic difficulties that students encounter.

Pelgrum and Plomp (2002) also compared frequency of instructional approaches used during mathematics lessons for high and low ICT using groups. In all countries, the majority of students in high ICT using groups also were frequently involved in student-centered approaches (project work, working in small groups, or working on mathematical problems related to daily life). When they checked this relationship within each country, there was a negative association between student-centered instructional practices and mathematics scores in almost all countries. Overall, they deduce that there is tendency to use ICT in student-centered approaches in teaching mathematics. They put forth a tentative hypothesis to explain the large score difference between low ICT users and high ICT users in mathematics education. This is caused by the fact that a student-centered pedagogical approach -including more frequent use of ICT- places less emphasis on competencies, such as those measured in TIMSS-95 mathematics test (Pelgrum & Plomp, 2002). It should be noted that TIMSS program is highly curriculum-oriented, and that is applied to eighth grades, in contrast to PISA which aims to measure basic skills used in daily life.

Fusch and Woessmann (2004) estimated the relationship between students' educational achievement and the access to and use of computers at home and at school in PISA 2000 student-level data. Their bivariate analyses indicate a positive correlation between achievement and access to computers both at home and at school. However, the relationship becomes negative for home computers and insignificant for school computers when they control extensively for family background and school characteristics. Fusch and Woessmann (2004) propose that merely having access to computer at home seems to distract students from effective learning. Holding the other family-background characteristics constant, students perform significantly worse if they have computers at home. This may reflect to the fact that computers at home may actually distract students from learning, because learning through computers may not be the most efficient way of learning, and computers may be used for aims other than learning (Fusch & Woessmann, 2004). Yet, only measures of computer use for education and communication at home indicate a positive conditional relationship with student achievement. As to school computers, the conditional relationship between student achievement and computer and Internet use at school has an inverted U shape (Fusch & Woessmann, 2004). Exactly the same conditional relationship for school computers is observed by Aşkar and Olkun (2005) on PISA 2003 data for Turkish students, as well. This appears to be a clue of continuing a similar trend after three years.

Based on the general notion in the literature that ICT can be used as a tool to improve low achievers' learning skills and motivation to learn, Sweet and Meates (2004) reanalyzed PISA 2000 data to investigate levels of literacy achievement and access to and patterns of ICT use at school and at home across 31 countries. Students with a combined reading literacy scale score at proficiency level as 1 or below defined by PISA, were identified as low achievers. The results show that there is a general trend that low achievers have significantly less ICT resources at home than higher achievers, especially than the highest achievers, in terms of number of computers at home (in 25 out of 31 countries), Internet access at home (in 22/31), and educational software at home (in 22/31). As Sweet and Meates (2004) report, inequalities in access to and use of ICT seem to be much more at home than at school. Thus, they point out the importance of the school as a source of access to ICT for low achievers. More specifically, they emphasize the importance of schools and school systems in addressing ways that low achievers can access and use ICT outside of the classroom and outside of normal school hours. Although the contribution of ICT resources to achievement is not yet a totally agreed claim; the role of schools in providing ICT access to low achievers is approved by this finding.

Sweet and Meates (2004) state that low achievers' perceived confidence and competence in using ICT are higher than their reported attitudes toward computers in English-speaking countries, yet the reverse is generally the case in the remaining countries. Sweet and Meates relate this result to the fact that around the world the most common operating systems and most of the software are in English. If this is a part of reason, they say, it could reinforce calls to develop educational software in other languages (Sweet & Meates, 2004), especially native languages.

Sweet and Meates (2004) also examined level and type of computer use across lowest and highest achievers. The overall level of computer use by low achieving students, in most of the PISA 2000 countries, is not significantly different from that of other students. When the particular purpose of computer use is examined, there is a strong and significant trend in 19 out of 23 countries that the lowest achievers in reading literacy report using computers for programming more than high achievers do. There is also a common trend in all countries for low achievers to report that they use computers for games more frequently than high achievers do, despite not being statistically significant. Drawing for graphics and using spreadsheet software are other computer use types by low achievers in the general trend. On the other hand, Internet use and word processing are more common by high achievers and less common by low achievers. Another noteworthy finding is that in four Scandinavian countries (Denmark, Finland, Norway and Sweden) low achievers tend to report more than high achievers that they use educational software. This trend is not significant in other countries, although the pattern is in the same direction in most of them (Sweet & Meates, 2004).

Based on their analyses, Sweet and Meates (2004) infer that in the case of low achieving students, the scale of the digital divide varies widely across countries, and they state that it need not be apparently related either to national welfare or to the ease and cheapness of ICT access in those countries. Rather, they propose that the digital divide especially depends on home conditions, in other words welfare in the home (Sweet & Meates, 2004, p. 10).

İş Güzel and Berberoğlu (2005) conducted a structural equation modeling study on PISA 2000 to investigate factors affecting mathematics and reading literacy performance. They found that there is a positive relationship between school resources, such as computers, calculators and libraries with math literacy performance at the medium level in Brazil, which is a developing country whose conditions are similar to Turkey. However, the same relationship is not significant in Norway and is weak, but negative in Japan. They attributed this discrepancy in findings to the novelty effect on education (Mcmillian and Schumacher, 2001 as cited in İş Güzel & Berberoğlu, 2005), because the use of computers and calculators is relatively new in the Brazilian education system compared to Norway and Japan. Technological school resources positively affect student performance as long as they are newly introduced into education system (İş Güzel & Berberoğlu, 2005). The authors suggest that as students get used to these resources, the positive impact diminishes, even changes direction to a negative one. They also concluded that the way educational technologies, especially computers, are used in the system is more important than providing these technologies.

### 2.4.4 Studies on PISA 2003 Dataset

Since PISA 2003 data was made available at the end of 2004, researchers throughout the world have conducted descriptive and inferential analyses exploring or testing relationships among the many variables included in this dataset. Studies focusing on ICT variables, mathematics, problem solving or science literacy measures are given in this section.

Despite an increasing rate of diffusion of technology in schools, the debate goes on about the use of computers in schools, especially on the question of effectiveness of technology on student attainment (Kulik, 2003; Reynolds, Treharne & Tripp, 2003). Aşkar and Olkun (2005) and Erbaş (2005) conducted some studies on PISA 2003 data regarding ICT variables and student achievement in Turkey. In the international arena, Wittwer & Senkbeil (2008) conducted a study to estimate the relationship between ICT use and mathematics achievement. These studies are given below.

Aşkar and Olkun (2005) conducted a descriptive study to have a snapshot of the use of ICT in schools and its possible associations with mathematics and problem solving scores in the PISA 2003 dataset. They compare mathematics and problem solving mean scores from Turkey with two developed countries (Sweden and the USA), two developing countries (Uruguay and Thailand) and the OECD total mean. Their comparison classifies students according to place of ICT access (whether access at school, at home and other places or not) and the level of ICT use, experience in computer use, frequency of computer use at school, frequency of Internet use, playing computer games, and educational software use. First, the proportion of students who have never used computers before is 13.76% in Turkey. This ratio is much larger than the OECD total mean of, 1.7%. Second, the proportion of students having access to ICT in schools in Turkey is 38.6%, which is considerably lower than the OECD average of, 84.19%. Third, when the mathematics and problem solving scores of students having access to ICT and not having access to ICT in schools are compared, while there are differences in achievement scores in favor of students having ICT access at schools in all other countries and in the OECD mean, the achievement rates of both groups are the same in Turkey. Aşkar and Olkun relate this situation to the fact that IT rooms are used only for computer courses, and not used in other courses in a regular manner (2005).

Fourth, students using computers at home have higher achievement scores than those not using computers at home for all countries. Aşkar and Olkun (2005) attribute this finding to a more underlying factor, the socioeconomic level of students, rather than using computers -even for educational purposes. Fifth, as to the level of experience of students in using computers, a positive relationship between experience in ICT use and achievement in mathematics and problem solving is found. The more experience in using computers, the more success in achievement scores, regardless of country. Sixth, as to frequency of using computers in school, students who use computers in school at a medium level (between once a week or once a month and less than once a month) are more successful in math and problem solving compared to those using computers very frequently or those never use computers in school. Seventh, considering frequency of Internet use to access information, students using Internet between once a week and once a month have higher achievement scores than others who uses Internet very frequently or rarely, except for in the USA and

Thailand, where the more frequently the Internet is used, the more success is attained in math and problem solving achievements. Eighth, when the frequency of game playing is considered, in almost all countries, students playing computer games at a medium frequency have relatively higher achievement scores than those who play very frequently or than those never playing computer games. Finally, for the frequency of educational software use, generally students using educational software less than once a month have relatively higher scores than those using educational software at other frequencies.

Based on these results, Aşkar and Olkun (2005) draw the following conclusions: (1) access to computers at schools in Turkey is at a low level compared to the OECD countries, (2) students having access to computers at schools have higher mathematics and problem solving achievement than those not having computers in schools, (3) students having computers at home have higher achievement scores than those not having computers at home, (4) students using computers for a long time have higher achievement scores than those using computers for a short time and (5) students using computers at school, using Internet and educational software, and playing computer games at a medium frequency have higher scores than the other students. It could be inferred that controlled, conscious and purposive computer use in education is associated with success. In fact, more ICT use does not mean better (OECD, 2006c)

Erbaş (2005) conducted a structural equation modeling study to explore the relationships between science literacy performance and attitudes toward computers (two dependent latent variables) with frequency of computer use, frequency of Internet use, having basic computer skills, and having advanced computer skills (four independent latent variables), on Turkish students' data from the PISA 2003 dataset. According to the fitted model, having basic computer skills and frequency of Internet use have positive and strong relationships with science literacy performance (standardized path coefficients for 0.51 and 0.43 respectively). On the contrary, frequency of computer use, and having advanced computer skills and attitudes toward computers have negative relationships with science literacy performance (standardized path coefficients for -0.52, -0.22, and -0.08 respectively). In addition, the model illustrates the positive relationship between Internet use, basic computer skills and advanced computer skills with attitudes toward computers (standardized path coefficients for 0.32, 0.23, and 0.18 respectively). It should be noted that there is no meaningful relationship between computer use and attitudes toward computers.

Wittwer and Senkbeil (2008) detect a mistake in studies concluding that having a computer at home and using it frequently are associated with better performance in schools. Such studies have serious methodological faults due to not considering the multiple determination of school performance. In this context, Wittwer and Senkbeil (2008) reanalyzed the PISA 2003 Germany data to investigate the relationship between students' home computer use and their performance in mathematics by controlling other factors that have been found to affect students' achievement. They also investigated possible differences in students' school performance depending on how students use the computer. Multiple regression models were conducted to predict students' mathematics and problem solving performance from availability of home computer, by controlling ESCS, gender, immigration background, cognitive abilities, reading in leisure time, reading newspapers, watching TV, watching news on TV, and watching films on TV. Their results indicated that students' access to a computer was not linked to their performance in mathematics. Moreover, the result remains the same regardless of how often they used it at home. However, a positive effect of computer use was detected in the case of those who used the computer in a self-determined way that engaged them in problem-solving activities, for only a small portion of students. Types of computer use at home play a very limited role in predicting their academic achievement. Wittwer and Senkbeil (2008) infer that computers had no substantial influence on academic achievement for the majority of students.

#### 2.4.4.1 Relationship between Mathematical and Problem Solving Literacy

In PISA 2003, it is focused on mathematical (as a major domain), science, reading and problem solving (as minor domains) literacy. As explained in Chapter 1, PISA wants to assess 15-year-old students' performance in analyzing, reasoning and communicating effectively when they examine, interpret and solve real life problems rather than any discipline in school curricula. Therefore, these literacy domains can be considered as basic complementary components of academic literacy performance of students, particularly at the end of compulsory education. Correlations between the ability estimates for individual students in each of these domains in the PISA 2003 are estimated to have unbiased estimates of the true correlation between the underlying latent variables. Correlation between mathematical and problem solving literacy is .89 for both the OECD countries and for all countries participated in the PISA 2003 (OECD, 2005b, p. 189). Thus, it can be said that relationship between mathematical and problem solving literacy is very strong.

## 2.5 Socioeconomic Status of Students and Achievement

Based on a comprehensive literature review, Yang states that there is a positive and medium relationship between SES and student academic achievement at an individual level in the literature, 0.30 (Yang, 2003). When classroom or school is selected as the unit of analysis, the relationship between these two variables rises from 0.60 to 0.80 (Yang, 2003). Yang conducted a two-level structural equation modeling study to simultaneously examine, both individual and school levels, dimensionality of SES and the pattern of relationships between the SES dimensions and mathematics and science achievement, by using TIMSS 95 data. Data from 17 countries, most of which are European countries, in addition to Hong Honk, Singapore, Canada and the USA, were selected. In total, 123,031 students from 3,148 schools are included in the analyses. The results confirmed that the ownership of a set of households can be used as SES indicators at both individual and school levels. Two dimensions were identified at student level for most of the countries: a general capital dimension and a cultural capital dimension. At school level, only the general capital factor accounts for SES differences for the majority of countries, while both the general and the cultural capital dimension emerged in six out of 17 countries to determine SES at school level. For the effect of SES on achievement, the cultural resource factor has a great impact on mathematics and science achievement at both student and school levels (Yang, 2003). The schools' social background, as a reflection of community demographic features explains over 35% of school differences in school mathematics and science achievement. Yang (2003) concludes that these findings confirmed the previous studies on the pattern of relationships between SES dimensions and achievement at the individual and school level.

## 2.6 Relationships between ICT use, Self-confidence in ICT and Attitudes toward ICT

Arthur and Olson (1991) made a correlational study to investigate relationships between cognitive ability, computer experience and computer attitude. Subjects of their study were 136 volunteer students (54 of them were female) at a large southwestern state university in the USA. They administered a 20-item computer attitude scale (CATT) to measure computer attitude, a 9-item computer experience scale to measure computer experience, a cognitive ability scale that consists of 36 matrix or design problem arranged in ascending order of difficulty (Advanced Progressive Matrices Set II (APM, Raven, Court, & Raven, 1985 as cited in Arthur & Olson,1991) to measure cognitive ability, the numerical section of the Wesman Personnel Classification Test (PCT- V, Wesman, 1965, as cited in Arthur & Olson,1991) to measure mathematical aptitude. They tested two path analytic models: (1) the cognitive ability $\rightarrow$ computer experience $\rightarrow$ computer attitude, (2) the cognitive ability $\rightarrow$ computer attitude $\rightarrow$ computer experience. The first model fitted to the data but the second did not. In the first model, the standard path coefficient for the path form cognitive ability to computer experience was .28 (t=3.31), and that for the path from computer use to computer attitude was .31 (t=3.81).

Based on the analyses, they concluded that low-cognitive ability persons report less experience with computers since they may escape from computer interactions due to initial negative encounters. They also concluded that their finding support the argument that "computer experiences precedes computer attitudes" (p. 53). Indeed, initial computer experiences may play a major role in the formation of computer attitudes (Arthur & Olson, 1991). Finally, they concluded that there is no significant relation between cognitive ability and computer attitudes. Moreover, they did not obtain gender, age, college class, GPA, or math aptitude differences in computer experience and attitude. Thus, they call for more research to investigate and identify variables that are exogenous to computer attitudes. Thus, the possible influences of ICT use and self-confidence in ICT on attitude toward computers were investigated in the mathematic and problem-solving literacy models.

Contreras (2004) conducted two stepwise multiple regression analyses to predict computer self-confidence by using demographic and personality variables and computer use indicators. His sample was 208 students enrolled in online college-credit classes. He measured computer self-confidence with one 10-choice question. Demographic variables included age, annual income, geographic region, gender, and ethnicity. He measured computer use with computer experience (in years, with one direct question) and by the number of online classes taken within a term. He measured personality variables with the Bicognitive Orientation to Life Scale (BOLS). The BOLS measures field independence (ability of math and science), field sensitivity (ability of social science), and cognitive flex (absolute difference between field independence and field sensitivity). After his analyses, Contreras (2004) concluded that computer experience, annual income, the number of online classes taken within a term, and cognitive flex are significant predictors of computer self-confidence. Based on these results, Contreras (2004) suggests that the relationship between computer self-confidence and academic performance should be the focus of future investigations. "If no relationship between computer self-confidence and academic performance exists, investigations of computer self confidence may be moot" (p. 178), Contreras said. In this sense, the relation between self confidence in ICT tasks and mathematical and problem-solving literacy performance were investigated in the path analytic models.

Based on the literature on computer-related behavior, Kay and Knaack (2004) inferred that more positive computer attitudes are generally associated with higher levels of computer ability and use. Since the research looking at the effect of one's ability in a specific subject area and the successful use of computers is far less prevalent (Kay & Knaack, 2004), the relationship between mathematical and problem-solving literacy and ICT aspects were investigated in the path analytic models proposed in this study.

Kay and Knaack (2004) stated that older students (15–16 years old), viewed computers as tools for accomplishing tasks and getting work done (e.g., word processing, programming, use of the Internet, and email), whereas younger students (11–12 years old) saw computers as a source of enjoyment (e.g., play games and use graphics software) (Kay & Knaack, 2004). It is not clear whether differences observed in computer-related behavior are a result of advances in cognitive and emotional maturity (age) or whether they are due to the cultural biases that may emerge at certain grade levels (Kay & Knaack, 2004). For the case in Turkey, Orhan and Akkoyunlu (2004) also reached a similar finding. They conducted a study on basic education students' Internet usage. In their study, they found that most of the students use Internet frequently. They stated that as students' age increases, frequency of their Internet use also increases; but their computer use for playing computer game decreases while use for accessing information and communication increase.

## 2.7 ICT-in-Education Policies and Implementations in the EU

Having examined many countries' performance indicators for ICT use in education, Tuti (2005) stated that countries basically select the followings as performance indicators: hardware, ICT curriculum, student-computer ratio, Internet connections, software, and digital divide between school degrees, national policies, teacher training and in-service training, access to computers and Internet and technical support. Thus, fhis section presents basic demographics, ICT-in-education policies and some indicators of their implementations in the EU, such as students' access to computers, integration of ICT into the curriculum, in-service teacher training on ICT and teachers' use of ICT in their teaching. These demographics are given comparatively for country groups.

### 2.7.1 Basic Demographic Data of the Country Groups

As countries are being categorized into three groups in this study, a multiphase strategy is taken as a base for state of belonging to the EU, status of the EU membership (the EU member group, the new EU member group and candidate member) and having ICT data in the PISA 2003 study. Total population, population growth, gross national income per capita, an e-government readiness index, ICT expenditure, schools connected to the Internet, Internet users, personal computers, and percentages of 15-year-old students frequently using a computer are considered as key demographic indicators for each country. They are chosen to represent some general facts, ICT-related developments and status. These demographic indicators and their definitions are taken from World Bank (2008) and OECD (2006c), and given in Table 2.2; data for these indicators for country groups, including members, can be seen as a whole in Table 2.3.

When the average populations of the country groups are compared, Turkey had a population of 67.4 million whereas the EU member group had 23.7 million and the new EU member group had 13.4 million in 2000. The population growth of country groups in 2000 indicates that Turkey had a population growth of 1.7%, the EU member group was strongest around 0.45%, and the new EU member group had a negative population growth, -0.36%. The population growth of Turkey is larger than both EU groups, but in 2005 the population growth Turkey regressed while that of the EU member group and the new EU member group progressed.

National welfare is the basic underlying factor for the development of a country in many respects. The World Bank (2008) reports that GNI per capita in 2000 was 23,173 for the EU member group, 4,414 for the new EU member group and 2,980 for Turkey (in US dollars). These numbers increased to 34,648, 8,634, and 4,750 for the EU member group, the new EU member group and Turkey, respectively, in 2005. Where these numbers are concerned, the EU member group has the highest prosperity, the new EU member group has the second highest on average and Turkey has the smallest prosperity level.

An e-government readiness index indicates the level of countries' provision of specific products and services via ICT. This scale could be zero at the least and one at the most, meaning that the higher the e-government index of a country, the more products and services provided via ICT. In 2005, the EU member group had the highest e-government readiness index, (0.77), the new EU member group had the second highest index, (0.66), and Turkey had the lowest e-readiness index, (0.50) (World Bank, 2008).

Table 2.2 Key Demographic Indicators and their Definitions

| Indicators | Definitions |
|---|---|
| 1. Total Population | Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship -except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. |
| 2. Population growth | Annual population growth rate. |
| 3. Gross National Income per Capita | GNI per capita (Atlas method) is the gross national income (GNI) converted to US dollars using the World Bank Atlas method divided by the midyear population. Gross national income is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. GNI, calculated in national currency, is usually converted to U.S. dollars at official exchange rates for comparisons across economies. To smooth fluctuations in prices and exchange rates, the Atlas method is used by the World Bank, which averages the exchange rate for a given year and the two preceding years, adjusted for differences in rates of inflation between the country, and the Euro Zone, Japan, the United Kingdom, and the United States. |
| 4. E-government readiness index | E-government readiness index is based on a five-stage model, ascending in nature, and building upon the previous level of sophistication of a government's online presence. These stages are Emerging, Enhanced, Interactive, Transactional, and Networked. Countries are scored on the basis of whether they provide specific products and services. |
| 5. ICT Expenditure | ICT expenditure include computer hardware (computers, storage devices, printers, and other peripherals); computer software (operating systems, programming tools, utilities, applications, and internal software development); computer services (information technology consulting, computer and network systems integration, Web hosting, data processing services, and other services); and communications services (voice and data communications services) and wired and wireless communications equipment. |
| 6. Schools connected to the Internet | Schools connected to the Internet are the share of primary and secondary schools in the country that have access to the Internet. |
| 7. Internet users | Internet users are people with access to the worldwide network. |
| 8. Personal computers | Personal computers are self-contained computers designed to be used by a single individual. |
| 9. Percentage of 15-year-old students frequently using a computer* | Percentage of 15-year-old students frequently using a computer at home and at school ("almost every day" or "a few times each week"), in PISA 2003 study. |

*Note:* The definitions labeled 1-8 are taken from World Bank (2008) and 9th definition is taken from OECD (2006c).

Table 2.3 Key Demographic Indicators of Country Groups and their Members

| Country Groups | | Total Population* | | Population Growth* | | Gross National Income per Capita* | | E-government Readiness Index* | ICT Expenditure* | | Schools connected to the Internet* | Internet Users* | | Personal Computers* | | Percentage of 15-year-old students frequently using a computer** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (million) | | (annual %) | | (US$) | | (scale 0-1) | (% of GDP) | | (%) | (%) | | (%) | | (%) | |
| | | 2000 | 2005 | 2000 | 2005 | 2000 | 2005 | 2005 | 2000 | 2005 | 2005 | 2000 | 2005 | 2000 | 2005 | at school | at home |
| EU Member Group | AT | 8.0 | 8.2 | 0.1 | 0,7 | 26,010 | 37,190 | 0.76 | 5.9 | 5.5 | 94 | 33.7 | 48.6 | 36.2 | 60.7 | 53 | 81 |
| | BE | 10.3 | 10.5 | 0.3 | 0,6 | 25,360 | 36,140 | 0.74 | 6.0 | 5.8 | 93 | 29.3 | 45.8 | 22.4 | 34.8 | 27 | 84 |
| | DK | 5.3 | 5.4 | 0.3 | 0,3 | 31,850 | 48,330 | 0.91 | 6.1 | 6.0 | 100 | 39.2 | 52.7 | 50.6 | 65.6 | 68 | 84 |
| | FI | 5.2 | 5.2 | 0.2 | 0,3 | 25,150 | 37,530 | 0.82 | 7.4 | 6.9 | 99 | 37.2 | 53.4 | 39.6 | 48.1 | 36 | 78 |
| | DE | 82.2 | 82.5 | 0.1 | -0,1 | 25,510 | 34,870 | 0.81 | 6.1 | 6.1 | 99 | 30.2 | 45.5 | 33.6 | 54.5 | 23 | 82 |
| | EL | 10.9 | 11.1 | 0.3 | 0,4 | 11,530 | 19,840 | 0.59 | 4.4 | 4.1 | 59 | 9.2 | 18.0 | 6.9 | 8.9 | 45 | 57 |
| | IE | 3.8 | 4.2 | 1.3 | 2,2 | 23,120 | 41,140 | 0.73 | 5.6 | 4.4 | 99 | 17.8 | 27.6 | 35.7 | 49.4 | 24 | 61 |
| | IT | 56.9 | 58.6 | 0.0 | 0,7 | 20,900 | 30,250 | 0.68 | 4.7 | 4.3 | 88 | 23.2 | 47.8 | 18.1 | 36.7 | 51 | 76 |
| | PT | 10.2 | 10.5 | 0.5 | 0,5 | 11,590 | 17,190 | 0.61 | 4.2 | 4.4 | 92 | 16.4 | 27.9 | 10.3 | 13.3 | 34 | 78 |
| | SE | 8.9 | 9.0 | 0.1 | 0,4 | 28,870 | 40,910 | 0.90 | 7.4 | 7.4 | 99 | 45.6 | 76.4 | 50.7 | 76.3 | 48 | 89 |
| | UK | 59.7 | 60.2 | 1.7 | 0,7 | 25,010 | 37,740 | 0.88 | 8.1 | 7.3 | 99 | 26.4 | 47.3 | 33.8 | 60.0 | - | - |
| **Average** | | **23.76** | **24.13** | **0.45** | **0.61** | **23,173** | **34,648** | **0.77** | **5.99** | **5.65** | **92.82** | **28.02** | **44.64** | **30.72** | **46.21** | **40.90** | **77.00** |
| New EU Member Group | CZ | 10.3 | 10.2 | -0.1 | 0,3 | 5,790 | 11,220 | 0.64 | 7.4 | 7.1 | 95 | 9.7 | 26.9 | 12.2 | 24.0 | 41 | 70 |
| | HU | 10.2 | 10.1 | -0.3 | -0,2 | 4,600 | 10,070 | 0.65 | 7.3 | 5.8 | 85 | 7.0 | 29.7 | 8.5 | 14.6 | 80 | 67 |
| | LV | 2.4 | 2.3 | -0.8 | -0,5 | 3,240 | 6,770 | 0.61 | - | - | 97 | 6.3 | 44.8 | 14.3 | 21.7 | - | - |
| | PL | 38.5 | 38.2 | -0.5 | -0,0 | 4,570 | 7,160 | 0.59 | 4.1 | 4,2 | 90 | 7.3 | 26.2 | 6.9 | 19.3 | 44 | 59 |
| | SK | 5.4 | 5.4 | -0.1 | 0,1 | 3,870 | 7,950 | 0.59 | 5.9 | 5.6 | 65 | 9.4 | 46.4 | 13.7 | 35.8 | 42 | 65 |
| **Average** | | **13.36** | **13.24** | **-0.36** | **-0.06** | **4,414** | **8,634** | **0.66** | **6.18** | **5.68** | **86.4** | **7.94** | **34.8** | **11.12** | **23.08** | **51.75** | **65.25** |
| **Turkey** | TR | **67.4** | **72.1** | **1.7** | **1.3** | **2,980** | **4,750** | **0.50** | **7.9** | **7.9** | **40** | **3.7** | **22.2** | **3.7** | **5.2** | **46** | **48** |

*Note:* Sources for data are * World Bank (2008) and ** OECD (2006c).

As to the ICT expenditure of countries, including computer hardware, software, computer services and communication services, it was 6% of gross domestic product (GDP) in the EU member group, 6.2% of GDP in the new EU member group and 7.9% of GDP in Turkey in 2000. This number regressed in both EU groups while remained the same in Turkey in 2005. Turkey shared a relatively larger budget for ICT hardware, software and service.

The proportion of Internet users among citizens could be another important indicator of a country's level of ICT use. On average, 28% of citizens in the EU member group, 8% in the new EU member group and 3.7% in Turkey were Internet users in 2000. From 2000 to 2005, the proportion of Internet users increased one and half times in the EU member group, four times in the new EU member group, and more than five times in Turkey. That is, in 2005, after five years, this proportion is 45% for the EU member group, 35% in the new EU member group and 22% in Turkey.

According to the World Bank report (2008), the rate of people owning personal computers drastically changes across country groups, as well. On average, 31% of citizens in the EU member group and 11% of citizens in the new EU member group had personal computers in 2000. This proportion increased to 46% in the EU member group and 23.8% in the new EU member group, on average, in 2005. As to Turkey, it was 3.7% in 2000 and increased to 5.2% in 2005. The rapid increase in the computer possession rate in both EU groups from 2000 to 2005 is not observed to the same extent in Turkey. Thus, after five years, there are still considerable differences between country groups; the proportion in the new EU member group is half of that of the EU member group, and it is considerably lower in Turkey compared to both EU groups.

After the data illustrated in Table 2.3 is comparatively considered, it appears that the EU member group has the best position and the new EU member group has the second best position, whereas Turkey is at disadvantaged position in terms of national prosperity, e-government readiness index, personal computer penetration and number of Internet users. There are positive relationships among these indicators. However, this order is not the same for average total population and ICT expenditure. Turkey is the most numerous group, the EU member group is the second most numerous, whereas the new EU member group has the smallest population on average. Turkey has allocated a slightly higher proportion of GDP for ICT expenditure than both EU groups. This could be due to the relatively recent efforts made to increase e-government services in Turkey, compared to those efforts in both EU groups.

### 2.7.2 Trends in Integration of ICT into Schools in the European Countries

In order to understand the panorama of ICT integration into the Kindergarten through to Twelfth Grade (K-12) curriculum in European countries, it is better to begin with a glance at general trends related to ICT integration in education systems in European countries. These trends are reported by the European Commission Education and Culture Department in two official documents published in 2001 and 2004. These documents comparatively review ICT-in-education policies and ICT related demographics as indicators of how ICT has been integrated into the school education systems of thirty European countries. Note that Turkey is not included in these reports.

In the 2001 report, entitled Basic Indicators on the Incorporation of ICT into European Education Systems: Facts and Figures, the following trends emerged throughout the EU countries in general:

- Education policies increasingly involve using ICT,
- Budgets are rarely managed only at central government level,
- Programming does not often take place in the curricular aims of the primary, lower and upper secondary levels of school education,
- A majority of teachers utilize ICT in their teaching on a regular basis, and
- An increasing number of countries in Europe involve ICT in the compulsory curriculum of preservice teacher training, but schools of teacher education are often largely free to determine how it should be taught (Eurydice, 2001a, pp. VII-VIII).

From these trends in European countries, it is understood that the EU countries give importance to gaining ICT literacy for their students and to integrate ICT into their school education systems in 2001.

After three years, in a 2004 report, entitled Key Data on Information and Communication Technology in Schools in Europe, the following trends were deduced for European countries:

a. Computer facilities at school and home:

- In most countries, the average ratio varies between 5 and 20 students per computer at schools which 15-year-old students attended.
- The percentage of young people having a home computer varies from 20% to over 90% throughout Europe, where most penetration is in Nordic countries and least penetration is in East European ones.
- The level of Internet connection is always lower than the level of computerization both at school and at home.
- There is a positive relationship between national prosperity and the development of school and home computer facilities

- Two main stages in school computerization are detected: computer facilities for staff at first, then for students.
- Students are provided with access to ICT facilities first outside the classroom, mostly in the form of IT rooms, and then -as school computerization increases- also within the classroom

b. Use of computer facilities at school and home

- ICT is an integral part of the compulsory curriculum in K-12 schools virtually everywhere in Europe. This is supplemented by separate ICT courses in secondary education.
- The frequency of using ICT in schools considerably increases from students aged 9-10 to students aged 15.
- No matter how much computerization there is at home, students aged 9-10 in European countries are able to access home computers, and their parents let them use it if a computer is available at home.
- At school, writing activity and information searches are typical purposes of ICT use for students aged 9 or 10. At home, computer games are the main activity.

c. Training teachers for ICT

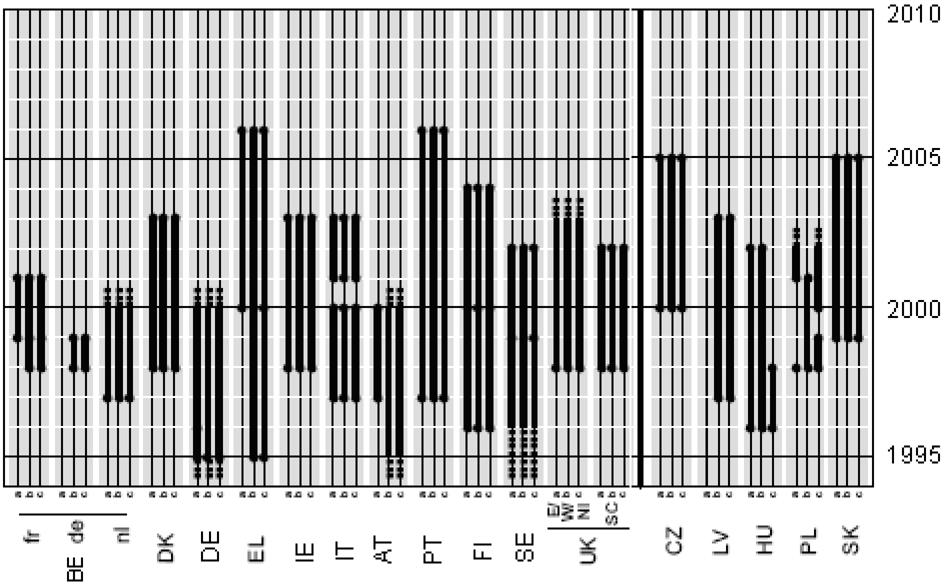
- Teachers in secondary education are often supported by ICT specialists. In many countries, irrespective of whether the curriculum offers separate ICT courses or ICT as a tool for teaching other subjects, teachers are assisted by ICT specialists. This practice is especially widespread in secondary education.
- Preservice teacher programs include basic training in the educational use of ICT in most countries.
- Official recommendations concerning training for teaching ICT are rarely detailed (Eurydice, 2004, pp. 8-11)

The ICT-in-education policies and ICT demographics for both EU groups are comparatively described below. Where related data for Turkey exist, it is included in the comparisons, as well.

### 2.7.3 ICT-in-Education Policies in European Countries

Projects to introduce ICT into secondary education have been initiated in all European countries (Eurydice, 2001a), mostly after 1995 as seen in Figure 2.3. With the exception of a very few education systems (the German-speaking Community of Belgium and Latvia), projects also exist at primary level. In most of the countries, these projects generally have main aims, such as to provide ICT equipment and facilities to K-12 schools, acquisition and construction of software, training of staff and students on ICT use, and the use of the Internet (Eurydice, 2001a).

Every European country has a policy document in the form of law, decree, curricular recommendation, and/or action plan for the use of ICT in primary and/or secondary education. These papers were generally written in the mid 1990s parallel to the nationwide ICT projects for schools. However, they are relatively recent in two members of the new EU member group, the Czech and Slovak Republics, compared to other EU countries. The majority of the EU member group also had official documents related to ICT in tertiary education (7 out of 11) while none of the members of the new EU member group had such a policy document in 2001 (Eurydice, 2001a).




Adapted from Eurydice (2001a)

Figure 2.3 Schedules for ICT project implementation for (a) primary, (b) lower and (c) upper secondary schools

In all European countries, one or more national or public bodies are responsible for implementing or promoting official ICT-related initiatives (Eurydice, 2004). The number of these bodies varies among countries, but their tasks normally include some or all of the following: they define the objectives to be pursued; they organize continuous professional development for teachers and develop new software and multimedia support; they monitor and coordinate the various initiatives and projects to be implemented in the area of ICT in education; and they are responsible for the application of the decisions taken and the agreements concluded (Eurydice, 2004). In most countries, it is the Ministry or the highest decision-making authority in education matters which takes over this role. However, there is at least one additional official body which takes co-responsibility in sixteen of thirty European countries. In most cases, this is either a body for coordinating educational activities in general terms or one specifically put in place for ICT or a higher education institution. It is only Sweden that has an official body that manages all ICT-related matters, independently from the ministry. This body also has an advisory role for the government (Eurydice, 2004).

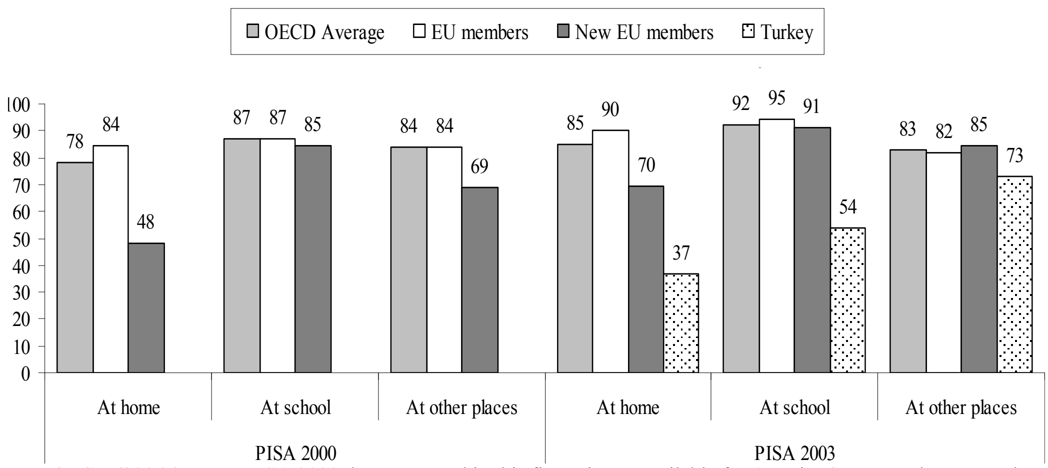
Most European countries have no central regulations fixing a maximum or minimum number of students per computer at school; this is left to local authorities. However, some countries or regions, for instance, Belgium (Flemish Community, 1:10 for primary and secondary education) and the United Kingdom (England, 1:11, 1:7 and Scotland, 1:7.5, 1:5), have central recommendations that specify a ratio for the number of students per computer. On the other hand, in Hungary and Poland it is specified that there should be at least one IT room in each school, irrespective of the number of students enrolled (Eurydice, 2004).

### 2.7.4 Overall Computer Access

Figure 2.4 illustrates 15-year-old students' overall computer access at home, school and other places in each country group, on average, in 2000 and 2003. Access to computer at school was most common in both EU groups and their access rates were also close to each other. From 2000 to 2003, the increase in access at school was 6-8% in these groups. In 2003, nearly all students (95%) stated that they had computer access at school in the EU member group, and 91% in the new EU member group, but this proportion was only 54% in Turkey. This means that by 2005 computerization of schools serving 15 year-old students was almost completed in both EU groups, while only around half of those schools were computerized in Turkey.

The level of computerization at home drastically varies in both EU groups and Turkey. The new EU member group is below the EU member group in computer penetration at home: 48% for the new EU member group and 84% for the EU member group in 2000. Yet it is seen that this gap was closing in 2003, because there was a considerable improvement in the proportion of access to computer at home in the new EU member group (from 48% to 70%), whereas 90% students in the EU member group had this access with a 6% improvement. However, the rate of access to computers at home was considerably lower in Turkey, at 37%. Computer penetration in the new EU member group was almost two times larger, and that in the EU member group was two and a half times larger, than in Turkey in 2003.

When the 2003 results are compared, the second most common computer access is at home in the EU member group while it is in other places in the new EU member group. In contrast, the most common access to computers is in other places (73%) and the second most common is at school in Turkey. Note that the rate of computer access at other places is relatively similar in the country groups, even if this rate is lower in Turkey than in both EU groups. In sum, students' computer access rates in all three places in Turkey are lower than both EU groups, with relatively closer access rates at other places.

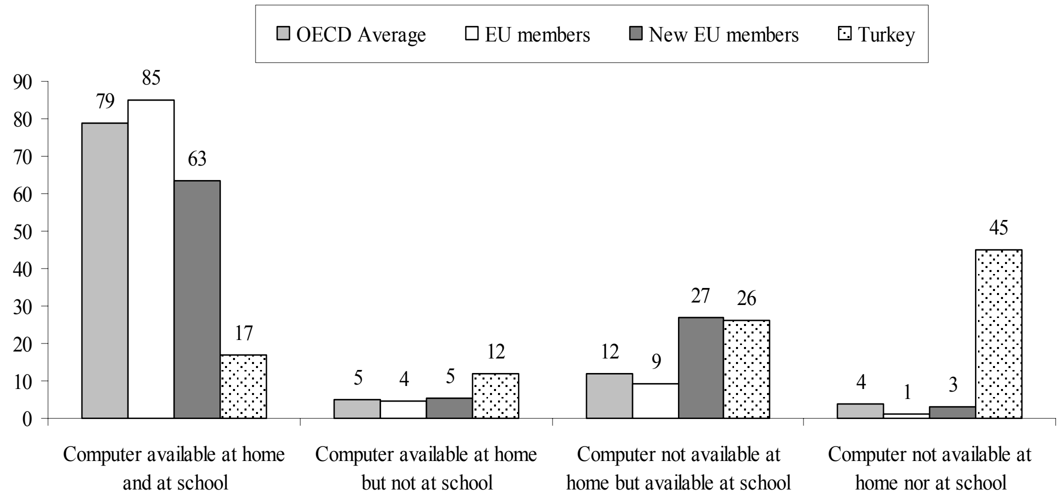



Source: OECD (2006c), Note: PISA 2000 data presented in this figure is not available for Austria, Greece, Italy, Portugal, Poland, Slovak Republic, and Turkey.

Figure 2.4 Percentages of 15-year-old students having access to computer at home and/or at school and at other places on average in PISA 2000 and 2003

As seen in Figure 2.5, while 85% of 15-year-old students in the EU member group and 63% in the new EU member group had computer access both at home and at school, this proportion was only 17% in Turkey in 2003. Furthermore nearly half of the students in Turkey reported that they had computer access neither at home nor at school. This rate was only 3% for the new EU member group and 1% for the EU member group.

Under these conditions, Turkish students are disadvantaged in terms of access to computers, particularly at home and at school, when compared to both EU groups. In other words, it could be inferred that both EU groups have higher rates of computer access at home and at school, when compared to Turkey. On the contrary, similar proportions of students have computer access at other places in both EU groups and Turkey (see Figure 2.4). In fact, Turkish students had computer access mostly at other places, most probably Internet cafes, in 2003.

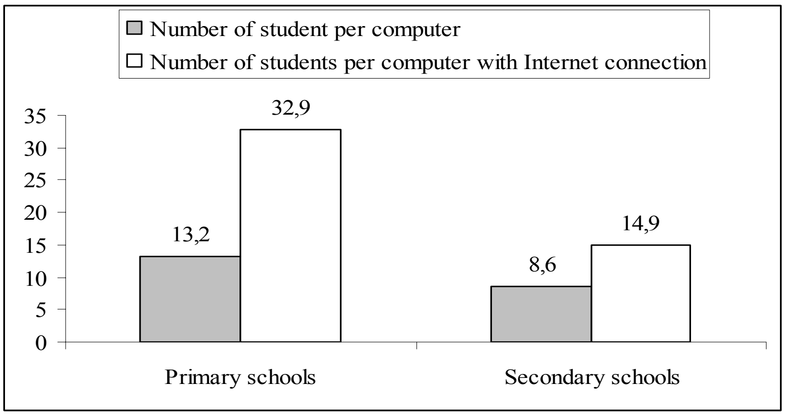


Source: OECD (2006c)

Figure 2.5 Percentages of students' computer access at home and/or at school in country groups in PISA 2003

### 2.7.4.1 Computer and Internet Access at School

Eurydice (2001a) reports several results of a Eurobarometer survey conducted for the European Commission in relation to eLearning in 2001, providing a quantitative view of computerization and its usage in schools of the EU member states. Figure 2.6 presents computer and Internet penetration in schools in the EU member group. At primary education schools (ISCED 1) the number of students per computer is 13.2 and the number of students per computer with Internet connection is 32.9. As to secondary education schools (ISCED 2 and 3), they have more computers and Internet connections when compared to primary schools: the number of students per computer is 8.6 and the number of students per computer with Internet connection is 14.9 (Eurydice, 2001a). Remember that the average number of students per computer at school was reported as between 5 and 20 in schools attended by 15-year-olds in most European countries in 2000 (Eurydice, 2004). Even in four members of the new EU member group that joined the EU in 2004 (except for the Slovak Republic), this ratio was 22.9 on average in 2000, if the arithmetic mean of those countries' student to computer ratio is calculated (Eurydice, 2004). When Turkey is considered, there were 37 students per computer in upper secondary schools (TBŞ, 2002). If most of those 15-year-old students are assumed to attend upper secondary schools in both EU groups, the ratio in Turkish high schools is one and a half times larger than the new EU member group, and considerably larger than the EU member group. Needless to say, this ratio is high in primary and lower secondary schools in total: 81 students per computer (TBŞ, 2002). Remember that in Turkey there were no comprehensive efforts to provide schools with fast Internet connections up to end of 2003. The limited number of existing Internet connections were slow (Akbaba-Altun, 2006). These comparisons indicate that both EU groups make more ICT related investments in K-12 schools than Turkey does. Indeed, the EU member group made earlier and heavier investments in ICT integration into the school system in terms of money, time and effort than do the new EU member group and Turkey.




Source: Eurydice (2001a)

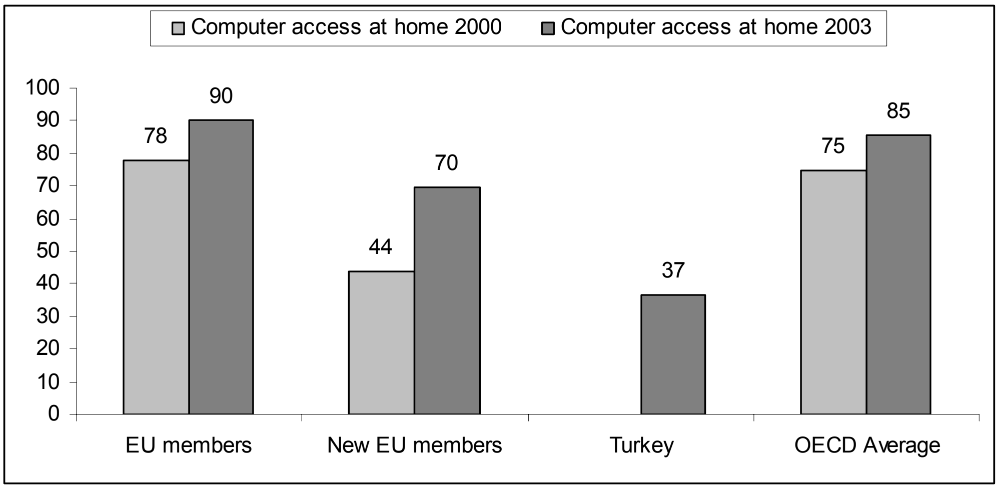
Figure 2.6 Number of students per computer and number of students per computer with Internet connection at primary and secondary schools in the EU member group in 2001.

In summary, the computer and Internet access in primary schools is more limited than in secondary schools in the EU member group. This could be due to the fact that including ICT as a separate subject is more common in secondary school curricula, besides using it as a tool in other subjects. Eurydice (2004) also reports that students aged 9-10 do not use computers at school as much as 15-year-old students. Parallel to facilities at schools and the place of ICT in curricula, students' use of ICT at school increases as grade level increases. Nevertheless, students' computer and Internet access rates in primary and secondary schools in both EU groups are considerably higher than in Turkey.

### 2.7.4.2 Computer and Internet Access at Home

When having computer and Internet access at home is considered, the proportion of students per access to computer is always larger that of students per access to Internet. This could be due to differences in Internet connection price policies in countries (Eurydice, 2004), and nations' perceptions of Internet.

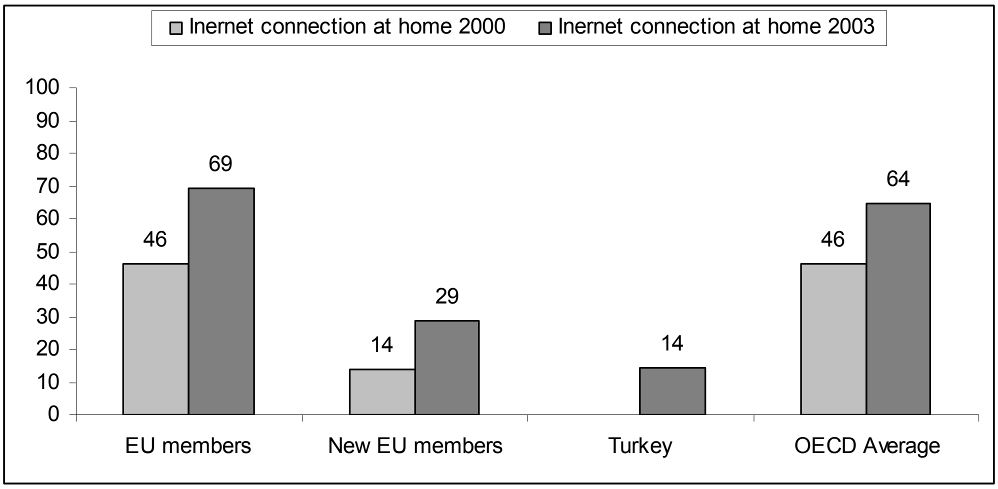
Computer access at home could be compared for the country groups with the data available in PISA 2000 and 2003 items, asking about computer possession at home or availability of a computer to use at home, as seen in Figure 2.7. It could be inferred that there is a trend towards increase in computer penetration at home in all country groups. The EU member group has the highest computer penetration at home and it was above the OECD average in both years. The new EU member group is second in order in this penetration, and seemed to be approaching the OECD average with a drastic increase in 2003. Computer penetration at home in Turkey was about half of that in the new EU member group, and considerably lower than that of the EU member group and the OECD average.




Data source: PISA 2000 (item no: ST22Q04) and PISA 2003 (item no: IC01Q01) interactive database. Note: These data is missing for Turkey and Slovak Republic in PISA 2000.

Figure 2.7 Percentages of 15-year-old students who claim to have a computer available at home, in PISA 2000 and 2003

As shown in Figure 2.8, in 2000 almost half of the students in the EU member group stated that they have access to computers with Internet connection at home, while only 14% of students in the new EU member group reported such an access, on average. Both EU groups particularly differ in students' access to computer and Internet at home at the beginning of the 2000s. This proportion rose to almost 69% for the EU member group and to 29% for the new EU member group, on average, in 2003. Yet only 14% of students in Turkey reported that they had Internet connection at home in 2003.

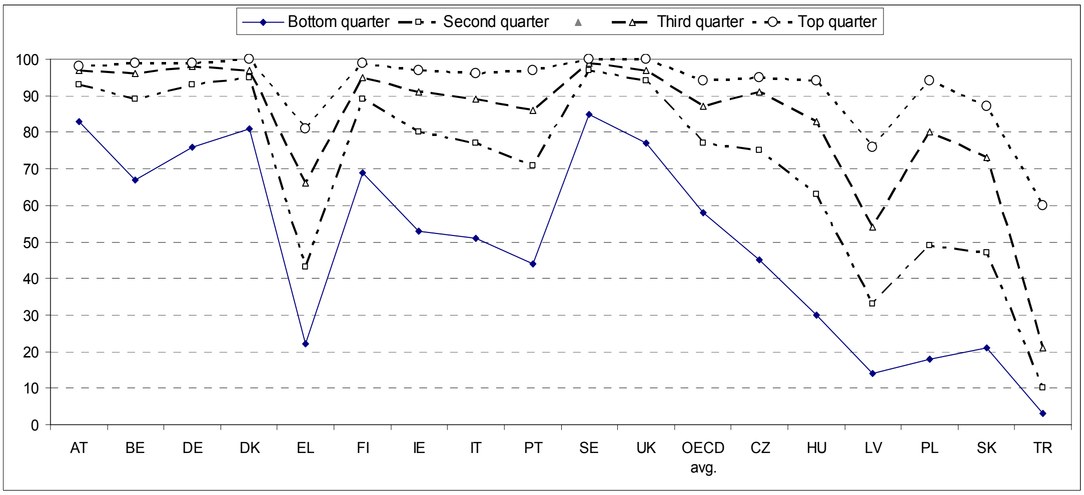



Data source: PISA 2000 and PISA 2003 database. Note: These data is missing for Turkey and Slovak Republic in PISA 2000.

Figure 2.8 Percentages of 15-year-old students who claim to have an Internet connection at home, in PISA 2000 and 2003

Based on the ICT demographics of county groups given up to now and the GNI per capita of the county groups in Table 2.3, there is a positive relationship between GNI per capita of a country and students' access to home computers (Göktaş, 2003; Eurydice, 2004; OECD 2006c). Furthermore, as rate of access to computers at home increases, rate of access to computers at school also tends to increase (Eurydice, 2004). Germany, Greece, Portugal are exceptions to this general trend. In these countries, computer penetration at home is high, but computer facilities in schools are not that widespread (Eurydice, 2004). Therefore, the higher the GNI per capita, the more the computer environment is developed, both at home and at school.

The OECD report on the PISA 2003 ICT questionnaire results deduces that socioeconomic background is a strong predictor of having access to a computer at home, and the differences in access at school and other places tend to be much smaller than socioeconomic differences at home (OECD, 2006c). In this report, the student population of each country was divided into four equal-sized groups, according to a ranking of student socioeconomic and cultural status. In most countries, students in the bottom quarter were significantly less likely to have a computer available at home than those in the top quarter (OECD, 2006c). According to this report, this socioeconomic and cultural driven digital divide is most apparent in Turkey, Mexico, the Russian Federation and Thailand. In these countries, the fewest students overall had home computer access compared to other countries, and where 11% or fewer students in the bottom quarter by ESCS can access home computers, compared to at least 70% in the top quarter. It should be noted that from the countries included in the present study only Turkey is among those countries having the considerable digital divide at home. Figure 2.9 shows proportion of access to home computer by ESCS quarters for the country groups.




Source: OECD (2006c).

Figure 2.9 Percentages of students having access to computer at home, by national quarters of the index of economic, social and cultural status (ESCS), PISA 2003

### 2.7.5 ICT in Primary and Secondary School Curriculum in the EU

In most EU countries' official recommendations for ICT, the minimum curriculum included objectives for primary, lower secondary and upper secondary education levels in 2000/2001 fell into the following categories:

- to develop programming skills,
- to learn correct use of a word processor, a spreadsheet, etc.,
- to learn to search for information on a CD-ROM (Compact Disk Read Only Memory), a network, etc., and
- to communicate via a network (Eurydice, 2001a, p. 16).

According to a survey conducted in the 2002-2003 school year by Eurydice, K-12 schools' compulsory curriculum in most EU countries also involve ICT related objectives under an additional category, namely, "to use ICT to enhance subject knowledge" for teaching or use of ICT (Eurydice, 2004, p. 23) besides the categories stated in 2001. By releasing this new objective, students' meaningful use of ICT for a specific purpose could be expected to increase in both EU groups.

### 2.7.5.1 Primary Education

When ICT is included in the curriculum, it may be taught either as a separate subject or used as a tool (Eurydice, 2001a). As seen in Table 2.4, except for the German community of Belgium, Greece and Italy, ICT is used as a tool and/or for carrying out projects in an interdisciplinary approach in the primary school curricula in the EU member group (Eurydice, 2001a). Based on the 2002/2003 data reported by Eurydice (2004), it is seen that ICT has become part of the compulsory minimum curriculum in the EU member group, except for Italy.

Table 2.4 Approaches to ICT Defined in the Primary Education Curriculum (ISCED 1), 2000/01

| | EU Member Group | | | | | | | | | | | New EU Member Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AT | BE fr,nl | BE de | DE | DK | EL | FI | IE | IT | PT | SE | UK | CZ | HU | LV | PL | SK |
| Separate subject | | | | | | | | | | | | | | + | | | |
| Used as a tool for other subjects | + | + | | + | + | | + | + | | + | + | | | | | | |
| Separate subject and used as a tool for other subjects | | | | | | | | | | | | + | | | | + | |
| Not included in the curriculum | | | + | | | + | | | + | | | | + | | + | | + |

Source: Eurydice (2001a).

As for the new EU member group, ICT was not included in the compulsory curriculum at primary education level in three members, the Czech Republic, Latvia and the Slovak Republic, in 2001. Only Poland and Hungary included ICT as a separate subject in its primary school curriculum, but Poland was the only country where ICT was used as a tool, among the new EU member group (Eurydice, 2001a). Where the 2002/2003 data provided by Eurydice (2004) is concerned, only Poland gave a place to ICT in the minimum compulsory curriculum of primary education.

On the other hand, in Turkey, an optional computer course as a separate subject was added to the 4$^{th}$ - 5$^{th}$ grades curriculum at primary level in 1998, but there were no curricular efforts to integrate ICT into other subjects (Göktaş, 2003). Such efforts were started in the 2004 curriculum reform.

For primary school curricula, programming skills were not covered by most of the EU member group at primary education level, the exceptions being Germany, Greece, and the United Kingdom (Eurydice, 2004). Nevertheless, this category is increasingly included in lower and upper secondary curricula.

### 2.7.5.2 General Lower Secondary Education

All members in both EU groups included ICT in their lower secondary education curricula, expect for Italy. Table 2.5 shows approaches to teaching ICT in the lower secondary curricula in 2001, as reported by Eurydice (2001a). There were only a few European countries in which the minimum curriculum did not include ICT as a subject in its own right at this level (Eurydice, 2001a). These countries add up to almost half of the EU member group who include ICT only as a tool for other subjects at this level of education. Several other members in the EU member group included ICT both as a tool, as is the case in primary education, and as a separate subject. ICT took place only as a separate subject in its own right in Greece at lower secondary level. As for the new EU member group, ICT was taught as a separate subject in all members, yet it was also used as a tool across the curriculum only in two of them: Latvia and Poland. As for Turkey, ICT has been found as separate optional course at lower secondary schools since 1998, depending on school conditions and students' preferences (Göktaş, 2003).

Table 2.5 Approaches to ICT Defined in the General Lower Secondary Education Curriculum (ISCED 2), 2000/01

| | EU Member Group | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AT | BE | | | DE | DK | EL | FI | IE | IT | PT | SE | UK | CZ | HU | LV | PL | SK |
| | | nl | fr | de | | | | | | | | | | | | | | |
| Separate subject | | | | | | | + | | | | | | | + | + | | | + |
| Used as a tool for other subjects | + | | + | | | + | | | + | | + | + | | | | | | |
| Separate subject and used as a tool for other subjects | | + | | + | + | | | + | | | | | + | | | + | + | |
| Not included in the curriculum | | | | | | | | | | + | | | | | | | | |

Source: Eurydice (2001a).

Table 2.6 Annual Number of Hours Recommended for Teaching ICT as a Subject in Its Own Right in General Lower Secondary Education (ISCED 2), 2000/01

| | EU Member Group | | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | UK | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT* | PT | SE | E/W/SC | NI | CZ | HU | LV | PL | SK |
| Recommendations solely on the inclusion of ICT in other subjects | + | | + | | | + | | | + | | + | + | | + | | | | | |
| Autonomy/No recommendations for hours to be allocated to ICT | | + | | | | | | + | | | | | + | | + | | | | |
| Annual number of hours recommended for teaching ICT as a subject in its own right. | | | | 30.3 | 18.8 | | 43.8 | | | | | | | | | 13.9 | 23 | 19 | 28 |
| # of years corresponding to the duration of lower secondary education | 4 | 2 | 2 | 2 | 5-6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 3 | 5 |

Source: Eurydice (2001a). * This subject is not included in the curriculum at this level of education.

Table 2.7 Objectives Defined in the Curriculum for Teaching or Use of ICT in General Lower Secondary Education (ISCED 2), 2000/01

| | EU Member Group | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT* | PT | SE | UK | CZ | HU | LV | PL | SK |
| To develop programming skills | | | | | | + | + | | + | | | | + | + | + | + | | + |
| To learn correct use of a word processor, a spreadsheet etc. | + | + | | + | + | + | + | + | + | | | + | + | + | + | + | + | + |
| To learn to search for information on a CD-ROM, a network etc. | + | + | | + | + | + | + | + | + | | | + | + | + | + | + | + | + |
| To communicate via Network | + | + | | + | + | + | + | + | + | | | + | + | + | + | + | + | + |

Source: Eurydice (2001a)

When the number of hours recommended by official documents for teaching ICT as a subject in its own right at this level is considered, the majority of countries in the EU member group generally have official recommendations merely concerning the inclusion of ICT in other subjects (see Table 2.6). Only some members recommend an annual number of hours to be devoted for ICT courses (Germany, Greece and the German community of

Belgium). On the contrary, all members in the new EU member group specify this, except for the Czech Republic.

In lower secondary education, to learn correct use of a word processor, and a spreadsheet etc., to learn searching for information on a CD-ROM, and a network etc., to communicate via Network and to develop programming skills were common categories of objectives in 2001. Note that “to use ICT to enhance subject knowledge” emerged as a new category in the 2002/2003 school year (Eurydice, 2004). Almost all members include these new types of objectives in their lower secondary curricula, except for Ireland and Italy, among the EU member group, and except for Hungary in the new EU member group. As seen in Tables 2.7 and 2.8, the most salient difference between the two EU groups is that objectives related to programming language are not as common in the EU member group as in the new EU member group at lower secondary level.

Table 2.8 Objectives Defined in the Curriculum of Lower Secondary (ISCED 2) for the Teaching or Use of ICT, 2002/2003

| | EU Member Group | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT* | PT | SE | UK | CZ | HU | LV | PL | SK |
| To develop programming skills | | | | | + | + | + | | + | | | | + | + | + | + | | + |
| To learn correct use of a word processor, a spreadsheet etc. | + | | + | + | + | + | + | + | + | | + | + | + | + | + | + | + | + |
| To learn to search for information on a CD-ROM, a network etc. | + | + | + | + | + | + | + | + | + | | + | + | + | + | + | + | + | + |
| To communicate via Network | + | | + | + | + | + | + | + | + | | + | + | + | + | + | + | + | + |
| To use ICT to enhance subject knowledge | + | + | + | + | + | + | + | + | | | + | + | + | + | | + | + | + |

Source: Eurydice (2004) *: This subject is not included in the curriculum at this level of education.

### 2.7.5.3 General Upper Secondary Education

ICT is taught as a separate subject in general upper secondary education in almost all countries in Europe (Eurydice, 2001a). After two years, except for Italy, all European countries involved ICT in general upper secondary education, mostly both as a separate subject and as a tool for other subjects (Eurydice, 2004). As seen in Table 2.9, the trend of using ICT as a tool in other subjects also exists in upper secondary schools in most of the EU member group. As to the new EU member group, all of them include ICT as a separate subject, but only two of them (Latvia and Poland) also include it as a tool for use in other subjects.

Table 2.9 Approaches to ICT Defined in the Curriculum of General Upper Secondary Education (ISCED 2), 2000/01

| | EU Member Group | | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | UK | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT* | PT | SE | E/SC | NI/W | CZ | HU | LV | PL | SK |
| Separate subject | | | | | | | + | | | | | | | | + | + | | | + |
| Used as a tool for other subjects | | | | | | | | | + | | | | | + | | | | | |
| Separate subject and used as a tool for other subjects | + | | + | + | + | + | | + | | | + | + | + | | | | + | + | |
| Not included in the curriculum | | + | | | | | | | | + | | | | | | | | | |

Source: Eurydice (2001a) *: This subject is not included in the curriculum at this level of education.

Teaching ICT as a separate subject is the most common approach in lower and upper secondary curriculum, in the form of optional courses, in Turkey. Indeed, using ICT as a tool in other subjects for a meaningful purpose not appear in the written curriculum until the curriculum reform that was initiated in 2004 in Turkey, while the curriculum change for upper secondary education is still in progress. Thus, using ICT as a tool in the teaching and learning of other subjects is not yet actually initiated in upper secondary education in Turkey.

If 2001 conditions, which have a grater impact on ICT aspects for the PISA 2003 students, are considered, what is different from lower secondary curriculum is that objectives related to developing programming skills are more common in upper secondary ICT objectives. Programming is included in the majority of countries in the EU member group, and in all of the new EU member group countries, as seen in Table 2.10.

Table 2.10 Objectives Defined in the Curriculum of General Upper Secondary Education (ISCED 2) for the Teaching or Use of ICT, 2000/01

| | EU Member Group | | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | UK | UK** | | | | | |
| | AT | nl* | fr | de | DE | DK | EL | FI | IE | IT* | PT | SE | SC | E/NI/W | CZ | HU | LV | PL | SK |
| To develop programming skills | | | | | + | + | + | + | + | | | + | + | | + | + | + | + | + |
| To learn correct use of a word processor, a spreadsheet etc. | + | | + | + | + | + | + | + | + | | + | + | + | | + | + | + | + | + |
| To learn to search for information on a CD-ROM, a network etc. | + | | + | + | + | + | + | + | + | | | + | + | | + | + | + | + | + |
| To communicate via a network | + | | + | + | + | + | + | + | + | | | + | + | | + | + | + | + | + |

Source: Eurydice (2001a). * This subject is not included in the curriculum at this level of education. ** In England, Northern Ireland and Whales, the objectives are not given in detail.

In the 2002/2003 school year, almost all members in the EU member group had objectives for ICT from all the following categories, in their compulsory curriculum of general upper secondary education: to learn the correct use of a word processor, and a spreadsheet etc., to learn to search for information on a CD-ROM, and a network etc., to communicate via a network, to use ICT to enhance subject knowledge, and to develop programming skills (Eurydice, 2004). Only in Belgium and Ireland the development of programming skills was not specified at this level of education. What is striking is that all of the new EU member group has defined ICT objectives in all of those five categories for the upper secondary level (with the only exception being that Hungary did not specify any objectives for using ICT to enhance subject knowledge) (Eurydice, 2004).

## 2.7.6 Teachers Specialized in ICT

Teachers specialized in ICT are responsible for teaching ICT as a separate subject mainly in secondary schools in most European countries (Eurydice, 2001a). In all members of the EU member group, except for Ireland and the French community of Belgium, specialist teachers in ICT are trained and these teachers work mainly at secondary level, as seen in Table 2.11. In Denmark, Italy and Portugal, they work only in upper secondary schools. As for the new EU member group, ICT teachers work at secondary schools;

additionally, in Hungary and Poland, they also work in primary schools. In Turkey, graduates of different programs in computer education work at three levels of education to teach students ICT skills in optional courses.

Table 2.11 Specialist ICT Teachers in Primary and Secondary Education (ISCED 1, 2 and 3), 2000/01

| | EU Member Group | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT | PT | SE | UK | CZ | HU | LV | PL | SK |
| Primary and secondary education | | | | | | | | | | | | | | | + | | + | |
| Lower and upper secondary education | + | + | | + | + | | + | + | | | | + | + | + | | + | | + |
| Upper secondary education | | | | | | + | | | | + | + | | | | | | | |
| Neither primary nor secondary education | | | + | | | | | | + | | | | | | | | | |

Source: Eurydice (2001a)

## 2.7.7 In-service Training and Teachers' Use of ICT

Where in-service training of teachers on "the use of computers and/or the Internet in their teaching" is concerned, the acquisition or upgrading of ICT skills is encouraged in the majority of the EU countries. National programmes (generally lasting at least two years) encourage this type of training for teachers at primary and secondary education levels (Eurydice, 2004).

For the EU member group, 62% of primary teachers and 50% of secondary school teachers had received official training in 2001 (Eurydice, 2001a). In line with ICT investments and in-service training on the use of ICT as a tool in other subjects, 71% of teachers used computers and 34% of teachers used the Internet in the classroom in primary schools, in the EU member group. Indeed, primary school teachers used computers five hours a week in the EU member group, on average (Eurydice, 2001a). As to lower and upper secondary school teachers, 60% of them used computers and 42% of them used the Internet in the classroom, in 2001 (Eurydice, 2001a). Among the objectives to be pursued in almost all EU countries, curricula for lower and upper secondary education refer to searching for information on a network or communicating via a network. Yet, on average, less than half of all teachers used the Internet with their students. The practice was therefore still not very widespread, except for in some countries such as Denmark and Finland. The proportion of primary school teachers using computers in the classroom was higher than that of secondary school teachers in the EU member group, but this discrepancy was observed less in Denmark, Ireland, Finland and Sweden (Eurydice, 2001a).

In Turkey, teachers who have participated in-service training for teaching with technology are not satisfied with the quality of in-service training activities due to such reasons as the training being not conducted in local settings, not addressing teachers' real needs and not ongoing and on time (Yıldırım, 2007). Furthermore, it is not yet common to find computers in classrooms in Turkey, rather, computers are in a room called the IT room, and these rooms are mostly used for optional ICT courses as a separate subject. According to MONE, ICT impact study results of 2004, all teachers perceived that IT rooms are installed only for ICT courses, and they were not aware of the fact that they had a right to use IT rooms in their teaching (MONE, 2004). It could be concluded that diffusion of ICT in schools and teachers' use of ICT in subject courses in Turkey are not as common as in European countries, although Turkey has been conducting ambitious projects and investing considerable sums in ICT provision to schools for educational purposes since the mid-1980s.

### 2.7.8 ICT in School of Teacher Education

According to Eurydice (2001a) report, ICT training is compulsory in preservice primary teacher training programs in the majority of the EU member group. In Ireland and Portugal it is left to institutional autonomy, and in Germany and Italy it is a core curriculum option. In the new EU member group, almost all countries leave this decision to institutional autonomy. It is compulsory only in Latvia (Table 2.12).

Table 2.12 Inclusion of ICT in Preservice Teacher Training Programs for Primary Education

| | EU Member Group | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT | PT | SE | UK | CZ | HU | LV | PL | SK |
| ICT compulsory training | + | + | + | + | | + | + | + | | | | + | + | | | + | | |
| Core curriculum option | | | | | + | | | | | + | | | | | | | | |
| Institutional autonomy | | | | | | | | | + | | + | | | + | + | | + | + |

As to preservice teacher education for secondary schools, based on Eurydice (2001a) it can be say that the general trend is also to place ICT in compulsory curriculum in the EU member group. However, ICT is a core curriculum option in Germany and Italy. ICT training is not provided in Greece. In Portugal and the UK (NI/W) this decision is left to institutions (Table 2.13). In the new EU member group, in the Czech Republic, Hungary and the Poland, decision to train lower and upper secondary teachers in ICT is left to institutional autonomy whereas ICT is part a compulsory training in Latvia and the Slovak Republic in secondary school preservice teacher training programs.

Table 2.13 Inclusion of ICT in Preservice Teacher Training Programs for Lower Secondary Education

| | EU Member Group | | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | UK | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT | PT | SE | NI/W | E/SC | CZ | HU | LV | PL | SK |
| ICT compulsory training | + | + | + | + | | + | | + | | | | + | | + | | | + | | + |
| Core curriculum option | | | | | + | | | | | + | | | | | | | | | |
| Institutional autonomy | | | | | | | | | | | + | | + | | + | + | | + | |
| Training not provided | | | | | | | + | | + | | | | | | | | | | |

As seen in Table 2.14, concerning preservice teacher training programs for upper secondary education, about half of the members in the EU member group place ICT in compulsory curricula. It is a core curriculum option in Austria, Germany and Italy, and left to institutional autonomy in the French community of Belgium, Ireland, Portugal, and the United Kingdom (NI/W). ICT training is not provided for prospective upper secondary teachers only in Greece.

### 2.7.9 Shared Responsibility for the Purchase and Maintenance of Hardware

The responsibilities of purchasing and maintaining hardware are either assumed solely at local level and/or by the school, or they are shared by different authorities, depending on the level of education (e.g. Poland) or type of expenditure (purchase of hardware or software, or equipment maintenance) in most European countries (Eurydice, 2001a). Sharing these responsibilities among different authorities is the most common approach (Eurydice, 2001).

Table 2.14 Inclusion of ICT in Preservice Teacher Training Programs for Upper Secondary Education

| | EU Member Group | | | | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BE | | | | | | | | | | | UK | | | | | | |
| | AT | nl | fr | de | DE | DK | EL | FI | IE | IT | PT | SE | NI/W | E/SC | CZ | HU | LV | PL | SK |
| ICT compulsory training | | + | | + | | + | | + | | | | + | | + | | | + | | + |
| Core curriculum option | + | | | | + | | | | | + | | | | | | | | | |
| Institutional autonomy | | | + | | | | | | + | | + | | + | | + | + | | + | |
| Training not provided | | | | | | | + | | | | | | | | | | | | |

As seen in Table 2.15, a majority of countries in the EU member group give the responsibility for purchasing and maintaining hardware to local authorities and/or schools, and in the remaining countries this responsibility is shared by different authorities, depending on the task and/or education level. On the other hand, the new EU member group tends to keep their centralized nature, but also give responsibility to different authorities depending on the task and/or education level.

Table 2.15 Responsibility for the Purchase and Maintenance of Hardware for Primary and Secondary Education (ISCED 1, 2, 3) in Projects Under Way in 2000/01

| | EU Member Group | | | | | | | | | | | New EU Member Group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AT | BE | DE | DK | EL | FI | IE | IT | PT | SE | UK | CZ | HU | LV | PL | SK |
| Responsibility at Ministry level or at central level | | | | | | | | | | | | + | | | | |
| Responsibility at local level and/or school level | | | + | + | | + | + | + | | + | + | | | | | |
| Responsibility at different levels depending on the task and/or the education level | + | + | | | + | | | | + | | | | + | + | + | + |

### 2.7.10 Expenditure on Human Resources

Although it is not possible to decide how much of the budget is shared for equipment provision/maintenance and human resources due to the fact that different bodies are responsible for these two branches of expenditure, greater emphasis was seen on expenditure on human resources in some countries, including Sweden, Belgium and Greece (at primary school level) in 2004 (Eurydice, 2004). It is stated in Eurydice's (2004) report that human resources occupy a more prominent position in the budgets of Belgium (German-speaking Community) and Sweden, where the budgets were clearly balanced in favor of equipment compared with the situation in 2000. Heavy investment in equipment was replaced by investment in teacher education in these countries in 2004. After investing in ICT equipment and maintenance, more budget is allocated to human resources, especially to the professional development of teachers.

## 2.8 ICT in Education in the EU

It was not until the end of the 1970s that ICT in education emerged in some European countries. Since then, some public initiatives have been launched to bring ICT into education systems in Europe. Early in the emergence of ICT in education, it was considered as a subject for teaching in the curriculum, not as any educational tool or as a teaching resource to make any contribution to the education system. However, later on, rapid advancements in multimedia computers, their dissemination in schools and a growing awareness of ICT's potential as teaching resource brought about the rapid growth of pilot projects and public financial support, especially in educational software development (Eurydice, 2001b).

From 1983 onwards, in order to integrate ICT into education and vocational training, the Commission, as a pioneer and catalyst, led and supported the organization of seminars, symposia, meetings and other occasions to share experiences pertaining to ICT. The necessity of cooperation between the Member States and of active contribution from the Commission for introduction of new information technologies in the field of education was recognized in the singed Resolution of 11 March 1982. Then, referring to some earlier Council resolutions, the Council and the Ministers for Education singed the Resolution of 19 September 1983 that concerned measures relating to the introduction of new information technologies, namely ICT, in education. The initiatives in this Resolution are related to organizations and visits for the professional development of teachers, comparative studies for transferability of software and teaching programmes and educational hardware systems, and the utilization of Eurydice for exchanging information and experience data. With the singing of this resolution, these initiatives would be implemented and monitored to supplement and support the actions and programmes of the member states until 1988. Consequently, this process prepares young people to use information technology as a tool and to judge its effects on daily life and to assess its social significance (Eurydice, 2001b; Council, 1983).

Later on, the Community programme Comett was launched to provide cooperation between universities and enterprise in the whole of Europe in 1986. Another programme, Eurotecnet was also started to promote innovation in vocational training considering ongoing technological change and its effects on competencies and employment. Similar to Comett and Eurotecnet, Socrates 1-2, Leonardo da Vinci 1-2, Lifelong Learning, and their sub-programmes, and others were launched in turn.

Open and Distance Learning (ODL) issues were introduced and discussed in the conference held on 30-31 March 1992 in Portugal. The conclusions of this conference were published as the Commission memorandum. The memorandum concludes that "open and distance learning elements should be incorporated whenever justified into appropriate Community education and training programmes. Moreover, the potential for developing better arrangements of ODL offered by Community programmes in other fields should be fully exploited" (Council, 1992a, p.1). After this memorandum, on 1 June 1992, the Council and Ministers confirmed their interest in receiving proposals in this area. The Council and the Ministers of Education considered action to support members and their cooperation in the field of ODL. Since then, action in the field of ICT has been consolidated and regularly expanded (Council, 1992b, p.1). The ODL action within Socrates 1 (1995-1999) helped ICT to integrate into education systems in the EU. The second phase of Socrates incorporated increased opportunities in the field of the ODL issues under the Minerva measure (Ertl, 2003).

In order to allow six European programmes -Socrates, Leonardo da Vinci, Targeted Socio-Economic Research, Esprit, Telematics Applications, and Trans -European Telecommunications Networks- to pool their efforts to increase development of the educational and training technology and its applications all over the EU, an Educational Software and Multimedia Task Force was established in 1995. The cooperation between these programmes provided the opportunity to contribute the implementation of policies made at the European level in the fields of education and training. For example, up to 1998 the Educational Software and Multimedia Task Force supported 46 educational multimedia projects involving 400 firms and institutions, around half of which were schools (Eurydice, 2001b).

Learning in the Information Society, launched in 1996, is an action plan that focused on making multimedia in general, and the Internet in particular, part of teaching practice. The initiative of the action plan had three main objectives to: "(1) accelerate schools' entry into the information society by giving them new means of access to the world, (2) encourage widespread application of multimedia pedagogical practices and the forming of a critical mass of users, products and educational multimedia services and (3) reinforce the European dimension of education and training with the tools of the information society whilst enhancing cultural and linguistic diversity" (Commission, 1996, p.7). In order to achieve these objectives, the initiative involved the following four lines of action (Eurydice, 2001b, p.17):

- Encouraging the establishment of electronic networks between schools throughout Europe;
- Boosting the development of educational multimedia resources;
- Promoting teacher training in the use of ICT; and
- Providing information on the potential of multimedia and audio-visual educational tools and resources.

Along with ODL action within Socrates 1 (1995-1999), the Minerva action within Socrates 2 (2000-2006) went on to develop ICT integration into education systems in the EU. The Minerva action focused generally on promoting transnational cooperation projects at the European level in the field of ODL, multimedia and the use of ICT in education. It had the following three main objectives (Europa, 2006, p. 1):

- to promote understanding among teachers, learners, decision-makers and the public at large of the implications of ODL and ICT for education, as well as the critical and responsible use of ICT for educational purposes,
- to ensure that pedagogical considerations are given proper weight in the development of ICT and multimedia-based educational products and services, and
- to promote access to improved methods and educational resources as well as to results and best practices in this field.

The Minerva action supported the following ICT related activities: "action and/or research aimed at highlighting the impact of ICT or open and distance education on the organisation of processes and models for teaching and learning; and the development, at European level, of information systems and services concerned with educational methods and resources involving the use of ICT and open and distance education" (Eurydice, 2001b, p. 18).

When looking back on the eLearning initiative, the originating point of it was based on a strategic goal of the Lisbon process in 2000. The "eLearning Action Plan: Designing tomorrow's education" initiative was adopted by the European Commission on 24 May 2000 and accepted by the Ministers of Education in June 2000. Considering the conclusions of the

Lisbon process, the principles, objectives and action lines of the eLearning initiative were started to improve the quality of learning, services, remote exchanges, and cooperation for education and training at the European level by using new multimedia technologies and the Internet. Although it had several actions, the ICT related one is "devising a decision-making support tool in the form of an information base that contains qualitative and quantitative indicators regarding the use of ICT for educational purposes" (Commission, 2001; Eurydice, 2001b, p.20).

The eSchola action is more obviously aimed at an educational venture that was to be implemented as part of the eLearning initiative. eSchola focused largely on indicating the information and communication potential of the new technologies, encouraging schools and teachers to share best practices and learn from each other. In 2001, there was a campaign, to increase awareness of using the Internet and ICT in schools, especially using eTeaching to require teachers to integrate ICT in teaching activities (Eurydice, 2001b).

Initially, the Information Society Technologies Programme (IST) was replaced with three sub-programmes in the Fourth Framework Programme, (1) the Advanced Communications Technologies and Services, (2) Esprit, and (3) Telematics Applications. Thereby the IST brought these activities together within a single programme. It indicated the growing close interrelationship among information processes, communications and multimedia technology. Then, the IST was also present at the Fifth Framework Programme as a major research and development theme. The strategic goal of the IST was to enable Europe to benefit from the advantages of the information society and to ensure that the needs of individuals and enterprises were satisfied. Although IST is structured into four key actions, the ICT-related action covers the following areas: "essential technologies and infrastructures: mobile and personal means of communication, microelectronics, the development of software and corresponding technology, systems and services, simulation and visualization technologies, new interfaces, the development of peripherals and subsystems and microsystems" (Eurydice, 2001b, p. 22).

The information network on education in Europe, Eurydice, has provided strategic mechanisms or an institutional network for gathering, monitoring, processing and circulating reliable and comparable information on education systems and policies all over Europe since 1980. In order to increase cooperation in answering and regulating needs of education systems and policies at the European level, Eurydice is primarily committed to provide policy makers and decision makers with an exchange of information and experiences in the field of education. It prepares and publishes the following issues: "readily comparable and regularly updated country descriptions on the organisation of education systems, comparative studies on specific topics of Community interest, and indicators" (Eurydice, 2007b, p. 1).

With the growing use of the Internet and ICT, the national governments and the Commission need to learn and measure the status of ICT and Internet use in educational institutions in the member states. In this, Eurydice publications on ICT in education are critically important, as they make available publications giving information about key data on education, ICT at schools in Europe and basic indicators relating to ICT incorporation into European education systems (Eurydice, 2001b). Furthermore, it has Eurybase, a highly detailed database on education systems, and makes it available to its users. Additionally, it cooperates closely with the other partners, Eurostat, Cedefop (the European Centre for the Development of Vocational Training), ETF (European Training Foundation), the Council of Europe, the OECD, and the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Eurydice, 2007b).

## 2.9 The Challenges, Roles and Promises of ICT in Education in the EU

In 2001, experts from most of the European countries published a report about five challenges to the quality of education and sixteen indicators of the quality of school education in Europe. The challenges are connected with knowledge, decentralization, resources, social inclusion, and data and comparability, all of which would have potency to change the face of Europe and impact on national education systems in Europe (Commission, 2000).

Firstly, the information explosion has demanded a fundamental rethinking of traditional conceptions of knowledge, its transmission and delivery by teachers, and its acquisition by students. This leads to a question prioritization in curricula, the setting of educational goals and objectives, the selection and using of teaching methods, and issues related to measurement and assessment etc. In short, essential purposes of school education need redefining to respond to the challenge of the knowledge society, for lifelong learning in Europe. Secondly, the decentralization of education systems at school level, in terms of autonomy, responsibility, accountability, and affordability is another challenge for the EU. Providing same standards, controlling educational inputs and outputs, comparability, equity, quality assurance, and inspection issues are placed in this challenge. Thirdly, money and time-related investments in education are resource challenges to quality of education. This challenge affects both the professional manpower and the students' childhood experiences in pre-school education and in compulsory schooling in terms of intelligence, personal development and, subsequently, social and economic integration into society. Fourthly, making education systems inclusive, to prepare young adults for life after school, is an other challenge related to social inclusion. The structures, curricula and learning environments of schools do not provide any incentive to go and attend on a regular basis, and they are often considered uncongenial or irrelevant to young adults' lives. Finally, benchmarking to make comparisons of national, local, and regional effectiveness and performances at the level of individual schools is the data and comparability challenge. Benchmarks can be used diagnostically and formatively to inform policy and practice, but sometimes they are also considered as a threat. Benchmarking involves creating or having standardized data (Commission, 2000).

The widespread diffusion of ICT has forced people to acquire and master key digital knowledge and competencies that are necessary for education and training, personal development, active citizenship, social inclusion, employment, and self development for the knowledge-based economy and society. Furthermore, ICT helps in providing for the acquisition of new knowledge and competencies to remain competitive in the global world, and in making society ready to grasp new opportunities in the future (Punie & Cabrera, 2006).

Since technological developments are faster than educational ones and educational institutions require some stability and certainty to deliver instructions and to evaluate their processes and/or outcomes, there is a difficulty in finding a balance between these elements in order to catch technological advancements and to integrate them into educational institutions. Although technological advancements, especially in ICT, provide many facilities for learning, they concurrently offer many ambiguities on how to integrate them into educational institutions. This also leads to some challenges that Europe faces in adapting, managing, and implementing ICT in learning environments, which partly explains why ICT-enabled learning has not carried out its promise so far. Nevertheless, ICT should be integrated into learning environments. This integration needs to have more and better investment, resources, research, availability of multi-stakeholders ready to get involved. It needs innovation, time for a trial-and-error process, social and institutional changes, and support from a positive policy (Punie & Cabrera, 2006).

Starting with the Lisbon process in 2000 and its strategic goal aforementioned, authorities from the Europe needed a new vision of learning for a knowledge-based economy and society; thereby they wanted both a radical transformation of European economy and society, and a challenging programme for the modernization of social welfare and education systems. Furthermore, in 2002, they declared that Europe should be the world leader in terms of the quality of its education systems by 2010, which means a fundamental transformation of education and training systems throughout Europe. This transformation can be considered as a need for a demanding and urgent process of change for policymakers, educational stakeholders, and practitioners in Europe (Europa, 2007).

This need for a fundamental transformation of education and training systems is met by especially some actions of the Education and Training 2010 Programme, which is based on three major goals to: "(1) improve the quality and effectiveness of the EU education and training systems; (2) assure that they are accessible to all and; (3) open up education and training to the wider world" (Europa, 2007). In order to realize the Lisbon strategic goal and to meet the need, each country in its national context should drive forward in cooperation with the others at the European level, working for common goals and sharing knowledge and experiences with the help of an open-method of co-ordination. Consequently, it has been working towards the ultimate goal that ICT-enabled lifelong learning in a knowledge-based economy and society becomes true; this involves improving all aspects of education systems: primarily integration of ICT, teacher training, basic skills, efficiency of investments, mobility and citizenship education etc. In this sense, ICT has a key role to play in making ICT-enabled lifelong learning a reality, and in meeting the need for a fundamental transformation of education and training (Europa, 2007).

Correspondingly, when new developments, shifts and trends in technology and education are considered by the Community, it is well aware of a new vision of 'ICT and learning' that is likely to transform the way people work, learn, and interpret their lives to envision, foresee and expect future learning needs, and requirements. The guiding principle of ICT in this vision can be considered as a strategic catalyst or an enabler in providing anyone with access to learning environments anywhere, anytime, and anyhow; but ICT alone is not enough to lead the entire change or transformation process automatically; it should be supported with, especially, necessary reforms in learning and education systems. Furthermore, teaching and learning without ICT seem to be almost impossible to envisage in future learning environments and even in current ones (Punie & Cabrera, 2006).

When ICT is integrated into education systems, it has some key roles to play, such as being a lever for change and adaptation, a catalyst for innovation, an enabler for lifelong learning, a support for employability, a bridge over the digital gap, and a platform for European cooperation (Diaz, 2002). Furthermore, ICT has a responsive role to play in meeting rapid technological changes and their effects on learning. In this connection, meeting challenges in ICT-enabled learning makes learning more flexible and modularized, multi-cultural and permanent in Europe. In addition to these, ICT has an inclusive role to play in including handicapped people in the social learning environment, to provide learning opportunities. It is very interesting that, to some extent, learning has an ICT paradox; this is that ICT may be a challenge for learning, especially at initial stage of integration, and adaptation, but then it may be an enabler. In connection with ICT, this situation is completely changeable, depending on such issues as the basis of existence, purpose, function, and use of ICT (Punie & Cabrera, 2006).

## 2.10 ICT-in-Education in the EU

ICT-related aims, strategies, action lines, initiatives, main programmes, projects, public and private partnerships, and sharing responsibilities pertaining to the EU members are explained separately below.

### 2.10.1 ICT-in-Education in the EU Member Group

#### 2.10.1.1 Austria

Considering the integration of ICT facilities, curricula, and teacher training in the education system of Austria, they vary; but they have reached a basic and more advanced level in lower secondary education. Some schools offer optional or compulsory courses related to ICT. The schools called computer science schools give particular importance to this. Some of them have Internet access and homepages (Eurydice, 2001b).

Within vocational training schools, in 1998 there were experiments for more extensive training to increase ICT familiarity. There are many various further training projects in progress: "training of teachers for industrial certificates in ICT; online training through the eFit academy; academy placements; training in information technologies; the foundation of specialized schools in computer technology and communication and data processing; and the obligation in future for all graduates in technical and vocational training to have obtained a level II grade in computer science testifying to specialized knowledge in this field etc." (Eurydice, 2001b, p. 94).

At lower and upper secondary academic schools, computer science was introduced as a compulsory subject in 1987. These schools were linked to their own network in 1995, and then all schools under the responsibility of federal authorities were linked to the network and the Internet in 1999. Later, education in ICT was included in the curricula of all levels of school from primary upwards (in 2001). Furthermore, several ICT related projects (school book and notebook) were being implemented (Eurydice, 2001b).

Integration of ICT in education and training was conducted to prioritize curriculum development and lesson administration by the Federal Ministry for Education, Science and Culture from the mid to end 1990s. However, since then the curriculum has been changed and adapted to the need for ICT integration in all disciplines of the curriculum. With the beginning of the ICT initiative “eFit-Austria” in 2000, increase in access to education, and improvement in quality of the entire education system through sustainable use of modern ICT was targeted. In 2003, thirteen training programmes related to ICT use were developed and implemented for such areas as, particularly, unemployed people, the development of new professional fields in university, and the further training of teachers. eFit-Austria entered its next phase as eFit2-Austria in 2005, aiming to increase the sustainability of the projects and to ensure the necessary technical infrastructure and pedagogical conditions (Commission, 2005b; Empirica, 2006a).

The scope of eFit-Austria consists of eEducation, eTraining, eScience, eCulture, eAdministration, ICT-infrastructure, and an eLearning portal. The focus of eEducation is to integrate ICT into general and vocational training systems; that of eTraining is to follow the strategy of developing and implementing modern learning and communication techniques via ICT for lifelong learning; that of eScience is to use ICT in teaching, learning, and research in science and higher education; that of eCulture is to explore, preserve, and access the cultural and scientific heritage with ICT; that of eAdministration is to transform education management to a more efficient and service-oriented form, through use of ICT; that of ICT-infrastructure is to take technical precautions to enable completion of the tasks defined before; and that of the eLearning portal is to provide central access to education, science and culture-related information, and to offer ICT services for interested users (eFit Austria, n.d.).

In Austria, the authorities focused generally on e-learning, learning on the network, training future teachers, and effective, permanent, and systematic ICT implementations in the field of education, science and culture. The main ICT strategy of the Ministry of Education is to transform e-learning and the Internet into natural learning resources. They therefore prioritized the following eight aims in their projects within this main strategy: “(1) establishing e-Learning academies; (2) extending opportunities for training in ICT; (3) developing on-line teaching content; (4) setting up ICT scientific centers; (5) enriching adult education and training; (6) promoting the Austrian cultural heritage over the Internet; (7) launching ‘e-Government’ in education; and (8) adapting the infrastructure” (Eurydice, 2001b, p. 93).

Public and private partnerships related to ICT are particularly found in vocational schools. There is also cooperation in providing compulsory education schools with issues of computers and secure Internet access in Vienna. In addition, there are many associations between schools for vocational training and the private sector in the field of humanities (Eurydice, 2001b, p.93).

### 2.10.1.2 Belgium

The Flemish, French and German Community had separate endeavors toward sharing responsibilities for ICT related studies. In the Flemish Community, there were four major initiatives in ICT. They had also sub-initiatives or programs as follow: (a) initiatives concerned with infrastructure (a1- The PC/KD programme, a2- The I-line, a3- The Telenet Pandora initiative, and a4- initiatives to promote video-conferencing); (b) initiatives to familiarize students with ICT (b1- The educational software project for special education, b2- The European Network of Innovative Schools, b3- The matrix programme); (c) teacher training initiatives (c1- In-service teacher training and c2- Initial teacher training); and (d) initiatives to promote international cooperation projects (d1- the OECD initiatives and d2- the European Schoolnet). As understood from the initiatives of the Flemish Community, they gave more importance to these endeavors than the other communities (Eurydice, 2001b).

The aims of these initiatives can be summarized as: a1- all schools would have one computer for every 10 students (10-18 years of age) by 2002; a2- primary and secondary schools would be provided with access to the Internet 24-hours-a day in the period 1998-2000; a3- primary and secondary schools would be provided with tax-free access to the Internet; a4- financial assistance would be offered by the department of education to schools in videoconferencing facilities and associated training for primary and secondary schools; b1- students enrolled in special education would be taught using educational software in pilot schools; b2- all types of institutions, especially for teachers in compulsory education, would be provided with a network that seeks to link up schools recognized for their experience in the area of ICT; b3- primary schools would be supported by a matrix programme of educational database software related to the Flemish language; c1- primary and secondary school teachers would be familiarized with new technologies by encouraging exchanges of expertise through computer networking; c2- primary and secondary school teachers would be prepared for their new roles as teachers in the future information society; d1- endeavors would be conducted by the 25 OECD member countries to provide “quality criteria for educational software and multimedia; changes in the market for educational software and the potential for partnerships in this area; and research and evaluation of the impact of ICT in education”; and d2- schools in the EU countries would be networked to communicate, test educational resources and services and invest in multilateral projects etc. (Eurydice, 2001b).

The German-speaking community had a deliberate policy on development of ICT in 1998. This policy focused on two main aims: “(1) action to develop ICT in schools and (2) initiatives concerned with in-service training and with fully mobilizing the energies of civil society” (Eurydice, 2001b, p. 40). French community had two general aims: “(1) the incorporation of ICT into compulsory education, which is regarded as a factor in boosting the economy, attaches priority to training young people in use of these new technologies, and (2) this concern is coupled with determination to develop a policy for equal opportunities ensuring that all students can secure access to ICT” (Eurydice, 2001b, p. 37). The general aims of the Flemish Community were as follow: “the acquisition and development of knowledge regarding ICT should constitute a new ‘lifelong learning’ process; and schools should make arrangements among themselves for ‘lifelong learning’ to become a reality and an opportunity open to everyone” (Eurydice, 2001b, p. 41).

The French community had initiatives under the following three major titles: (1) primary and secondary levels: (1a) the scheme for multimedia equipment, (1b) connecting to the Internet, and (1c) in-service teacher training; (2) tertiary level; and (3) ICT media/multimedia education. The scheme for multimedia equipment (1a), aimed to provide primary and secondary schools with such equipment for the period of 1998-2001. Connecting to the Internet (1b), aimed to connect 1665 primary and secondary schools to the Internet in 1998. In-service teacher training (1c) aimed to provide primary and secondary in-service teachers with ICT teacher training, financed and subsidized by the French community, including training in handling computer tools, their applications for teaching purposes and the development of critical familiarity with ICT media, in 1999. Tertiary level (2) aimed to integrate a new content into training about knowledge and teaching applications of ICT and its media for primary and lower secondary school teachers, in 2000. ICT media/multimedia education (3) refers to providing education in the ICT media for all primary and secondary school staff. The French community aimed to establish priorities in this area, incorporating media education into school curricula, initial and in-service training, and encouraging necessary partnerships in delegating a team consisting of the Council for Education in the Media and three officially recognized resource centres (Eurydice, 2001b).

The German Community focused on a joint action involving different levels of authority. The French Community had been working together to provide schools with multimedia equipment and ICT related studies. The French Community had also been supervising the integration of ICT into educational teacher training activity. There was nothing of note in public and private partnerships in the German and French Communities.

However, in the Flemish community, both governmental and sectoral level partnerships about ICT were better than the others (Eurydice, 2001b).

Similar to the French community, In the German Community, there were mainly three major initiatives about ICT, that are as follow: (1) connecting secondary schools in the German-speaking Community to the Internet; (2) the "CyberMedia" initiative; and (3) regular involvement in "Netd@ys" and opening of a "Learnbox" unit. The main aim of the first initiative was to provide as many secondary schools as possible with an Internet connection. The first initiative was completely realized by Belgacom and the German-speaking community in the year 1998. The main purpose of the second initiative, CyberMedia, was to provide primary and secondary schools with multimedia equipment and facilities in 1999. Primary schools received 300 computers and 13 upper secondary schools were provided with computer and multimedia equipment under the second initiative (Eurydice, 2001b). The last initiative of the German community, Netd@ys and Learnbox, aimed to create general public awareness about the potential of the new media and the challenges emerging from ICT. In 2000, this initiative served schools throughout the Community in such a way that "two teachers who assisted with the introduction of ICT in primary and secondary schools opened an interactive educational Internet website, known as Learnbox, which amongst other things includes databases providing for the exchange of practical information among all schools throughout the Community" (Eurydice, 2001b, p. 41).

#### 2.10.1.3 Denmark

In 1984, ICT was offered to students as optional subject under the name of "computing". ICT became an obligatory subject known as "electronic data processing" in 1990. The integration of ICT as an obligatory subject into the teaching of all subjects was the major objective for primary schools in 1994. Parallel to this, "word processing", "technology" and "media" were also established as three new subjects for students. This transformation process ensured that all students would have a similar level of computer skills. Therefore, Danish ICT policy at the primary level perceived ICT as not a particular subject or topic, but an integrated part of all subjects. Correspondingly, ICT skills can be considered as a fourth basic skill along with reading, writing, and arithmetic (Pedersen, 2003).

In 1998, the Danish government set a primary goal in terms of ICT implementation which was that the Danish education system would be among the best five in the World. The Danish ICT policy, based on an information society, covers all kinds of people that should not be divided into different ICT skill levels. The Danish government also emphasized investment in ICT, which equally would serve to the following two main purposes: "(1) to improve education by adding more quality and by making it more efficient, (2) to give students the basic ICT qualifications that allow them to operate in present-day society and the society of the future" (Pedersen, 2003, p. 185).

As a result of these concerns, the Danish Ministry of Education made an action plan for 1998-2003. This action plan focused on the following five areas: (1) the implications of ICT for students, (2) teachers and ICT, (3) areas of study and ICT, (4) fair and flexible access to lifelong learning, (5) coordination between research into ICT and education. In addition to the action plan, the following general aims were set: provide all schools with reliable and inexpensive connections to the Internet and intranet through a sufficient number of computers integrated into education, develop significant ICT-related content and online courses to promote lifelong learning, develop teacher training program for in-service teachers to certify their ICT knowledge and skills related to the ICT (Eurydice, 2001b).

After that, the Danish strategy related to ICT in education was based on a wide range of innovative ICT projects. This led to some initiatives, including ICT at lower levels in primary schools, connection of all basic schools into an ICT network, in-service teacher training through distance education and teachers as ICT users etc. Some major initiatives are the Danish ICT Center for Education and Research (UNI-C), Sektornet, and School-ICT: The Educational ICT Driving License. The UNI-C is an ICT company and IT frontline organization that provides services for education, research, and business and offers a common platform for the exchange of knowledge within the Danish educational sector respectively. It also connects schools to the Internet and develops educational materials, particularly software and homepages. Sektornet was a kind of network that improved and intensified communications between Danish educational institutions. The ultimate goal of Sektornet was to connect all Danish educational institutions to the Internet in order to offer net-based education in the future. School-ICT: The Educational ICT Driving License is the basic ICT in-service training program for primary school teachers through distance education. With this program, teachers would revise the content and raise the quality of their teaching (Pedersen, 2003).

In addition to these, there are five cutting-edge projects: (1) Cutting-edge municipalities, (2) The Janus project, (3) Electronic gymnasium, (4) Cutting-edge colleges of education, and (5) Poseidon. Firstly, cutting-edge municipalities (1995) aimed to improve public services by affecting a more efficient administration. Secondly, the Janus project (1995-1997) aimed to instill the principles of goal-oriented ICT planning in schools. Thirdly, Electronic gymnasium (1995-1998) offered schools experience with the latest computer technology in education. Fourthly, Cutting-edge colleges of education (1995) aimed to integrate ICT into colleges of education and understand how ICT influences the teaching of subjects and assessment-related work of teachers. Finally, Poseidon (1997-1999) aimed to test tools and procedures for the integration of ICT through ten pioneering institutions (Pedersen, 2003).

After the action plan for 1998-2003, the Danish government initiated another action plan for ICT in the field of primary and lower secondary education for the period of 2004-2007. ICT integration into subjects where deemed appropriate, and the development of new forms of online teaching materials, are launched and funded within this action plan. It is expected that both low and high performance students take advantage of ICT integration in the teaching process through access to ICT, and use it as a daily personal tool. This also improves the regular cooperation between teachers and students at all grades (Empirica, 2006c).

#### 2.10.1.4 Finland

In order to build a Finnish information society, a position paper outlining a Finnish information society strategy was drawn up by the government in 1995. An initial national strategy -the National Strategy on Education, Training and Research- was specified to achieve the following two general aims: “(1) enabling everyone, in accordance with the principle of equality of opportunity, to acquire the ICT knowledge and skills needed to study and develop their intellectual ability; and (2) encouraging the development of a real information society based on interactive knowledge” (Eurydice, 2001, p. 99). In order to implement this strategy, the national Information Society Programme was conducted from 1996 to 1999. With this programme, school computer network activity and methods of in-service education and training for trainers areas are covered (Eurydice, 2001b).

Along with the implementation of its initial strategy, in 1996, Towards a Culture-oriented Information Society was set up and realized by the Ministry of Education as an information strategy. The guiding principle of this strategy was to guarantee all citizens equal access to cultural services in the new media, especially through producing Finnish content. Furthermore, this strategy provided the Finnish people with new content and information services to diminish alienation and enhance internationalization in Finnish society (Kankaanranta & Linnakyla, 2003).

A consecutive strategy, the National strategy for 2000-2004, was based on appraisal of the initial strategy. It was recognized in 1999 that the information society in Finland was of a high standard, especially in terms of infrastructures, but there was inadequate and inconsistent use of ICT in education, while resources were earmarked for development of computer networks and its facilities. Therefore, four action lines were defined: “(1) development of the knowledge and skills needed in the information society; (2) promotion of computer networks as a means of learning; (3) accumulation of information digital capital; and (4) the strengthening of infrastructure in the education and research sectors” (Eurydice, 2001b, p. 100).

The responsibility for these strategies, aims and action lines and related initiatives, programmes, projects and measures was taken and shared by the Ministry of Education and the National Board of Education at the central level, and by local authorities, schools, and teaching staff at the local level. More specifically, the Ministry of Education determined and monitored the strategy and aims of the information society in the fields of education, training and research; the National Board of Education implemented and coordinated the programme for basic education, general and vocational upper secondary education and adult education; and local authorities were a key partner responsible for a major share of the financing of primary and secondary education. However, it was not until 2001 that there was a private and public partnership related to computer equipment manufacturing and content producing (Eurydice, 2001b).

With the declaration of the national information strategy of Finland for education and research in the period 2000-2004, the Ministry set out seven major initiatives, and their aims and content: (1) citizenship skills in the Information Society; (2) training of teaching staff; (3) information industry and digital communication professionals; (4) virtual university; (5) virtual school; (6) research and development relating to learning environments; and (7) content production (Eurydice, 2001b).

The aim of the first initiative was generally to encourage people to learn the skills necessary for the Information Society. The aim of second initiative was two fold: (1) to develop a strategy for the use of ICT in education and (2) to provide educational staff and teachers with training about ICT. The third initiative aimed to overcome challenges in information industry sectors through making these sectors more attractive, developing the quality of education in these sectors and increasing their employment. The fourth and fifth initiatives, virtual university and virtual school, basically aimed to develop and introduce cooperative and interactive open learning environments and teaching methods (Kankaanranta & Linnakyla, 2003). The sixth initiative’s aim was to meet needs emerging from the adoption of an information strategy that requires developing top quality learning environments related to virtual university and school projects. The final initiative aimed to increase the development of a digital culture and to support industries producing an educational digital content (Eurydice, 2001b).

In addition to these, the programme of the Information Society for Education, Training and Research 2004-2006 aimed to give information society skills to citizens, to provide ICT in educational institutions and to establish social innovation through ICT. Through this programme, "all those completing studies [were] to be given the opportunity to obtain the basic skills and knowledge required in an information society; […] at least 75% of teachers [were] to have the skills to use ICT in teaching, and […] on-line instruction [was] to be well-established" (Empirica, 2006d, p. 10).

### 2.10.1.5 Germany

With advent of worldwide advancements and general trends in multimedia, telecommunications and the Internet since the mids-1990s, ICT has become an important political issue in education in Germany. Therefore, a nationwide initiative was started by German Telekom AG to connect schools to the Internet in 1995. This played a critical role in recognizing the significance of multimedia and the Internet for teaching and learning in schools. After this, several initiatives and funding programmes were launched to transform the country an industrial society to a knowledge-based society. The "Forum Info 2000" initiative was Germany's first national activity to reach the Information Society, and was started by the Federal Government in 1996 (Empirica, 2006e). In addition, ICT-related measures have been taken to integrate ICT into schools and utilize its facilities for educational purposes, to provide in-service teacher training, and develop learning software etc. (Schulz-Zander, 2003).

Several meetings and panels have been conducted by experts and authorities in order to respond to ICT-related challenges on the level of ICT/media-related competency. These have produced some reports and then a declaration, New Media and Telecommunications in Education, published in 1997. This declaration can be considered as a reference point for the federal states in their endeavors to implement changes in the education system. By this declaration, the Ministry confirmed that ICT as new media would be needed to facilitate teaching and learning, to provide teaching aids, and to be a medium for distance learning. Consequently, it has been concluded that the general aim is for ICT to be integrated into general and vocational schools at both lower and upper secondary levels (Schulz-Zander, 2003). Furthermore, the ICT-related general aims are stated as to "include ICT in the initial and in-service training of teachers; encourage partnerships between multimedia centres and the teacher training institutes in the Länder" (Eurydice, 2001b, p. 49).

The shared responsibilities in administrative levels in Germany are as follow: state responsibilities: the ministries of education and research in the Länder are responsible for the in-service training of their teachers (who are civil servants); municipal responsibilities: municipalities are generally responsible for the provision of ICT facilities in public-sector schools. Federal government responsibilities: the federal authorities share responsibility with the Länder in areas concerned with tax law, literary and artistic property rights, rights relating to use of the Internet, distance education and the quality assurance of services and educational software. The federal government is also responsible for financial assistance (Eurydice, 2001b).

In Germany, there are ICT-related private-public partnerships, in both nationwide and local level industry, to promote the use of ICT in education system. The most outstanding partnerships can be given under two titles: (1) partnership with INTEL, an in-service teacher training programme known as 'Teaching for the Future', provides 120,000 teachers with in-service training in the use of ICT both in the classroom and for distance purposes; and (2) an other partnership with over 120 firms in the information technology sector, which provides schools with computer-related infrastructure and a free consultancy service (Eurydice, 2001b).

The initiatives can be grouped into the following four areas: (1) the "IT in education: communication rather than isolation Action Programme"; (2) Innovation and Jobs in the Information Society of the 21st Century; (3) joint actions involving the federal government and the Länder; and (4) Initiatives of the States (Eurydice, 2001b).

Firstly, "IT in education: communication rather than isolation Action Programme" has four components: (1a) the initiative of 'Schools on Line', between the federal government and Deutsche Telekom, provided all schools with free Internet access (including installation and monitoring) and 20,000 computers for primary and secondary schools in the period of 1996-2001. However, this initiative is to continue for an unspecified period beyond 2001; (1b) the initiative of support for the development of educational software was launched by the federal Ministry for Education and Research, to develop educational software in the period of 2000-20004; (1c) the initiative of a Programme to modernize vocational education institutions was set up between the Federal Institute for Vocational Training and various social partners in order to modernize vocational education institutions. It is centered on the provision of ICT facilities and implemented by the federal Ministry for Education and Research; and (1d) the initiative of facilities for public libraries provides all public libraries with Internet access, giving priority to those with inadequate equipment (Eurydice, 2001b; Empirica, 2006e).

Secondly, Innovation and Jobs in the Information Society of the 21st Century (the D21 Initiative) was adopted in 1999. The actions supported by the federal Ministry for Education and Research are the following: development of the Lehrer-Online website with a new priority called ‘Women teachers and pupils go online’; establishment of the DFN-Verein network for higher education and research institutions; support for various types of industrial pilot projects involving companies, institutions and teachers etc.; and promotion of some Internet teaching projects for five years: the first is about the establishment of virtual cooperation among Universities of Applied Sciences, the second concerns the development of multimedia support for courses in chemistry, and the third is about technical and organizational approaches to ‘telelearning’ in centres for continuing training (Eurydice, 2001b).

Thirdly, a joint action involving the federal government and the Länder has three components: (1) ‘construction of institutions of higher education’, a joint action aimed to support the programme for providing computer facilities, the establishment of communications networks in higher education institutions, and the extension of opportunities for training in computer science; (2) joint actions for distance education aimed at using computer networks and multimedia content in education; and (3) the SEMIK pilot project (systematic incorporation of media and ICT in teaching and learning processes), which was launched in 1998 and aimed to ensure the continued introduction and use of ICT in all schools at all levels (Eurydice, 2001b).

Finally, there were also some information society development programmes as initiatives at a regional level supported by the States. They can be listed as: “Baden-Württemberg media-perspectives for the development of the media in the state of Baden Württemberg; Bayern Online- an information society programme of the Bavarian state government; Brandenburg’s Information Strategy 2006 (BIS 2006); Bremen’s Regional Information Society Strategy Development (BRISE); Initiative Information Society Schleswig-Holstein; the Berlin way towards the Information Society; and Media NRW - an initiative of the state of north Rhine-Westphalia” (Eurydice, 2001b; Chatrie & Wraight, 2000, p. 24).

### 2.10.1.6 Greece

In Greece, the Ministry for Education and Religious Affairs launched a plan called the “Operational Programme for the Information Society” for the 2000-2006 period. This plan extended a previous action (Odysseia, which consists of 19 programmes and aims to include ICT in daily activities over 380 secondary schools), and complements its general measures to provide schools with equipment and facilities, linking them in a network and developing ICT in education. The plan has two general aims: (1) to offer a service and better quality of living to citizens; and (2) to contribute to general economic and human resources development. In addition to these aims, there are several ICT-related strategies: providing a network of all primary, secondary and special needs schools and administrative units with ICT facilities; completing the network on education (EduNet) in all schools by 2001; and installing an intranet linking in all schools by 2006 (Eurydice, 2001b).

Responsibilities shared by authorities can be categorized under two titles: (1) administrative duties and (2) products. Firstly, the Pedagogical Institute and the ministerial departments (implementation and monitoring of programmes) are responsible for planning education policies for primary and secondary education. Secondly, the hardware issue is under responsibility of the Ministry and the Pedagogical Institute. Putting out to tender contracts for the development of educational software is the responsibility of universities or institutes working with high tech companies. The Pedagogical Institute is responsible for supplying teaching equipment and materials and establishing their standards (Eurydice, 2001b).

The national initiatives of Greece have generally focused on supplementing hardware, the development and assessment of educational software, and the training of teachers and staff at all levels of the education system. In the area of primary education, the "Island of Phaeakes Programme" was launched in 1998 as a main initiative, and conducted by the Institute of Computer Technology, and the departments for the training of primary school teachers at the Universities of Athens, Thessaly and Crete. This programme aimed to provide teachers and trainee teachers with training and a database, and to provide every twelve students with one computer by 2006. Giving trainees basic computer skills, integrating ICT in the education process, and increasing familiarity with educational software were also targets for the database. It also sought to provide 14 pilot public-sector schools with computerized laboratories, having Internet access and new educational software, which led students to acquire basic skills in the use of ICT (Eurydice, 2001b; McCaffery, 2003).

In the area of secondary education, since 1997 modernization of the infrastructure and services of a national network (under the Odysseia programme in the period of 1996-2000) were provided 400 high schools with the IT rooms since 1997. New educational software was produced for the teaching of all subjects in junior high schools, and the Institute of Computer Technology localized international educational software in 1999. This initiative, in the period of 2000-2006, tried to provide all schools with access to a network by the end of 2001, and to link all schools by means of an intranet by 2006. Furthermore, it wanted all 51 prefectures, 1,800 schools and 117 administrative units to be connected to each other.

In addition to these, there has been a development of educational exchanges and the twinning of primary and secondary schools in Greece and schools abroad. These include such activities as communication on the Internet and the exchange of projects, leading to exchange programmes and visits. Greece is one of the founding members of the eLearning programme EUN-European Schoolnet, an organisation founded in 1997 aimed at the co-operation and communication of all Ministries of Education of the EUN member states on issues related to e-Learning and the use of ICT in education (Empirica, 2006f).

### 2.10.1.7 Ireland

In Ireland, the government committed itself to a programme aimed at providing computer literacy throughout the school system for the new millennium. Although there were several ICT related policies, goals and programmes, the most comprehensive action programme, Schools IT 2000 –A Policy Framework for new Millennium, was launched in 1998 and extended from 2000 to 2003 in order to invest in ICT in primary and secondary schools. In this context, several goals and related initiatives covered the establishment of ICT infrastructure in schools, the development and upgrading of teacher ICT skills, giving computer literacy to students in the information society, support facilities and the integration of ICT into teaching and learning environments. With these initiatives, student/computer ratios changed from 35:1 to 11:1 at primary level and from 16:1 to 9:1 at second level from 1998 to end of the 2001. Therefore, considerable progress in relation to teacher ICT skills and use of ICT in classroom was made in Ireland (Eurydice, 2001b; Empirica, 2006g).

ICT related responsibilities were shared among the authorities as follow: the Department of Education and Science is responsible for education policy on curricula and ICT integration into the education system; the National Council for Curriculum and Assessment is responsible for the curriculum implementation of ICT; the National Center for Technology in Education provides advice and guidance to schools about ICT infrastructure for schools; and a Computer Service Manager is responsible for purchasing software, and hardware etc. The Department/School within a particular Institute proposes teaching courses, course content and teaching methodology, which is approved internally by the Academic Council of the Institute and externally by the National Council of Education Awards (Eurydice, 2001b).

In Ireland, there is an ICT-related public-private partnership between the Irish telecommunications company (EIRCOM) and the Department of Education and Science, in order to provide each primary and secondary school with the following within the Schools IT 2000 policy framework: a telephone line providing Internet access; an Internet service; a ready-to-use multimedia computer connected to the Internet; free Internet dial-up access for five hours a week. Furthermore, EIRCOM also supplied 30 education centers with an ISDN connection and a network of 10 multimedia computers for teacher training. Moreover, in 1999, in order to offer educational services and materials for a variety of groups -including students, parents and teachers- and to put them in contact with each other, the other major agreement on development, maintenance and operation of the Scoilnet (the Irish version of the European network called as European Schoolnet) network between Intel Company and the Department of Education and Science was signed for at least three years. Additionally, many partnerships between the private and public sector were formed under the School Integration Project within the Schools IT 2000 project to develop models of best practice for ICT applications, pedagogies, and resources and schemes for ICT use in teaching and learning (Eurydice, 2001b).

In addition to the comprehensive initiative, Schools IT 2000, there are also ICT related major initiatives at primary and secondary level that can be categorized under the following three titles: (1) development of technological infrastructure; (2) development of the professional skills of teachers; and (3) development of an infrastructure for guidance and support (Eurydice, 2001b).

Firstly, it was aimed to increase the number of multimedia computers in primary and secondary schools in the period of 1998-2003. Measures for promotion and implementation were taken to finance the establishment of class computer networks, and to examine the national infrastructure for extending Internet access and expanding facilities. Secondly, in order to develop the ICT-related professional skills of primary and secondary school teachers in the period 1998-2003, ICT training was designed, developed and implemented. Finally, efforts were made to create an infrastructure for guidance and support that provides curricular innovations to enhance the use of ICT in classroom; to set up national network to advise and support schools with ICT related plans; to establish a national framework to support multimedia products and tools tailored to the Irish curriculum; and to distribute appropriate curricular resources in schools (Eurydice, 2001b).

As Chatrie and Wraight (2000) note, in 1997 the Information Society Steering Committee published a report entitled “Information Society Ireland: Strategy for Action”. In this report, there were strategies and measures concerning how ICT would transform the economy and society. How this transformation could be realized is given in the following objectives, strategies, and specific actions:

- ensure a strong and independent regulatory office for the telecommunications sector;
- provide Irish businesses and households with low cost access to broadband services including through the offering of a cable franchise in 1997;
- develop a centre of excellence for the creation, provision and export of content for the Information Society and encourage similar regional centres;
- develop Dublin as a flagship Irish "virtual city" providing citizens and visitors with on line access to information and services using ICT;
- establish a National Learning Initiative linked to two flagship projects: "Cyber-Schools" to link schools and libraries to the Internet with ISDN and "Knowledge Resource Centres'1 to facilitate the provision of information and introduction of ICT;
- create a legal framework for the Information Society including the amendment of intellectual property rights legislation and introduction of legislation on areas inadequately covered such as electronic commerce (Chatrie & Wraight, 2000, p. 140).

#### 2.10.1.8 Italy

In Italy, ICT as a subject is normally given in technical and vocational schools, that kept up with technological innovations from the 1960s to 2003. Computer Science was introduced to technical schools in 1967 and the National Plan for Computer Science introduced the teaching of computer science in mathematics and physics courses in secondary schools in the 1980s. However, the introduction of computers to nursery schools (preschools) and primary and lower secondary schools was varied, because of a limitation of finances and dependency on local resources. There were several initiatives for this issue, but the official action, the decision to introduce ICT in all schools, was realized by the government of Italy in the mid-1990s. This large-scaled program went under the name of the Program for the Development of Educational Technologies in 1997-2000. It was launched by the Ministry of Education to promote the use of ICT throughout the whole Italian school system. After piloting related initiatives in 1996, the program was affected with public funds in 1997 and completed in 2000 (Melchiori & Picco, 2003).

Along with the Program for the Development of Educational Technologies, there were various experimental and pilot projects, coordinated plans for teacher training and practices requiring use of ICT; but between 2001 and 2003 the Ministry of Education, University and Research strengthened this program. With release of the Education Reform Act as a core element, access to ICT would be improved through installing a computerized network infrastructure with broadband cabling and satellite reception equipment in schools. This led to support for teaching Computer Science as a core element in the primary school curriculum and for providing teachers with continuous ICT training (Melchiori & Picco, 2003; Empirica, 2006h).

In this sense, the ICT-related main strategies were set to: provide schools with appropriate infrastructure; connect all schools to the Internet; establish networks and support services; encourage development and use of educational software and multimedia; integrate ICT into curricula as a compulsory subject for the first two years of secondary school and in other subject areas at all levels; explain how ICT can be effectively integrated into each discipline; and provide teachers with ICT related training (Eurydice, 2001).

The Ministry of Education is generally responsible of financing ICT training and the provision of computer equipment for schools. However, regional and provincial authorities are also responsible for the establishment of service, advisory or resource centers for the benefit of schools. The schools or research bodies are sometimes given responsibility for resources to carry out pilot projects (Eurydice, 2001b).

The Programme for the Development of Teaching Technology aimed to train teachers, supply schools with multimedia equipment, connect schools to the Internet and set up networks and services for transmission. This programme supported teachers and students in primary and secondary education for the period of 1997-2000, through the Ministry, schools, and private partners, including RAI (Radiotelevisione Italiana), computer equipment suppliers and Internet providers. There were some measures to promote and implement this programme: establishing multimedia premises or facilities for teachers; delivering multimedia literacy courses; introducing and using all kinds of ICT; providing multimedia work stations for groups or individuals; installing a link to the Intranet; connecting computers to the Internet free of charge; and developing network services for students and teachers (Eurydice, 2001b).

There was an important initiative, Progetto SeT (Project SeT), for students and teachers in primary and lower-upper secondary education, to support the implementation of the Italian Action Plan for Information Society for the period of 1999-2002. In this sense, Project SeT helped schools in providing the right resources to improve their ICT related tools and facilities, and thereby to organize their scientific and technological teaching. It also helped in creating services, support tools, actions and training opportunities for teachers, and in promoting specific technological and scientific organizations to provide ICT-related support for schools (Eurydice, 2001b; Melchiori & Picco, 2003).

Similar to Project SeT, in 2000, there was another initiative, The Tools and Facilities for Scientific and Technological Education, to support the implementation of the Italian Action Plan for Information Society. This initiative was associated with Project SeT and aimed to provide equipment and resources for scientific and technological education. Therefore, it can be said that this initiative supported the Project SeT and produced ICT-related tools and services for scientific and technological education, especially projects carried out by the network of schools in cooperation with public agencies interested in education and science. There were also some measures to promote and implement this initiative: calls for project proposals, project appraisal by a special expert committee, and distribution of funding-related activities (Eurydice, 2001b; Melchiori & Picco, 2003).

There were various ICT related initiatives in Italy, but the noteworthy ones can be summarized as: (1) The 100 Projects whose aims were the same as those of the Tools and Facilities for Scientific and Technological Education, but which was launched earlier and focused on more than just scientific subject areas; (2) Scientific Literacy: this aimed to arrange training and counseling for teachers, training activities for students and the production of multimedia equipment for teachers in primary and lower secondary schools; (3) The Center for Teacher Training: this aimed to utilize ICT in education for teachers; (4) Multimedia in the Classroom: this aimed to give teachers and students involved multimedia laboratories or networks experience with innovative hardware materials and new technologies; (5) Technological Observatory: this aimed to inform teachers on how to monitor and make available ICT-derived products (network, services, software and good practice); (6) Catalogue of Software for Teaching Purposes: this aimed to collect, classify and make available multimedia products for all levels of education; and (7) PCs for Students: this initiative aimed to encourage families with young students enrolled in the first year of upper secondary school to buy a personal computer conforming to the required quality, safety and service standards, by making available interest-free loans, repayable over a two-year period. Partners of this initiative were the presidency of the Council of Ministers and the Italian banking association (Eurydice, 2001b; Melchiori & Picco, 2003).

In addition to these initiatives, there were projects that involved ICT use in the areas of teaching, teacher training, technological innovation and research. LES is an example of these, that covered the entire school system. It aimed to establish a national school network supported by education researchers who were to produce, test and validate innovative ICT related educational practices and materials for use in schools. Another example is LABTEC for teachers and students in the first two years of upper secondary school. It aimed to enhance experimental methodologies and practical activities through use of ICT and therefore it encouraged the production of multimedia and online materials, training of online tutors, online seminars and tutoring in schools and planning, and implementing and updating websites (Eurydice, 2001b; Melchiori & Picco, 2003).

### 2.10.1.9 Portugal

Portugal since the mid-1990s has focused on issues relating to the notion of the information society. Considering these issues led the government to develop policies and programs to transform Portuguese society to a knowledge or information society. In order to fulfill this, the national education authorities have implemented policies and programs across different sectors of Portuguese society (Henriques, Ribeiro, Amaro & Ferreira, 2003).

ICT-related initiatives in education and a national action plan that aimed to increase the introduction and use of ICT throughout society are under the responsibility of the Ministry of Education. Parallel to this, there is a funding programme, Prodep 3, for the development of education in Portugal, which has three strategies: (1) installation of school computer facilities and networks, (2) development of multimedia educational content, and (3) teacher training. In 2001, the National Lifelong Learning Strategy was formulated to develop a national system for training and developing competencies in the use of ICT. Furthermore, the Network of ICT Competency Centres, as a part of the Nónio Secule 21st Century Programme (ICT Programme for Schools), played a noteworthy role in the provision of pedagogical support for the integrated use of ICT in education (Eurydice, 2001b; Empirica, 2006i).

In general, the Ministry of Education is responsible for the whole education system and for integration of ICT into school curricula, and the Ministry of Science and Technology is in charge of connecting schools and other institutions (e.g. libraries) to the Internet. However, the regional authorities are responsible for providing ICT facilities in schools, which is executed by local authorities for primary schools. Provision of ICT facilities for schools is realized within the Internet Portugal na Escola programme, conducted by the Ministry of Science and Technology, and is planned to complete by 2001. The Ministry encourages schools to act autonomously in deciding how they use their resources (Eurydice, 2001b).

There were some ICT-related initiatives in Portugal as well. The ICT Programme for Schools aimed to provide multimedia computers for compulsory and secondary schools, to train teachers to fully use and develop the equipment, to provide incentives for the development of educational software, and to promote information exchange and international cooperation (Henriques, Ribeiro, Amaro & Ferreira, 2003). The Prodep III initiative, funded by the European Social Fund and the European Regional Development Fund, began in 2000. It aimed to provide schools with computers in such a way that there should be one computer for 20 students in primary schools, and one computer for 10 students in secondary schools. By 2006, there should be one computer for 10 students in all schools.

It also aimed to give all teachers basic ICT skills before 2006 and to develop multimedia educational content (Eurydice, 2001b; McCaffery, 2003).

The Internet initiative started in August 2000 and aimed at all students having access to a computer by 2003, all citizens having Internet access; all teachers having a computer in their homes before 2004, and providing fixed-rate broadband width connections (cable TV, ADSL, UMTS). Another initiative related to the Internet connection of schools was the Internet na Escola. This initiative covered secondary school levels, universities and polytechnic institutes, municipal libraries and, particularly, primary schools, all of which should be connected by the end of 2001. It aimed to extend the Internet connections through the Ministry of Science and Technology (Eurydice, 2001b).

### 2.10.1.10 Sweden

After a change of government, the second national commission on IT in 1995 developed guidelines for a national action plan and its implementation. Three areas were prioritized: (1) the legal system, (2) education, and (3) the provision of information to society at large. One year later, a third IT commission advised the government on the necessary legal changes to be implemented as a result of rapid developments in ICT. On the basis of the fourth IT commission findings and advice, many public initiatives were launched between 1996-1999. There were also initiatives related to the cultural sector and public administrations in Sweden (McCaffery, 2003).

Sweden has two general aims related to ICT: (1) to enable all citizens to take an active part in public debate and professional life through access to ICT and acquisition of the skills needed to use ICT; and (2) to encourage use of ICT as an interactive learning tool to enable all citizens to upgrade and extend their skills, given that lifelong learning is becoming essential to overcome the rapid changes affecting society. More specifically, it aims to enhance the educational potential and development prospects of schools through use of ICT (Eurydice, 2001b).

Along with the Ministry of Education and Science, the development of an e-community and some of its education related activities are under the responsibility of the Ministry of Industry. Most of the municipalities introduce strategies designed to broaden access to ICT. Central and local level administrative divisions work together flexibly in terms of responsibilities. Considering the needs and characteristics of school students, each school prepares a working programme, including its objectives, measures and activities at school level. Municipalities also provide schools with ICT related equipment and facilities for school activities (Eurydice, 2001b).

In this sense, the national programme for ICT in schools (the Nationellt program för IT i skolan, ItiS) was launched in 1999 to support the development of ICT in compulsory and upper secondary education. In this way, the government hopes enable to students to acquire the same degree of proficiency in ICT, which can prepare students in post-compulsory education for lifelong learning. Furthermore, use of ICT as a learning tool at all levels of education was strategically adopted to teach use of ICT in a meaningful way, so that students in compulsory and upper secondary education should be familiar with ICT, select different sources of information, process information, create and manage data and evaluate the data. Moreover, one of the aims was to develop positive attitudes toward aspects of ICT for students in upper secondary education. In addition, financial investment in the integration of ICT into the education system, including teacher training and tertiary education, helps the development of ICT related courses (Eurydice, 2001b).

The National Programme for ICT in Schools (ItiS) was designed mainly for compulsory and upper secondary education, but pre-primary education and municipal adult education is also covered. This initiative was specifically aimed to develop ICT knowledge and skills on the part of teachers and school heads, to provide teachers with training with their own computers, to increase Internet access for schools and supply teachers and students with their own e-mail address, to support the development of educational multimedia tools for disadvantage students through funding, to develop the Schoolnet network at national and European levels aforementioned, and to reward teachers who make an outstanding contribution to the use of ICT in education (Eurydice, 2001b).

ItiS involves offering a skill development programme to teachers working in a team and with students. It was the largest and most comprehensive national investment programme implemented by the Swedish government between the years 1999-2002. Within this programme, the 70,000 teachers' competency in using ICT as a tool to support the students' learning was raised over a four-year period. The programme had a state grant for infrastructure improvements, including Internet connections and e-mail access for all teachers and students (Empirica, 2006j).

### 2.10.1.11 The United Kingdom

After the Superhighway Initiative involving 25 projects and around 1,000 schools in 1995, was launched, it was decided to start the British Governments National Grid for Learning (NGfL) initiative for 1998-2002. This generally aims to provide high quality educational software to teachers and students through public/private partnerships. More specifically, it aimed to have 1 computer for every 5 students in secondary school, for every

8 in primary schools and for at least 75% of 14 year-old students to have ability to use the Internet for studies and ICT. In 1998, the government declared an ICT-related policy and covered the following ICT-related key area as complementary general objectives for England, Wales and Northern Ireland: transforming education - using ICT in education in such a way that all can acquire the knowledge and skills needs for the information age (McCaffery, 2003; Eurydice, 2001b).

In 1998, the government issued the NGfL initiative to take forward and adopt the following ICT-related targets for ICT in 1998-2002: connect all educational institutions, libraries and community centers to the Grid, train teachers to feel confident and be competent in teaching using ICT within the curriculum, and train librarians similarly, ensure general administrative communications between education bodies and the government and its agencies stop using paper-based work and make Great Britain a centre for excellence in the development of networked software content and a world leader in the export of learning services (Eurydice, 2001b).

In Scotland, ICT related general policies, objectives, aims and strategies were also set by the government. Complementary general objectives focused on the issues of: developing of the information society, supporting teaching-learning processes and increasing educational levels, and preparing learners for a society based on lifelong learning. More specifically, it aimed to equip students with experience and skills in ICT appropriate to help them work universally and to enable researchers to pursue their activities on a world-wide basis. In addition to these, there were strategies related to ICT. Firstly, in-service teacher training on using ICT in teaching started in 1999 and was forwarded to training institutes in order to be completed in 2002, which was adopted by the Scottish Further Education Funding Council. Secondly, provision of facilities and Internet connections to schools and development of multimedia services and resources focused on connecting primary, secondary, higher institutions and community centers to the Internet and on making students and teachers use their own electronic addresses. Finally, training students in better ICT skills as determined by the Higher Still Core Skills framework would be realized before the 2002 (Eurydice, 2001b).

Although several departments have authority and responsibility for devolving ICT-related resources to schools, the British Educational Communications & Technology Agency (BECTA) is responsible for supporting government and national agencies in the use and development of ICT to raise standards in education. The New Opportunities Fund is responsible for distributing grants for health, education and environment initiatives as determined by the government. Local Education Authorities in England and Wales are in charge of distributing additional funds to schools and supporting them with their own ICT development plans. In Northern Ireland, the Education Technology Strategic Management Group has overall responsibility for education technology strategy. Schools are in charge of developing their own ICT plans and budgeting for their implementation. In Scotland, Learning and Teaching Scotland is responsible for ICT courses and applications in education and for supplying a wide range of innovative products and services. Local authorities and schools in Scotland are responsible for purchasing and maintenance of software and hardware (Eurydice, 2001b).

The aforementioned NGfL is a major initiative related to ICT in the UK. It can also be defined as an educational portal or gateway and a programme for providing educational institutions with appropriate infrastructure. Local authorities, BECTA, schools and private sectors are common partners of this initiative for all learners, and lifelong learning services at all levels of education. This initiative has three aims: (1) deliver high quality educational software and services to teachers and students; (2) to remove barriers to learning in order to ensure quality of access for all, and (3) to provide information and learning resources for teachers to improve their ICT skills. In Scotland, this initiative is used to modernize schools in terms of computer facilities, networks and connections to the Internet and use of ICT as a resource for teaching and learning (Eurydice, 2001b; McCaffery, 2003).

In England, Wales, and Northern Ireland, New Opportunities Fund Training is an initiative supporting the NGfL initiative. It aimed to train teachers and librarians to use ICT effectively in meeting their teaching needs by 2003. This led newly qualified teachers to reach the level of expertise for mandatory standards in ICT in England and Wales. This initiative focused on teachers and school librarians at primary and secondary levels. In Scotland, it also aimed to train all in-service teachers and school librarians to use ICT effectively for the period of 1999-2002 (Eurydice, 2001b).

In 2000, BECTA and independent suppliers launched other initiatives, being the Computers for Teachers, Fast-track programmes (in England and Wales) and Laptops for head-teachers (in Wales) programmes to raise teachers' confidence and competence in ICT by enabling them to have personal access to a computer. In these programmes, teachers in Computers for Teachers supported 50% of the purchase price of a laptop or desktop computer and school head-teachers in Laptops for head-teachers were supplied with laptops (Eurydice, 2001b).

City Learning Centers were launched as part of Excellence in Cities in England. It was conducted by Local Education Authorities and schools for the 2001-2002 period to improve the education of city children through using ICT to deliver extended educational opportunities to schools, students and adults in determined areas of major cities. Through this initiative, students and adults can improve their education technology knowledge and skills; thereby the attainment levels of students are increased. Research and Development was an initiative in Scotland. It aimed to develop new ICT-linked educational content and services for the Internet for primary and secondary education (Eurydice, 2001b).

The ICT for Learning Strategy was another initiative in Wales. It was interested in the provision for use, both within and outside school, to provide the foundation for the development of lifelong learning across the Wales. It generally aimed to make ICT more available to disadvantaged areas, improve ICT skills, and raise standards of attainment in schools. Local Education Authorities and schools were partners of this initiative for all learners, particularly for the socially disadvantaged (McCaffery, 2003; Eurydice, 2001b).

The education Technology Strategy in Northern Ireland was started by the Department of Education Northern Ireland in 1997 to provide all schools with the necessary infrastructure of equipment and online services to be in the information society. More specifically, it aimed to provide teachers with training on competency in ICT use and its facilities, to integrate ICT into both teaching and learning, to provide schools with curriculum content, professional support and guidance on effective use of ICT in teaching and learning, and in school administration and management (McCaffery, 2003; Eurydice, 2001b).

The new Labor government promised to modernize the country with new strategies for the information age in 1997. Then, the Information Society Initiative Programme was launched and ran until 2000. Within this initiative there many initiatives were conducted. In the early 2000s, it was declared that all government services would be online and the Internet would be provided to all who wanted it by 2005. Later on, the Digital Scotland Initiative, the Wales Information Society Initiative and the Northern Ireland Information Age Initiative were indicators of how devolved administrations were developing the information age programmes at a regional level (McCaffery, 2003).

### 2.10.2 ICT-in-Education in the New EU Member Group

#### 2.10.2.1 The Czech Republic

In 2000, the government approved the ICT-related national policy that aimed to ensure that through integrating ICT into the education system, all pedagogical staff, students and citizens would acquire a certain level of access to mastery of ICT. This helps in developing a real information society. In order to realize this, the following strategic and specific objectives were settled: to provide an ICT coordinator in each school to help teachers and students in using ICT as resource for teaching and learning, to enable students, teachers and librarians in basic and upper secondary education to demonstrate some mastery in working with ICT, to enable upper secondary schools and libraries to become information centers with ICT facilities for citizens considering lifelong learning before 2005, to train 75% of civil servants and teachers in upper secondary education to use ICT as a teaching resource by 2006, and to enable all schools and libraries to have Internet connections in a national information infrastructure (Empirica, 2006l; Eurydice, 2001b; Kramplova, 2003).

The process of implement of the national ICT policy depended on the following timeline: the first step (2000-2001) included training teachers and librarians and providing schools and other organizations with ICT equipment; the second step (2002) required assessing a situation in terms of what had been done up to 2002 in implementing ICT policy, and making an inventory of ICT equipment already present in educational institutions. In this way, a roadmap can be drawn to update ICT policy operationally and to update its implementation for the following years; the third step (2003) was to finish the process of providing schools and libraries with ICT facilities and to ensure that teachers, librarians and public servants could be ICT literate; a fourth step (2004) was also required to evaluate what had been achieved in terms of implementing ICT policy since most of the students could have been students of schools and be ICT literate; and the fifth step (2005) was to equip nursery schools with ICT. By that year it was expected that the active population of the Czech Republic would have reached a basic ICT literacy level (Kramplova, 2003).

The national ICT policy of the Czech Republic covered equipping schools with ICT facilities, connecting schools to the Internet and using these facilities. For this, the following time schedule was also set to implement ICT policy: every basic and upper secondary school would be equipped with at least one multimedia computer connected to the Internet as of 2002; at least one computer with Internet would be accessible for all teachers in each school by the end of 2003, every larger basic and upper secondary school would have one special room with a minimum of 8 multimedia computers connected to the intranet, every teacher in these schools would have individual access to the Internet, each of these schools would have its own website designed and maintained by its students and students in upper secondary schools would have their own individual e-mail addresses by 2004, and school administration issues would be conducted electronically and ICT would be fully integrated into the management process of every school in 2005 (Kramplova, 2003).

The Ministry of Education is basically responsible for funding training programmes, purchasing and maintaining hardware and basic software for all levels of education, and equipping ICT facilities. The regional and local authorities are also partly responsible for these funding issues, especially for specialised software and for initiatives in school management. Schools are in charge of their own educational content and the teaching methods used. There is a public/private partnership in supplying schools with ICT equipment and services (Eurydice, 2001b).

In order to realize these ICT related policies, the Ministry of Education and other private organizations started a set of initiatives. For the period 2001/05, the following major initiatives were started: Information Literacy was started by the Coordination Centre of the Ministry of Education and the Czech Information Society to train teachers, documentary research librarians, ICT coordinators and citizens for ICT use; Educational Software and Information Sources was launched by the Coordination Centre of the Ministry of Education and an expert council to integrate ICT into teaching and school activity and the establishment of an educational gateway, pilot projects and on-line distance education were taken and conducted as measures for the promotion and implementation of this initiative; Infrastructure was also started to provide schools with ICT and teachers and students with access the ICT-related services by the Coordination Centre of the Ministry of Education, the general contractor and the general auditor (Eurydice, 2001b).

#### 2.10.2.2 Hungary

In the early 1980s, there was a government programme requiring all secondary schools to have computer in Hungary. Later on, the National Information Strategy developed in 1995 attached an important role to the implementation of ICT in education. The Sulinet (School-Net) programme was designed as a large-scale information technology development programme by the Ministry of Education in 1996. As a result of this programme, all secondary schools with dormitories and some 250 primary schools had full and free access to the Internet for a 5 year period. Furthermore, these schools also had a computer room with 7 to 16 multimedia computers including necessary software. Moreover, every secondary school with dormitories and 25% of primary schools had IT rooms (aggregately 4,000) with access to the WWW. This programme was financed by central and local authorities (Aux-Banfi & Körös-Mikis, 2003).

The School-Net programme also aimed to help local systems integrate into a wider educational network, which facilitates access to educational services and documents, and ICT-based teaching materials for various curriculum subjects. This required content digitalization and management for teachers and students. Consequently, in 1997, Digital Lessons (a basic multimedia package in the form of teaching materials on CD-ROM) and Homework (promoting individual learning in the Hungarian language) were created through offering tenders to develop the School-Net programme and better utilization school laboratories. Digital Lessons and Homework related to subjects in the national core curriculum were free to schools and available as CD-ROMs or on the Internet in 1998. They provided digital reusable teaching materials that could be used for either individual learning or cooperative learning in groups. In this sense, this was the first step to a digital paradigm shift in education (Aux-Banfi & Körös-Mikis, 2003; Empirica, 2006m).

After 1998, with a new government, the trend shifted from developing infrastructure in schools to effective application of ICT, developing network services and supporting in-service teacher training programmes. The School-Net programme was continued, but its name and focus were changed respectively as Iris-Sulinet and the elaboration of content elements of services and further development of the public education information system. More specifically, ICT development in public services (hospitals, community houses and mobile education centers) also enables citizens, teachers and students to utilize them (Aux-Banfi & Körös-Mikis, 2003).

Ninety-seven percent of primary and secondary schools, and pedagogical institutions were integrated into the Iris-Sulinet network hierarchically. The Ministry of Education was responsible for the monitoring working and utilization ratio of the network, and thereby suggestions could be made for further developments. Maintaining and repairing this network system was guaranteed to be free of charge for three years by the supplier company. With this networking action, The Iris-Sulinet portal was created in 1999 to provide teachers and students with a variety of educational services related to information on in-service training, reference materials for teaching-learning activities, electronic references, and educational reference databases (Aux-Banfi & Körös-Mikis, 2003).

With the coming of the new millennium, the hot topic in Hungary was the information society as it was in the entire world. Therefore, the information society and its requirements were put on the educational agenda. As part of this, some aims and strategies on the ICT were determined by the Hungarian policy-makers and curriculum developers. They have focused generally on the following issues: improving education at all levels, improving ICT skills required for information society, supporting teachers with in-service training, providing schools with ICT equipment (network, Internet and digital content), providing opportunities through ICT to share international knowledge and experience and national cultural and scientific capital, enabling students to realize the importance of ICT in society, and having students regularly use ICT knowledge and skills (Aux-Banfi & Körös-Mikis, 2003; Eurydice, 2001b).

The Ministry of Education is responsible for determining strategies, action programmes and all funding issues related to the ICT-related initiatives, but local authorities are responsible for providing schools with hardware, equipment and the materials allocated to them. The Public Foundation for Schools Education also provides schools with ICT facilities at a regional level. Educational software can generally be provided through the Iris-Sulinet programme and its website, and schools can purchase their own chosen software. In-service teacher training is financed by the government (80%), and the remaining part (20%) is financed by schools, individual teachers chosen by schools or other sponsors. There was no major partnership among public and private organization until 2001 (Eurydice, 2001b).

Similar to other countries, there were various ICT-related initiatives. The major ones can be summarized as: Equipment, Methods and Educational Content aimed to improve computer facilities and the quality of methods and educational content in single structure primary schools and general secondary schools, training in ICT aimed to organize ICT training courses within higher education institutions for teachers, prospective teachers and students expecting to undertake more specialised training in ICT, a Research and Development initiative that aimed to increase research and development, and thereby circulation and exploitation of its results; Supporting Bodies aimed to ensure maintenance of systems through establishment of a Systems Operator Service and ICT-based Pedagogy Counseling Service; International Involvement that aimed to increase international professional relations participation in the European Schoolnet network, and Development of e-Learning Materials that aimed to improve the quality of open and distance learning courses through using digital teaching materials for higher education, vocational training, adult education, and in-company training (Eurydice, 2001b).

#### 2.10.2.3 Latvia

As of 2001, the general aim of policy-makers in Latvia was to develop a sound high quality education system, and thereby the cultural heritage and well-being of the country would be supported. Within this general aim, it was the specific aim to train qualified specialists in computer programming and ICT so as to develop a major economic sector to increase exportation. In this sense, the main strategies aimed to computerize the education system and train specialists in ICT-related fields through taking several measures. In the computerization of the education system, students and teachers would be prepared to live and work in the information society, the process of learning would be modernized to be more effective, and all education institutions would be networked through the initiative of the Latvian Education Informatization System (LIIS) started in 1997 (Eurydice, 2001b).

Responsibilities among the central, regional and local level authorities were shared at a central level. The General Education Department of the Ministry of Education and Science was in charge of specifying the guidelines for educational content and the government was responsible for financing LIIS. The Ministry of Education and Science, the University of Latvia, the local authorities and the schools were responsible for project implementation and they were also supposed to determine the number of teachers who would receive in-service teacher training administered by LIIS regional centers. The LIIS project monitoring committee was responsible for evaluating the resources allocated for regions. Additionally, the Ministry of Transport was responsible for the informatics national programme and the Ministry for Economic Affairs administered eLatvia programme. There were no major partnerships between public and private organizations until 2001 (Eurydice, 2001b).

In Latvia, there were ICT-related initiatives. The Latvian Education Informatization System (LIIS) was one of the major initiatives. The LIIS project is one of the main priorities of the Latvia Informatics programme for an information society. It aimed to integrate ICT into teaching in such a way that computers would support, but not replace teachers; teachers and students would be active participants, but not passive consumers, and computerization would provide equal opportunities for the development of everyone. Furthermore, Latvia also aimed to train all teachers (over 40,000), through LIIS, to use ICT in their teaching for lifelong learning. Moreover, ICT was introduced into management and information services. All these projects were started by the Ministry of Education and Science, the University of Latvia, local authorities and schools, in 1997. In order to realize this initiative, the following ICT-related measures were taken for promotion and implementation: development of software for students and the introduction of ICT in the learning process (Eurydice, 2001b).

eLatvia was the major initiative that aimed to provide all citizens with secure access to information and fundamental knowledge, and to help them utilize these in their daily lives through the acquisition of basic knowledge skills related to ICT. In this way, eLatvia would lead to improvement in the country’s effectiveness and competitiveness on the world market (e-commerce) and in terms of social well-being (e-government) by 2004. The following measures were taken to reach the determined aims: speeding up the computerization of schools through supporting computer-assisted learning and teacher training, connecting all schools to the Internet and exploiting resource this; transforming libraries into information centers in all fields, and introducing the European Computer Driving License (Eurydice, 2001b).

### 2.10.2.4 Poland

In Poland, the education system at all levels and sectors was reformed at the end of the 1990s. This reform tried to support modernization and development of the information society. As such, it was intended to enable students to use new technologies for learning, researching and problem solving. Furthermore, prospective and in-service teachers would be trained to adopt ICT both as a subject to be taught and as a resource to be used in the teaching of other subjects. Some main strategies were also settled: to introduce new common and detailed curricula, prepare school textbooks with multimedia attachments, launch the initiative of Interkl@sa to develop the information society in 1999, introduce ICT into schools, and prepare a White Paper for the development of the information society in Poland for the years 2001-2006 – ePolska (Eurydice, 2001b).

The Ministry of Education was responsible for specifying the common curriculum, school textbooks and other teaching materials for financing software and for hardware. Local authorities were also responsible for financing the purchase and maintenance of hardware and software. Schools were in charge of preparing their detailed curricula, selecting their teaching methods and covering Internet and other expenditure like paper and ink for printouts etc. (Eurydice, 2001b).

There were partnerships among the private and public sectors. INTEL and Microsoft included the project “Teach to the Future” for training 100 trainers and 400 teachers (each would be responsible for training 20 teachers) to use ICT in various school subjects. CISCO worked together with local authorities on the CISCO Networking Academy project for training Internet and intranet specialists and technicians. The Ministry of Education and the Polish telecommunications company (TP SA) reached an agreement to offer free Internet access to all levels of education in schools for a determined period of time (Eurydice, 2001b).

In Poland, there were also major ICT-related initiatives. In 1998, an Internet laboratory initiative aimed to provide 2,500 primary and lower secondary schools with IT rooms including 10 computers with Internet access and general and educational software, at local authority level. Furthermore, 7,000 teachers were trained in a 40 hours training programme within this initiative. Furthermore, in 1999-2000, an initiative providing one Internet laboratory in each gymnasium provided 3,300 lower secondary schools with IT rooms that had the same specifications as the Internet laboratory initiative mentioned above. Moreover, in the years ahead, this initiative was to be continued with appropriate facilities for primary and upper secondary schools. The other initiative, the Interkl@sa, has been conducted by parliamentary committees for education, and for science youth, the Ministry of

Education, local authorities, NGOs and private and media companies since 1999. It aimed to increase ICT use at all school levels, to diminish the digital divide and to involve students and teachers in the information society (Eurydice, 2001b).

### 2.10.2.5 The Slovak Republic

In the Slovak Republic, computer systems, programming and algorithm processing as separate subjects were introduced and taught in selected upper secondary schools until 1986. Informatics and computer technology began to be taught as independent subjects in all upper secondary schools within the national project on the "electronization" of schools in 1986. Within this project, selected schools were equipped with computers and informatics was taught as a course. Its content covered the essentials of programming and algorithm processing in Basic and Pascal. In this sense, mathematics teachers were trained in computer skills and programming in Basic. Actually, the training of informatics teachers had already started in 1984 and they graduated from the Faculty of Mathematics and Physics, Comenius University in Bratislava, in 1989. The Slovak Republic developed its own computers which replaced the ones in secondary schools in 1988. This process then directed the teaching of ICT to application programs, such as word-processing and spreadsheets, and gave less importance to programming (Blahova, 2003).

After 1989, the Slovak Republic opened its doors to the world market; thereby many computers were imported from abroad. At that time, both the government and the Ministry of Education did not have any idea of an official information technology program. Schools had a limited budget to purchase computers. Therefore, computers and their peripherals were received by schools as grants or from sponsors. Schools in the Slovak Republic were allowed to use multi-license Comenius Logo for Windows free of charge in 1993. They frequently used Comenius Logo until 2000. The Ministry of Education and Microsoft (which supplies schools with the Microsoft Windows operating system and with Microsoft Office) reached an agreement for Slovakian schools to obtain licenses in 2000. In 2002, the new object-oriented programming language "Imagine" was developed and distributed to 500 schools in the Slovak Republic within the project of "Infovek" (Blahova, 2003).

ICT was not integrated into the primary school curriculum, but a computer-based unit was offered as part of technical education for the second stage of primary schools (grades 5 to 9). Primary schools providing education by means of computers were gradually increasing in terms of extended lessons or optional subjects, but these lessons included only computer basics and playing games for common schools, or a programming at schools oriented to mathematics and programming. Since ICT was not a compulsory subject and the

Ministry did not help schools financially, those primary schools that wanted to use ICT in their teaching had difficulty in finding money to purchase computers and related equipment (Blahova, 2003).

On the other hand, informatics as an independent subject was taught in high schools, and other related subjects were also taught as optional subjects. All schools had one or two IT rooms (mostly connected to local area networks) only for teaching informatics. From 1997 on, The objective of the secondary school curriculum focused not on only acquiring skills for operating a personal computer and using word-processing and spreadsheet applications, but also on teaching the essentials of the science of information processing, strategies for gathering, manipulating and presenting information, working with ICT and applying ICT and developing algorithmic thinking (Blahova, 2003, p. 520).

The basic aims were to enable students in primary (second stage) and secondary schools to use computers and the Internet and appropriate software. In other words, ICT knowledge and skills would be given to students in education. In this sense, the following strategies were determined: projects would be financed and established by the Ministry of Education, computer networks between higher education institutions and the universities would be developed (SANET project), primary and secondary schools would be provided with computer facilities and the Internet (Infovek project), primary and secondary school-teachers would be provided with training (Infovek project), school projects would be financed (Infovek project), and a national and international exchange of information and experience would be provided (Infovek project) (Eurydice, 2001b).

The Ministry of Education and regional authorities were responsible for integrating ICT into schools through pilot projects (e.g. Infovek). Some primary and all secondary schools had autonomy to purchase hardware, software, and laboratory equipment with appropriate maintenance. Public/private partnerships were developed by Infovek and EUNIS (the civic association comprising higher education institutions and other members) – those were known as SK projects. Telenor Slovakia and Nextra were the private donors and they supported the Infovek project especially with equipment. Microsoft and CISCO were also partners of the EUNIS-SK project (Eurydice, 2001b).

The Internet and Secondary Schools project helped schools in connecting to the Internet for the period 1996-2000. Within this project, certain schools were selected and provided with a server. The Internet fees for these schools were met, and teachers in these schools were trained in using Internet applications for various subjects. The first website for teachers was developed in 1996/99 and then a new program, a distance education initiative using Internet, was launched in 1999 (Blahova, 2003).

Similar to other countries, there were various initiatives related to ICT. The Slovak Academic Network (SANET) was among the major ones. SANET aimed to establish an Internet computer network including primary and secondary schools, higher education institutions and the universities. It also took part in a European project, the Gigabyte European Academic NeTwork (GEANT) that was launched by the European Commission in 2000 to link up previously existing national education and research networks. SANET was administered by the Minister of Education and the EU from 1991 to 2001 (Eurydice, 2001b).

The aforementioned project of Infovek aimed to integrate ICT into the teaching and learning environment in primary and secondary schools through connecting them to the Internet before the end of 2002, and to train their all teachers and students to master basic computer skills before the end of 2003. It also intended to develop sound educational ICT-related content and to enable teachers to integrate ICT in every subject. In 1998, it was officially launched by a non-governmental and non-profit-making civic association, the Ministry of Culture and private donors (Eurydice, 2001b; Blahova, 2003).

## 2.11 Summary of the Literature Review

### 2.11.1 ICT-in-Education Policies and Implementations in Turkey

**ICT related initiatives and projects in education:** ICT investments started in secondary schools in 1984. These investments continued, especially in upper secondary schools, in the years 1984-1991. Attempts to develop instructional software for CAI in collaboration with MONE, the private sector and universities were seen in 1988-1991. In the late 1980s and early 1990s, a few in-service training activities were also held on basic computer skills for teachers, with the support of universities. In the 1990s, within the framework of the National Education Development project, 53 CES and 182 CLS projects were started in selected secondary and basic education schools (in 1993 and 1996, respectively). The main aim of these two projects was to investigate ways to integrate computers into the Turkish education system.

With the Education Master Plan 1996-2011 formed on the basis of policy recommendations from the Seventh 5th Year Development Plan and the 15th National Education Council, Project 2000 for Keeping Pace with the Age in Education was launched as a short-term project. Afterwards, in 1997, compulsory education was expanded from five to eight years. The long-term plan, as a strategy of the master plan, BEP was initiated in 1998. It was one of the largest education projects in the world in terms of its scope, the affected population, and budget. The main purpose of this project was to generalize basic education throughout Turkey, to enhance the quality of basic education and to convert schools into community learning centers. One of BEP objectives was directly related to ICT: generalizing the use of computer technologies in education through establishing IT rooms in every basic education school. The government had a loan of 300 million dollars from the World Bank for the first phase of this project that was implemented in 1998-2003, and an additional 300 million dollar for the second phase in 2002-2007. Since the government in Turkey and project leaders in the World Bank changed, the second phase of BEP actually started in 2005. The main aims and objectives of BEP were kept for the second phase. Additionally, it was planned to improve pre-primary school education and special education in the second phase.

It could be concluded that hardware investments were more dominant in the ICT integration process up to 2003. These investments for basic education schools were actually made in 1998-2000 within BEP I (3,188 IT rooms in 2,802 primary schools). However, the Internet connections at schools were limited and slow (Akbaba-Altun, 2006; TBŞ, 2002) until December 2003. Nevertheless, with MONE ADSL Connection Project, schools started to access the Internet with broadband. After the PISA 2003 data collection, the E-learning - Education Portal, Education for the Future, and the Campaign for Supporting Computer Aided Education Project were other major projects and initiatives concerning ICT integration into primary and secondary education.

**ICT in the Primary and Secondary School Curriculum:** There was no formal computer education curriculum for basic education until 1998. Computer education started from the 4$^{th}$ grade, with the curriculum being accepted in 1998. This development could be attributed to ICT objectives in BEP I. As of 2005, students in the first three grades were allowed to take optional computer courses, as well. With the 2004 curriculum reform, this curriculum was cancelled and a new curriculum for 1$^{st}$ - 8$^{th}$ grades was accepted in 2006. The new curriculum is more student-centered compared to the previous one. When integration of ICT into other subjects is considered, there is little evidence of an effort for curriculum change in basic education (Göktaş, 2003). For this aim, hardware and in-service training have been provided within BEP I, but only one optional computer course has been added to the basic education curriculum. In fact, the curriculum reform that started in 2004 is the first apparent curricular evidence of efforts to integrate ICT into all primary and secondary school curricula. As to upper secondary education, optional courses named Computer 1-2 and Information Technology 1-2 were added to the curriculum, but they are still optional. Furthermore, computer courses could be offered in schools with IT rooms and computer teachers.

### 2.11.2 Issues and Suggestions about Integration of ICT into Education in Turkey

The major issues concerning the ICT-in-education policy and implementations in Turkey that have emerged in studies could be summarized as follow:

- The Turkish education system serves a considerably large number of students (Yıldırım, 2006; Göktaş, 2003).
- Students are at a low readiness level for ICT integration (Reynolds, Treharne & Tripp, 2003; Aydın & McIsaac, 2004).
- There is a lack of communication and cooperative work on ICT integration in MONE (Özar, 1996).
- There is higher emphasis on hardware investments (Özar, 1996; Bhullar, 2005).
- There is inadequate and/or low quality in-service training on ICT integration into the curriculum (Çağıltay et al., 2001; Akbaba-Altun, 2006; Aşkar, Usluel & Mumcu, 2006; Yıldırım, 2007).
- There is a lack of appropriate supervision of IT rooms and ICT integration (Akbaba-Altun, 2006).
- There is a lack of leadership in schools (Yıldırım, 2007; Akbaba-Altun, 2006).
- There are an inadequate number of computers, Internet connections are slow and there are maintenance problems at schools (Yıldırım, 2006; Akbaba-Altun, 2006; TBŞ, 2002; Çağıltay et al., 2001; Akkoyunlu, 1995).
- The curriculum structure is inconvenient for integration of computers (Çağıltay et al., 2001; Yıldırım, 2007; Göktaş, 2003; World Bank, 2004)
- There is a problem with poor software quality or inappropriate software for the curriculum and local needs (Aydın & McIsaac, 2004; Akbaba-Altun, 2006; Akkoyunlu, 1995).

Suggestions for remedy these issues and others in the literature regarding ICT-in-education policy and implementations in Turkey can be listed as:

- Provide strong leadership (Yıldırım, 2007; Akbaba-Altun, 2006; Bhullar, 2005).
- Reform or revise the curriculum (Özar, 1996; Akkoyunlu, 1992).
- Find school based solutions to problems (Özar, 1996; Bhullar, 2005; Aşkar, Usluel & Mumcu, 2006).
- Provide a more effective in-service training system (Yıldırım, 2007; Aşkar, Usluel & Mumcu, 2006; Akbaba-Altun, 2006; Göktaş, 2003; Çağıltay et al., 2001; Addo, 2001).

- There is a necessity for collaborative work between MONE the universities and the private sector (Özar, 1996; Yıldırım, 2006).
- Needs analysis to identify local needs should be conducted before purchasing or developing software (Özar, 1996; Aydın & McIsaac, 2004; Akbaba-Altun, 2006; Addo, 2001).
- Avoid focusing largely on pedagogical and organizational issues rather than on technological ones with a holistic approach in ICT-in-education policies and implementations (Bhullar, 2005).

### 2.11.3 ICT and Attainment

The influence of access to computers at home and school on student achievement has become a significant research realm as computerization increases in these places. The literature indicates that there is a positive relationship between access to computers and student achievement (OECD, 2006c; Fusch & Woessmann, 2004; Sweet & Meates, 2004). However, when the family background characteristics of students are taken into consideration, this relationship becomes negative (Fusch & Woessmann, 2004) or insignificant (Wittwer & Senkbeil, 2008). Moreover, the results remain the same regardless of how often students use computers at home (Wittwer & Senkbeil, 2008). This means, holding family background characteristics constant, that students perform significantly worse when they have computer access at home. Non-educational use of computers or ineffective ways of using computers for learning may lead to home computers negatively affecting student learning. In brief, students' access to a computer may not be linked to their performance in mathematics. Only some conditional positive relationships between computer access at home and student achievement are detected, if computers are used for education and communication purposes (Fusch & Woessmann, 2004) and for problem-solving activities in a self-determined way (Wittwer & Senkbeil, 2008). Similarly, when school characteristics are taken into consideration, the relationship between access to computers at school and achievement becomes insignificant (Fusch & Woessmann, 2004). Still, a conditional relationship exists at school: computer use is associated with student achievement only at medium level frequency, not at the least or most frequencies (Fusch & Woessmann, 2004; Aşkar & Olkun, 2005).

Inequality in access to ICT resources at home is larger than at school, between high and low achievers regardless of the level of prosperity of a country (Sweet & Meates, 2004). The same trend is also detected in the PISA 2003 data (OECD, 2006c). In this sense, schools should have a mission to provide low achievers (who have less ICT resources at home) with ICT resources (Sweet & Meates, 2004).

There are some patterns of computer use peculiar to low and high achievers (Sweet & Meates, 2004). Low achievers tend to use computers more frequently for programming, computer games, drawing for graphics and using spreadsheets in general. Contrary to this, high achievers use Internet and word processing more frequently.

There are various studies on students' attainment and ICT use in learning. These studies yield contradictory results. Thus, the literature about the effects of ICT on achievement is still inconclusive and leads to merely tentative conclusions (Kulik, 2003). Kulik's (2003) meta-analysis of seven studies concludes that ICT often considerably enhances student achievement in mathematics. Indeed, schools have become more successful in utilizing instructional technology in teaching and learning in the 1990s, compared to earlier years, due to advancements in technology and the greater familiarization with technology of both teachers and students (Kulik, 2003). On the other hand, Balanskat, Blamire and Kefala (2006) contend that ICT does not improve the mathematics performance of students aged 7-16, while it is effective on English, Science, and Design and Technology courses. They emphasize the importance of the arrangements of ICT facilities at school as productive and supportive for student learning. ICT is considered to be a contributor to student achievement by students, teachers, and parents (Balanskat, Blamire & Kefala, 2006).

As to use of ICT in math courses, it was rare in 8$^{th}$ grade classes between the years of 1995-1999 (Pelgrum & Plomp, 2002). Moreover, students who reported more frequent computer use in their math courses had lower math scores than students who did not report any computer use in their math courses (Pelgrum & Plomp, 2002). According to Pelgrum and Plomp, this result may stem from two reasons. First, the most common use of computers in math courses is for drill and practice for lower ability students. Sweet and Meates (2004) also stated that low achievers tend to use educational software more than high achievers do. Second, students who use computers frequently in math courses engage in more student-centered instruction compared to those who do not use computers in math courses. Most probably, student-centered instruction does not focus on the competencies measured in TIMSS (Pelgrum & Plomp, 2002). Thus, these students may become low achievers, according to the results of these tests.

### 2.11.4 Comparison of Turkey and the EU in ICT Integration into K-12 Schools

**Overall computer access at home, school and other places:** Access to computers at school is most common in both EU groups and their rates are also close to each other.

However, the second common form of access in the EU member group is at home, while it is at other places in the new EU member group. Although there was a gap between the rates of computer access at home between both EU groups in 2000, this gap was closing in 2003. The country groups could be compared on the basis of PISA 2003 data for overall computer access. On the contrary, the most common form of access is not at school, but at other places (73%) for Turkish students. The second most common form of access in Turkey is school. However, the rate of this access is 54% for Turkey, while it is 95% for the EU member group and 91% for the new EU member group. Similarly, the rate of access to computers at home is very low in Turkey, at 37%. This rate is almost two times larger in the new EU member group (70%) and two and half times larger in the EU member group (90%). Nevertheless, it should be noted that the rate of computer access in other places is relatively similar in all country groups, but even this rate is lower in Turkey than in both EU groups. Under these conditions, Turkish students are in a disadvantaged position in terms of access to computers, particularly at home and at school.

**Integration of ICT into Primary and Secondary Education in Turkey and the EU:** Developed countries have invested in technology for educational settings since the early 1980s. According to the Eurydice report on the integration of ICT into education, ICT investments have been seen in K-12 schools in almost all EU countries, through nationwide ICT projects beginning around the mid 1990s (Eurydice, 2001a).

Every European country has a policy document in the form of a law, decree, curricular recommendation, and/or action plan for the use of ICT in primary and/or secondary education. Parallel to these developments, it is seen that the number of students per computer is between 5 and 20 in most European countries according to PISA 2000 data (Eurydice, 2004). This ratio is 22.9 on average, even in the new EU member group. In 2001, this number was 37 students per computer in upper secondary schools in Turkey (TBŞ, 2002). Computerization of schools in Turkey is relatively low when compared with the new EU member group, and considerably lower than the EU member group. It is clear that the EU member group makes more ICT related investments in K-12 schools than Turkey.

As to in-service training, percentages of primary and secondary school teachers who had received official training in the use of computers and/or the Internet in their teaching are 62% and 50% respectively in the EU member group in 2001 (Eurydice, 2001b). On the other hand, in Turkey teachers who have participated in-service training are not satisfied with the quality of in-service training activities for teaching with technology, due to these activities not being offered in local settings, not addressing real needs and not being ongoing and not being on time (Yıldırım, 2007).

In the EU member group, in line with ICT investments and in-service training on using ICT as a tool in other subjects, 71% of teachers use computers and 34% of them use the Internet in the classroom in primary schools. Primary school teachers use computers five hours a week on average. As to secondary school teachers, in 2001 60% of them used computers and 42% of them used the Internet in the classroom in this country group (Eurydice, 2001a). In contrast, in Turkey it is not common to put computers into classrooms yet, rather, computers are in a room, called the IT room, and these rooms are mostly used for optional ICT courses as a separate subject. Furthermore, according to the ICT impact study conducted in 2004 by MONE, all teachers perceived IT rooms as installed only for ICT courses, and they were not aware of their rights to use the IT rooms in their teaching (MONE, 2004). In-service training for teachers at least until 2004 seems only to have aimed at providing basic ICT skills, not at teaching how to utilize technology or IT rooms in lessons. The pedagogy of teaching with ICT should be the main focus of in-service training activities. Indeed, the role of pedagogy and teachers' beliefs about teaching and learning are central to ICT integration (Mumtaz, 2000).

ICT is generally used as a tool in primary school curricula in the EU member group (Eurydice, 2001a). This trend also exists in secondary schools with the support of separate ICT courses (Eurydice, 2004). According to the survey conducted in 2002-2003 school year by Eurydice, K-12 schools' compulsory curriculum in most EU countries involves ICT-related objectives under an additional category, namely, to "use ICT to enhance subject knowledge" for teaching or use of ICT (Eurydice, 2004, p. 23). With implementation of this new objective, students' meaningful use of ICT for a specific purpose could be expected to increase in the EU countries. However, teaching ICT as a separate subject is the most common approach in the K-12 curriculum in Turkey. Indeed, using ICT as a tool for a meaningful purpose did not appear in the written curriculum until the curriculum reform initiated in 2004. Thus, Turkey could be seen to be at the initial stages of using ICT as a tool in the teaching and learning of other subjects.

In summary, the infrastructure and teachers' use of ICT in subject courses in Turkey are not as common as in European countries, although Turkey has been conducting ambitious projects and investing considerable sums of money in ICT provision to schools for educational purposes since the mid-1980s.

# CHAPTER 3

# METHODOLOGY

The present study has two phases. The first one is in the quantitative research paradigm and the second one is in the qualitative research paradigm. The methodology of each phase is given separately. After giving information about the design of the study, firstly, the population, sampling, sample, instruments, data collection procedure, statistical data analyses, validity and reliability, limitations, missing data analysis, and effect size pertaining to the quantitative phase are presented. Secondly, the participants, data collection instrument, data collection procedure, data analysis procedure, validity and reliability, and limitations pertaining to the qualitative phase are also presented.

## 3.1 Design of the Study

This study has both quantitative and qualitative phases, with separate main purposes. The main purpose of quantitative phase is three-fold: firstly it aims to reanalyze the PISA 2003 dataset with respect to ICT aspects controlling ESCS and attitudes toward computers, across country groups; secondly it models the relationships between mathematical literacy performance and affecting factors, such as ICT aspects and ESCS, by using the PISA 2003 dataset across country groups; thirdly it models the relationships between problem solving literacy performance and those factors across country groups. On the other hand, the main purpose of the qualitative phase is to investigate exemplary education policy makers' perceptions of the quantitative phase results of this study and of issues and possible solutions in ICT policy making and implementations in Turkey. More specifically, the research questions of this study are as follow:

**a) Quantitative Research Questions:**

1. How does ICT use –Internet/Entertainment Use and Program/Software Use– differ among students in PISA 2003 across the EU member group, the new EU member group and Turkey (country groups), controlling for attitudes toward computers and the economic, social and cultural status of students?

2. How does self-confidence in ICT –Confidence in Routine Tasks, Confidence in Internet Tasks and Confidence in High Level Tasks– differ among students in PISA 2003 across country groups, controlling for attitudes toward computers and the economic, social and cultural status of students?
3. How do attitudes toward computers differ among students in PISA 2003 across country groups, controlling for the economic, social and cultural status of students?
4. How well do ICT-related factors and student family background explain variances of PISA 2003 students' mathematical literacy performance across country groups?
5. How well do ICT-related factors and student family background explain variances of PISA 2003 students' problem solving literacy performance across country groups?

**b) Qualitative Research Questions:**

1. How do Turkish education policy makers evaluate the quantitative findings of this study across Turkey and the EU?
2. According to Turkish education policy makers, what are the issues in developing and implementing an ICT-in-education policy in Turkey?
3. What are the Turkish education policy makers' suggestions for developing and implementing an ICT-in-education policy in Turkey?

Considering the quantitative and qualitative phases together, along with the interrelated and complete structure and procedures, and the theoretical drives of this research, according to Morse (2003), the overall design of such a study is referred to as a multimethod research design. When the characteristics and principles of this research design are taken into account, it is best fit in a quantitative -dominance- study followed by a qualitative study with a deductive theoretical drive. The multimethod research design type of this study is notated as: QUAN $\rightarrow$ qual. The separate focuses and the related research questions of quantitative and qualitative phases of the study also require the multimethod research design.

## 3.2 Methodology for the Quantitative Phase of the Study

### 3.2.1 Population, Sampling, and Sample

Since there are natural differences in national education systems with relation to grade or structure of the educational institutions in the countries that participated in PISA 2003, the target population in each country is defined as all 15-year-old students in grade 7 or higher, enrolled in any type of educational program, except for students schooled at home or abroad. The age of the students in PISA 2003 study ranges from 15 years and 3 (completed) months to 16 years and 2 (completed) months. In other words, they were born in 1987. It is normal that a small variation in the distribution of their ages leads to diversity in the grades of schools in different countries. Therefore, the international target population of PISA 2003 is not dependent upon the grades of students or schools, but is based on the ages of the target students. This age-based arrangement provides researchers and policy makers with more robust international comparability than a grade-based one (OECD, 2005b).

Experts from the PISA Consortium determine the population and sampling procedure and closely monitor the countries for their national sampling. Before the PISA 2003 study was conducted, National Project Managers (NPMs) were informed about stratification for sampling and sampling standards, to reduce sampling variance. In the study, a two-stage stratified sample design was generally used for thirty nine countries, but a three-stage stratified sample design is also used although only for two countries. In the first stage, schools were selected, where 15-year-old students were enrolled; afterwards, students were randomly stratified-sampled within each selected school. In school sampling, probabilities proportional to school size (a kind of formula) were systematically used to ensure that all students had the same chance of selection (OECD, 2005a, p. 124). Based on this sampling procedure, at least 150 schools (if the number of schools in a country was less than 150, all of schools were selected) and 4,500 students (the within-school sample size is usually 35 students; if there were less than 35, all the students were sampled) were selected for each country. In addition to these, the standardization of students' and schools' response rates was such that the minimum participation rate of students was 80 per cent and that of schools was between 65 and 85 per cent, to minimize potential response biases (OECD, 2005b). In this sense, these standards lead the population and sampling of the PISA 2003 study to be more extensive and comparable than other international studies such as TIMSS, Third International Mathematics and Science Study-Repeat (TIMSS-R), PIRLS and so forth.

For the present study, before statistical analyses were conducted, the countries that participated PISA 2003 were categorized into three groups: (1) a EU member group (founders or countries that joined before 2004), (2) a new EU member group (those that joined in 2004) and (3) Turkey (a candidate member). Table 3.1 represents the countries with ICT data in PISA 2003, the country groups, and their members. Consequently, the EU member group has 11 members, the new EU member group has five members and Turkey is the third group.

Table 3.1 Country Groups, Members and Countries with ICT Data in PISA 2003 Dataset for This Study

| **Countries** | | | | **Country Groups** |
|---|---|---|---|---|
| Austria (AT)<br>Belgium (BE)<br>Denmark (DK) | Finland (FI)<br>Germany (DE)<br>Greece (EL) | Ireland (IE)<br>Italy (IT)<br>Portugal (PT) | Sweden (SE)<br>United Kingdom (UK) | EU Member Group |
| Czech Republic (CZ)<br>Hungary (HU)<br>Latvia (LV) | | Poland (PL)<br>Slovak Republic (SK) | | New EU Member Group |
| Turkey (TR) | | | | Turkey |

Since the scope of this study and its research questions are limited to the EU member group, the new EU member group and Turkey, the target and accessible population of this research is computed by adding up the students in members in each country group. The numbers and total numbers of the target and accessible population, and the sample for countries and country groups in PISA 2003 are given in Table 3.2. The numbers of the target populations for the EU member group, the new EU member group and Turkey are 2,933,559, 938,496, and 725,030; that of accessible populations for these groups are 2,893,300, 916,389, and 719,702; and that of the samples are 66,980, 27,441, and 4,855, respectively.

Table 3.2 Target and Accessible Populations and Samples for PISA 2003

| Country Groups with Members | | Target Population | Accessible Population | Sample |
|---|---|---|---|---|
| EU Member Group | AT | 89,049 | 88,728 | 4,597 |
| | BE | 118,185 | 117,624 | 8,796 |
| | DK | 58,188 | 57,560 | 4,218 |
| | FI | 61,107 | 59,783 | 5,796 |
| | DE | 916,869 | 911,269 | 4,660 |
| | EL | 108,314 | 107,506 | 4,627 |
| | IE | 58,977 | 58,042 | 3,880 |
| | IT | 574,611 | 571,743 | 11,639 |
| | PT | 99,216 | 98,390 | 4,608 |
| | SE | 112,258 | 110,643 | 4,624 |
| | UK | 736,785 | 712,012 | 9,535 |
| ***Total*** | | ***2,933,559*** | ***2,893,300*** | ***66,980*** |
| New EU Member Group | CZ | 126,348 | 125,054 | 6,320 |
| | HU | 123,762 | 120,074 | 4,765 |
| | LV | 37,138 | 35,719 | 4,627 |
| | PL | 569,294 | 554,694 | 4,383 |
| | SK | 81,954 | 80,848 | 7,346 |
| ***Total*** | | ***938, 496*** | ***916,389*** | ***27,441*** |
| ***Turkey*** | TR | ***725,030*** | ***719,702*** | ***4,855*** |

Source: (OECD, 2004, pp. 321-322) and (OECD 2005b, p. 172)

As all the national target populations of the countries consists of 15-year-old students in the PISA 2003 dataset, the sample of this study is also 15-year-old students, but only those from the EU member group, the new EU member group and Turkey and those who have used computers before. As seen in Table 3.3, the sample size for this study changes, depending on statistical analyses.

Table 3.3 Sample Sizes with respect to Research Questions and Country Groups

| Research Questions | Statistical Data Analyses | Sample Size | | |
|---|---|---|---|---|
| | | EU Members | New EU Members | Turkey |
| Research Questions – 1 and 2 | One-way multivariate MANCOVA | 56,610 | 24,834 | 3,231 |
| Research Question – 3 | A-univariate ANCOVA | | | |
| Research Questions – 4 and 5 | Path Analytic Models within SEM | 57,787 | 25,359 | 3,590 |

The difference in sample sizes for multivariate variance analyses and path analytic models exist because of a different deletion method used for missing data. Students with data on all ICT indexes and ESCS index are taken for multivariate analysis of covariance (MANCOVA) and analysis of covariance (ANCOVA) analyses (i.e. listwise deletion). On the other hand, students with at least one non-missing ICT index are taken for path analytic models within structural equation modeling (SEM) analysis (i.e. pairwise deletion).

### 3.2.2 Data Collection Instruments

The designing, developing and implementing of PISA 2003 assessment instruments are interactive processes involving the cooperative responsibility of the OECD members, and international PISA consortium. This consortium consists of the PISA Governing Board, diverse expert committees, and international experts from noteworthy institutions such as the Australian Council for Educational Research (ACER), the National Institute for Educational Measurement (CITO) in the Netherlands, Westat and ETS in the United States, the National Institute for Educational Research (NIER) in Japan, senior policy makers, and international expert groups, as the subject matter expert group (SMEG). In particular in establishing assessment instruments, SMEG works on the identification of the critical knowledge, skills and competencies of 15-year-students, having to successfully join and contribute to modern society. Considering and balancing the national, cultural, linguistic, and educational contexts of countries, SMEG consulted the other national test development professionals in the PISA 2003 assessment domains. Therefore, the assessment instruments used in PISA 2003 have high authenticity and educational validity (OECD, 2004b, 2005a, 2005b).

In PISA 2003, four subject domains, mathematical (as a major domain), reading, scientific and problem solving (as minor domains) literacy performance, are assessed to understand whether the ability of 15-year-old students in using their knowledge and skills meets real-life problems or challenges or not. However, only two domains -mathematical and problem-solving literacy performance- are included in this study. Therefore, the assessment of the mathematical and problem-solving literacy performance parts of the instruments is described below.

The test items for mathematical and problem-solving literacy performance were developed in the consortium item development centers, ACER, CITO, NIER and the University of Leeds. Both the submitted items from individuals as a mathematical expert group from the countries and those from the professional item developers were allocated in the item development centers. The items from the centers originated, or those from submissions developed with negotiations, in a cyclic manner. In order to prepare, develop, clarify, review or revise items and a coding guide, some procedures, analyses or methodologies were followed by professional item developers in a minimum of two of the centers. After that, international colleagues closely examined these items to give feedback, which was then used to improve them. Afterwards, pilot studies were conducted to obtain items to be sent to national centers. In the pilot studies, plenty of students in a similar age range from different schools and classes were used to reach multiple versions of responses to items. In this way, alternative items could be produced by means of comparing, analyzing or revising repetitive pilot test results. These pilot test results helped coders in coding diverse responses to items (OECD, 2005b).

A set of guidelines were sent to the NPMs for the remaining items from pilot studies to help in reviewing items and providing feedback. The main reasons for reviewing items and providing feedback were to obtain information on the relevance and acceptability of items from a cultural perspective, to identify special issues or problems related to cultural differences and relevant to curricula, the PISA framework or any other matters. These are thought to be very important by the national center. The feedback from NPMs was reported critically in a comparative manner and served for all NPMs on the PISA web site. The reports are often used in the meetings of the SMEG, in developing and revising items in terms of translation and cultural issues.

Later, similar to the guideline procedures for pilot studies, field trial studies were conducted. Finally, 167 selected items were used to assess the performance of the 15-year-old students in four literacy domains, in 2003. The information on items in terms of quantity, allocated time, and booklet number (referring to test booklets) in the PISA 2003 assessment are given in Table 3.4.

Table 3.4 Distribution of Literacy Domains' Items by Quantity, Allocated Time, and Booklet Numbers in Pisa 2003

| Literacy Domains | Item Quantity | Allocated Time (minutes) | # of Booklet |
|---|---|---|---|
| Mathematical Literacy | 85 | 30 | 1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11, 12, 13 |
| Problem Solving Literacy | 19 | 30 | 3, 4, 9, 10, 11, 12, 13 |
| Science Literacy | 35 | 30 | 5, 6, 7, 8, 9, 12, 13 |
| Reading Literacy | 28 | 30 | 1, 2, 7, 8, 9, 10, 11 |

Source: OECD (2005b)

In the PISA 2003 assessment, the test design is based on paper and pencil and has five item formats: (1) open-constructed response items, (2) close-constructed response items, (3) short response items, (4) complex multiple-choice items, and (5) multiple choice items (OECD, 2004b).

In the PISA 2003 assessment instrument, there are 13 booklets, each of which includes 13 item clusters. The total number of items in the PISA 2003 study is 167, allocated to literacy domains as: 7 for the mathematics item clusters and 2 for each of the other domains of item clusters. A rotated test design is used in order to be representative and cover an intended broad range of content and for each student to respond to all assessment items in 120 minutes. According to the rotated test design (see Table 3.5), each booklet is composed of four rotated clusters.

Each item cluster can be seen exactly once in each of the four rotated clusters within a booklet. Each rotated item cluster contains approximately 12 test items and is equivalent to 30 minutes. As seen from Table 3.5, after each rotated item cluster, there are short breaks and then a long break between the test of all rotated item clusters and the context questionnaires (Student and ICT Questionnaires). Therefore, each student has two hours to complete a booklet. This kind of test design ensures a wide coverage of content and measurement of item difficulties and student abilities. Any of the 13 testing booklets is randomly given to sampled students from stratified schools (OECD, 2005b).

Table 3.5 PISA 2003 Rotated Test Design to Form Booklets

| | Booklets | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Clusters** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **Cluster 1** | M1 | M2 | M3 | M4 | M5 | M6 | M7 | S1 | S2 | R1 | R2 | PS1 | PS2 |
| | | | | | | **Short Break -1** | | | | | | | |
| **Cluster 2** | M2 | M3 | M4 | M5 | M6 | M7 | S1 | S2 | R1 | R2 | PS1 | PS2 | M1 |
| | | | | | | **Short Break -2** | | | | | | | |
| **Cluster 3** | M4 | M5 | M6 | M7 | S1 | S2 | R1 | R2 | PS1 | PS2 | M1 | M2 | M3 |
| | | | | | | **Short Break -3** | | | | | | | |
| **Cluster 4** | R1 | R2 | PS1 | PS2 | M1 | M2 | M3 | M4 | M5 | M6 | M7 | S1 | S2 |
| | | | | | | **Long Break and Administering Questionnaires** | | | | | | | |

Source: (OECD 2005b, p. 17). M1-M7: Mathematics items clusters, PS1-PS2: Problem solving items clusters, S1-S2: Science items clusters, R1-R2: Reading items clusters

### 3.2.2.1 Mathematical Literacy Assessment

The dimensions of the mathematical literacy domain can be divided into three categories, as mathematical content, mathematical process, and mathematical situation. Their distribution with item formats can be easily seen in Table 3.6. Mathematical content comprises four overarching areas: space and shape, change and relationships, quantity and uncertainty. Mathematical content, drawn from the broad content areas, consists of different problems and questions.

In determining the mathematical content process, related research literature is considered and a general agreement among the OECD countries is reached so as to have appropriate mathematical content for international comparisons. The mathematical process requires these skills for mathematics: reproduction (basic mathematical operations), connections (combining ideas to solve simple problems), and reflection (more complex mathematical thinking). They can be generally assumed to represent hierarchical difficulty, but some tasks include overlapping components in mathematics item clusters. These clusters, reproduction, connection, and reflection, can be called competency clusters, as well.

Mathematical situation is the abilities of students to use mathematics in a variety of situations, and depends upon lives of students. The types of mathematical situation are personal, educational/occupational, public, and scientific. These types are also divided into two parts: the first part is questions in the mathematical realm and the second part is questions not in the mathematical realm (OECD, 2005b).

Table 3.6 Distribution of Mathematical Literacy Categories with Item Formats in PISA 2003

| Mathematical Literacy Categories | Item Formats | | | | | |
|---|---|---|---|---|---|---|
| | Multiple-choice items | Complex multiple-choice items | Closed-constructed response items | Open-constructed response items | Short response items | Total |
| **Mathematical Content** | | | | | | |
| Space and Shape | 4 | 4 | 6 | 4 | 2 | 20 |
| Change and Relationship | 1 | 2 | 4 | 11 | 4 | 22 |
| Quantity | 4 | 2 | 2 | 1 | 14 | 23 |
| Uncertainty | 8 | 3 | 1 | 5 | 3 | 20 |
| Total | 17 | 11 | 13 | 21 | 23 | 85 |
| **Mathematical Process (Competency)** | | | | | | |
| Reproduction | 7 | 0 | 7 | 3 | 9 | 26 |
| Connections | 5 | 9 | 4 | 9 | 13 | 40 |
| Reflection | 5 | 2 | 2 | 9 | 1 | 19 |
| Total | 17 | 11 | 13 | 21 | 23 | 85 |
| **Mathematical situation** | | | | | | |
| Personal | 5 | 3 | 1 | 3 | 6 | 18 |
| Educational/occupational | 2 | 4 | 6 | 2 | 6 | 20 |
| Public | 8 | 2 | 4 | 8 | 7 | 29 |
| Scientific | 2 | 2 | 2 | 8 | 4 | 18 |
| Total | 17 | 11 | 13 | 21 | 23 | 85 |

Source: (OECD 2004b, p. 334)

### 3.2.2.2 Problem-Solving Literacy Assessment

The problem-solving literacy domain can be categorized into three dimensions: (1) the type of problem encountered, (2) the processes involved in solving a problem, and (3) the situations involved. In the first dimension, there are three types of problem-solving approaches, such as decision-making, system analysis and design, and trouble shooting. In the second dimension, there are six processes: understanding, characterizing, representing, solving, reflecting on the solution, and communicating the solution. In the third dimension, the problems are formed from personal life, work and leisure, community and society. They are given in Table 3.7 with their item formats (OECD, 2004a).

Table 3.7 Distribution of Problem Solving Approaches with Item Formats in PISA 2003

| Problem Solving Approaches | Item Formats | | | | | |
|---|---|---|---|---|---|---|
| | Multiple-choice items | Complex multiple-choice items | Closed-constructed response items | Open-constructed response items | Short response items | Total |
| Decision Making | 2 | 0 | 2 | 3 | 0 | 7 |
| System Analysis and Design | 2 | 0 | 1 | 4 | 0 | 7 |
| Trouble shooting | 3 | 0 | 0 | 2 | 0 | 5 |
| Total | 7 | 0 | 3 | 9 | 0 | 19 |

Source (OECD, 2004a, p.61)

The PISA 2003 study focused basically on creating both a national, and an international educational survey, and assessing the knowledge and skills of the population, not of particular students. Therefore, making fewer errors in making inferences for the target population is more important than making fewer errors about individuals. In this sense, student performances in the mathematical and problem-solving literacy domains are not observed directly, but they are inferred from the student item responses. Although there are several methodologies to make inferences of mathematical and problem-solving literacy performance, PISA uses the imputation approach –called plausible values (PVs). According to the PISA 2003 Data Analysis Manual, SPSS Users (OECD, 2005a), the methodology of PVs calculates distributions around the reported values and assigns to each observation a set of random values drawn from the posterior distributions. This imputation approach generates reliable estimators of population parameters, so PVs are more appropriate to depict the performance of populations than individuals (OECD, 2005b).

### 3.2.2.3 Student Questionnaire

Along with literacy domains, PISA collects data on the socioeconomic and cultural background of students through a student questionnaire. In the preparation process of the PISA 2003 student questionnaire, some constructs or variables in PISA 2000 were used, but most of them were new and developed through the years 2001 to 2002. With international experts, the PISA Governing Board (PGB) provided a development process of student questionnaire with its priorities and elaborations in the framework of research realms. First of all, an initial version of the student questionnaire was examined in the manner of qualitative and quantitative aspects of item responses, belonging to students from a few countries. After that, a second version of the student questionnaire was administered by national centers and developed with guidance from experts from the OECD, national, and international centers. Afterwards, two different student questionnaires were administered to all participant countries for a field trial, in 2002. Later on, the results of field trial data analysis and the criteria, constituted by national centers, international experts and the OECD, determined the final student questionnaire (OECD, 2005b).

PISA 2003 has collected information about characteristics of 15-year-old students with the help of the Student Questionnaire. This questionnaire could be obtained from the official PISA web site (PISA, n.d.). Students had 35 minutes to respond to the student questionnaire items. The socioeconomic and cultural background of students collected through the Student Questionnaire is taken into account in the analyses of the present study.

In PISA 2003, the Student Questionnaire has many items about student characteristics. Although some items are simple and analyzed as single items (e.g. gender), some of them are not simple and not observed directly. Therefore, they can be measured with latent constructs, for instance, the economic, social, and cultural status of students. Consequently, transformations or scaling procedures are used to construct meaningful simple or scale indexes in the PISA 2003 study. The concepts of simple and scale indexes are defined in the PISA 2003 Technical Report (OECD 2005b, p. 272) as:

> Simple indexes: These indexes were constructed through the arithmetical transformation or recoding of one or more items. Item responses were used to calculate meaningful variables.
>
> Scale indexes: Variable construction through the scaling of items. Typically, scale scores for these indexes are estimates of latent traits derived through IRT (item response theory) scaling of dichotomous or Likert-type items.

The index of ESCS in PISA 2003 was derived from three family background variables as follow: (1) PARED: the index of highest level of parental education in number of years of education according to the ISCED (International Standard Classification of Education, see Table 3.8); (2) HISEI: the index of highest parental occupation status; and (3) HOMEPOS: the index of home possessions, ascribed to income (OECD, 2005a, p. 382). These family background variables (scale indexes) were selected by PISA since education, occupational status and income are usually seen as indicators of socioeconomic status (OECD, 2005b). So as to confirm overlapping family background indexes with theory and research, and to validate their comparability across (between or within) countries, structural equation modeling is conducted to understand their appropriateness (OECD, 2004b, p. 282). Details of the ESCS index, its component indexes, and their items are given in Table 3.9.

In PISA 2003, the ESCS index, particularly composed of PARED, HISEI, and HOMEPOS, is naturally derived from items that require students to give responses in either a

Table 3.8 The ISCED Classification in PISA 2003

| Category | Explanation |
|---|---|
| None | Did not go to school |
| ISCED 1 (primary education) | Completed ISCED Level 1 (Primary education) |
| ISCED 2 (lower secondary) | Completed ISCED Level 2 (Lower secondary education) |
| ISCED Level 3B or 3C (vocational/pre-vocational upper secondary) | Completed ISCED Levels 3B or 3C (Upper secondary education providing direct access to the labor market or to ISCED 5B programmes) |
| ISCED 3A (upper secondary) and/or ISCED 4 (non-tertiary post-secondary) | Completed ISCED Level 3A (Upper secondary education providing access to ISCED 5A and 5B programmes) |
| ISCED 5B (vocational tertiary) | Completed ISCED Level 5B (Non-university Tertiary education) |
| ISCED 5A, 6 (theoretically oriented tertiary and post-graduate) | Completed ISCED Level 5A (University level tertiary education) |

Source: OECD, (2004b, p. 312)

Likert type items or a dichotomous (yes/no) format. The international metric system is used for all scale indexes, including the ESCS and ICT indexes. Positive values in the index are only a sign of students' responses being more positive than the average across the OECD countries that participated in PISA 2003. Similarly, negative values in the index indicate that students' responses are less positive than the average across the OECD countries (OECD, 2004b).

After imputing missing values in the PARED, HISEI, and HOMEPOS indexes and transforming them into the international metric system with an OECD average of 0 and an OECD standard deviation of 1, principal component analysis is performed using standardized PARED, HISEI, and HOMEPOS indexes, to obtain ESCS scores (OECD, 2004b, 2005a, 2005b). The descriptive statistics for PARED, HISEI, and HOMEPOS are given for country groups in Appendix A. The construction processes of these indexes are explained under separate titles below.

#### 3.2.2.3.1 The Index of Highest Parental Occupation Status

The students' parents' occupational data are collected by using both multiple choice questions and open-ended questions (see Table 3.9). In multiple choice questions, students are required to select whether their parents are working (full/part time), not working but looking for a job, or other. In open-ended questions, students are asked to state occupational status in terms of the title of their parents' main job and the job's obligations. At the beginning, students' open-ended responses are coded in accordance with the international standard classification of occupations (ISCO); and then the occupations, derived from the ISCO, are recoded into the international socioeconomic index of occupational status (ISEI), providing a comparable the index of occupations for PISA 2003 countries. Finally, three indexes are calculated from the ISEI scores: (1) an index of mother's occupational status, (2) an index of father's occupational status, and (3) an index of the highest occupational level of parents (HISEI), which is derived from either parents' or the available parent's, higher ISEI score. In the HISEI index, the meaning of higher (or lower) values is a higher (or lower) level of occupational status of parents or parent (OECD, 2004b, 2005b).

#### 3.2.2.3.2 The Index of Highest Level of Parental Education in Number of Years of Education

As can be seen easily from Table 3.9, data for the index of highest level of parental education in terms of years of education is calculated from students' responses to multiple choice questions. In order to have internationally comparable categories of the educational status of parents, the data on the index of highest level of parental education in number of years of education (PARED) are then coded in accordance with the ISCED, a typology systematically arranging school programs or educational qualifications. The data related to the education status of both mothers and fathers are classified by means of the ISCED categorization. At first, the indexes of the highest level of parental education status for mothers and fathers are computed separately, and then the index of the highest educational level of parents is calculated together. Finally, the index of the highest educational level of parents is transformed into PARED on the basis of years of schooling (OECD, 2004b, 2005b).

#### 3.2.2.3.3 The Index of Home Possessions

In the PISA 2003 study, considering that data on family income is not available, there is an endeavor to indirectly understand family wealth by means of gathering information on students' home possessions. The data on home possession are collected through a multiple choice question with 13 alternatives and a dichotomous question. As seen from Table 3.9, there are 13 different household items and there is a dummy variable indicating whether there are more than 100 books, or not. Since the structure of students' responses is binary, the scale index of home possessions (HOMEPOS) construction is realized by way of IRT scaling. Like HISEI, positive values in the index of HOMEPOS signify higher levels of home possessions (OECD, 2004b, 2005b). Contrary to the indexes of PARED and HISEI, the HOMEPOS index is categorized into Weighted Likelihood Estimates (WLE) indexes.

Table 3.9 The Index of Economic, Social, and Cultural Status of Students, its Questionnaire Questions, Formats of Questionnaire Questions, Containing Indexes, and Its Items in PISA 2003

| Economic, Social, and Cultural Status of Students - **ESCS** | | | | |
|---|---|---|---|---|
| Question Format | Component Indexes | | Questionnaire Questions | Items of ESCS Component Indexes |
| Multiple Choice Question | **HISEI** | The index of highest parental occupation status | What is your mother/father currently doing? | a) Working full-time<for pay><br>b) Working part-time<for pay><br>c) Not working ,but looking for a job<br>d) Other(e.g. home duties, retired) |
| Open Ended Questions | | | What is your mother's/fathers' main job? What does your mother/father do in her/his main job? | |
| Multiple Choice Questions | **PARED** | The index of highest level of parental education in number of years of education according to the ISCED | Which of the following did your mother/father complete at school? | a) <ISCED level 3A><br>b) <ISCED level 3B, 3C><br>c) <ISCED level 2><br>d) <ISCED level 1><br>e) None of the above |
| | | | Does your mother/father have any of the following qualifications? | a) <ISCED 5A, 6><br>b) <ISCED 5B><br>c) <ISCED 4> |
| Multiple Choice Question | **HOMEPOS** | The index of home possessions | Which of the following/s do you have in your home? | a) A desk for study<br>b) A room of your own<br>c) A quiet place to study<br>d) A computer you can use for school work<br>e) Educational software<br>f) A link to the Internet<br>g) our own calculator<br>h) Classic literature<br>i) Books of poetry<br>j) Works of art<br>k) Books to help with your school work<br>l) A dictionary<br>m) A dishwasher |
| Dichotomous Question | | | In your home, do you have more than 100 books? | a) Yes<br>b) No |

### 3.2.2.4 Information and Communication Technologies Questionnaire

Along with tests of literacy domains and a student questionnaire, the PISA 2003 study also offered two subsequent and optional questionnaires –an educational career questionnaire and an information and communication technology (ICT) questionnaire. After or concurrently with the international student questionnaire, the ICT questionnaire is administered to students. It takes around five minutes. Information concerning access to and use of ICT at home and schools, type of ICT use, self-confidence in ICT, attitudes toward computers, and the learning background of students' ICT knowledge are collected through ICT questionnaire as seen in Appendix B. The present study specifically analyzed ICT aspects and their relationships with mathematical and problem-solving literacy performance, along with the ESCS index. Therefore, ICT indexes, -specifically, type of ICT use (Internet/entertainment use and Program/software use), self-confidence in ICT tasks (Routine tasks, Internet tasks, and High level tasks), and attitudes toward computers-, are called ICT aspects. These ICT aspects are the main focus of this study. The detailed information on ICT aspects, ICT indexes, its items, and related questions are given in Table 3.10.

In the PISA 2003 study, similar to the HOMEPOS index, ICT indexes are also calculated with the WLE method. All items in ICT indexes are inverted for scaling, as well. The positive scores in all ICT indexes indicate more frequent use than the OECD international average for the Internet/entertainment use (INTUSE) and program/software use (PRGUSE) indexes, high self-confidence for confidence in routine tasks (ROUTCONF), confidence in Internet tasks (INTCONF), and confidence in high level tasks (HIGHCONF) indexes, and positive attitudes for the attitudes toward computers (ATTCOMP) index. Negative scores in all ICT indexes denote less frequent use than the OECD international average for INTUSE, and PRGUSE, and low self-confidence for ROUTCONF, INTCONF, and HIGHCONF, and negative attitudes for ATTCOMP (OECD, 2005a, 2005b). As seen from Table 3.10, likert-scale format and numbers of items in ICT indexes vary as follows: a five-point likert-type scale is used with six items for each of INTUSE and PRGUSE, a four-point likert-type scale is used for ROUTCONF with eleven items, INTCONF with five items, HIGHCONF with seven items, and ATTCOMP with four items.

#### 3.2.2.4.1 The Meaning of ICT Indexes

Each ICT index combines into a composite score each student's responses to several related questions in the ICT questionnaire. These scores are represented as index numbers so that the average of each index is zero for all students in all OECD countries, and about two-thirds of students' scores are between -1 and +1. Thus, for example, a score of -1 for the program/software use index indicates that a student uses computers more than about one sixth of the students internationally, and a score of +1 indicates that he or she uses computers more than about five-sixths of the students internationally. It should be considered that the mean of any ICT index for a country indicates the relative position of that country compared to the OECD average. In this sense, comparing two ICT index means of a country to decide which one is higher is not possible, for instance in comparing program/software use and Internet/entertainment use indexes such a comparison is not allowed between countries (OECD, 2006c, p. 38). This comparison could only be made with the observed variables constructing the index. For each country group, the observed variables with their descriptive statistics for each ICT index used in this study can be seen in Appendix A. Comparing two countries' means of the same index shows that the country with the higher mean is at higher position in that index with reference to the international scale.

### 3.2.3 Data Collection Procedure

PISA 2003 assessment is designed for international comparable studies, but it is nationally realized in the participant countries. At a national level, NPMs, responsible for school coordinators and test administrators, have operational responsibilities and duties in the implementation of the PISA 2003 assessment. NPMs are assisted by school coordinators and test administrators in the implementation process of assessment at the schools.

Pursuing two methods of data collection procedure in PISA 2003 ensures high confidence, high standard and high quality. The first method is to design, develop and document procedures, to obtain the desired data. The second is to monitor and record implementation of the documented procedures. At the international level, the PISA consortium as an authorized unit and NPMs as practitioners worked together on quality monitoring procedures –continuous process that recognizes potential problems and challenges, and takes precautions in advance against operational problems– in order to systematically collect, retrieve and store data in accordance with previously developed manuals and described procedures. the NPM manual, test administrator manual, school coordinator manual, school sampling preparation manual and the PISA data management manual were created for quality monitoring procedures and developed quality monitoring instruments, such as The National Center Quality Monitor (NCQM) interview schedule, PISA Quality Monitor (PQM) instruments, NPM quality surveys, and a PISA test administrator test session report (OECD, 2005b).

In the NPM manual, there is detailed information on the responsibilities and duties of NPMs. They are responsible for organizing the preparation of national versions of the test instruments, questionnaires, manuals, and coding guides and for implementing the PISA 2003 assessment. NPMs are also supposed to make some adaptations to the questionnaires and manuals given by PISA consortium. A school sampling preparation manual gives instruction for NPMs to document a school sampling plan, frame, and issues, i.e. a definition of target population, and school level exclusions. A test administrator manual developed by the PISA consortium explains the activities and responsibilities of test administrators (from not participating schools and assessment domains) to provide and maintain fair, objective, consistent and valid assessment and questionnaires administration.

The PISA consortium also prepared a school coordinator manual to give precise instructions and describe the activities and responsibilities of the school coordinators. In addition to these manuals, the PISA consortium prepared data entry software (KeyQuest) for data from the test booklets and questionnaires. A data entry and management manual given to NPMs explained all aspects of the KeyQuest, as well (OECD, 2004b, 2005b). These comprehensive procedural manuals, quality monitoring procedures, and their application provide a rigorous quality assurance system for valid data collection procedure and its implementation.

### 3.2.4 Data Sources and Preliminary Statistical Procedures for Data Analyses

In the PISA 2003 study, the students' responses in the assessment booklets and three questionnaires (the student questionnaire, the information communication technology questionnaire, and the educational career questionnaire, the last two being internationally optional) simply constitutes the PISA 2003 dataset. In the PISA 2003 international database, there are three data files: the student questionnaire file, the assessment items file, and the school file. Their names are as follow, respectively: int_stui_2003.txt, int_cogn_2003.txt, and int_schi_2003.txt. These files, in text or ASCII format, correspond to both Statistical Package for the Social Sciences (SPSS) and Statistical Analysis Software (SAS). Besides the observed data, the student questionnaire file (int_stui_2003.txt) also includes indexes (ICT indexes, PVs for mathematical and problem solving literacy performance, and ESCS index) drawn from the original items in the questionnaires. Therefore, the student questionnaire file (int_stui_2003.txt) was selected to conduct statistical data analyses in this study.

Table 3.10 ICT Aspects, Questionnaire Questions, Formats of Questionnaire Questions, ICT Indexes, and Its Items in PISA 2003

| Aspects | Questionnaire Questions | Question Format | Indexes | Items used to derive/calculate ICT Indexes | |
|---|---|---|---|---|---|
| ICT Use | How often do you use… | Likert-type<br>• Almost every day<br>• A few times each week<br>• Between once a week and once a month<br>• Less than once a month<br>• Never | Internet/ Entertainment Use (INTUSE) | a) The Internet to look up information about people, things, or ideas<br>b) Games on a computer<br>c) The Internet to collaborate with a group or team | d) The Internet to download software<br>e) The Internet to download music<br>f) A computer for electronic communication (e.g. e-mail or “chat rooms”) |
| | | | Program/ Software Use (PRGUSE) | a) Word processing (e.g. Microsoft Word or Word Perfect<br>b) Spreadsheets (e.g. Lotus 1-2-3 or Microsoft Excel<br>c) Drawing, painting or graphics programs on a computer | d) Educational software such as mathematics programs<br>e) The computer to help you learn school material<br>f) The computer for programming |
| Self-confidence in ICT | How well can you do each of these tasks on a computer? | Likert-type<br>• I can do this very well by myself.<br>• I can do this with help from someone.<br>• I know what this means but I cannot do it.<br>• I don’t know what this means | Confidence in Routine Tasks (ROUTCONF) | a) Start a computer game.<br>b) Open a file.<br>c) Create/edit a document.<br>d) Scroll a document up and down a screen.<br>e) Copy a file from a floppy disk<br>f) Save a computer document or file. | g) Print a computer document or file.<br>h) Delete a computer document or file.<br>i) Moves files form one place to another on a computer.<br>j) Play computer games.<br>k) Draw pictures using a mouse. |
| | | | Confidence in Internet Tasks (INTCONF) | a) Get on to the Internet.<br>b) Copy or download files from the Internet. | c) Attach a file to an email message<br>d) Download music from the Internet.<br>e) Write and send emails. |
| | | | Confidence in ICT High Level Tasks (HIGHCONF) | a) Use software to find and get rid of computer viruses.<br>b) Use a database to produce a list of addresses.<br>c) Create a computer program (e.g. in Logo, Pascal, Basic) | d) Use a spreadsheet to plot a graph<br>e) Create a presentation (e.g. using <Microsoft PowerPoint>).<br>f) Create a multi-media presentation (with sound, pictures, vide.<br>g) Construct a Web page. |
| Attitudes toward Computer | How much do you disagree or agree with the following statements about you and computers? | Likert-type<br>• Strongly agree<br>• Agree<br>• Disagree<br>• Strongly disagree | Attitudes Toward Computers (ATTCOMP) | a) It is very important to me to work with a computer.<br>b) To play or work with a computer is really fun. | c) I use a computer because I am very interested.<br>d) I lose track of time, when I am working with the computer. |

The raw PISA 2003 dataset was obtained from the official PISA web site on the Internet. In addition to obtaining the raw data file, some other files, such as codebooks, questionnaires, and manuals etc., were taken from the official PISA web site, as well. These files were used to understand and refine the raw data file in order to make it statistically understandable and analyzable in SPSS and LISREL. In the raw data file, data are in both nominal and scale measure, and the names and labels of variables are well-defined by the expert statisticians of the OECD. Deleting unrelated variables and making some modifications required by research questions make the huge dataset become smaller and easily manageable. The procedures for refining and modifying the complete data file (int_stui_2003.txt), such as filtering, creating variable and transforming, were as follow:

1. Students from the countries included in this study (see Table 3.1) were selected for all statistical analyses. Students from the other counties were deleted from the data file.
2. Students who used computers (those who answered the question “Have you ever used a computer” with “yes”), were drawn from the selected data. The other students were deleted from data file. Thus, the study sample was filtered.
3. A new nominal variable was created to identify the country groups (labeled as 1: the EU member group, 2: the new EU member group, and 3: Turkey).
4. User missing and system missing values in ICT indexes and ESCS index were transformed into system missing in the data file.
5. Two data files were derived after the fourth stage.
    a) Students for whom all ICT indexes and ESCS index were non-missing were filtered for one-way MANCOVA and ANCOVA analyses.
    b) Students for whom at least one of the ICT indexes was non-missing were filtered for testing proposed path analytic models.
6. Consequently, seven data files were obtained for statistical analyses:
    a) One data file was derived at stage 5a to conduct a one-way MANCOVA and ANCOVA analyses. Therefore, the following variables in parentheses were obtained by deleting unrelated variables in the data file (INTUSE, PRGUSE, ROUTCONF, INTCONF, HIGHCONF, ATTCOMP, ESCS, and Country Groups).
    b) Six separate data files were derived at stage 5b to test path analyses of mathematical and problem solving literacy performance for the three country groups. Therefore, the following variables in parentheses were obtained by deleting unnecessary variables in the data file (INTUSE,

PRGUSE, ROUTCONF, INTCONF, HIGHCONF, ATTCOMP, ESCS, MATHLIT (Pv1math, Pv2math, Pv3math, Pv4math, and Pv5math), and PROBSOL (Pv1prob, Pv2prob, Pv3prob, Pv4prob, and Pv5prob). Then three files for mathematical literacy performance models, one for each country group, were obtained (including ICT indexes, ESCS and five PVmaths), and the other three files for problem solving literacy performance models, one for each country group, were obtained (including ICT indexes, ESCS and five PVprobs).

### 3.2.5 Statistical Data Analyses in the study

After obtaining original data from the OECD official web site and following the preliminary procedures above, the data files for this study were ready to conduct statistical data analyses. Research questions and the nature of variables determined the statistical data analyses -one-way MANCOVA, univariate ANCOVA and path analytic models- to be conducted. SPSS 13.0 and LISREL 8.30, statistical package programs, were used for data analyses. The information on quantitative research questions, variables and statistical analyses are given in Table 3.11.

#### 3.2.5.1 Descriptive Statistics for MANCOVA and ANCOVA

The variables used in one-way MANCOVA and ANCOVA to answer the first three research questions are examined through the descriptive statistics in this section. Table 3.12 includes basic descriptive statistics, such as mean, standard deviation, skewness and kurtosis for the three country groups. Skewness and kurtosis values indicate the shape of distribution compared to normal distribution (Hair, Black, Babin, Anderson & Tatham, 2006). Most of the skewness and kurtosis values of variables are between -2 and +2. According to Hair et al. (2006) and Tabachnick and Fidel (1996), violation of the normality assumption for multivariate statistics can have serious effects in small samples (less than 200 cases), but the impact effectively diminishes when sample sizes reach 200 cases or more. In this study, since the sample sizes are large, the normality assumption is said to be ensured.

Table 3.11 Research Questions, Variables and Statistical Data Analyses of Quantitative Phase

| Quantitative Research Questions | IV | DVs | COVs | Statistical Data Analyses |
|---|---|---|---|---|
| 1. How do ICT use –INTUSE and PRGUSE– differ among students in PISA 2003 across country groups, controlling ATTCOMP and ESCS?<br>2. How do self-confidence in ICT –ROUTCONF, INTCONF and HIGHCONF– differ among students in PISA 2003 across country groups, controlling ATTCOMP and ESCS? | Status of a country group in EU<br>1: EU Member Group<br>2: New EU Member Group | INTUSE<br>PRGUSE<br>ROUTCONF INTCONF HIGHCONF | ATTCOMP<br>ESCS | One-way MANCOVA and follow – ups (ANCOVA & Contrast-K matrix for pairwise comparison) for the 1st and 2nd research questions |
| 3. How does ATTCOMP differ among students in PISA 2003 across country groups, controlling ESCS? | 3: Turkey<br>(as a candidate state) | ATTCOMP | ESCS | Univariate ANCOVA for the 3rd research question |
| 4. How well do ICT related factors and student background variables explain variances of PISA 2003 students' mathematical literacy performance across country groups?<br>5. How well do ICT related factors and student background variables explain variances of PISA 2003 students' problem solving literacy performance across country groups? | Exogenous Variables<br>INTUSE<br>PRGUSE ROUTCONF<br>INTCONF<br>HIGHCONF<br>ESCS | Endogenous Variables<br>MATHLIT<br>ATTCOMP<br>PROBSOL<br>ATTCOMP | - | Recursive Path Analysis with observed variables for the 4th and 5th research questions |

IV: Independent Variable
DVs: Dependent Variables
COVs: Covariates
INTUSE: Internet/entertainment use
PRGUSE: Programs/software use
ROUTCONF: Confidence in routine tasks
INTCONF: Confidence in Internet tasks
HIGHCONF: Confidence in high-level tasks
ATTCOMP: Attitudes toward computers
ESCS: Economic, Social, and Cultural Status of Students
MATHLIT: Mathematical Literacy
PROBSOL: Problem Solving Literacy

Table 3.12 Sample Sizes and Basic Descriptive Statistics for Variables

| Country Groups | Variables | Sample Sizes (N) | M | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| EU Member Group | INTUSE | 56,610 | -.008 | .973 | .746 | 1.894 |
| | PRGUSE | | .007 | .933 | .267 | **2.565** |
| | HIGHCONF | | .003 | .961 | .239 | .581 |
| | INTCONF | | -.001 | .951 | -.833 | .149 |
| | ROUTCONF | | .075 | .921 | -1.097 | .850 |
| | ATTCOMP | | -.008 | 1.003 | -.359 | -.198 |
| | ESCS | | .061 | .968 | -.218 | -.101 |
| New EU Member Group | INTUSE | 24,834 | -.221 | .915 | .952 | **2.796** |
| | PRGUSE | | .038 | 1.003 | .190 | **2.443** |
| | HIGHCONF | | -.173 | 1.007 | .154 | .805 |
| | INTCONF | | -.351 | 1.072 | -.570 | -.032 |
| | ROUTCONF | | -.069 | 1.039 | -.908 | .097 |
| | ATTCOMP | | -.019 | .950 | -.221 | -.231 |
| | ESCS | | .084 | .822 | .135 | -.305 |
| Turkey | INTUSE | 3,231 | -.235 | 1.049 | .325 | 1.668 |
| | PRGUSE | | .092 | 1.286 | -.008 | .844 |
| | HIGHCONF | | -.150 | 1.036 | -.467 | 1.452 |
| | INTCONF | | -.503 | 1.165 | -.630 | .206 |
| | ROUTCONF | | -.671 | 1.206 | -.395 | -.227 |
| | ATTCOMP | | .182 | .976 | -.557 | .130 |
| | ESCS | | -.754 | 1.091 | .326 | -.361 |

### 3.2.5.2 One-way MANCOVA

In order to investigate the fourth and fifth research questions, a one-way multivariate analysis of covariance (MANCOVA) was conducted. In MANCOVA analysis, the differences in INTUSE, PRGUSE, ROUTCONF, INTCONF, and HIGHCONF of students across the country groups were analyzed, controlling for students' attitudes toward computers (ATTCOMP) and the economic, social, and cultural status of students (ESCS). Therefore, the status of the country group is the independent variable with three levels, and INTUSE, PRGUSE, ROUTCONF, INTCONF, and HIGHCONF are the dependent variables, while ATTCOMP and ESCS are the covariates. Analyses of covariances (ANCOVAs) as follow-ups and Contrast-K matrix as pairwise comparisons were also performed in MANCOVA. After checking the assumptions of the MANCOVA, one-way MANCOVA was run.

According to Stevens (2002), there are two rationales for using several covariances in analysis of covariance. First, the use of several covariates will result in greater error reduction than can be obtained with just one covariate. The error reduction will be substantially greater if the covariates have relatively low intercorrelations among themselves (<.40). Second, with several covariates, a better adjustment for initial differences between intact groups can be made.

As the assumptions of MANCOVA are considered, multivariate normal distribution of dependent variables is assumed to be met, since the sample size of each population is large enough (Tabachnick & Fidel, 1996).

The assumption of homogeneity of variance-covariance matrices was not met. Box's M = 3522.277, F (30, 250278640) = 117.372, p <.001. SSCP (Sum of square and cross product matrix) Matrix was also examined and variances of dependent variables in diagonals showed some variances four times bigger than others. Thus, we expect a significant F value for Box's M. In addition to Box's M Test, Levene's tests were used to check whether error variances of the dependent variables are equal across country groups. Significance values were also smaller than .05 for all dependent variables (see Table 3.13). This was also expected because of the large sample size. Considering the violation of this assumption, Pillai's Trace statistic was used instead of Wilks' Lambda statistic, to evaluate multivariate significance (Olson, as cited in Tabachnick & Fidel, 1996).

Table 3.13 Levene's Test of Equality of Error Variances for MANCOVA

| Dependent Variables | *F* | *df1* | *df2* | *p* |
|---|---|---|---|---|
| INTUSE | 40.488 | 2 | 84672 | <.001 |
| PRGUSE | 326.390 | 2 | 84672 | <.001 |
| HIGHCONF | 21.167 | 2 | 84672 | <.001 |
| INTCONF | 325.694 | 2 | 84672 | <.001 |
| ROUTCONF | 378.265 | 2 | 84672 | <.001 |

Another important assumption of MANCOVA is the homogeneity of regression slopes assumption. For two covariates, the assumption of homogeneity of regression slopes is called parallelism of regression planes (Stevens, 2002). A violation means there is a covariate by treatment interaction. Stevens (2002) states that in examining the printout from statistical packages it is important first to make two checks to determine whether covariances are appropriate: (1) Check to see that there is a significant relationship between the dependent variables and covariates and (2) Check to determine that homogeneity of regression slopes (when there is one covariate) or the parallelism of regression planes (when there are two covariates) or the homogeneity of regression hyperplanes (when there are more than two covariates) is satisfied (p. 347, 354). For this study, the syntax proposed by Stevens to check these assumptions was run, as seen in Figure 3.1 (see Stevens, 2002, p. 361). The first check was ensured because the multivariate test for significant association between the dependent variables and the covariates was significant (Wilk's $\lambda$=.63, multivariate F (10, 169332) = 4353.64, p<.001, $\eta$2=.20). The second check, the parallelism of regression planes assumption, was not exactly met, because Wilk's $\lambda$=.98, multivariate F (20, 280793.04)= 84.57 , p<.001. However, the effect size of this test was so small ($\eta$2=.005) that this assumption is accepted to be satisfied.

```
MANOVA intuse prguse highconf intconf routconf attcomp escs BY cntry_grps (1 3)/
ANALYSIS intuse prguse highconf intconf routconf WITH attcomp escs/
PRINT = PMEANS
SIGNIF (EFSIZE)/
DESIGN/
ANALYSIS= intuse prguse highconf intconf routconf/
DESIGN= attcomp + escs, cntry_grps, attcomp BY cntry_grps + escs BY cntry_grps/.
```

Figure 3.1 SPSS syntax for testing the parallelism of regression planes

In order to ensure the first check for covariates stated above, that is to evaluate the relationship between the covariates and the linear combination of dependent variables, the main effects of covariates in MANCOVA results are examined by controlling the country groups, as well. As seen in Table 3.14, this relationship is significant for both covariates. Moreover, partial eta squares of covariates indicate large effect sizes. Significant relationship between covariates and dependent variables and large effect sizes of the relationships for both covariates are indicators of good covariates.

Table 3.14 The Multivariate Tests for MANCOVA

| Effect | Pillai's Trace Value | *F* | Hypothesis *df* | Error *Df* | *p* | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | .031 | 548.872 | 5000 | 84666 | <.001 | .031 |
| ATTCOMP | .295 | 7,072.429 | 5000 | 84666 | <.001 | **.295** |
| ESCS | .115 | 2,202.863 | 5000 | 84666 | <.001 | **.115** |
| CNTRY_GRPS | .058 | 508.983 | 10000 | 169334 | <.001 | .029 |

### 3.2.5.3 Univariate ANCOVA

In order to investigate the sixth research question, univariate ANCOVA was conducted. In this analysis, the economic, social, and cultural status of students (ESCS) was controlled in order to understand the relationships between attitudes toward computers (ATTCOMP) and the status of a country group in the EU (the EU member group, the new EU member group and Turkey in PISA 2003). Therefore, country group was the independent variable with three levels; ATTCOMP was the dependent variable and ESCS was the covariate.

Univariate ANCOVA assumes normal distribution of the dependent variable, homogeneity of variances in the dependent variable across levels of the factor, independence of observations, reliability of covariates, and linearity between covariate and dependent variables (Tabachnick & Fidel, 1996).

As aforementioned, since most of the values of skewness and kurtosis are between -2 and +2 for the dependent variable and the cell sizes are large, the distribution of the dependent variable for any specific value of the covariate and for any level of independent variable is normally distributed.

In order to find out whether error variances of the dependent variables are equal or not, Levene's Test is used, $F(2, 84672) = 65.709$, $p < .001$. This result is expected owing to the large sample sizes, and it leads us to interpret results of follow-up tests cautiously in a descriptive manner.

Covariates have to be measured with no measurement error (Stevens, 2002). However, in the social sciences it is not possible to measure variables with no error. For the reliability of ESCS, the calculated alpha coefficients were .67, .69 and .76 for the EU member group, the new EU member group and Turkey on average, respectively, as seen in Table 3.19. These reliability measures could be accepted as satisfactory.

Although the researcher had no chance or possibility to observe the data collection procedure in PISA 2003, NPMs with school coordinators and test administrators had been employed to provide valid and reliable implementation and administration of data collection processes. In other words, it is presumed that the items in the instruments were the students' own, and independence of observations is assumed to be met.

Before conducting ANCOVA, the homogeneity of slopes assumption was checked to decide whether the ANCOVA could be carried out or not. In this sense, the interaction between the covariate and independent variable was evaluated. As seen from Table 3.15, there is a significant interaction between country groups and economic, social, and cultural status of students (ESCS), but the partial eta square or effect size is too small (.001) to violate the homogeneity of slopes assumption. Besides, this significant interaction between country groups and ESCS is likely to stem from the large sample sizes. Thus, the homogeneity of slopes assumption is accepted as met.

Table 3.15 The Results of the Test of Homogeneity of Slopes for ANCOVA

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| CNTRY_GRPS * ESCS | 73.765 | 2 | 36.883 | 37.976 | <.001 | **.001** |

### 3.2.5.4 Descriptive Statistics for Path Analytic Models

The variables that are used in path analytic models to answer the seventh and eighth research questions are examined through the descriptive statistics in this section. Table 3.16 includes basic descriptive statistics, such as sample sizes, mean, standard deviation, skewness and kurtosis for the three country groups.

Table 3.16 Sample Size and Basic Descriptive Statistics for Path Analytic Models

| Country Groups | Variables | Sample Size (N) | M | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| EU Member Group | INTUSE | 57,787 | -.012 | .977 | .732 | 1.875 |
| | PRGUSE | | .004 | .939 | .259 | **2.542** |
| | HIGHCONF | | .065 | .930 | -1.099 | .886 |
| | INTCONF | | -.006 | .955 | -.834 | .165 |
| | ROUTCONF | | .000 | .965 | .225 | .593 |
| | ATTCOMP | | -.009 | 1.005 | -.363 | -.189 |
| | ESCS | | .054 | .971 | -.218 | -.102 |
| | Pv1math | | 509.281 | 95.872 | -.134 | -.099 |
| | Pv2math | | 509.320 | 95.510 | -.137 | -.103 |
| | Pv3math | | 509.260 | 95.579 | -.140 | -.109 |
| | Pv4math | | 509.457 | 95.593 | -.124 | -.110 |
| | Pv5math | | 509.342 | 95.430 | -.132 | -.117 |
| | **MATHLIT (average)** | | 509.332 | 95.597 | -.133 | -.108 |
| | Pv1prob | | 51.372 | 93.897 | -.272 | .086 |
| | Pv2prob | | 51.474 | 93.892 | -.284 | .088 |
| | Pv3prob | | 51.328 | 93.741 | -.285 | .073 |
| | Pv4prob | | 51.458 | 93.815 | -.273 | .092 |
| | Pv5prob | | 51.533 | 93.762 | -.261 | .059 |
| | **PROBSOL (average)** | | 51.433 | 93.822 | -.275 | .080 |

Table 3.16 Continued.

| Country Groups | Variables | Sample Size (N) | M | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| New EU Member Group | INTUSE | 25,359 | -.226 | .919 | .928 | **2.766** |
| | PRGUSE | | .033 | 1.011 | .183 | **2.401** |
| | HIGHCONF | | -.081 | 1.047 | -.909 | .143 |
| | INTCONF | | -.357 | 1.075 | -.569 | -.034 |
| | ROUTCONF | | -.177 | 1.009 | .147 | .799 |
| | ATTCOMP | | -.023 | .951 | -.221 | -.226 |
| | ESCS | | .074 | .824 | .132 | -.275 |
| | Pv1math | | 508.671 | 92.944 | .017 | -.161 |
| | Pv2math | | 508.757 | 93.404 | .004 | -.145 |
| | Pv3math | | 508.729 | 93.092 | .023 | -.190 |
| | Pv4math | | 508.536 | 93.417 | .000 | -.185 |
| | Pv5math | | 508.903 | 93.297 | .009 | -.209 |
| | **MATHLIT (average)** | | 508.673 | 93.214 | .011 | -.170 |
| | Pv1prob | | 508.074 | 91.907 | -.105 | -.069 |
| | Pv2prob | | 508.333 | 92.036 | -.115 | .019 |
| | Pv3prob | | 508.351 | 92.060 | -.115 | -.038 |
| | Pv4prob | | 508.082 | 92.331 | -.117 | -.053 |
| | Pv5prob | | 508.355 | 91.966 | -.110 | -.069 |
| | **PROBSOL (average)** | | 508.210 | 92.083 | -.113 | -.035 |
| Turkey | INTUSE | 3,590 | -.240 | 1.059 | .284 | 1.538 |
| | PRGUSE | | .096 | 1.302 | .000 | .799 |
| | HIGHCONF | | -.705 | 1.197 | -.344 | -.245 |
| | INTCONF | | -.524 | 1.163 | -.600 | .173 |
| | ROUTCONF | | -.153 | 1.038 | -.454 | 1.397 |
| | ATTCOMP | | .168 | .977 | -.550 | .133 |
| | ESCS | | -.814 | 1.093 | .338 | -.283 |
| | Pv1math | | 436.941 | 105.364 | .481 | .381 |
| | Pv2math | | 435.255 | 104.745 | .425 | .185 |
| | Pv3math | | 436.691 | 104.794 | .485 | .243 |
| | Pv4math | | 436.052 | 105.297 | .461 | .209 |
| Turkey | Pv5math | | 437.167 | 103.378 | .429 | .124 |
| | **MATHLIT (average)** | | 436.296 | 104.968 | .463 | .270 |
| | Pv1prob | | 419.336 | 94.440 | .272 | .446 |
| | Pv2prob | | 418.582 | 94.017 | .282 | .279 |
| | Pv3prob | | 418.989 | 94.387 | .315 | .235 |
| | Pv4prob | | 419.347 | 94.999 | .324 | .294 |
| | Pv5prob | | 419.389 | 93.134 | .324 | .288 |
| | **PROBSOL (average)** | | 418.969 | 94.281 | .290 | .320 |

As mentioned before, since the sample sizes of the groups are large, the distributions of dependent variables in country groups are assumed to be normal (Hair et al., 2006). Therefore, the assumption of normality for SEM analyses is already ensured.

Table 3.17 represents the correlations among the predictor variables used in mathematical and problem solving literacy performance models for each country group.

Most of the correlations among ICT indexes are medium or large according to Cohen's classification (Cohen, 1977). ESCS has generally medium level correlations with INTUSE, ROUTCONF, and INTCONF in Turkey and the new EU member group, whereas these correlations are relatively smaller in the EU member group.

Table 3.17 Correlation Matrix of the Predictor Variables in Mathematical and Problem Solving Literacy Performance Models for Country Groups

| | ATTCOMP | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| EU Member Group | | | | | | | |
| ATTCOMP | 1.00 | | | | | | |
| INTUSE | 0.49 | 1.00 | | | | | |
| PRGUSE | 0.39 | 0.53 | 1.00 | | | | |
| ROUTCONF | 0.39 | 0.38 | 0.31 | 1.00 | | | |
| INTCONF | 0.38 | 0.58 | 0.29 | 0.62 | 1.00 | | |
| HIGHCONF | 0.44 | 0.51 | 0.50 | 0.58 | 0.61 | 1.00 | |
| ESCS | 0.02 | 0.18 | 0.06 | 0.21 | 0.28 | 0.15 | 1.00 |
| New EU Member Group | | | | | | | |
| | ATTCOMP | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
| ATTCOMP | 1.00 | | | | | | |
| INTUSE | 0.42 | 1.00 | | | | | |
| PRGUSE | 0.37 | 0.57 | 1.00 | | | | |
| ROUTCONF | 0.39 | 0.41 | 0.43 | 1.00 | | | |
| INTCONF | 0.36 | 0.60 | 0.39 | 0.64 | 1.00 | | |
| HIGHCONF | 0.40 | 0.53 | 0.54 | 0.61 | 0.70 | 1.00 | |
| ESCS | 0.07 | 0.26 | 0.19 | 0.36 | 0.34 | 0.25 | 1.00 |
| Turkey | | | | | | | |
| | ATTCOMP | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
| ATTCOMP | 1.00 | | | | | | |
| INTUSE | 0.37 | 1.00 | | | | | |
| PRGUSE | 0.29 | 0.67 | 1.00 | | | | |
| ROUTCONF | 0.43 | 0.38 | 0.38 | 1.00 | | | |
| INTCONF | 0.41 | 0.52 | 0.34 | 0.68 | 1.00 | | |
| HIGHCONF | 0.40 | 0.48 | 0.52 | 0.67 | 0.67 | 1.00 | |
| ESCS | 0.13 | 0.27 | 0.14 | 0.36 | 0.36 | 0.22 | 1.00 |

### 3.2.5.5 Path Analytic Models

In order to specify and investigate the relationships between ICT aspects, students' family backgrounds and mathematical literacy performance, and problem solving literacy performance across country groups, substantive conceptual models were generated to answer fourth and fifth research questions. As given Table 3.11, the exogenous (i.e predictor) variables are PRGUSE: Programs/software use, INTUSE: Internet/entertainment use, ROUTCONF: Confidence in routine tasks, INTCONF: Confidence in Internet, tasks, HIGHCONF: Confidence in high-level tasks, and ESCS: Economic, Social, and Cultural

Status of Students; and endogenous (i.e. criterion) variables are ATTCOMP: Attitudes toward computers, MATHLIT: Mathematical Literacy Performance, and PROBSOL: Problem Solving Literacy Performance.

The path analytic models, constructed in connection with theoretical concepts and constructs, were estimated through the structural equation modeling (SEM) approach with LISREL (LInear Structural RELationship) software. SEM is a collection and an extension of several multivariate statistical methods (factor analysis, MANOVA, and multiple regression etc.) designed to examine a set or a series (not only a single) of relationships between variables and to test whether data fit a causal theoretical model. As defined by Wright (1934), "path analysis is a technique to assess the direct causal contribution of one variable to another in a nonexperimental situation" (as cited in Jöreskog and Sörbom, 1993, p. 11). Path analysis, one of the models performed in LISREL or one of the special types of SEM, is a way to visualize relationships of variables along with estimated coefficients (Ullman, 1996).

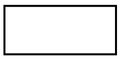
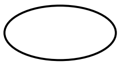
There are several reasons for conducting SEM (the path analytic model with observed variables) instead of multivariate statistical analyses in this study, but the major ones are: first, SEM considers an overall model as a system of equations and it also estimates all the coefficients directly rather than estimating each equation separately (Jöreskog & Sörbom, 1993, p.11); second, SEM enables both an overall test of model fit and individual parameter estimates simultaneously; third, SEM also unifies several multivariate methods into one analytic framework to test simultaneously the estimation of multiple equations/interrelated relationships with/between multiple dependent and independent variables in a single model.

Although path analytic models are categorized into several types, two basic forms of models are the recursive and nonrecursive ones. If all directions of paths move in one direction with no feedback direction and no reciprocal patterns in any path diagram, this path analytic model is called as a recursive path analysis. The path analytic models in this study, therefore, are recursive ones.

In order to increase the comprehensibility of basic shapes, key terms, and concepts about path analysis as a type of SEM, some definitions and explanations are given in Table 3.18 and below:

***Path Diagram:*** A visual representation of a model and a complete set of relationships among the variables of model.

Table 3.18 Basic Shapes and Explanations in Path Analysis

| Names | Shapes | Explanations |
|---|---|---|
| Observed (indicator or manifest) variable |  | It is observed and measured directly. The researcher must specify which indicators are associated with each latent. |
| Latent (construct or unobserved) variable |  | It can be represented or indirectly measured by observed variables. |
| Direct effect (straight one-headed arrow from one variable to another) | $\longrightarrow$ | It depicts causal or correlational effects that are presumed to flow from independent (exogenous) variable to dependent (endogenous) one. Statistical estimates of direct effects are called path coefficients. |
| Reciprocal effect (straight two-headed arrow between variables) | $\longleftrightarrow$ | It depicts causal or correlational effects between two variables. It is also called as feedback loops or bidirectional effect. |

Source: (Hair et al., 2006, pp. 703-882)

***Indirect Effect:*** An influence of a variable, having no single straight arrow toward a dependent variable, rather, on a dependent variable as mediated by the presence of another variable.

***Total Effect:*** The summation of the direct and indirect effects of dependent and independent variables on a particular dependent variable.

***Exogenous Variable:*** A prior variable. It exerts an influence on other variables, not influenced by other variables in the model. Its value is assumed to be measured without error.

***Endogenous Variable:*** This is affected by exogenous and/or other endogenous variables in the model. It is predicted by other variables and its variability is assumed to be explained by its predictors.

SEM has two basic parts: Confirmatory Factor Analysis (CFA) with SEM and a structural model with SEM. First, CFA shows how observed variables come together to represent latent variables. CFA tests the measurement theory through a measurement model. Second, the structural model examines and tests the hypothesized relationships between observed or latent variables. The structural model (path analytic model with observed variables in this study) indicates the explained and unexplained variance of each endogenous variable.

Confirmatory factor analyses had already been conducted to specify the observed variables of latent variables for item dimensionality in the PISA 2003 study, and composite scores called an index were calculated for each construct. Since the CFA part of the SEM was completed in the PISA 2003 study (OECD, 2005b), this study focused mainly on testing hypothesized relationships among variables in path analyses with observed variables. Note that indexes and plausible values are used as observed variables in the models.

As Adams indicated, PVs are not students' test scores and they are randomly generated values, extracted from the distribution of scores for each individual (as cited in OECD, 2005b). In the PISA 2003 student data file, there are 40 PVs. Mathematical literacy as a major domain has 25 of them, 20 for the mathematical literacy subscales –space and shape, change and relationship, uncertainty and quantity– and 5 for the combined mathematical literacy scale. The other literacy domains, as minor ones, have 15 plausible values: 5 for problem solving literacy, 5 for reading literacy and 5 for science literacy (OECD, 2005b). In this study, five plausible values from PV1MATH to PV5MATH (MATHLIT) for combined mathematical literacy performance and five plausible values from PV1PROB to PV5PROB (PROBSOL) for problem solving literacy performance are used as observed variables to represent mathematical, and problem solving literacy performance.

As the PISA 2003 Technical Report (OECD, 2005b) explains, the statistical analyses involving plausible values should be run five times, each for one relevant plausible variable, and the results should be averaged. Therefore, the path analyses were conducted five times for mathematical, and five times for problem solving literacy performance models and their results –p-values, t-values, estimates, error variances, and goodness-of-fit indexes etc.- were averaged for mathematical and problem solving literacy performance models separately in this study.

In order to conduct a path analytic model as a structural model in SEM, the indexes -INTUSE, PRGUSE, INTCONF, ROUTCONF, HIGHCONF, ATTCOMP, and ESCS- and plausible values (PVs) -MATHLIT and PROBSOL- were analyzed with LISREL 8.30 with SIMPLIS Command Language.

In literature, SEM applications have several stages to develop and test measurement and structural models. These stages are (1) defining individual constructs, (2) developing the overall measurement model, (3) designing a study to produce empirical results, (4) assessing the measurement model validity, (5) specifying the structural model and (6) assessing the structural model validity (Hair et al., 2006). The first four stages belong to the measurement model and last two stages belong to the structural model. Since the first four stages of SEM applications had already been completed by PISA, the only last two stages were conducted through reanalyzing the PISA 2003 dataset in this study.

Assessing the structural model validity stage requires testing the validity of the structural model and its corresponding hypothesized relationships. The validation of measurement model in stage four is a precondition for the specifying structural model and assessing the structural model validity. Similar to measurement model assessment, structural model assessment uses fit indexes to test how well a researcher's theory of specified structural relationships among variables really matches reality (Hair et al., 2006).

In order to asses fit indexes and statistically evaluate the structural model, the most common fit indexes are used in this study, such as Chi-Square ($\chi 2$), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (S-RMR). These are explained below.

***Chi-Square ($\chi^2$):*** In practice, chi-square is the fundamental measure of overall model fit, and the other fit measures are functions of chi-square. A chi-square ($\chi 2$) test gives a statistical test of the difference in the observed sample covariance matrix and SEM estimated covariance matrix. This difference in these covariance matrices is the key value in understanding how well the model specified. In other words, a non significant chi-square value indicates that these matrices are not statistically different. This is exactly what the researcher desired. Therefore, a small chi-square corresponds to a good fit, a large chi-square corresponds to a bad fit, and a zero chi-square corresponds to a perfect fit. However, chi-square is very sensitive to sample size due to its mathematical formula, and studies with large sample sizes tend to produce significant probability (p-value). Since the sample sizes of country groups in this study are considerably large, the other goodness-of-fit indexes are also taken into account (Jöreskog and Sörbom, 1993; Hair et al., 2006).

***Goodness-of-Fit Index (GFI):*** The goodness-of-fit index is less sensitive to sample size, but it is still indirectly sensitive to sample size due to the effect of sample size on sampling distribution. Nonetheless, the goodness-of-fit index can be proposed to reduce the effect of sample size. The values of goodness-of-fit index theoretically range from 0 (poor fit) to 1 (perfect fit). Although there is inconsistency in setting the value of a goodness-of-fit index, a value exceeding .90 is commonly accepted as a good fit (Hair et al., 2006).

***Adjusted Goodness of Fit Index (AGFI):*** The AGFI is the GFI adjusted for the degrees of freedom of a model relative to the number of variables. This fit index is generally used for more complex models considering differing degrees of model complexity. No statistical test is associated with either GFI or AGFI, only guidelines exist to fit. As with GFI, exceeding .90 is assumed to be a good fit for AGFI. GFI and AGFI are less sensitive to sample size than chi-square (Hair et al., 2006).

***Root Mean Square Error of Approximation (RMSEA):*** This index is computed on the basis of the analysis of residuals and adjusts for degrees of freedom. It tries to correct for both model complexity and sample size by including each in its computation. RMSEA also considers the error of approximation in the population. Moreover, the confidence interval can be constructed in RMSEA by giving the range of RMSEA values for a given level of confidence. A test of significance of the RMSEA is provided by LISREL and the RMSEA values of less than .05 are accepted as indicating a better fit (Hair et al., 2006).

***Standardized Root Mean Square Residual (S-RMR):*** This is the average difference between the predicted and observed variances and covariances in the model, based on standardized residuals. Standardized residuals are fitted residuals divided by the standard error of the residual. S-RMR residuals are calculated for every possible covariance. The smaller the standardized RMR, the better the model fit. Values of less than .05 are generally interpreted as a good fit (Hair et al., 2006).

### 3.2.6 Validity and Reliability

In any research, Fraenkel and Wallen (2000, p. 169) define validity as “referring to the appropriateness, meaningfulness, and usefulness of the specific inferences researchers make based on data they collect”. According to Smith, high validity largely depends on constructs consisting of observable variables; therefore, validity is higher in direct measuring than in indirect measuring (as cited in Karasar, 1995). The concept of reliability is simpler than that of validity. Reliability alone is necessary for validity, but it is not sufficient to verify validity. In reliability, following same processes and using the same criteria give the same measures or findings, -that is, reliably concerns consistency among independent measurements of whatever the instrument measures for the same thing.

### 3.2.6.1 Content-Related Validity

In PISA 2003, students are required to respond to assessment instruments for various literacy performance and student and ICT questionnaires as mentioned before. Content-related validity focuses mainly on the content and format of instruments and questionnaires to logically measure what was intended as determined by experts. Since the PISA 2003 assessment aims international comparisons, what is critical is to ensure content-related evidence of validity, considering the language and cultural settings of the instruments' content and format. In order to provide this, the PISA consortium experts worked collaboratively with test developers, expert groups, a national expert from Mathematics Forum, and so forth, on issues such as the development of assessment frameworks, test development procedures, item submission guidelines, national and international review of items, and translation (OECD, 2004b, 2005b).

The development of the PISA 2003 assessment frameworks was an initial and most important phase of test development process. These assessment frameworks, approved by the PGB, are used as a guideline in determining the definition of the literacy domains, the scope of the assessment instruments, the number of items for each component in the domain, and question types (OECD, 2005b).

In test development procedures, cognitive laboratory procedures are used as a new kind of review and refinement test development methodology. By using this methodology, weakly working items may be taken out before the field test, and an item pool is created. Moreover, this methodology provides test developers trained by the consortium in this new methodology with evidence on student responses that reflects the student's actual cognitive activities, as necessitated for the assessment item (OECD, 2005b).

Since PISA 2003 assessment is internationally comparative, the items in the instruments are drawn from a consideration of different languages and cultural settings. In order to support this situation, item submission guidelines of mathematical and problem solving literacy domains were developed and distributed to NPMs. The inclusive and detailed information on how to write items, sample items, and a submission form are given in the item submission guidelines. Consortium test developers worked on all the submitted items (OECD, 2005b).

Test developers and translation staff translated items from English to French in order to obtain a double source language. Many revisions were made on items in the translation and verification process, with the help of experts in French. This translation, as an initial process, facilitated item translations into other languages in such a way that modification of wording and identification of items provided a more accurate translation into other languages. All selected items were edited by professional editors in terms of their grammatical consistency, textual and layout regularities. So as to obtain a high quality in the final product, the English and French versions of booklets, including items, clusters and other materials for the field trial, distributed to all countries. All national centers adapted and translated all selected items into their own languages (OECD, 2005b).

In the translation process, detailed adaptations, translation guidelines and strict verification procedures were followed to translate the two source versions of the assessment instruments, and the questionnaires, in English and French into their national language and then reconcile them into one national version. A double translation procedure, requiring two independent translations from two different source languages to one target language, was followed. Then, a third person, a reconciler, reconciled them into one. Two national translators, one reconciler and one verifier were used to provide linguistic equivalence between source and target languages. Both national translators were trained and their translations were verified by international translators appointed by the PISA consortium (OECD, 2005b).

NPMs in national centers reviewed the items and gave feedback based on item review guidelines. Besides, they identified, commented on, and rated items considering differences as curricular and non-curricular, translation, and any other cultural issues in the relatedness, appropriateness, and acceptability of different cultural, and contexts. The given feedback generally brought about more revisions to the items. Then, mathematics items were reviewed by national experts who participated in an international mathematics forum. The problem solving items are also reviewed and revised by pertinent expert groups (OECD, 2005b).

### 3.2.6.2 Construct-Related Validity

Construct-related evidence of validity is necessary to compare student performances on the basis of comparable constructs (indexes) drawn from instruments in international educational-comparative studies. In the field trial process, the questionnaires with the achievement test in PISA 2003 were used to develop constructs in all participating countries during the two years prior to the main assessment. In order to review the dimensional structure of questionnaire items and to determine constructs with items in the questionnaires, exploratory and confirmatory factor analyses were performed to constitute constructs in field trial data across countries. Cross-country validation of constructs is concerned with similar characteristics, attitudes and perceptions in different national and cultural contexts. Confirmatory factor analysis is used to acquire a theoretical model of item dimensionality, and structural equation modeling (SEM) is used to confirm theoretically expected dimensions. SEM also explores the validity of comparisons across countries (OECD, 2004b, 2005b).

The constructs -especially ICT related indexes and ESCS index- for this research are derived from student and ICT questionnaires in the PISA 2003 study. Constructs of this study are used to explore relationships in ICT aspects and the economic, social, and cultural status of students across country groups (OECD, 2005b).

### 3.2.6.3 Reliability

A separate reliability analysis was conducted to obtain constructs' internal-consistency estimates of reliability for each country in the country groups. These constructs are ICT indexes and the ESCS index. The internal-consistency estimates of reliabilities pertaining to countries and the internal consistency estimate of averages for country groups are given in Table 3.19.

Table 3.19 The Alpha Reliability Coefficients of the ICT Indexes and ESCS Index in Country Groups

| | | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ATTCOMP | ESCS |
|---|---|---|---|---|---|---|---|---|
| EU Member Group | AT | 0.79 | 0.76 | 0.87 | 0.77 | 0.82 | 0.82 | 0.65 |
| | BE | 0.83 | 0.77 | 0.90 | 0.85 | 0.83 | 0.83 | 0.67 |
| | DK | 0.77 | 0.79 | 0.82 | 0.71 | 0.85 | 0.84 | 0.63 |
| | FI | 0.79 | 0.78 | 0.88 | 0.73 | 0.87 | 0.83 | 0.60 |
| | DE | 0.81 | 0.77 | 0.87 | 0.81 | 0.84 | 0.82 | 0.65 |
| | EL | 0.85 | 0.82 | 0.89 | 0.84 | 0.86 | 0.81 | 0.73 |
| | IE | 0.82 | 0.80 | 0.87 | 0.82 | 0.85 | 0.81 | 0.67 |
| | IT | 0.82 | 0.77 | 0.88 | 0.87 | 0.82 | 0.78 | 0.71 |
| | PT | 0.85 | 0.79 | 0.93 | 0.88 | 0.86 | 0.82 | 0.77 |
| | SE | 0.78 | 0.76 | 0.85 | 0.69 | 0.85 | 0.82 | 0.60 |
| | UK | 0.82 | 0.79 | 0.88 | 0.77 | 0.83 | 0.81 | 0.65 |
| ***Average*** | | ***0.81*** | ***0.78*** | ***0.88*** | ***0.79*** | ***0.84*** | ***0.82*** | ***0.67*** |
| New EU Member Group | CZ | 0.83 | 0.78 | 0.87 | 0.81 | 0.85 | 0.78 | 0.72 |
| | HU | 0.77 | 0.74 | 0.90 | 0.84 | 0.84 | 0.82 | 0.76 |
| | LV | 0.84 | 0.81 | 0.91 | 0.86 | 0.84 | 0.78 | 0.56 |
| | PL | 0.86 | 0.87 | 0.92 | 0.85 | 0.85 | 0.85 | 0.74 |
| | SK | 0.82 | 0.82 | 0.92 | 0.88 | 0.86 | 0.78 | 0.67 |
| ***Average*** | | ***0.82*** | ***0.80*** | ***0.90*** | ***0.85*** | ***0.85*** | ***0.80*** | ***0.69*** |
| ***Turkey*** | TR | ***0.86*** | ***0.85*** | ***0.93*** | ***0.88*** | ***0.86*** | ***0.80*** | ***0.76*** |

Source: (OECD, 2005b, pp. 307-320). Reliabilities (Cronbach's alpha) computed with weighted national samples.

The alpha reliability coefficients of the overall mathematical and problem solving literacy performance (PVs as MATHLIT and PROBSOL), generated using multidimensional scaling and conditioning scores, were separately calculated. The alpha reliability coefficients of the mathematics and problem solving scales at international level are 0.92 and 0.87 respectively. Although the reliability coefficients of ICT indexes and ESCS index are changeable, the reliability coefficients of PVs represent high reliability (OECD, 2005b).

### 3.2.7 Limitations

There are some limitations that can affect the results, interpretations and generalizability of this research. These are as follow:

1. This study is limited to the schools that participated in PISA 2003 study.
2. This study is limited to the sample of 56,610, 24,834, and 3,231 students in the EU member group, the new EU member group and Turkey, respectively, for comparisons across country groups and 57,787, 25,359, and 3,590 students in the EU

member group, the new EU member group and Turkey, respectively, for path analytic models.

3. The PISA study provides only observational data, that is, students who used ICT are not randomly divided into a treatment group using ICT facilities and a control group not using ICT facilities. In other words, in contrast to randomized experimental design, the country groups used in this study are intact groups. As Stevens indicates, inferring cause-effect from intact groups is untrustworthy, regardless of the type of statistical analysis. Thus, the task is to do one's best and exercise considerable caution (Stevens, 2002). In this sense, the result of this study has to be interpreted cautiously in the manner of descriptive conditional correlations, which do not necessarily allow for causal inferences. In fact, the results may also reflect effects of other factors, like unobservable characteristics of students and schools.
4. This study is limited to the honesty of the subjects' responses to student and ICT questionnaires in the PISA 2003 study.
5. This research is only focused on the aspects of ICT, students' family background and mathematical and problem solving literacy domains in the PISA 2003 study.

### 3.2.8 Missing Data Analysis

There are four types of missing data in the PISA 2003 study. According to the PISA 2003 Technical Report (2005b), they can be explained as follow:

1. Item level non-response: where items are not responded to, although the subjects were expected to answer.
2. Multiple or invalid responses: if there are invalid responses or more than one alternative answers for multiple choice question, they are accepted as missing data.
3. Not applicable: if items are not possible for respondents to answer because of some reasons such as misprinting, deletion and not administering the questions, these are also accepted as missing data.
4. Not reached items: if a cluster of items have no responses starting from the end of each test session, they coded as not-reached, except for the first value of the missing series, which is coded as missing.

Since user-missing and system-missing in data file are transformed into system-missing in preliminary statistical procedure, and a listwise deletion method was preferred and used in the handing of the missing data in one-way MANCOVA and ANCOVA analyses, missing data analysis is not conducted for these analyses.

Missing data must always be addressed if missing data are more than 10% of the data items (Hair et al., 2006). There was no missing value in sets of PVs for mathematical and problem solving literacy performance, so there was no need to conduct missing data analyses for PVs before SEM analyses. However, when the ICT indexes were analyzed separately to examine the size of the missing percentages for each of the country groups, there were missing values in the ICT indexes. As seen from Table 3.20, the percentages of missing values in ICT indexes ranged from 0.4% to 6.3%. Since the percentages of the missing values were less than 10%, there was no need to conduct missing value analysis. The missing values of the EU member group are the lowest, but those of Turkey are the highest.

Table 3.20 The Percentages of Missing Values of ICT Indexes in Path Analytic Models

| Mathematical and Problem Solving Literacy Performance | | | |
|---|---|---|---|
| | Country Groups | | |
| ICT Indexes | EU Member Group (%) | New EU Member Group (%) | Turkey (%) |
| INTUSE | 0.4 | 0.5 | 2.7 |
| PRGUSE | 0.5 | 0.8 | 4.7 |
| INTCONF | 0.5 | 0.7 | 3.5 |
| ROUTCONF | 0.8 | 1.0 | 5.8 |
| HIGHCONF | 0.6 | 1.0 | 6.3 |
| ATTCOMP | 1.0 | 1.0 | 4.0 |

As to handling missing data, since the sample sizes were large enough and the amount of missing data was less than 10%, pairwise deletion was a good alternative in handling missing data for path analytic models (Hair et al., 2006).

### 3.2.9 Effect Size

Fraenkel and Wallen (2000) defined the effect size as “an index used to indicate the magnitude of an obtained result or relationship”. It can be considered as an indicator that evaluates the magnitude of the relationship(s)/difference(s) between two or more variables/groups, and that usually clarifies the proportion of explained variance on dependent variables, regardless of whether statistical significance exists, or not (Cohen, Cohen, West, & Aiken, 2003).

Although different classifications about effect size are suggested, the most prevalent and acceptable guideline on effect size for the social sciences is Cohen’s (1977). Therefore, his classification of effect size can be considered as standard for the social sciences. In accordance with common practices, he offers the frame of reference as follow: .01 is small, .09 is medium and .25 or greater is large. The effect size values of one-way MANCOVA analysis and its follow-up ANCOVAs and univariate ANCOVA were interpreted according to this classification. Since the roots of structural equation modeling are largely based on the logic of multiple regression, and path coefficients can be estimated using multiple regression methods, squared multiple correlation ($R^2$) in structural equation modeling can be roughly attributed to the effect size of multiple regression. Therefore, squared multiple correlation ($R^2$) in path analytic models is accepted and interpreted as the effect size, as well. Thus $R^2$ of the path analytic models were also interpreted according to the classification of Cohen (1977).

## 3.3 Methodology for the Qualitative Phase of the Study

### 3.3.1 Participants

The natural structure of the present study, the qualitative research questions, and the personal judgment of the researcher in selecting the key informants required a purposive sampling method. Purposive sampling enables the researcher to select information-rich cases for in-depth data collection (Fraenkel & Wallen, 2000). Although purposive sampling was selected by the researcher, some of the prospective participants did not want to be interviewed due to lack of time, inconvenience, their political positions and other reasons. It is noticed that the cognitive load of the interview schedule required all prospective participants to examine it. Therefore, some of them were not likely to be interviewed by the researcher. The researcher then followed a strategy that asked the interviewee in the second pilot study "who are the key informants that you know through considering this interview?" The other interviews with policy makers were conducted in the same way. In this case, it can be said that referential sampling, or snowball sampling was also used to sample policy makers in this study. Referential sampling is most appropriate when identifying key informant participants who are members of a group (Krathwohl, 1993). In other words, it can be said that referential sampling was used to find key informants. However, referential sampling did not work sampling academicians.

There were seven participants. Four of them from MONE and three of them were from universities. Three of the policy makers (PM) are members in Authority of the Turkish Education Board (TTKB) and the other is a policy implementer (PI) in the ICT related projects in the Educational Research and Development Department (EARGED). Two of the academicians (AC) are in Instructional Technology related departments as chairmen, one of whom is in the team that is charge of new curriculum construction for basic education in computer courses. The other academician (AC) has a Doctor of Philosophy (Ph.D.) degree and is an expert in the field of Instructional Technology. The detailed background information of the interviewees of this study is given in Table 3.21.

### 3.3.2 Data Collection Instrument

A comprehensive national and international literature review on ICT in education policy was conducted to explain, interpret and give meaning to key findings in the first phase of the study and an ICT related educational issues in Turkey. Reviewing related literature not only enabled the researcher to understand the general trend of ICT in education with its policies and practices, but also helped the researcher to determine qualitative research questions, the data collection instrument and the participants. Since the perceptions, thoughts, beliefs and views of policy makers could not be learnt through observation, semi-structured interview was selected as the most appropriate data collection technique. Furthermore, the semi-structured interview schedule was an instrument that provided the researcher with additional, hypothetical, alternative questions and probing to collect information on what the researcher wanted to learn or clarify in depth.

The findings of the first phase of the present study and ICT related educational issues in Turkey were considered in the light of the qualitative research questions. In order to collect data from policy makers on the findings of the first phase, these findings should be transformed into representations whose meaning should be understood as the same by every participant with different backgrounds. The process of transforming quantitative findings into representations was challenging and demanding for the researcher. Therefore, the researcher asked for consultation from two experts (one was an expert in the field of Instructional Technology and the other one was an academic giving a course in this subject) on qualitative research in education during this transformation process. The representations were then transformed and embedded into the interview schedule. Furthermore, consultancy in terms of meaningful, understandable and unambiguous questions in the interview schedule was also taken from the experts. In the light of experts' suggestions, some questions were revised, one alternative question and some prompts were added and some questions were removed. In this way the interview schedule was formulated for the pilot studies. In addition to these, the interview schedule was also examined by a Turkish literature teacher in order to increase the comprehensibility of the introduction, questions, representations and their explanations. Some small grammar mistakes were corrected.

Table 3.21 Background Information of Interviewees

| Interviewees | University | Graduation Departments | Year | Institution | Employment Unit | Employment Duty | Title | Area of Specialization |
|---|---|---|---|---|---|---|---|---|
| 1 | Gazi University | Woodwork Education | 1972 | MONE | Authority of Turkish Education Board (TTKB) | Member of TTKB | Specialist (Master of Arts -MA) | Educational Technology<br>Special Education |
| 2 | Gazi University | Educational Administration Supervision Planning and Economics<br>School of Journalism and Mass Communication-Radio-TV | 1985<br>1981 | Hacettepe University | CEIT | Academic Staff | Asst. Prof. Dr. | Instructional Technology Specialist<br>Multimedia-Computer Consultant<br>Educational Technology<br>Distance Education |
| 3 | Gazi University | Clothing /Prepared Clothing Fashion Design | 1985 | MONE | Educational Research and Development Department | Project Implementer | Specialist (MA) | Curriculum Development<br>Teacher Training<br>Instructional Material Development |
| 4 | Atatürk University | Mathematics | 1982 | MONE | TTKB | Member of TTKB | Ph.D. | Mathematics Education |
| 5 | Çukurova University | Foreign Language Education | 1984 | MONE | TTKB | Member of TTKB | Specialist (MA) | Learning Styles<br>Brain Based Learning |
| 6 | Hacettepe University | Biology | 1978 | Middle East Technical University (METU) | CEIT | Academic Staff | Prof. Dr. (Chairperson) | Educational Technology<br>Distance Education<br>In-service Training |
| 7 | METU | Mathematics-Physics Education | 1979 | Hacettepe University | CEIT | Academic Staff | Prof. Dr. (Chairperson) | Computers in Education<br>Educational Statistics<br>Educational Research<br>Measurement and Evaluation<br>Mathematics Education |

Two pilot studies were conducted to test the comprehensibility of questions and representations in the interview schedule. First a pilot study was conducted with a computer teacher who was a doctoral student in Instructional Technology. The second one was conducted with a policy maker. After the pilot studies, some explanations about representations were added, in consultation with experts, to increase the understandability of figures in the interview schedule.

The interview schedule consists of two separate parts. The first part, “Interview Schedule-Interviewer”, was used by the researcher as an interviewer and the second part, “Interview Schedule – Before and During Interview”, was used by both the interviewees and the researcher. The first and second parts of the interview schedule are given in Appendix C and D, respectively.

Interview Schedule-Interviewer was used during the interview. It covered the introduction, main and closure parts. The introduction part explains the study. The main part had two sections. The first one was related to demographic information about the interviewee, but the demographic information was collected at the end of the interviews. The second one covered questions concerning a separate evaluation of each finding and a general evaluation of findings together, and ICT policies, implementations, issues, problems, challenges, and suggestions for Turkey. Finally, the closure part was summarized spoken issues, asking if the interviewees wanted to add something and thanking them.

Interview Schedule – Before and During Interview covered an explanation of the study, representations of students’ socioeconomic and cultural background, attitudes toward computers, and separate and entire representations of comparisons of ICT aspects and models, and some explanations pertaining to representations. Since Interview Schedule – Before and During Interview was cognitively loaded, due to these results and their representations, it was given to interviewees before conducting the interview. More concisely, this part concerned the policy makers’ perceptions about ICT in education with respect to the findings of the quantitative phase of this study and ICT policies, and practices, issues, problems, challenges and suggestions in the context of Turkey.

### 3.3.3 Data Collection Procedure

Before conducting interviews, the researcher applied to obtain official permission from the Human Researches Ethic Committee within the university. This application requires filling in forms involving detailed information about the study and attaching the interview schedule with separate two parts. These forms and the interview schedule were examined by the committee and then the permission was given to conduct the study. The permission document is given in Appendix E.

Afterwards, Interview Schedule – Before and During Interview was given to the interviewees approximately 10 days before the interviews. While giving it, general information about the study, the purpose of the study, and information about the interview to be conducted were explained. Furthermore, an appointment with the interviewee was fixed and contact information was given to the interviewee in the case of any question. Seven interviews were conducted at the offices of interviewees. Since appointed times and offices were used for the interviews, there were no any distractions. Each of the interviews took around one and a half hours. Similar to study of Özar (1996), the researcher recognized, in the second pilot study, that interviewees (policy makers) felt hesitation and inhibition due to the voice recording; from that reason, note taking instead of voice recording was used in the interviews of all policy makers. However, voice recording was used for academic participants. Before starting the interview, the researcher tried to make conversation and build a rapport and intimacy with interviewees. Moreover, the questions concerning background information about the participants were asked at the end of the interview to avoid being misconceived by interviewees. The interviews were conducted between June and July of 2007.

Before going on to the interview process, the researcher explained the purpose of the study and interview, and confidentiality issues. The value and importance of their perceptions, expressions and sayings in making a contribution to the Turkish education system through this kind of study was also explained. The researcher prepared a printed form to take notes during the interviews with policy makers. Almost all the words of the interviewees were written in those printed forms. The researcher thanked the interviewees at the end of the each interview session.

Interviewing participants for any academic study is not easy. A good interview requires some knowledge and skills of interviewing. Not only having interviewing knowledge and skills, but the personality of the interviewer is also important. Self-confidence, a cool and positive manner are some necessary characteristics of the interviewer.

### 3.3.4 Data Analysis Procedure

The most challenging part of the qualitative study was data analysis. Data analysis in the qualitative study systematically involved transcribing, organizing, examining, arranging, categorizing, dividing, synthesizing, discovering, understanding data and presenting findings. As Yıldırım and Şimşek (2000) stated, there are various methods of data analysis in a qualitative study, descriptive and content data analyses being the most common ones. Inductive, deductive and integrated coding approaches are used in content analysis in the literature. In integrated coding, it is possible to define the general conceptual framework and general categories, and to discuss whether new codes are added on the basis of predefined categories, or predefined ones are changed as new codes emerged during the coding process (Yıldırım & Şimşek, 2000). Integrated coding was selected for this study due to the existence of the previous related studies.

Since the contents of data collection instruments with their representations and explanations were different from ordinary qualitative research, the data collected were not routine. In order to simplify and classify complex data, all transcriptions and notes, excluding demographic information, belonging to each interview question were put into a table and marked with numbers for each row, using Microsoft Word processor. This led to more manageable and meaningful data chunks. Then, through reading these chunks several times, the most relevant parts of the data were highlighted for data reduction and coding. Later, one column was added to the right of the table and the highlighted parts were translated and transformed into English with relevant phrases, sentences and labels. This was the first level coding. Afterwards, one more column was added to the right of the table and second level coding was done in such a way that relevant phrases, sentences and labels were converted into patterns and major categories. Finally, a last right-hand column was printed out, and then axial coding was conducted to develop a coding system through examining the original data, major and sub categories and patterns. Axial coding is the act of relating categories to sub-categories along the lines of their properties and dimensions (Strauss & Corbin, 1998). In each coding level, predefined categories were considered in the approach of integrated coding. After producing a coding system, it was revised to check coding, name codes and describe codes operationally. The structure and components of the coding system can be seen in Figure 3.2. The coding system provided the researcher with information on who expresses thing, where, and what express and the frequency of expressions. In other words, the researcher could track anything that was made during the data analysis.

While creating the coding system, in order to generate, understand and interpret more meaningful patterns from the codes, selective coding processes were followed to integrate and refine the theory (Strauss & Corbin, 1998). That is, the researcher clustered some codes into broader categories and organized some subcodes logically according to relationships, explanations and patterns. By doing so, a central concept and idea was identified to make interpretations. The final coding system is given in Appendix F.

| | Categories and Sub-categories | Line Number of Interviewees | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | F |
| 1 | Issues in ICT policy and implementations in Turkey | | | | | | | | |
| 1.1 | Conflicts in existence of ICT policy in operation | | 286 | 287 | 288 | 289,293, 295,296 | | 496 | 5 |
| 1.1.1 | Lack of cultural accumulation | 323 | | | | | | | 1 |

Figure 3.2 An Example of Coding System after Data Analysis

### 3.3.5 Validity and Reliability

Since qualitative research focuses largely on the existence of phenomena, their meaning and quality, the researcher should take some measures to increase validity and reliability that are the most important criteria for trustworthiness of qualitative study (Yıldırım & Şimşek, 2000). Credibility and consistency of qualitative research are provided with validity and reliability, respectively. Although validity and reliability issues may not be addressed completely, due to the nature of the qualitative research paradigm, the researcher should consider external and internal validity and reliability issues and take measures carefully. In this regard, the researcher took validity and reliability issues into consideration and took the relevant measures and precautions below.

In qualitative research selecting an interview technique to collect data that provides more detailed and in-depth data about the participants' perceptions than do other data collection techniques is one of the these measures. Since semi-structured interview schedule with open ended questions and prompts was used as a data collection instrument, it enabled the researcher to ask alternative questions and to use probes, which leads to clarifying ambiguous points and collecting more comprehensive and meaningful data.

Taking help from two experts and a Turkish literature teacher made the interview schedule sound in terms of qualitative research, the Instructional Technology field and its language.

Meeting with participants, giving the interviewees a schedule and making an appointment before conducting the interview was a chance to generally explain the study and interview process to be conduct. This also led to interviews being conducted without any distractions, disturbances, interventions or time restrictions.

Transcribing voice recordings and writing notes into Microsoft Word processor enabled the researcher to immerse in the data. Furthermore, this software enabled the researcher to effectively arrange, organize, highlight, analyze and code data. The researcher utilized the previous conceptual framework through using an integrated coding approach during the data analysis.

### 3.3.6 Limitations

This study is limited to responses from seven participants who were policy makers and academicians from two division of MONE: the Authority of the Turkish Education Board, and the Educational Research and Development Department, and two different universities. So, this study can not be directly generalized to other institutions within MONE and higher education. Furthermore, the results of this study are limited to the perceptions of seven policy makers and academicians.

The interviews were only used as a data collection technique for this study. Therefore, the source of data is based on the honesty of participants' responses. Other technique/s could have been used to make triangulation.

Along with an evaluation of comparisons of ICT aspects across country groups, interviews also aimed to collect data on participants' perceptual evaluation of path analyses representing the relationships between ICT aspects and mathematical/problem solving literacy performance. Although representations of path analyses results were designed to be more understandable and simple through path diagrams, graphics illustrating the size and direction of relationships among variables across country groups and simplified plain text explanations, this part of the interviews did not work as intended. However, this difficulty continued despite taking measures after the pilot studies. The possible reasons of this could be that not all the participants' educational, statistical and instructional technology background and interest areas are suitable to interpret the relationships between ICT aspects and students' mathematical and problem solving literacy performance. Actually, most of the interpretations about these relationships came from academicians. In order to prevent participants from any misconceptions resulting from representations, different graphic styles could have been used to represent comparisons of ICT aspects and the relationships in the models.

## 3.4 Summary of the Methodology

Chapter three presented the methodology of the quantitative and qualitative phases of this study, separately. Since the research questions investigating the what and how part of the phenomena in quantitative research paradigm are followed by research questions to understand the why part of the same phenomena in the qualitative research paradigm, this study has a quantitative-dominant multimethod research design.

### 3.4.1 Summary of the Quantitative Methodology

In the quantitative phase, the target population in each country is defined as all 15-year-old students, enrolling any type of educational programs, except for students schooled at home or abroad. The target and accessible population of this study are computed by adding up students from members in the country groups in the EU. The country groups are formed on the basis of the status of a country in the EU, and that of having ICT data in the PISA 2003 study. They are as follow: the EU member group (founded the EU or joined the EU before 2004), the new EU member group (joined the EU in 2004), and Turkey (as a candidate state for the EU). A two-stage stratified sample design is generally used by PISA as a sampling procedure for most of the countries; schools and students are selected at the first and second stages respectively. In this study, students who have used computers before were selected as samples from each country group.

The data collection instruments were assessment instruments (measuring mathematical and problem solving literacy performance), student questionnaires (only socioeconomic and cultural background information is used in this study), and ICT questionnaires (only ICT aspects). In order to design, develop and implement these instruments, the PISA consortium works together with official institutions in the countries, and national and international experts (in subject-matter, in measurement and evaluation) from well-known institutions (ACER, CITO, Westat, and NIER etc.).

Note that the ESCS index and ICT indexes, as constructs and PVs estimating mathematics and problem solving scores, are used in the statistical analyses in this study. MANCOVA and ANCOVA are used to compare and contrast the country groups in terms of ICT aspects, and path analytic models are used to understand the relationships between students' mathematical and problem solving literacy performance and ICT aspects and socioeconomic and cultural background.

For ensuring content-related validity, the content and format of assessment instruments and questionnaires are developed by experts to measure logically what is intended, through considering the language and cultural context issues of students. In order to provide international educational-comparative studies, construct-related validity is particularly worked to draw constructs concerning similar characteristics, attitudes and perceptions in different national and cultural contexts. Since the separate reliability analysis was conducted to have reliable constructs for each country, the reliability of constructs in the quantitative phase were averaged out for country groups. The alpha reliability coefficients for overall mathematical and problem solving literacy performance at international level were separately calculated. All averaged reliabilities of variables in the quantitative phase were in the acceptable level.

User missing and system missing in data file were transformed into system missing in the data. A listwise deletion method was preferred in handing the missing data in MANCOVA and ANCOVA. On the other hand, a pairwise deletion was performed in the path analytic models.

The classification (.01 is small, .09 is medium and .25 or greater is large) of Cohen et al. (2003), the most prevalent and acceptable guideline on effect size for social sciences, was preferred to interpret the effect size for MANCOVA, ANCOVA and squared multiple correlation values of the path analytic models.

### 3.4.2 Summary of the Qualitative Methodology

Purposive and referential or snowball sampling procedures were used to conduct interviews with participants. In the sampling procedure, referential or snowball sampling was effective with policy makers, although purposive sampling is designed for academicians. Four policy makers from MONE and three academicians from universities were the participants in the qualitative phase of this study.

Since the qualitative phase is largely focused on ICT policy development and implementation issues, and perceptual evaluation of the quantitative phase results, the interview was selected as the best data collection technique. An interview schedule, as a data collection instrument, was required to represent the results of the quantitative phase as comprehensibly as possible for the interviewees. The interview schedule questions were then developed through conducting a literature review on ICT-in-education policy. Finally, a semi-structured interview schedule was developed with the help of two experts in the field of qualitative research in education and Turkish literature teacher, for the grammar and meaning of questions.

Approximately ten days before interviewing, the interview schedule, including the results of the quantitative phase, was given to the participants, so that they could examine and understand the results of the quantitative phase. Seven interviews were conducted at appointed times and places. During the interviews, each of which lasted around one and a half hours, note-taking and voice recording were used for policy makers and academicians, respectively.

Recorded interviews were transcribed and notes were transformed into digital format in a Word processor program. Transcriptions were analyzed with content analysis. More specifically, integrated coding -both using inductive and deductive coding- was conducted to understand the data and interpret the findings. In the data analysis, Microsoft Word processor was used to simplify and classify complex data for more manageable and meaningful data chunks. These chunks, such as relevant phrases and sentences, were labeled through open coding, and then patterns and major themes emerged. Axial coding was then conducted to develop a coding system through relating categories to sub-categories. Finally, selective coding was conducted to identify a central category for interpreting the whole phenomena.

In connection with validity and reliability, the data collection of technique of a semi-structured interview with open-ended questions and prompts is the most appropriate one to clarify ambiguous points and collect more comprehensive and meaningful data. Taking help from two experts and a Turkish literature teacher, and conducting two pilot studies also contributes to increased validity and reliability of the qualitative phase. Furthermore, neither using any leading probes, cues or corrections during the any of interviews, nor experiencing any distraction, disturbance, and intervention or time restriction also enhance validity and reliability. The qualitative phase of this study is limited to the responses of seven participants from MONE and universities and to their honesty in their responses. The formats of representations and their explanations about the quantitative phase of this study are limited to participants' background and perceptions.

# CHAPTER 4

# RESULTS

In this chapter, the findings of the quantitative and qualitative phases are given in two sections. In the first section, the findings of the quantitative phase are presented in two parts. The first part displays the findings of one-way MANCOVA and ANCOVA regarding the comparison of country groups on ICT aspects, whether controlling for the students' socioeconomic and cultural backgrounds and attitudes toward computers or not. The second part separately explains the fitted mathematical and problem solving literacy performance models for each country group. In the second section, the findings regarding the qualitative phase of this study are presented.

## 4.1 Results for Quantitative Phase of the Present Study

### 4.1.1 Results of One-Way MANCOVA

In order to answer the first and second research questions, one–way MANCOVA was conducted to investigate the relationships between students' ICT use, self-confidence in ICT and the status of a country in the EU, controlling for attitudes toward computers, and the economic, social and cultural status of the students. The independent variable is the status of a country in the EU (the EU member, the new EU member, and Turkey as a candidate state). The dependent variables are the ICT indexes related to ICT use and self-confidence in ICT. These indexes are specifically as follows: Internet/entertainment use (INTUSE), Programs/software use (PRGUSE), Confidence in routine tasks (ROUTCONF), Confidence in Internet tasks (INTCONF), and Confidence in high-level tasks (HIGHCONF). The covariates are the indexes of attitudes toward computers (ATTCOMP), and the economic, social and cultural status of the students (ESCS).

As mentioned in Chapter 3, Pillai's Trace statistic was preferred and interpreted from the multivariate ANCOVA tests since Box's M test was significant. Significant differences were found among the three country groups on ICT indexes, controlling for ESCS and ATTCOMP, Pillai's Trace = .058, $F$ (10, 169334) = 508.983, $p$ <.001 (see Table 4.1).

However, the multivariate $\eta^2$ based on Pillai's Trace was small, .029 (Cohen, et al., 2003). The adjusted mean scores and standard errors (*SE*) on the dependent variables are shown in Table 4.2.

Table 4.1 The Results of One-Way MANCOVA and ANCOVA

| | Dependent Variables | Covariates | Pillai's Trace | df | Error df | *F* | *P* | $\eta^2$ |
|---|---|---|---|---|---|---|---|---|
| MANCOVA | INTUSE<br>PRGUSE<br>ROUTCONF<br>INTCONF<br>HIGHCONF | ATTCOMP<br>ESCS | .058 | 10 | 169334 | 508.983 | <.001 | .029 |
| ANCOVA as follow-up for MANCOVA | INTUSE | | - | 2 | 84670 | 582.112 | <.001 | **.014** |
| | PRGUSE | | | | | 23.952 | | .001 |
| | ROUTCONF | | | | | 897.294 | | **.021** |
| | INTCONF | | | | | 1,493.256 | | **.034** |
| | HIGHCONF | | | | | 351.836 | | .008 |

Table 4.2 Adjusted Mean Scores and Standard Errors of ICT Indexes for Country Groups, Holding ESCS and ATTCOMP Constant

| | | | Country Groups | | |
|---|---|---|---|---|---|
| | | | EU Member Group | New EU Member Group | Turkey |
| **Dependent Variables** | INTUSE | *M* | **-.011** | -.224 | -.163 |
| | | *SE* | .003 | .005 | .015 |
| | PRGUSE | *M* | .006 | .039 | **.096** |
| | | *SE* | .004 | .006 | .016 |
| | ROUTCONF | *M* | **.070** | -.076 | -.538 |
| | | *SE* | .004 | .005 | .015 |
| | INTCONF | *M* | **-.007** | -.360 | -.333 |
| | | *SE* | .004 | .006 | .016 |
| | HIGHCONF | *M* | **.003** | -.175 | -.092 |
| | | *SE* | .004 | .006 | .016 |

Covariates appearing in the model are evaluated at the following values: ICT: Attitudes toward computers = -.00370, Index of Socioeconomic and Cultural Status = .03679. The numbers in bold are the biggest adjusted mean for each dependent variable.

All the ANCOVAs conducted as follow-up tests for MANCOVA were statistically significant as well. However, their partial $\eta^2$ values were small. Thus, the results have not much practical significance. The statistical significance could be due to the large sample size. In this sense, the follow-ups were examined in a descriptive manner. Follow-up tests

(Contrast-K matrix that compares adjusted mean scores) indicated that there are significant mean scores differences among Turkey, the EU member group and the new EU member group for almost all ICT indexes, controlling for ATTCOMP and ESCS (see Table 4.3). ANCOVAs and their related pairwise comparisons were explained under the related research questions below.

Table 4.3 Pairwise Comparison Results of ANCOVAs that are the Follow-up for MANCOVA

| ICT Indexes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INTUSE | | | PRGUSE | | | ROUTCONF | | | INTCONF | | | HIGHCONF | | |
| | 2 | 3 | | 2 | 3 | | 2 | 3 | | 2 | 3 | | 2 | 3 |
| 1 | * | * | 1 | * | * | 1 | * | * | 1 | * | * | 1 | * | * |
| 2 | | * | 2 | | * | 2 | | * | 2 | | - | 2 | | * |

*: there is significant difference between related group adjusted means. -: there is no significant difference between related group adjusted means, 1: EU Member Group, 2: New EU Member Group, 3: Turkey

### 4.1.1.1 Answer to Research Question 1

RQ-1: How do ICT use –Internet/entertainment use and program/software use– differ among students in PISA 2003 across country groups, controlling for attitudes toward computers, and the economic, social and cultural status of the students?

As stated before, one-way MANCOVA was conducted to compare the ICT indexes across country groups by controlling for ATTCOMP and ESCS. When INTUSE is considered, the follow-up ANCOVA on INTUSE was significant $F$ (2, 84670) = 582.112, $p$ <.001, partial $\eta^2$ = .014 (see Table 4.1). The effect size (partial $\eta^2$) is small. By controlling for ATTCOMP and ESCS, the EU member group had the biggest adjusted mean score of INTUSE ($M$= -.011), Turkey had a smaller adjusted mean score ($M$= -.163), and the new EU member group had the smallest adjusted mean score ($M$= -.224) (see Table 4.2 and Figure 4.1).

Pairwise comparisons indicate that all the country groups have significantly different adjusted mean scores of INTUSE from the others (see Table 4.3). By partialling out the effects of ATTCOMP and ESCS from INTUSE, there is a significant difference in the adjusted mean scores of INTUSE between Turkey and the new EU member group. It is important that Turkey has second larger adjusted mean score of the INTUSE while she has smallest mean score of INTUSE. Controlling ATTCOMP and ESCS in ANCOVA made the adjusted mean score of Turkey increase most among the country groups, compared to the INTUSE mean (from -.235 to -.163).

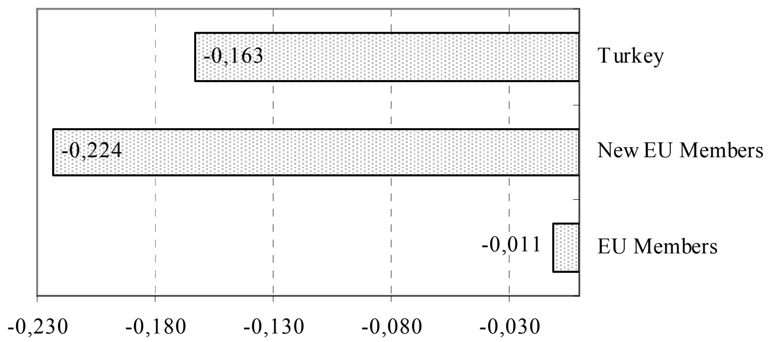



Figure 4.1 Adjusted Mean Scores on Internet/Entertainment use for Country Groups

The ANCOVA on PRGUSE was significant as well, $F$ (2, 84670) = 23.952, $p$ <.001, partial $\eta^2$ =.001 (see Table 4.1). The effect size is very small; thus, the adjusted mean differences in PRGUSE across country groups are not practically meaningful. Table 4.2 and Figure 4.2 illustrate that when ATTCOMP and ESCS were held constant, Turkey has the biggest adjusted mean score of PRGUSE ($M$= .096); the new EU member group has a smaller adjusted mean score ($M$= .039); and the EU member group has the smallest adjusted mean score ($M$= .006).

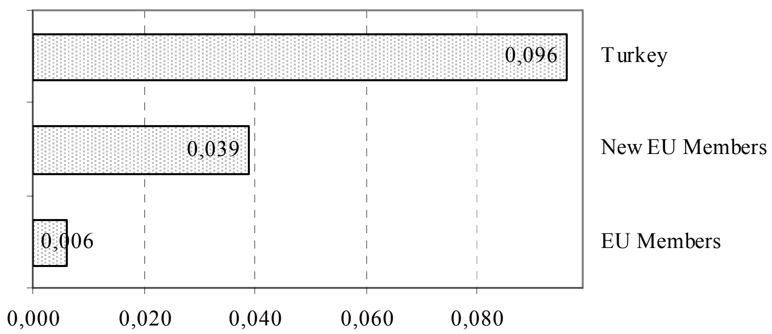



Figure 4.2 Adjusted Mean Scores on Program/Software use for Country Groups

Nevertheless, when the pairwise comparisons were examined, they indicated that all the country groups are significantly different from the others in adjusted mean scores of PRGUSE (see Table 4.2). When ATTCOMP and ESCS are controlled, there were significant differences in the adjusted mean scores of PRGUSE among Turkey, the EU member group and the new EU member group. Note that the effect size of INTUSE is relatively larger than that of PRGUSE (eta square values were .014 and .001 respectively). INTUSE is thus more distinctive than PRGUSE across country groups.

#### 4.1.1.2 Answer to Research Question 2

RQ-2: How do the self-confidence in ICT indexes –confidence in routine tasks, confidence in Internet tasks and confidence in high level tasks– differ among students in PISA 2003 across country groups, controlling for students' attitudes toward computers and economic, social and cultural status?

The ANCOVA on ROUTCONF was significant, $F$ (2, 84670) = 897.294, $p$ <.001, partial $\eta^2$=.021 (see Table 4.1). The effect size was small. When ESCS and ATTCOMP are held constant for all samples, the EU member group has the biggest adjusted mean score of ROUTCONF (*M*= .070), the new EU member group has a smaller adjusted mean score (*M*= -.076), and Turkey has the smallest adjusted mean score (*M*= -.538) (see Table 4.2 and Figure 4.3).

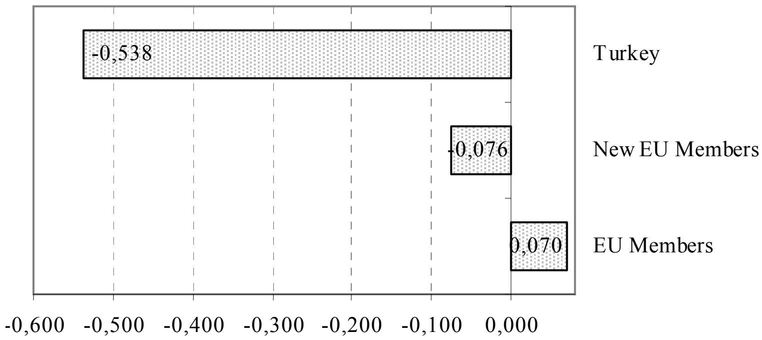


Figure 4.3 Adjusted Mean Scores on Confidence in Routine Tasks for Country Groups

According to pairwise comparisons, there are significant differences in the adjusted mean scores of ROUTCONF between all country groups (see Table 4.3).

The ANCOVA on INTCONF was significant as well, at $F$ (2, 84670) = 1,493.256, $p$ <.001, partial $\eta^2$=.034 (see Table 4.1). The effect size could be accepted as small. It should be noted that among follow-up ANCOVAs, the largest effect size was yielded by ANCOVA for INTCONF, indicating that the ICT variable most varying across groups is confidence in Internet tasks. By controlling for ESCS and ATTCOMP, the EU member group has the highest adjusted mean score of INTCONF (*M*= -.007), Turkey has a smaller adjusted mean score (*M*= -.333), and the new EU member group has the smallest adjusted mean score (*M*= -.360), as shown in Table 4.2 and Figure 4.4.

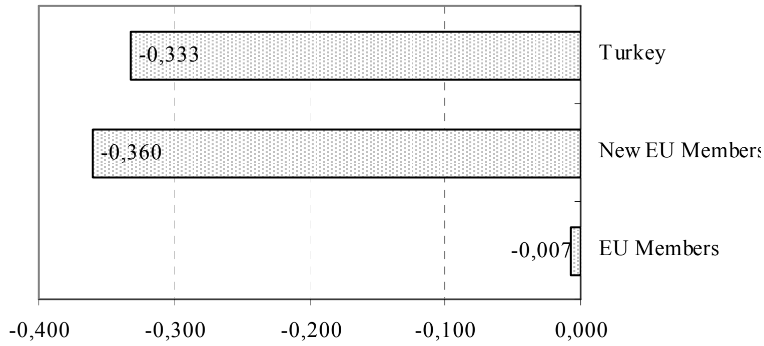



Figure 4.4 Adjusted Mean Scores on Confidence in Internet Tasks for Country Groups

According to pairwise comparisons for INTCONF, the EU member group has a significantly higher adjusted mean score than do the new EU member group and Turkey. Yet there is no significant difference in the adjusted mean scores of Turkey and the new EU member group. In fact their adjusted mean scores are close to each other (see Figure 4.4). The adjusted mean score of the new EU member group is slightly smaller, but that of Turkey is higher by approximately .200 points, compared to their INTCONF means (see Table 3.12 and Table 4.2). Moreover, this places Turkey in second position in the adjusted mean scores of INTCONF.

The ANCOVA on HIGHCONF was significant as well, at $F$ (2, 84670) = 351.836, $p$ <.001, partial $\eta^2$=.008 (see Table 4.1). Since the effect size is smaller than .01, the mean differences are said to be not meaningful, according to Cohen's effect size classification. When ESCS and ATTCOMP were held constant, the EU member group had the biggest adjusted mean score of HIGHCONF ($M$= .003), Turkey had a smaller adjusted mean score ($M$= -.092), and the new EU member group had the smallest adjusted mean score ($M$= -.175) (see Table 4.2 and Figure 4.5).

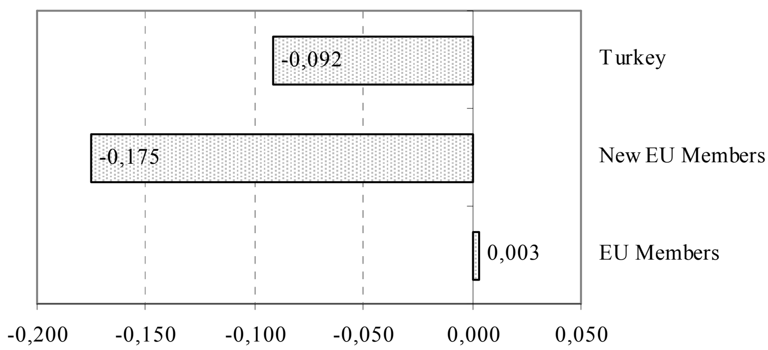



Figure 4.5 Adjusted Mean Scores on Confidence in High Level Tasks for Country Groups

Nevertheless, pairwise comparisons indicate significant differences in these adjusted mean scores of HIGHCONF between all pairs of country groups (see Table 4.3) when ATTCOMP and ESCS are controlled.

### 4.1.2 Results of Univariate ANCOVA

#### 4.1.2.1 Answer to Research Question 3

RQ-3: How do attitudes toward computers differ among students in PISA 2003 across country groups, controlling for economic, social and cultural status of students?

In order to answer the third research question, univariate ANCOVA was run to investigate the relationship between students' attitudes toward computers and the status of a country in the EU, holding economic, social and cultural status of students constant. The independent variable is the status of a country in the EU (the EU member, the new EU member, and Turkey as a candidate state). The dependent variable is the students' attitudes toward computers (ATTCOMP). The covariate is the economic, social and cultural status of the students (ESCS). Although there are several reasons why ANCOVA is used to analyze data for different studies, the main reason for this study is that country groups may differ in attitudes toward computers due to variables other than status of the country group in the EU, such as ESCS. In fact, covariates enable a better adjustment for initial differences between intact groups (Stevens, 2002), such as the country groups in this study.

ANCOVA was significant, at $F$ (2, 84671) = 80.399, $p$ <.001, partial $\eta^2$=.002 (see Table 4.4). Yet, the effect size is too small, thus the differences in the mean scores of ATTCOMP are not practically meaningful. Turkey has the biggest adjusted mean score of attitudes toward the computers index ($M$= .213). The EU member group has a smaller adjusted mean score ($M$= -.009), and the new EU member group has the smallest adjusted mean score ($M$= -.021) (see Table 4.5 and Figure 4.6).

Table 4.4 The Results of One-Way ANCOVA

| | Dependent Variable | Covariate | *df* | Error *df* | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| ANCOVA | ATTCOMP | ESCS | 2 | 84671 | 80.399 | <.001 | .002 |

ESCS: Economic, social and cultural status of students

Table 4.5 Adjusted Mean Scores and Standard Errors of Attitudes toward Computers, Controlling for Economic, Social and Cultural Status of Students

| | | | Country Groups | | |
|---|---|---|---|---|---|
| | | | EU Member Group | New EU Member Group | Turkey |
| | | ***# of Cases (N)*** | 56,610 | 24,834 | 3,231 |
| **Dependent Variable** | ATTCOMP | *M* | -.009 | -.021 | **.213** |
| | | *SE* | .004 | .006 | .018 |

Covariates appearing in the model are evaluated at the following values: Index of Socioeconomic and Cultural Status = .03679. The number in bold is the biggest adjusted mean for each dependent variable

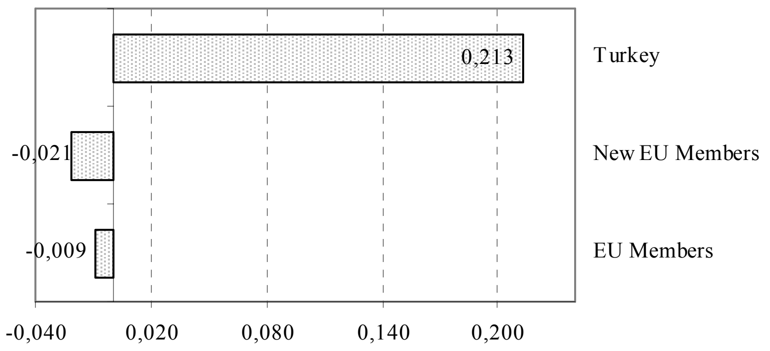



Figure 4.6 Adjusted Mean Scores on Attitudes toward Computers for the Three Groups

Nevertheless, if the post hoc tests are interpreted, there are significant differences between Turkey and the others. However, there are no significant differences between both EU groups when the effect of ESCS is eliminated (see Table 4.6).

Table 4.6 Pairwise Comparison Results of a Univariate ANCOVA

| | ATTCOMP | |
|---|---|---|
| | 2 | 3 |
| 1 | - | * |
| 2 | | * |

*: there is significant difference between adjusted means of related groups. -: there is no significant difference between adjusted means of related groups. 1: EU Member Group, 2: New EU Member Group, 3: Turkey

### 4.1.3 Path Analytic Models

In this part, the results of testing the proposed mathematical and problem solving literacy performance models with respect to ICT use, self-confidence in ICT, attitudes toward computers, and the economic, social and cultural status of students in PISA 2003 were given for the country groups. LISREL 8.30 for Windows (SSI Inc., 1999b) with the SIMPLIS command language was used to formulate, estimate and test the mathematical and problem solving literacy performance models for the EU member group, the new EU member group and Turkey. Pairwise Deletion and Maximum Likelihood were used as deletion and estimation method respectively in testing the models. Significance levels for all the analyses were set at .05. For each model and country group, covariance matrices were obtained with PRELIS, a sub program in the LISREL package. Two different models -one for both EU groups and the other one for Turkey- were obtained. Mathematical and problem solving literacy performance models were explained separately for the country groups.

#### 4.1.3.1 Mathematical Literacy Performance Models

At first, the proposed mathematical literacy performance model was tested for the EU member group. Since the highest meaningful modification index suggested by LISREL, indicated that the path from self-confidence in Internet related tasks (INTCONF) to attitudes toward computers (ATTCOMP) had an insignificant t-value at .05, this path was deleted to improve the model. Then, the decisive mathematical literacy performance model for the EU member group was obtained. After that, the relationships in the proposed mathematical literacy performance model were written in SIMPLIS syntax and tested for the new EU member group. Therefore, the final mathematical literacy performance model for this group was also obtained, which had exactly the same relationship pattern with that of the EU member group. Afterwards, the proposed mathematical literacy performance model for Turkey was tested, but the highest modification index generated by LISREL showed an insignificant t-value at .05 level for the path between program/software use (PRGUSE) and attitudes toward computers (ATTCOMP). Consequently, the model was tested through deleting this path. Finally, a mathematical literacy performance model for Turkey was obtained. Path diagrams with standardized coefficients for the EU member group, the new EU member group and Turkey are given in Figures 4.7, 4.8 and 4.9 respectively. In addition, path diagrams with t-values for country groups are given in the Appendix G. The final SIMPLIS syntaxes of the mathematical literacy performance model for country groups can be found in Appendix H. As can be easily understood from Figure 4.7, 4.8 and 4.9, these models examine the relationships between six exogenous or predictor -INTUSE, PRGUSE, ROUTCONF, INTCONF, HIGHCONF, and ESCS- observed variables and two endogenous or criterion (ATTCOMP and MATHLIT) observed variables.

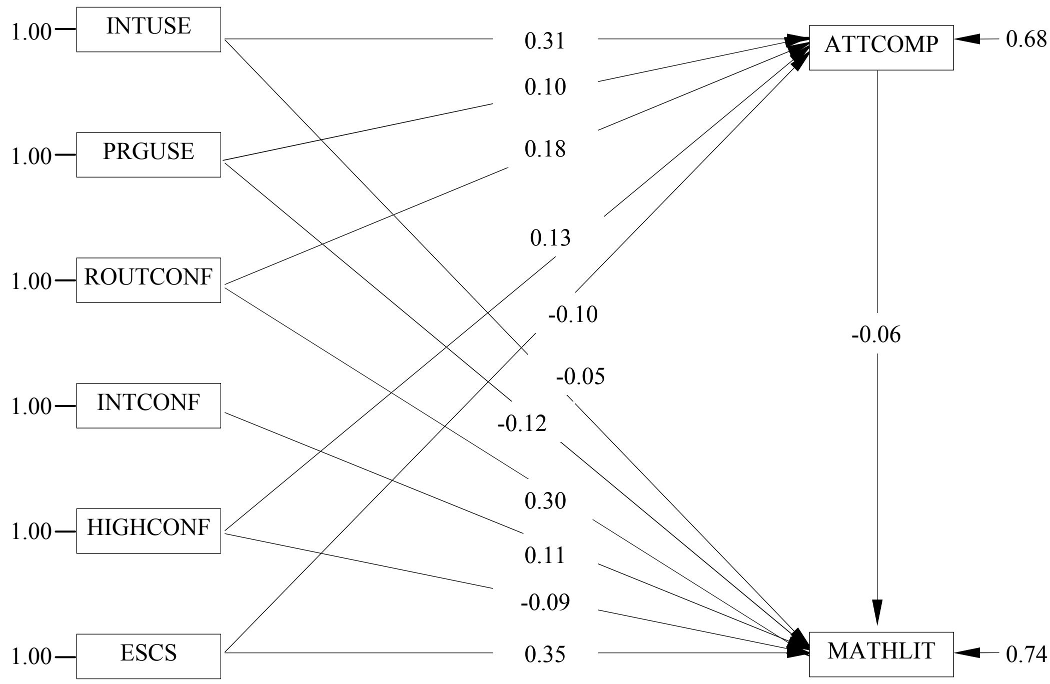



Figure 4.7 Structural Model of Mathematical Literacy Performance for the EU Member Group (Coefficients in Standardized Value)

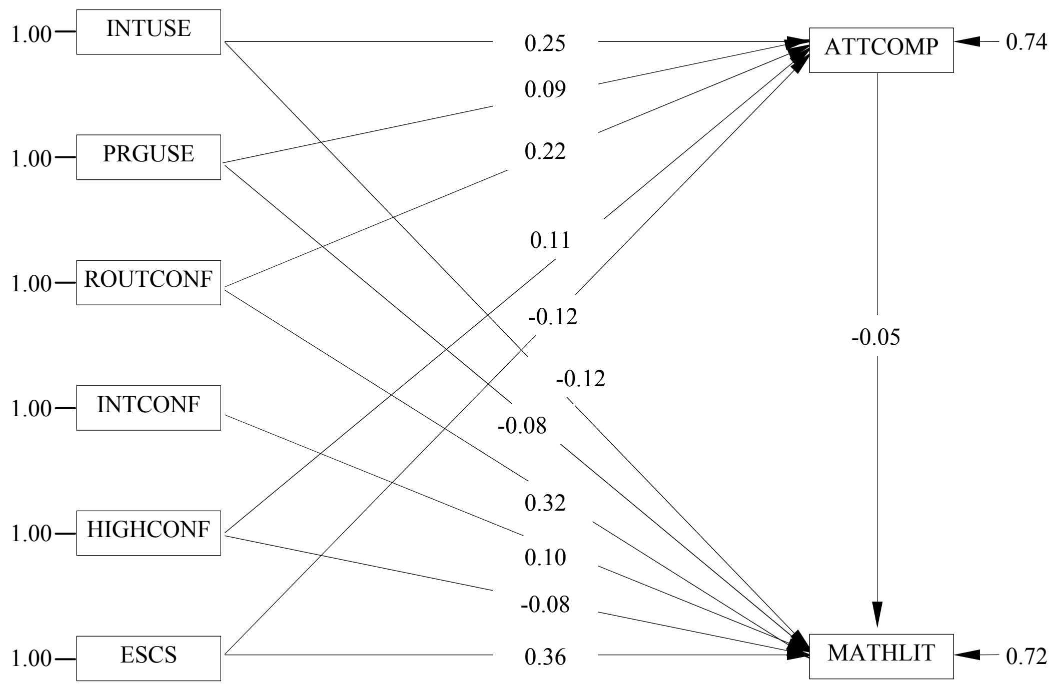



Figure 4.8 Structural Model of Mathematical Literacy Performance for the New EU Member Group (Coefficients in Standardized Value)

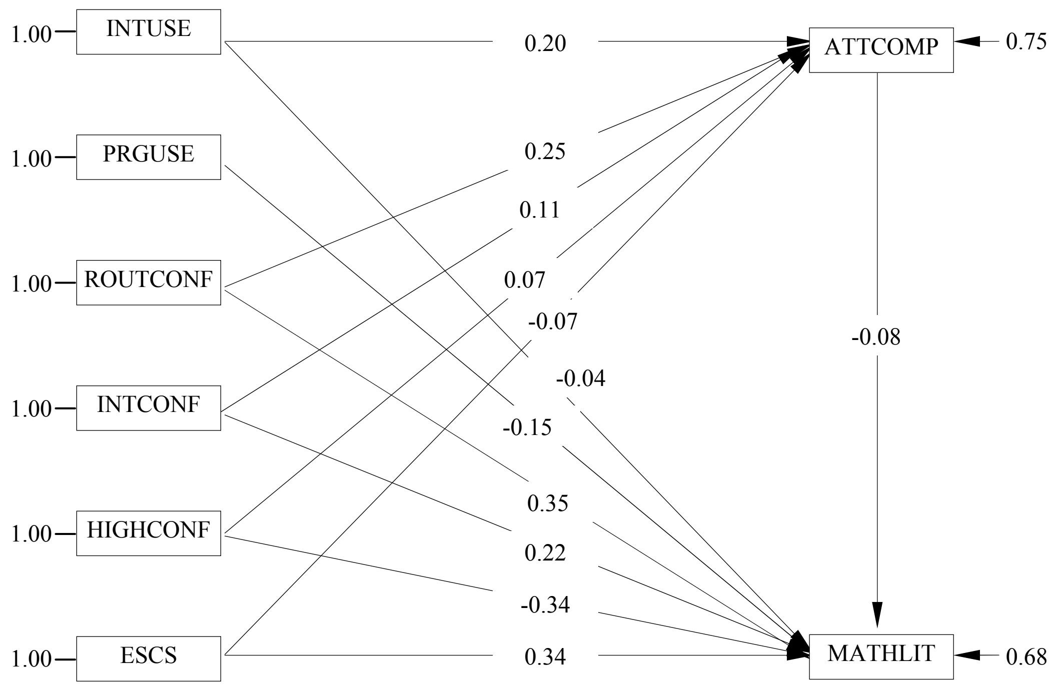



Figure 4.9 Structural Model of Mathematical Literacy Performance for Turkey (Coefficients in Standardized Value)

All t-values in the mathematical literacy performance models for country groups are significant at significance level of .05, except for a non-significant t-value from INTUSE to MATHLIT for Turkey (see Appendix G).

The goodness-of-fit index values of the mathematical literacy performance models for the country groups are given in Table 4.7. The fit indexes generated by LISREL indicate that the mathematical literacy performance models fitted very well with the PISA 2003 dataset for the country groups. However, chi-square indexes of the mathematical literacy performance models for all country groups had significant p-values, due to the large sample sizes. Hence, these results are expected and the chi-square indexes are not taken into account.

The ε (lowercase epsilon) and δ (lowercase delta) are the measurement errors of the endogenous and exogenous variables (Ys and Xs) respectively. All measurement coefficients of mathematical literacy performance models for the country groups are given as standardized values in Table 4.8.

Table 4.7 The Fit Index Values of the Mathematical Literacy Performance Model for Country Groups

| Fit Indexes | Criteria | EU Member Group | New EU Member Group | Turkey |
|---|---|---|---|---|
| Chi Square | Non-significant | 85.63 | 4.49 | 8.84 |
| | | $p$ = .000 | $p$ = .03401 | $p$ = .0029 |
| Goodness of Fit Index (GFI) | > 0.9 | 1.00 | 1.00 | 1.00 |
| Adjusted Goodness of Fit Index (AGFI) | > 0.9 | 0.99 | 1.00 | 1.00 |
| Root Mean Square Error (RMSEA) | < 0.5 | 0.038 | 0.012 | 0.047 |
| Standardized Root Mean Square Residual (S-RMR) | < 0.5 | 0.0035 | 0.0012 | 0.005 |

Table 4.8 Measurement Errors of Mathematical Literacy Performance Model for Country Groups

| Observed Variables | Measurement Errors | | |
|---|---|---|---|
| | EU Member Group | New EU Member Group | Turkey |
| ATTCOMP | 0.68 (ε) | 0.74 (ε) | 0.75 (ε) |
| MATHLIT | 0.74 (ε) | 0.72 (ε) | 0.68 (ε) |
| INTUSE | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| PRGUSE | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| ROUTCONF | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| INTCONF | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| HIGHCONF | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| ESCS | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |

The $\beta$ (lowercase beta) value indicates the size and direction of the relationship among the endogenous observed variables. The structure path coefficients for the mathematical literacy performance models for the country groups were displayed as standardized path coefficients in Figures 4.7, 4.8 and 4.9. The values of $\beta$ as standardized path coefficients from ATTCOMP to MATHLIT are negative and very small in the mathematical literacy performance models for the EU member group ($\beta$ = -0.06), the new EU member group ($\beta$ = -0.05) and Turkey ($\beta$ = -0.08).

The $\gamma$ (lowercase gamma) values indicate the size and direction of the relationship between the exogenous observed variables and endogenous observed variables. All the structure path coefficients for the mathematical literacy performance models for the country groups are displayed as standardized values in Figures 4.7, 4.8 and 4.9 and Table 4.10. The values of $\gamma$ (lowercase gamma) as standardized path coefficients represent variability in mathematical literacy performance models for the country groups, as explained below for each group.

Table 4.9 β (Lowercase Beta) Path coefficients for Mathematical Literacy Performance Models for Country Groups

| Country Groups | Endogenous Variable | β | Endogenous Variable |
|---|---|---|---|
| EU Member Group | | -0.06 | |
| New EU Member Group | ATTCOMP | -0.05 | MATHLIT |
| Turkey | | -0.08 | |

Table 4.10 γ (Lowercase Gamma) Path coefficients for Mathematical Literacy Performance Models for Country Groups

| Exogenous Variables | Country Groups (γ) | | | Endogenous Variables |
|---|---|---|---|---|
| | EU Member Group | New EU Member Group | Turkey | |
| INTUSE | 0.31 | 0.25 | 0.20 | ATTCOMP |
| PRGUSE | 0.10 | 0.09 | - | |
| ROUTCONF | 0.18 | 0.22 | 0.25 | |
| INTCONF | - | - | 0.11 | |
| HIGHCONF | 0.13 | 0.11 | 0.07 | |
| ESCS | -0.10 | -0.12 | -0.07 | |
| INTUSE | -0.05 | -0.08 | -0.04 | MATHLIT |
| PRGUSE | -0.12 | -0.12 | -0.15 | |
| ROUTCONF | 0.30 | 0.32 | 0.35 | |
| INTCONF | 0.11 | 0.10 | 0.22 | |
| HIGHCONF | -0.09 | -0.08 | -0.34 | |
| ESCS | 0.35 | 0.36 | 0.34 | |

For the EU member group, PRGUSE, ROUTCONF, HIGHCONF and ESCS have small; and INTUSE has medium path coefficients in the path coefficients for ATTCOMP. Only ESCS has a negative path coefficient, the others have positive path coefficients for ATTCOMP. As to the path coefficients for MATHLIT, INTUSE, PRGUSE, INTCONF and HIGHCONF, these have small path coefficients and ROUTCONF and ESCS have medium ones for the EU member group. Although INTUSE, PRGUSE and HIGHCONF have negative path coefficients, ROUTCONF, INTCONF and ESCS have positive ones.

For the new EU member group, INTUSE, HIGHCONF and ESCS have small and PRGUSE and ROUTCONF have almost medium path coefficients for ATTCOMP. Only ESCS has a negative path coefficient, the others have positive path coefficients for ATTCOMP. As to MATHLIT for this group, ROUTCONF and ESCS have medium and the others have small path coefficients. Even though INTUSE, PRGUSE and HIGHCONF have negative path coefficients, ROUTCONF, INTCONF and ESCS have positive ones of MATHLIT for this group.

For Turkey, INTCONF, HIGHCONF and ESCS have small and INTUSE and ROUTCONF have almost medium path coefficients for ATTCOMP. Only ESCS has a negative path coefficient, the others have positive path coefficients for ATTCOMP. When MATHLIT is considered, ROUTCONF, HIGHCONF and ESCS have medium path coefficients for MATHLIT. INTUSE and PRGUSE have small and INTCONF has almost medium path coefficients for MATHLIT, for Turkey. Even though INTUSE, PRGUSE and HIGHCONF have negative path coefficients, ROUTCONF, INTCONF and ESCS have positive ones of MATHLIT for Turkey.

Squared multiple correlation ($R^2$) gives information about the strength of a linear relationship, the proportion of explained variance in the endogenous variables accounted for by the variables in the structural equations and model assessment and modification (Jöreskog and Sörbom, 1993, 1996-2001, p.105). Table 4.11 indicates the magnitudes of squared multiple correlation ($R^2$) or effect sizes of the endogenous variables of ATTCOMP and MATHLIT for the country groups. The $R^2$ values can be interpreted according to the indexes of Cohen et al. (2003). Both endogenous observed variables of ATTCOMP and MATHLIT for the country groups have large effect sizes. Moreover, mathematical literacy performance models explain the variances of the EU member group ($R^2$ = .32), the new EU member group ($R^2$ = .26) and Turkey ($R^2$ = .25) on ATTCOMP and that of the EU member group ($R^2$ = .26), the new EU member group ($R^2$ = .28) and Turkey ($R^2$ = .32) on MATHLIT.

Table 4.11 Squared Multiple Correlations of Endogenous Variables for Mathematical Literacy Performance Models for Country Groups

| **Endogenous Variables** | **Country Groups** | ***R*$^2$** |
|---|---|---|
| ATTCOMP | EU Member Group | .32 |
| | New EU Member Group | .26 |
| | Turkey | .25 |
| MATHLIT | EU Member Group | .26 |
| | New EU Member Group | .28 |
| | Turkey | .32 |

The sum of the direct effect and all indirect effect is called the total effect in LISREL software (Jöreskog & Sörbom, 1996-2001). Therefore, the following mathematical equation can be written: total effects = direct effects + indirect effects. The standardized direct, indirect and total effects of exogenous variables on endogenous variables for country groups, generated by the LISREL can be seen in Table 4.12, Table 4.13 and Table 4.14, respectively. Since there is no path from MATHLIT to ATTCOMP in mathematical literacy performance models for the country groups, there is no indirect effect on ATTCOMP. Therefore, direct effects are equal to the total effects for ATTCOMP.

INTUSE has positive direct and total effects on ATTCOMP in the mathematical literacy performance models of the EU member group (0.31), the new EU member group (0.09) and Turkey (0.20), but it has negative direct, indirect and total effects on MATHLIT in the mathematical literacy performance models of the EU member group (-0.05, -0.02 and -0.07), the new EU member group (-0.12, -0.01 and -0.13) and Turkey (-0.04, -0.02 and -0.06).

Table 4.12 Direct Effects of Exogenous Variables on Endogenous Variables of Mathematical Literacy Performance Models for Country Groups

| Endogenous Variables | Country Groups | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| ATTCOMP | EU Members | 0.31 | 0.10 | 0.18 | - | 0.13 | -0.10 |
| | New EU Members | 0.09 | 0.25 | 0.22 | - | 0.11 | -0.12 |
| | Turkey | 0.20 | - | 0.25 | 0.11 | 0.07 | -0.07 |
| MATHLIT | EU Members | -0.05 | -0.12 | 0.30 | 0.11 | -0.09 | 0.35 |
| | New EU Members | -0.12 | -0.08 | 0.32 | 0.10 | -0.08 | 0.36 |
| | Turkey | -0.04 | -0.15 | 0.35 | 0.22 | -0.34 | 0.34 |

Table 4.13 Indirect Effects of Exogenous Variables on Endogenous Variables of Mathematical Literacy Performance Models for Country Groups

| Endogenous Variables | Country Groups | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| MATHLIT | EU Members | -0.02 | -0.01 | -0.01 | - | -0.01 | 0.01 |
| | New EU Members | -0.01 | 0.00 | -0.01 | - | -0.01 | 0.01 |
| | Turkey | -0.02 | - | -0.02 | -0.01 | -0.01 | 0.01 |

Table 4.14 Total Effects of Exogenous Variables on Endogenous Variables of Mathematical Literacy Performance Models for Country Groups

| Endogenous Variables | Country Groups | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| ATTCOMP | EU Members | 0.31 | 0.10 | 0.18 | - | 0.13 | -0.10 |
| | New EU Members | 0.09 | 0.25 | 0.22 | - | 0.11 | -0.12 |
| | Turkey | 0.20 | - | 0.25 | 0.11 | 0.07 | -0.07 |
| MATHLIT | EU Members | -0.07 | -0.13 | 0.29 | 0.11 | -0.10 | 0.36 |
| | New EU Members | -0.13 | -0.08 | 0.31 | 0.10 | -0.09 | 0.37 |
| | Turkey | -0.06 | -0.15 | 0.33 | 0.21 | -0.35 | 0.35 |

Since there is no path from PRGUSE to ATTCOMP for Turkey, PRGUSE has no direct and total effects on ATTCOMP for Turkey. Thus, PRGUSE has no indirect effect on MATHLIT for Turkey. PRGUSE has positive direct and total effects on ATTCOMP in the mathematical literacy performance models of the EU member group (0.10) and the new EU member group (0.25), but it has mostly negative direct, indirect and total effects on MATHLIT in the mathematical literacy performance models of the EU member group (-0.12, -0.01 and -0.13), the new EU member group (-0.08, 0.00 and -0.08) and Turkey (-0.15 and -0.15).

ROUTCONF has positive direct and total effects on ATTCOMP in the mathematical literacy performance models of the EU member group (0.18), the new EU member group (0.22) and Turkey (0.25). Although ROUTCONF has positive direct and total effects on MATHLIT in the mathematical literacy performance models of the EU member group (0.30 and 0.29), the new EU member group (0.32 and 0.31) and Turkey (0.35 and 0.33), it has negative indirect effects on MATHLIT in the mathematical literacy performance models of the EU member group (-0.01), the new EU member group (-0.01) and Turkey (-0.02).

Since there is no path from INTCONF to ATTCOMP for both EU groups, there is no direct and total effect of INTCONF on ATTCOMP for both EU groups. Thus, INTCONF has no indirect effect on MATHLIT for both EU groups. INTCONF has only positive direct and total effects on ATTCOMP for Turkey (0.11), but it has a negative indirect effect on MATHLIT for Turkey (-0.01). INTCONF has positive direct and total effects on MATHLIT in the mathematical literacy performance models of the EU member group (0.11 and 0.11), the new EU member group (0.10, and 0.10) and Turkey (0.22 and 0.21).

HIGHCONF has positive direct and total effects on ATTCOMP in the mathematical literacy performance models of the EU member group (0.13), the new EU member group (0.11) and Turkey (0.07); but it has negative direct, indirect and total effects on MATHLIT in the mathematical literacy performance models of the EU member group (-0.09, -0.01 and -0.10), the new EU member group (-0.08, -0.01 and -0.09) and Turkey (-0.34, -0.01 and -0.35).

Contrary to the ICT related factors, ESCS has a negative direct and total effect on ATTCOMP in the mathematical literacy performance models of the EU member group (-0.10), the new EU member group (-0.12) and Turkey (-0.07), but it has a positive direct, indirect and total effect on MATHLIT in the mathematical literacy performance models of the EU member group (0.35, 0.01 and 0.36), the new EU member group (0.36, 0.01 and 0.37) and Turkey (0.34, 0.01 and 0.35).

Finally, regression equations of mathematical literacy performance model for the EU member group, the new EU member group and Turkey, $Y_{ATTCOMP}$ and $Y_{MATHLIT}$, including standardized total effects as coefficients are given in Table 4.15.

Table 4.15 Regression Equations of Mathematical Literacy Performance Models for Country Groups

| | |
|---|---|
| EU Member Group | $Y_{ATTCOMP} = 0.31*X_{INTUSE} + 0.10*X_{PRGUSE} + 0.18*X_{ROUTCONF} + 0.13*X_{HIGHCONF} - 0.10*X_{ESCS}$<br>$Y_{MATHLIT} = -0.07*X_{INTUSE} - 0.13*X_{PRGUSE} + 0.29*X_{ROUTCONF} - 0.11*X_{INTCONF} - 0.10*X_{HIGHCONF} + 0.36*X_{ESCS}$ |
| New EU Member Group | $Y_{ATTCOMP} = 0.09*X_{INTUSE} + 0.25*X_{PRGUSE} + 0.22*X_{ROUTCONF} + 0.11*X_{HIGHCONF} - 0.12*X_{ESCS}$<br>$Y_{MATHLIT} = -0.13*X_{INTUSE} - 0.08*X_{PRGUSE} + 0.31*X_{ROUTCONF} + 0.10*X_{INTCONF} - 0.09*X_{HIGHCONF} + 0.37*X_{ESCS}$ |
| Turkey | $Y_{ATTCOMP} = 0.20*X_{INTUSE} + 0.25*X_{ROUTCONF} + 0.11*X_{INTCONF} + 0.07*X_{HIGHCONF} - 0.07*X_{ESCS}$<br>$Y_{MATHLIT} = -0.06*X_{INTUSE} - 0.15*X_{PRGUSE} + 0.33*X_{ROUTCONF} + 0.21*X_{INTCONF} - 0.35*X_{HIGHCONF} + 0.35*X_{ESCS}$ |

### 4.1.3.2 Problem Solving Literacy Performance Models

After completing mathematical literacy performance models for all country groups, the proposed problem solving literacy performance model for the EU member group was set in SIMPLIS syntax and tested. In the first attempt, since the path from self-confidence in

Internet related tasks (INTCONF) to attitudes toward computers (ATTCOMP) had an insignificant t-value at .05 level, the problem solving literacy performance model for the EU member group did not meet the criteria of fit indexes. Therefore, similar to the mathematical literacy performance model, this path was removed from the problem literacy performance model and the model was tested again. Consequently, the problem solving literacy performance model for the EU member group fitted. After that, the relationships in the proposed problem solving literacy performance model were written in SIMPLIS syntax and tested for the new EU member group. Subsequently, the LISREL generated an insignificant t-value (.05) for the path from self-confidence in Internet related tasks (INTCONF) to attitudes toward computers (ATTCOMP) in problem solving literacy performance model for the new EU member group. Then, this path was deleted from the model and it was tested again. Therefore, the final problem solving literacy performance model for the new EU member group was obtained. The relationships in SIMPLIS syntax of proposed problem solving literacy performance model for Turkey did not generate the statistics that meet to fit index criteria. Afterwards, highest meaningful modification index indicated that insignificant t-value at .05 level for the path between program/software use (PRGUSE) and attitudes toward computers (ATTCOMP). Therefore, this path was removed from the model and it was tested again. Finally, the definite problem solving literacy performance model for Turkey was acquired. Path diagrams with standardized coefficients for country groups are given in Figures 4.10, 4.11 and 4.12 respectively. In addition, path diagrams with t-values for country groups are given in Appendix G. The final SIMPLIS syntaxes of the problem solving literacy performance models for the country groups can be seen in the Appendix I. As can be easily understood from Figures 4.10, 4.11 and 4.12, these models examine the relationships between six exogenous (INTUSE, PRGUSE, ROUTCONF, INTCONF, HIGHCONF, and ESCS) observed variables and two endogenous (ATTCOMP and PROBSOL) observed variables.

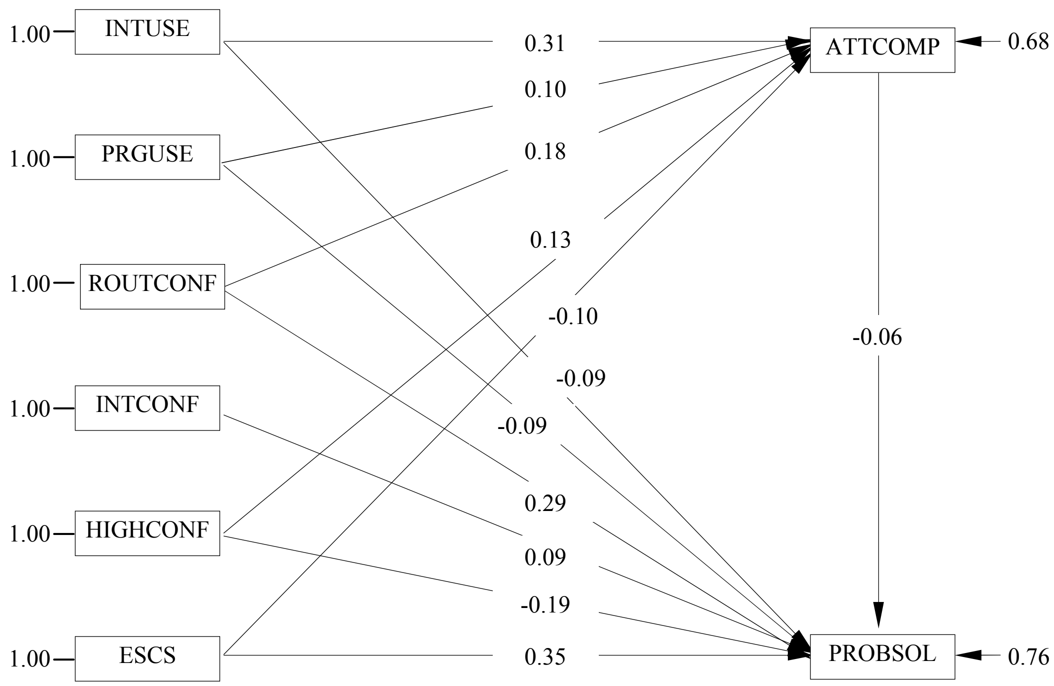



Figure 4.10 Structural Model of Problem Solving Literacy Performance for the EU Member Group (Coefficients in Standardized Value)

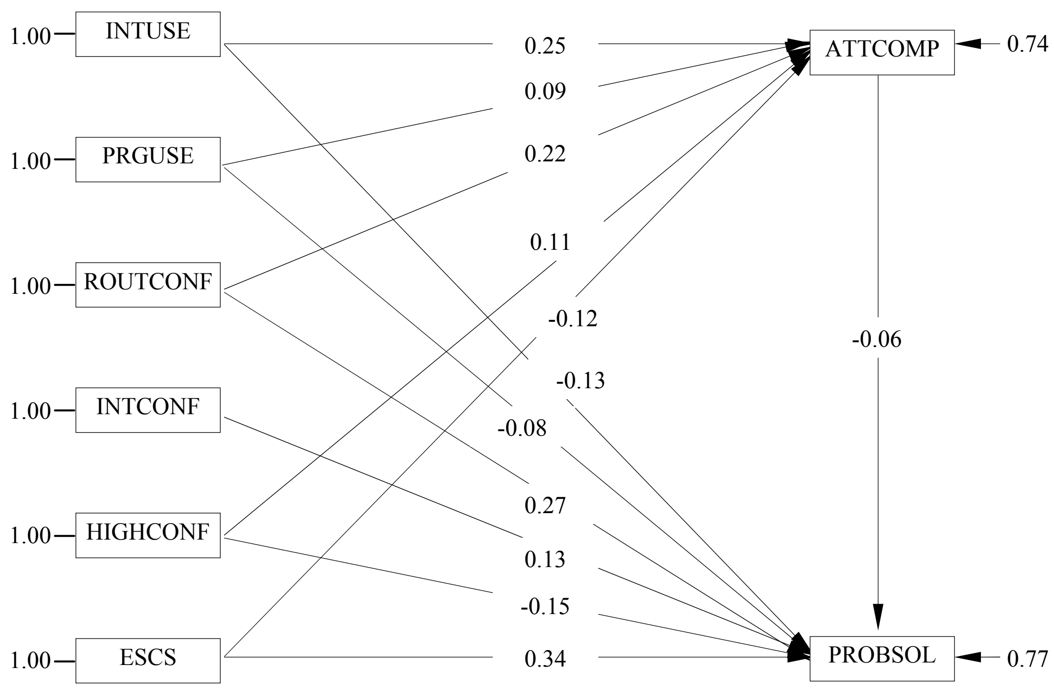



Figure 4.11 Structural Model of Problem Solving Literacy Performance for the New EU Member Group (Coefficients in Standardized Value)

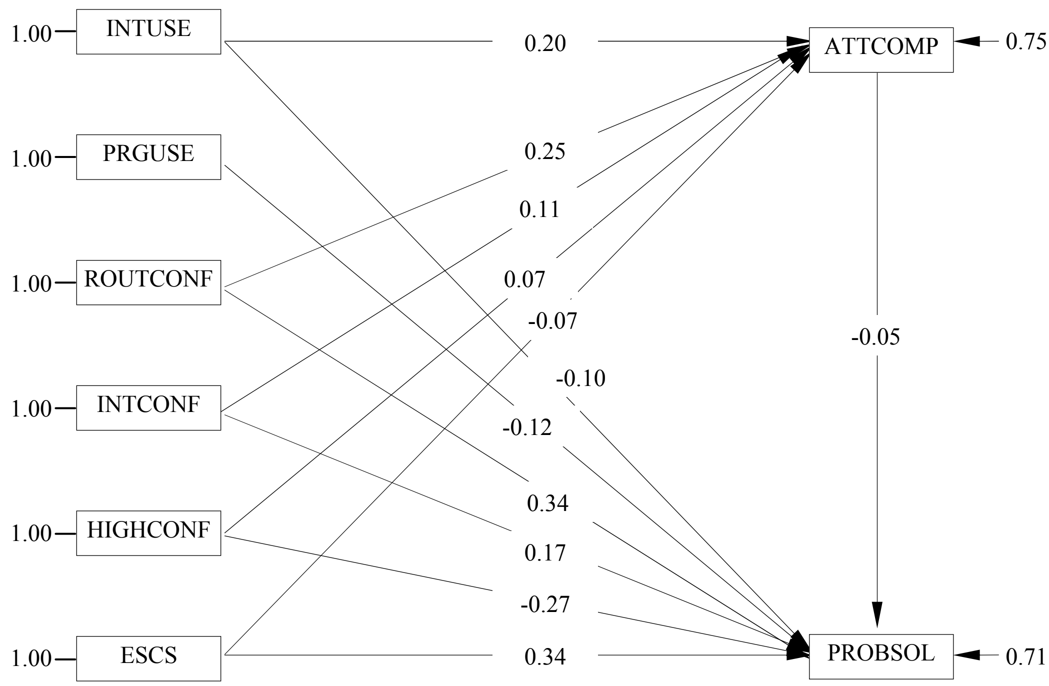



Figure 4.12 Structural Model of Problem Solving Literacy Performance for Turkey (Coefficients in Standardized Value)

All t-values in the problem solving literacy performance models for country groups are significant at .05. That is, all path coefficients have significant t-values.

The goodness-of-fit indexes and their criteria for the problem solving literacy performance models for country groups are given in Table 4.16. The fit indexes, generated by LISREL, indicate that the problem solving literacy performance models fitted very well with the PISA 2003 dataset for country groups. The only exception is that the chi-square indexes of the problem solving literacy performance models for all country groups had significant p-values, due to the large sample sizes. Therefore, these chi-square indexes are expected and they are not taken into account.

As in Table 4.8, the ε (lowercase epsilon) and δ (lowercase delta) are the measurement errors of the endogenous and exogenous (Ys and Xs), respectively. All measurement coefficients of problem solving literacy performance models for country groups were given as standardized values in Table 4.17.

Table 4.16 The Fit Index Values of the Problem Solving Literacy Performance Model for Country Groups

| **Fit Indexes** | **Criteria** | **EU Member Group** | **New EU Member Group** | **Turkey** |
|---|---|---|---|---|
| Chi Square | Non-significant | 85.63 | 4.49 | 8.84 |
| | | $p = .00$ | $p = .03401$ | $p = .00294$ |
| Goodness of Fit Index (GFI) | > 0.9 | 1.00 | 1.00 | 1.00 |
| Adjusted Goodness of Fit Index (AGFI) | > 0.9 | 0.99 | 1.00 | 0.98 |
| Root Mean Square Error (RMSEA) | < 0.5 | 0.038 | 0.012 | 0.047 |
| Standardized Root Mean Square Residual (S-RMR) | < 0.5 | 0.0034 | 0.0012 | 0.0049 |

Table 4.17 Measurement Coefficients of Problem Solving Literacy Performance Model for Country Groups

| **Observed Variables** | **Measurement Errors** | | |
|---|---|---|---|
| | **EU Member Group** | **New EU Member Group** | **Turkey** |
| ATTCOMP | 0.68 (ε) | 0.74 (ε) | 0.75 (ε) |
| PROBSOL | 0.76 (ε) | 0.77 (ε) | 0.71 (ε) |
| INTUSE | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| PRGUSE | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| ROUTCONF | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| INTCONF | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| HIGHCONF | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |
| ESCS | 1.00 (δ) | 1.00 (δ) | 1.00 (δ) |

Again, the β (lowercase beta) value indicates the size and direction of the relationship among the endogenous observed variables. The structure path coefficients of the problem solving literacy performance models for the country groups were displayed as standardized path coefficients in Figures 4.10, 4.11 and 4.12. The values of β as standardized path coefficient from ATTCOMP to PROBSOL are negative and very small in the problem solving literacy performance models for the EU member group ($\beta = -0.06$), the new EU member group ($\beta = -0.06$) and Turkey ($\beta = -0.05$).

The γ (lowercase gamma) values indicate the size and direction of the relationship between the exogenous observed variables and endogenous observed variables. All the structure path coefficients for the problem solving literacy performance models for country groups were displayed as standardized values in Figures 4.10, 4.11 and 4.12. The values of γ (lowercase gamma) as standardized path coefficients indicate variability in problem solving literacy performance models for the country groups as explained below. Since exactly the same relationships are obtained from the same exogenous variables to ATTCOMP with the mathematical literacy performance models, they will not be explained again, only the relationships between the factors and problem solving literacy performance are described below.

Table 4.18 β (Lowercase Beta) Path coefficients for Problem Solving Literacy Performance Models for Country Groups

| Country Groups | Endogenous Variable | β | Endogenous Variable |
|---|---|---|---|
| EU Member Group | ATTCOMP | -0.06 | PROBSOL |
| New EU Member Group | | -0.06 | |
| Turkey | | -0.05 | |

Table 4.19 γ (Lowercase Gamma) Path coefficients for Problem Solving Literacy Performance Models for Country Groups

| Exogenous Variables | Country Groups (γ) | | | Endogenous Variables |
|---|---|---|---|---|
| | EU Member Group | New EU Member Group | Turkey | |
| INTUSE | 0.31 | 0.25 | 0.20 | ATTCOMP |
| PRGUSE | 0.10 | 0.09 | - | |
| ROUTCONF | 0.18 | 0.22 | 0.25 | |
| INTCONF | - | - | 0.11 | |
| HIGHCONF | 0.13 | 0.11 | 0.07 | |
| ESCS | -0.10 | -0.12 | -0.07 | |
| INTUSE | -0.09 | -0.13 | -0.10 | PROBSOL |
| PRGUSE | -0.09 | -0.08 | -0.12 | |
| ROUTCONF | 0.29 | 0.27 | 0.34 | |
| INTCONF | 0.09 | 0.13 | 0.17 | |
| HIGHCONF | -0.19 | -0.15 | -0.27 | |
| ESCS | 0.35 | 0.34 | 0.34 | |

For the EU member group, INTUSE, PRGUSE, INTCONF and HIGHCONF have small path coefficients and ROUTCONF and ESCS have medium ones to PROBSOL. Although INTUSE, PRGUSE and HIGHCONF have negative path coefficients, ROUTCONF, INTCONF and ESCS have positive ones.

For the new EU member group, ROUTCONF and ESCS have medium path coefficients for PROBSOL and the others have small ones. Even though INTUSE, PRGUSE and HIGHCONF have negative path coefficients, ROUTCONF, INTCONF and ESCS have positive ones for PROBSOL for this group.

For Turkey, ROUTCONF, HIGHCONF and ESCS have medium path coefficients for PROBSOL, and INTUSE, PRGUSE and INTCONF have small path coefficients for PROBSOL. Even though INTUSE, PRGUSE and HIGHCONF have negative path coefficients, ROUTCONF, INTCONF and ESCS have positive ones for PROBSOL.

Table 4.20 indicates the magnitudes of squared multiple correlation ($R^2$) or effect sizes of the endogenous variables of ATTCOMP and PROBSOL for the country groups. Both endogenous observed variables of ATTCOMP and PROBSOL for country groups have large effect sizes. That is, problem solving literacy performance models explain the variances of PROBSOL in the EU member group ($R^2$ = .24), in the new EU member group ($R^2$ = .23) and Turkey ($R^2$ = .29).

Table 4.20 Squared Multiple Correlations of Endogenous Variables for Problem Solving Literacy Performance Models for Country groups

| Endogenous Variables | Country Groups | $R^2$ |
|---|---|---|
| ATTCOMP | EU Member Group | .32 |
| | New EU Member Group | .26 |
| | Turkey | .25 |
| PROBSOL | EU Member Group | .24 |
| | New EU Member Group | .23 |
| | Turkey | .29 |

Standardized direct, indirect and total effects of exogenous variables on endogenous variables in problem solving literacy performance models for the country groups can be seen in Table 4.21, Table 4.22 and Table 4.23, respectively.

INTUSE has negative direct, indirect and total effects on PROBSOL in the problem solving literacy performance models of the EU member group (-0.09, -0.02 and -0.11), the new EU member group (-0.13, -0.01 and -0.14) and Turkey (-0.10, -0.01 and -0.11).

As to PRGUSE, it has no indirect effect on PROBSOL for Turkey. PRGUSE has negative direct, indirect and total effects on PROBSOL in the problem solving literacy performance models of the EU member group (-0.09, -0.01 and -0.10), the new EU member group (-0.08, -0.01 and -0.09) and Turkey (0.12 and -0.12).

Table 4.21 Direct Effects of Exogenous Variables on Endogenous Variables of Problem Solving Literacy Performance Models for Country Groups

| Endogenous Variables | Country Groups | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| ATTCOMP | EU Members | 0.31 | 0.10 | 0.18 | - | 0.13 | -0.10 |
| | New EU Members | 0.25 | 0.09 | 0.22 | - | 0.11 | -0.12 |
| | Turkey | 0.20 | - | 0.25 | 0.11 | 0.07 | -0.07 |
| PROBSOL | EU Members | -0.09 | -0.09 | 0.29 | 0.09 | -0.19 | 0.35 |
| | New EU Members | -0.13 | -0.08 | 0.27 | 0.13 | -0.15 | 0.34 |
| | Turkey | -0.10 | -0.12 | 0.34 | 0.17 | -0.27 | 0.34 |

ROUTCONF is the ICT factor most related to PROBSOL. Although ROUTCONF has positive direct and total effects on PROBSOL in the problem solving literacy performance models of the EU member group (0.29 and 0.28), the new EU member group (0.27 and 0.26) and Turkey (0.34 and 0.33), it has negative indirect effects on PROBSOL in the problem solving literacy performance models of the EU member group (-0.01), the new EU member group (-0.01) and Turkey (-0.01).

Table 4.22 Indirect Effects of Exogenous Variables on Endogenous Variables of Problem Solving Literacy Performance Models for Country Groups

| Endogenous Variables | Country Groups | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| PROBSOL | EU Members | -0.02 | -0.01 | -0.01 | - | -0.01 | 0.01 |
| | New EU Members | -0.01 | -0.01 | -0.01 | - | -0.01 | 0.01 |
| | Turkey | -0.01 | - | -0.01 | -0.01 | 0.00 | 0.00 |

As to INTCONF, it has a negative indirect effect on PROBSOL for Turkey (-0.01). On the other hand, INTCONF has positive direct and total effects on PROBSOL in the problem solving literacy performance models of the EU member group (0.09 and 0.09), the new EU member group (0.13, and 0.13) and Turkey (0.17 and 0.16).

HIGHCONF has negative direct, indirect and total effects on PROBSOL in the problem solving literacy performance models of the EU member group (-0.19, -0.01 and -

0.20), the new EU member group (-0.15, -0.01 and -0.16) and Turkey (-0.27, 0.00 and -0.27).

Table 4.23 Total Effects of Exogenous Variables on Endogenous Variables of Problem Solving Literacy Performance Models for Country Groups

| Endogenous Variables | Country Groups | INTUSE | PRGUSE | ROUTCONF | INTCONF | HIGHCONF | ESCS |
|---|---|---|---|---|---|---|---|
| ATTCOMP | EU Members | 0.31 | 0.10 | 0.18 | - | 0.13 | -0.10 |
| | New EU Members | 0.25 | 0.09 | 0.22 | - | 0.11 | -0.12 |
| | Turkey | 0.20 | - | 0.25 | 0.11 | 0.07 | -0.07 |
| PROBSOL | EU Members | -0.11 | -0.10 | 0.28 | 0.09 | -0.20 | 0.36 |
| | New EU Members | -0.14 | -0.09 | 0.26 | 0.13 | -0.16 | 0.35 |
| | Turkey | -0.11 | -0.12 | 0.33 | 0.16 | -0.27 | 0.34 |

ESCS has a positive direct, indirect and total effect on PROBSOL in the problem solving literacy performance models of the EU member group (0.35, 0.01 and 0.36), the new EU member group (0.34, 0.01 and 0.35) and Turkey (0.34, 0.00 and 0.34).

Table 4.24 Regression Equations of Problem Solving Literacy Performance Models for Country Groups

| | |
|---|---|
| EU Member Group | $Y_{ATTCOMP} = 0.31*X_{INTUSE} + 0.10*X_{PRGUSE} + 0.18*X_{ROUTCONF} + 0.13*X_{HIGHCONF} - 0.10*X_{ESCS}$<br>$Y_{PROBSOL} = - 0.11*X_{INTUSE} - 0.10*X_{PRGUSE} + 0.28*X_{ROUTCONF} + 0.09*X_{INTCONF} - 0.20*X_{HIGHCONF} + 0.36*X_{ESCS}$ |
| New EU Member Group | $Y_{ATTCOMP} = 0.25*X_{INTUSE} + 0.09*X_{PRGUSE} + 0.22*X_{ROUTCONF} + 0.11*X_{HIGHCONF} - 0.12*X_{ESCS}$<br>$Y_{PROBSOL} = - 0.14*X_{INTUSE} - 0.09*X_{PRGUSE} + 0.26*X_{ROUTCONF} + 0.13*X_{INTCONF} - 0.16*X_{HIGHCONF} + 0.35*X_{ESCS}$ |
| Turkey | $Y_{ATTCOMP} = 0.20*X_{INTUSE} + 0.25*X_{ROUTCONF} +0.11*X_{INTCONF} + 0.07*X_{HIGHCONF} - 0.07*X_{ESCS}$<br>$Y_{PROBSOL} = - 0.11*X_{INTUSE} - 0.12*X_{PRGUSE} + 0.33*X_{ROUTCONF} + 0.16*X_{INTCONF} - 0.27*X_{HIGHCONF} + 0.34*X_{ESCS}$ |

Finally, the regression equations for the problem solving literacy performance model for the EU member group, the new EU member group and Turkey, YATTCOMP and YPROBSOL, including standardized total effects as coefficients, are given in Table 4.24.

## 4.2 Results for Qualitative Phase of the Present Study

In this section, the findings of the interviews are presented in the light of the qualitative research questions. The findings regarding the following major themes will be presented: issues in ICT policy and implementations in Turkey, suggestions for ICT policy and implementations in Turkey, perceptual evaluation of ICT aspects, and relationships between program/software use, self-confidence in high level tasks and socioeconomic background with mathematical and problem solving literacy performance. The themes and their related subcategories are given in Appendix F.

### 4.2.1 Issues in ICT Policy and Implementations in Turkey

Issues in ICT Policy and Implementations in Turkey is the first category including the following sub-categories: conflicts in existence of ICT policy in operation, insufficient financial resources, curriculum and teacher training. Each sub-category may also have a second level sub-category. These are given below.

It is intriguing that most of the participants (PM-2,3, PI, and AC-1,3) in this study expressed inconsistent statements on the ICT policy in operation in Turkey. There were some contradictory expressions, as follows: "since I have low personal confidence in the existence of an ICT policy in education in Turkey, I have generally superficial knowledge in this issue" (AC-1), "there is no policy by the name of ICT … as far as I know I do not know of an issue in respect of developments or change in ICT policy" (PM-2), "an ICT policy should be developed" (AC-3) and "we do not know these results directly from PISA, but news emerging from results really reflected on education policy, thereby they also reflected on our studies" (PI). It can be concluded from the responses of the interviewees that there is no concrete ICT policy document, namely, no consensus on the existence of an ICT policy document.

Political intervention in MONE, in developing and implementing ICT policies, results in discontinuity and lack of a monitoring and evaluation system in ICT policies. This was stressed by two participants (AC-1,2). Discontinuity in ICT policy and implementations in Turkey is indicated by two of the participants as one of the most critical issues. One of the participants emphasized that discontinuity not only exists in ICT policy and implementations, but it also in the general structure of Turkish society. More specifically, he stated, “what the system tells us is to take and use, but not continuity; teachers are trained, but there is no sustainability” (AC-1). The other participant pointed out a mistake, which is that “every government carries its new thing, there is no sustainability” (AC-2). In this sense, discontinuity in ICT policy and its implementations can be regarded as a negative effect of political intervention.

A negative effect of political intervention on the evaluation of ICT policy and its implementations is brought up by the same participants (AC-1,2), as well. They made complaints about the nonexistence of an evaluation system for ICT policy and implementations. Although one of the participants just mentioned that “there is no monitoring mechanism, no evaluation system about ICT policy and implementations” (AC-1), another stated, “we should not cancel policy or implementation until it is evaluated, for example, nobody knows why we canceled the old curriculum, is there any data on hand?” (AC-2). Furthermore, the nonexistence of an evaluation system makes identification of possible problems or challenges in the ICT-related implementations difficult; therefore, generating solutions to possible problems or challenges is likely to be difficult, too. In this context, the absence of a monitoring and evaluation system can negatively affect the continuity and sustainability of sound ICT policies and implementations, which can be attributed again to the negative effects of political intervention.

In different contexts, the same participants also explicitly indicated negative effects of political intervention due to the perception of managerial positions as power positions in Turkey. One of them expressed the perception of authorities as “since people who take the lead, consider a position of management as a position of power, they are in authority, but not well aware [of what has to be done]” (AC-1). Another participant called attention to the property of political implementation as, “I am sure that the same data will be differently interpreted if you interview with another colleague, now, once these interpretations are different, we act according to the person who has authority power” (AC-2). Unfortunately, the negative effects of political intervention, discontinuity and lack of monitoring and evaluation are indicators of lack of cultural accumulation in Turkey.

Policy makers’ lack of awareness and understanding about the importance of ICT policy and implementations was expressed by two participants (AC-1 and PM-1) as another indicator within the lack of cultural accumulation. One of them (AC-1) indirectly underlined the importance of universities in ICT policy and implementations in Turkey. More specifically, this person said “look at importance given by governments, I mean, does a computer do itself? Somebody who is in education will do it; you know the importance of trained manpower" Unawareness or not understanding the importance of ICT and its implementations can be considered as possible underlying reasons for other issues.

In addition to these issues within cultural accumulation, conservatism is specified by one participant (PM-1). Conservatism as a resistance to innovation is mentioned, "as an obstacle, rejection of innovations in the system and not giving a chance to innovation" Although one participant mentioned this issue, it seems to be crucial in the development and implementations of ICT policy.

There are deficiencies in developing and implementing ICT policies in Turkey. Three participants criticized MONE for its overemphasis on the distribution of hardware. The most striking expressions are as follow: "while MONE is giving numerical information to us, this much information technology, that many Internet connections" (AC-1), "computers have already been installed in every school within the basic education project, you know, Internet connections … that is, installing IT rooms, providing computer teachers and a computer course curriculum is not sufficient anymore" (AC-3) and "it is true that IT rooms initially installed have become outdated without having being used" (PI). It can be understood from all these expressions and their contexts that the distribution of hardware to schools is overemphasized by MONE, but other relevant issues such as software, the in-service training of teachers and school staff, maintenance, sustainability, continuity, and update, and upgrade etc. were not focused on by most of the participants as much as hardware.

Not considering research findings, including the ICT dimension of the PISA 2003 study, is another sub-category of deficiencies in developing and implementing ICT policies. Two policy makers and implementers talked about research including ICT. One of them put the case with research results clearly, as "not a culture in this country, but I mean, these kind of studies are conducted and put on shelves, putting them into practice is, of course, a separate phenomenon" (PM-1). Another policy maker stated expressly the condition related to research as "I can not say that the results of PISA are very effective in the 2004 curriculum" (PM-3). Furthermore, one policy implementer declared that, "we do not know these results directly from PISA" (PI). However, only one participant (PM-2) pleaded in favor of considering the PISA 2003 study findings, and the rest of the participants did not touch on this issue. It is understood from the statements of the participants that the results of PISA 2003 study are considered to be concerned with building a new curriculum, but the ICT dimension was not considered.

In addition to these deficiencies, the following were also mentioned in relation to developing and implementing ICT policies: using imported solutions, insufficiently active role of universities and the private sector, and groundless and baseless solutions due to focusing only on one component of the system. Each one was discussed by separate participants. Using imported solutions is about using foreigners' solutions generated for their peculiar problems. One of the participants stressed this issue, saying "as for me, the biggest problem is that foreigners also work on this data, now they generate solutions and we use them as it is, through transferring" (AC-2). This is the key point in generating solutions considering the peculiar problems or reality of any country. Other participants touched on the lack of charging universities and the private sector with ICT related tasks. This is expressed by one participant as "more active role can be given to universities, not only universities, but also other parts of society" (AC-1). This issue indicates the importance of cooperation between MONE, the universities and the private sector. Another participant pointed out the wrong approach due to focusing only on one part of the system to work out an ICT-related problem. More specifically, it is stated by the participant as, "the student, the teacher, the environment should be considered as a whole, which is a thing that we do not frequently" (PM-1).

Lack of a monitoring mechanism in the implementation process of ICT initiatives and projects is another issue. In different contexts, two participants talk about not operating IT rooms very well, hardware and software incompatibility, outdated IT rooms and corruption in ICT-related implementations. Two participants spoke about the operation of IT rooms. They contended that IT rooms are not operated functionally (AC-1, PI). One of them declared, "from our students, I know that the situation of these laboratories is not very good… they are not operated very well" (AC-1). The existence of IT rooms in schools does not mean a functional use of them, for several reasons. The same participant pointed to the technical conditions of laboratories, regarding outdating laboratories and hardware and software compatibility. In his explanation, "technology rapidly becomes obsolete, laboratories installed in 1998 are considered as outdated; therefore, they are not used since new software does not work" The same participant went on to talk about corrupt practices in ICT-related initiatives "when a project with the World Bank is on the agenda, big companies try to become the preferred bidder for the project, some of the money is lost … relevant administrative authorities may be always deceived" This issue also indicates a lack of a monitoring mechanism before implementing ICT initiatives.

Insufficient financial resources is another issue raised by four participants. Although different dimensions are expressed, serving a huge target audience, the role of power authority, and the need for hardware distribution to students and teachers were focused on by participants. All four participants stressed the importance of financial resources. Two policy makers complained about the large number of people (students, teachers and other staff), and they believe that sufficient financial resources will solve the problem, if sufficient money is allocated by such external resources as the World Bank and the EU, or donations (PM-2,3). One of the participants said, “we are huge mass, 20 million addresses, I mean, in this case, we have difficulties as quantity” (AC-1). The numerical greatness of the target audience of MONE is a striking fact, but it is inevitable that policy makers have to scope out this challenge. Insufficient resource allocation is also emphasized by one academician (AC-1) and a policy implementer. As one of the participants expressed, “the human being is slightly egoist, if the human being is in politics, s/he is more egoist and reflects this egoism on his/her behavior, I mean, the existence of sufficient resources resolves many things” (AC-1). Power authority plays a critical role in providing sufficient resources for infrastructure, distribution of hardware and software, in-service training, maintenance, sustainability and so on. It is interesting that financial resources are mentioned within the context of hardware and its distribution, but not in relation to other issues such as in-service training, and software development etc.

The place of ICT in the curriculum is another important issue of the ICT policy and implementation. Two of the policy makers emphasized the importance of the low ICT readiness level of students, due to the low level of pre-primary education and its lack of an ICT-related curriculum (PM-1,2). Since the introduction of ICT to children is left to families, inequalities in acquisition of ICT knowledge and skills are inevitable, due to the different socioeconomic and cultural statuses of families. One of the participants verbalized this issue as:

> Ignoring preschool education until seven years transforms the comparison into that of apples with pears … there is a natural difference between children who have natural ICT knowledge and skills and those who have not, he or she comes with ICT readiness (PM-1).

Furthermore, lack of an interdisciplinary approach to teaching ICT status and using it in the curriculum is also put into words as a “lack of an interdisciplinary approach, that is, ICT remains as only the computer, functional use of ICT in other disciplines, that is, considering ICT as a tool in mathematics, physics, music, vocational education is ignored” (PM-1) and “there is no ICT related course as a separate subject, we have separate courses” (AC-3). Diffusing ICT use into other disciplines as a tool rather than offering it only as a separate subject should be undertaken by MONE. One of the participants expressed some problematic properties of the ICT course curriculum in different places and intensiveness as:

> Not doing some things immediately, I mean, when the curriculum is changed, it lasts two or three years, for example, our students complain about this continuously, the same thing is done at grade 3, 4, 5, 6, 7 and 8, that is to say, the

> child gets bored or feels a need to do a different thing, the curriculum is not digressed much (AC-1).

Teacher training is the last issue of the ICT policy and implementation. Although teachers are the most important component of the education system, participants do not stress teacher training as much as the other components. Three of the participants mentioned teacher training. One of them blamed universities for educating unqualified teachers in this quotation "MONE is the mirror of universities, the more failure in MONE, the more reflection of products from the universities" (PM-1). Unfortunately, there seems to be a mutual exclusion and a conflict between the universities and MONE. Therefore, people who work in one side blame the other in terms of educational issues, which can be considered as a negative interaction between them. Two other participants focused heavily on the lack of sustainability in teacher training after graduation (AC-1, PI). Teacher training, especially ongoing in-service training about ICT knowledge and skills, is indispensable to meet teachers' real needs in utilizing ICT in their teaching.

### 4.2.2 Suggestions for ICT Policy and Implementations in Turkey

Suggestions for ICT policy and implementations in Turkey is the second category including the following sub-categories: sound and certain decision on policy, freedom from political intervention, continuity in policy and implementations, strictly following to policy and implementations, evaluation of completed policy implementations, filling the gaps in the social, economic and cultural status of students through giving ICT education at school, using a system approach in ICT integration into education, knowing Turkish reality and taking measures peculiar to Turkey through research, curriculum, and teacher training. Most of the suggestions are generally related to the issues mentioned in the previous part. The suggestions are given below.

First and foremost, in order to put an end to the preeminent dispute of existence or nonexistence of ICT policy document, the ICT policy document should be developed and made public. There are several suggestions made by four participants to develop sound and decisive ICT policy. In their expressions, they emphasized that everything should be explicit. For example, one of the participants stressed that:

> An ICT policy should be developed, that is to say, as for me, there is a sincere need for a 10-15 year policy document regarding ICT integration that includes what are the needs, what decisions need to be taken, what should be done and what kind of research should to be conducted (AC-3).

Another participant proposed cooperation between major institutions in Turkey, saying:

> Indeed within the framework of a national program, not only MONE, but also various scientific circles, like TÜBİTAK, in accordance with themselves set macro goals, realized by each institution through doing one's own part, as a whole more positive results can be got (PM-2).

In this sense, it is critical that a long term national ICT policy should be explicitly developed with the participation of public and private institutions and stakeholders. This policy has to be developed through a consensus of all stakeholders. Furthermore, ICT-related initiatives, projects and programmes should be supported, launched, monitored and evaluated in cooperation between public and private institutions.

As mentioned in the issues part, political intervention in ICT-related implementations exists in Turkey; therefore, one of the participants proposed that ICT policy should have the following properties:

> I mean, sustainability should be provided at first. In order to provide sustainability, appropriate policies for this sustainability should be certainly decided. Indeed, these policies should be inflexible and directly applicable, I mean, ICT policy should be above political parties, races, religions … we should not cancel the policy or implementation until it is evaluated (AC-2).

Most probably, political intervention originates from change of government. If the ICT policy had the suggested properties, political intervention would not, probably, affect ICT policy and implementations. At this point, the question of "How to maintain sustainability of ICT policy and implementations when the government is changed?" is explained to some extent. At different times, the same participant touched on such interrelated points of ICT policy as: continuity in policy and its implementations, strictly following to policy and its implementations, and evaluation of completed policy implementations. These points, presented as issues in the previous part, involve developing a sound and decisive ICT policy, strictly following its implementations, and evaluating them without political intervention.

Three of the participants underlined the social, economic and cultural deficiencies, and then indicated how to deal with this serious issue through using ICT and its facilities (AC-2,3, PM-1). One participant approached this matter with the following statement:

> That is, within this whole system, computer and Internet use should be given to children free from socioeconomic and cultural status, that is to say, it should be free from family or provisions of family, therefore, school should provide this (AC-3).

This participant loaded the responsibility of providing computer and Internet connection on to schools. It is accepted as a plausible approach. On the other hand, another participant suggested compensating for deficiencies in social, economic and cultural status through using ICT, "more concentration on ICT education can be a chance to close the gap originating from social and cultural differences [across country groups]" (PM-1). Considering the social and cultural status and economical conditions of Turkey, schools giving ICT knowledge and skills to students and utilizing ICT are the most important points to fill the gap. In this sense, the provision of computer and Internet availability to students by schools is accentuated by two participants. This should be also a very important responsibility given to schools to lessen the inequalities in the social, economical and cultural status of families.

Two of the participants commented on a system approach for integration ICT into education and on interrogation of system components. One of the participants drew attention to measures to be taken within the system approach, which is talked about in the issues part. More explicitly, he expressed this as:

> The system approach, that is, all components in compatible with each other in complete functioning and generating a product … our education system, implementations, curriculum, teacher education, school structure, learning environments should be seriously questioned … measures to be taken should be considered as a whole within the system approach (PM-1).

Here, the critical thing is that education system components including ICT should be considered through holistic evaluation, the components should not be focused on separately.

Most of the participants expressed similar ideas about knowing the problematic reality of Turkey and taking measures peculiar to Turkey through research. This process requires transformation and takes time. In order to complete this process successfully, four of the participants claimed that there should be cooperation between MONE, research institutions and the universities. One of the participants spoke particularly about the cooperation between MONE and universities, saying:

> A system should be formed to provide MONE and research institutions with cooperation … a serious cooperation should be made between university and ministries … research should be oriented to cooperation and needs … scientific findings should be prescriptive (PM-1).

At this point, conflict between the universities and MONE should first be removed, and then studies on joint research projects should be launched to give prescriptions towards problems peculiar to Turkey. Furthermore, other participant focused on who should be charged in ICT related tasks, saying that "policy makers should frequently assign experts … a more active role can be given to universities" (AC-1). This is also an important factor in realizing the transformation process. Moreover, another factor broached by another participant is sharing responsibilities and performing one's duty. Individuals should be upstanding, as the participant indicated: "everyone should do one's own duty, which is not done" (PM-1). This is also mentioned by another participant for institutions (PM-2). In addition, as one of the participants indicated, the transformation process also involves studies on planning, implementing and research related to ICT (AC-3). As a consequence, the transformation process of learning the problematic reality and taking measures peculiar to Turkey requires policy makers to change their mentality or perspectives on ICT.

Suggestions for the curriculum in connection with ICT were put forward by five participants. One of the participants focused largely on requiring ICT literacy as a qualification in compulsory education. He emphasized at different times and places as:

> ICT knowledge and skills should be a natural integral of people educated with ICT, should be goal of curriculum. All people who have graduated from basic or compulsory education should be master of this … if we demanded Turkish or Mathematics as a qualification from students who have graduated from basic education, ICT knowledge and skills should have been decreed by policy makers, as well (PM-1).

Giving ICT knowledge and skills to students at schools is inevitable for Turkey because of the huge gap in the socioeconomic and cultural status of families and their ICT facilities compared to families in both EU groups. The same participant proposed increasing ICT courses in number and in hours (PM-1). Preparing an ICT related curriculum associating virtual and real life was put forward by another participant (PI).

The majority of participants emphasized putting computers into classrooms and utilizing ICT as a tool in other subjects across the curriculum, through integrating ICT into the curriculum. Two of the participants suggested that learning environments with computers should be supported and computers should be put into classrooms (PM-1, AC-3). Furthermore, five of the participants focused largely on diffusing and integrating ICT into other subjects, with two participants suggesting the "diffusion of ICT into disciplines, since ICT is not anymore oneself alone, that is to say, ICT acts together with many disciplines" (PI) and "ICT should be gotten into some more disciplines … that is to say, it is really my belief that, ICT should be integrated into courses" (AC-3). Moreover, one of the participants stated many times that homework and projects done by students using ICT should be promoted with such incentives as bonuses, awards and exhibiting the products (PM-1). In addition to these, two of the participants stressed a point on increasing the prevalence of pre-primary education to introduce ICT education to children of more early ages, since families may not have any ICT facility or not train their children about ICT as soundly as pre-primary schools (PM-1,2).

Participants also called attention to teacher training, including in-service and preservice education. One of the participants laid an emphasis on sharing educational experiences and resources through online interaction at a provincial level. According to the participant, "teachers in the same subjects can share their professional experiences and problems lived at the province level, questions in exams and applications can be done" (PM-1). Saving time and money in sharing sound and visuals through the Internet may increase the motivation of teachers in their professional activities. This kind of online professional experience can lead to a high quality of teaching. Two of the participants underlined the necessity and importance of in-service teacher training about ICT (PM-1, PI). Another participant gave information on the current trend in teachers' ICT use in the developed countries, through saying:

> In a big educational technology fair in the England, that is to say that, the teacher manages all kinds of tasks through computer hereafter, complete management, I mean, there is a trend that the teacher completely manages through computer (AC-3).

In this sense, MONE and universities together should follow these developments, develop policies and take measures on in-service and preservice teacher training. On the other hand, one of the participants drew attention to preservice teacher training saying:

> It is not possible to think of the teacher separately from the child, since the teacher conditions the student, sets the learning environment, solves learning problems, guides learning, then, in order to make this guidance, preservice teacher training should be in such a way that the teacher will be able to teach ICT (PM-1).

Teacher education programs should give prospective teachers ICT knowledge and skills and MONE should demand ICT qualifications from teachers. In other words, if knowledge and skills to utilize ICT are given to teachers and ICT utilization is given place in the curriculum, then these will reflect on the students' abilities.

Two participants drew attention to the positive effects of CEIT departments. One of the participants made an explanation about the effects of graduates from CEIT departments on the development of software. According to the participant,

> Our CEIT graduates, for example, are continuously called to software companies, why? A CEIT student knows some things about software, knows design, knows educational dimension of job, knows instructional dimension of job (AC-1).

Considering the software buying capability conditions of Turkey, and addressing the local needs of students, teachers and the curriculum, developing educational software as our own production becomes vital. Another participant commented on that their existence of CEIT departments, computer teachers and of computer courses in primary and lower secondary school curriculum (AC-3) -this kind of course does not exist in EU primary schools. The same participant also focused on transforming the role of computer teachers into coordinator teachers to support subject teachers and to develop instructional materials in schools. At least this situation could be turned to advantage through in-service teacher training, working as coordinator and instructional material development consultant in schools. The same participant went on to talk about the necessity for computer teachers who have graduated from CEIT departments in the integration of ICT into other subjects.

### 4.2.3 Perceptual Evaluation of ICT Aspects

An ICT aspect is the third category of main themes including the following sub-categories: attitudes toward computers, type of ICT use, self-confidence in ICT use, and the perceptions of the EU member group and the new EU member group regarding ICT. Each aspect has its own sub-categories that have also second level sub-category. They are given below.

#### 4.2.3.1 Attitudes toward Computers

All participants tried to give explanations for why Turkish students' attitudes toward computers are more positive than those in the EU culture. They related this finding to cultural characteristics and low economic conditions. Four participants highlighted that the entertainment and gratification dimension of computer use in Turkish culture reflect on students' attitudes toward computers. Some of the participants commented on the, "perception of computers, perceiving and using computers as a preferential game and entertainment tool, and a new, different, unusual and mysterious thing" (PI), saying: "our students indulge themselves in games" (PM-3), and "our students have an extra aspiration and interest in electronics and computers … perhaps, all electronic things are reminiscent of games and entertainment, then they are pleased with them" (PM-2). This indicates that the likeness dimension of attitudes toward computers due to entertainment is very effective on students around 15 years old.

Most of the participants related the more positive attitudes of Turkish students toward computers to the following rationales, stemming from low economic status: extra aspiration, extra interest and curiosity to imported and popular technology, the image of computers in society, still perceiving computer use as an indicator of social class, not routine, prevalent and available, but still a luxury. These can be attributed to a hungriness for computers due to the low economic conditions of families in Turkey. Some of the participants gave voice to these reasons in this way:

> Absence in family, state, home, school, environment. A natural result of high attitude towards computers due to this much absence" (PM-1), "There is such hungriness. There is a thing that is unavailable, guy hasn't got a proper pants, but he has a mobile phone. That mobile phone is more important than pants, pardon me -than underpants! This value is in the general structure in society. As a consequence of this structure, there is an extra aspiration, an extra aspiration towards that technology. This positive attitude toward computers is a small

> indicator of this" (AC-1) and "this nation is hungry for technology, that is to say, this culture is hungry for technology. This culture is the most curious than others, such a problem that they have (AC-2).

One participant insisted that having a computer is not an indicator of a social class since people buy a computer for entertainment purposes actually, rather than showing off (PM-3). However, another participant pointed out that the perception of Turkish society is that "Computer use is still perceived as an indicator of social class" (PM-2). In addition to these, one of the participants brought attention to the meaning of computers in Turkish society with his statement that:

> Most of the people in the society can not benefit from this. Television is routine, telephone is ever routine, but these technologies are not such, yet. There is a hungriness caused by not routine, society is not satisfied, that is to say that major portions of the society consider this as a luxury consumption material to be accessed. In the past, TV was such, not in every home (AC-1).

These rationales that emerged from a consideration of low economic status, explaining why a positive attitude toward computers belongs to Turkish society, are in interaction with cultural ones and influence each other mutually.

Four participants set forth some properties peculiar to the Turkish nation to explain the more positive attitudes among these free from low economic status. In other words, they were all connected by participants to the cultural structure of Turkish. These properties are learning technology by a trial-error approach, no fear of using computers, rapid adaptation to computers and the likeness of computers. They are labeled as a greater inclination towards technology in the Turkish nation. For example, one of the participants stated that:

> Learning by trial-error, that is, regular education has not worked for us … here, cultural difference arises, we are more inclined to technology use, that is all… the important thing is that if there is technologic instrument, you rapidly adapt this culturally … there is a such thing in you that whether there is no a fear of technology use, which is trouble, that is to say, this differentiates us from the European actually. In order to buy a computer as an European, before you buy it you should know it, but for me it is not necessary to know it to buy a computer, after bought it I will learn it in somehow (AC-2).

In addition, two participants underlined the importance of positive attitudes toward computers; the readiness level of students can be increased and the ICT qualifications of students can be developed and improved, if students' positive attitudes toward computers are utilized properly. One of the participant opined that:

> This visible picture in connection with attitude tells us many things, that is, this is an event that will be able to change other pictures, forasmuch as attitude is important, that is, you can slowly improve self-confidence, Internet and computer use, as well. As for me, good attitude is an important variable … such a good attitude in us indicates having a good grounding of job, indicate people being ready, it is an advantage for us (AC-1).

Exploiting Turkish students' positive attitudes toward computers give advantages to students in an otherwise, disadvantageous position, in terms of ICT use and self-confidence in computer tasks.

#### 4.2.3.2 Type of ICT Use

Most of the participants talked about type of ICT use -Internet/entertainment use and program/software use. Two participants remarked on the low level of ICT use for Internet /entertainment in Turkey. They related this to inaccessibility due to the low national welfare. They explained their perceptions on this issue by saying:

> This indicates that the more welfare, the more wealth and the more the environment is enriched, this thing [Internet/entertainment use] gets better, I think" (PM-1) and "Socioeconomic and cultural status is a key factor, of course; does any man who is hungry use the Internet for games?, does any man who does not carry Internet to his home use Internet? that is, this is completely, directly monetary … if the same possibilities are provided to the new EU member group, a little later they catch up with the EU member group, Turkey catches up with them, too (AC-2).

In this context, some measures should be taken to increase levels of employment, productivity and exportation for a better national welfare that positively affects access to and use of technology. As to another type of ICT use, program/software use, four participants gave opinions on its good position. Most of the participants supported the idea of the existence of curriculum content and computer teacher regarding program/software for students. This leads to an increase in the program/software use of students. Two of them stated this, saying:

> This, for example, is coherent with our basic paradigm … thing we teach as computer, when I look at this, thing we say curriculum in K-12 is seen here … since we have already worked to teach this from morning till night, students say that I use it, that's all" (AC-2) and "There is no course in them, of course, we have courses. That is, this indicates status of CEIT departments, that is, teacher curriculum in existence, everything is defined, there is no such a thing in other countries (AC-3).

Stress is laid on the positive effects of the content of the curriculum, CEIT departments and computer teachers on program/software use; therefore, Turkish students are in better position in this type of ICT use.

#### 4.2.3.3 Self-Confidence in ICT Use

The last ICT aspect is self-confidence in ICT use, including the following sub categories: having a direct relation to functional computer use, reflecting Turkish students' general low self confidence on other subjects, focusing only on chat and games, lack of internalization of computer use, self confidence in routine tasks, self confidence in Internet tasks, suggestions to improve self-confidence in Internet tasks and self confidence in high level tasks.

Two of the participants established relations between students' self-confidence in ICT use and having functional computer competencies. One of them stated this as "This and other self-confidences are completely related to content and functionality, to functionally master and use a computer, when we realize this as a ratio, naturally self-confidence is in that ratio" (PM-1). Another participant also indicated this issue by saying, "children do not use computers for any purpose, needs … that is, children use computers like an aimless game, any aimless object, that is, not a conscious use, that's why self-confidence is low" (PI). It is natural that aimless and nonfunctional ICT use may result in having low self-confidence in ICT related tasks in Turkish students.

p. 206 Two of the participants explained their opinions on reflection of general low self-confidence in other subjects that most probably students who are in general low self-confidence in other subjects have low self-confidence in ICT use. As one of them stated as:

> We use computer, but with low self-confidence. Of course, it should not be separated from thing, that is, students' self-confidence in general courses and tasks done by them. That is, today if you ask about math, science, humanities and art, we may have a similar low self-confidence problem, that is, it may be considered in this framework (AC-3).

In addition to this, three participants called attention to the low self-confidence of Turkish students in computer-related tasks, due to using computers heavily for chat and computer games. Since chat and computer games do not require students to acquire many computer related knowledge and skills, they have low self-confidence in computer related tasks.

Most of the participants concentrated on the basic rationales of the low self-confidence of students in computer-related tasks. More specifically, five participants put forward a series of rationales or reasons why Turkish students have low self-confidence. Their rationales can be ascribed to the general conception of a lack of internalization in computer-related tasks. The lack of internalization in computer-related tasks has the following dimensions: not feeling the need, reason or purpose to use a computer; insufficient computer-related education about using computers functionally by oneself; lack of individual computer use due to the high ratio of students per computer at schools; and having no home computer due to the low SES of the family. Each dimension has its own effect on Turkish students' low self-confidence in computer related tasks. Every one influences every other, since they are interdependent. Two of the participants noted some dimensions as:

> I think, we could not internalize this computer, if we internalized, our self-confidence could have been developed despite this much interest and curiosity, high attitude" (PI) and "Here, put these in front of them, and ask them to do these [self-confidence items] yourself, they do not, since these [computers] do not exist at home, done at school, but a friend or teacher helped, and such like, and left the school, that's that. That is, they tasted, but not ate, that's all (AC-2).

As to self-confidence in specifically computer related routine tasks, three participants indicated that the Turkish students' reported program/software use contradicts their self-confidence in routine tasks. This contradiction is generally related to not doing computer tasks by oneself. The contradiction is commented on with statements like "a thing is shown to him, he tells us what is shown, but not know what he does with that thing to what extent? No, look, we always reach same place, he tells us what is shown to him, not what he does" (AC-2). In such a case, there is a curriculum including program/software use content and as far school conditions permit, the students are introduced to computers in Turkey; however, most of them have no chance to use computers by themselves at school. Therefore, their responses to questions on frequency of program/software use are positive, but their responses to questions on self-confidence in similar tasks are negative, when doing similar tasks by themselves is concerned. Another participant remarked on the effects of income and educational level of parents on children's self-confidence in routine computer tasks and conscious computer use. She emphasized this in different cases by saying the following:

> The higher the income level and education of the family, naturally the more increase in the rate of schooling and computer use … I think, when level of income and education increases, computer is used more consciously and productively. This leads children or individuals to increase self-confidence (PI).

Most of the participants gave their opinions specifically on reasons for low self-confidence in Internet-related tasks in Turkey, as well. Having high self-confidence in Internet tasks involves having basic computer competencies and using the Internet by oneself. Two participants touched on the prerequisite of self-confidence in Internet-related tasks, that is, basic computer competencies. One of them remarked on this issue as "Since using Internet requires basic knowledge and skills of computer use, our case may be affected this" (PM-2). Furthermore, as the income level of families increase in all country groups, self-confidence in Internet tasks increases. The relationship between Internet use and self-confidence in Internet tasks with level of income is indicated by two participants. They emphasized that the better the income, the more Internet use, and thus high self confidence, regardless of country group. Moreover, there was limited Internet access and use in schools in Turkey in 2003. In addition, Internet was not included in the curriculum in 2003. Three participants established the grounds of low self-confidence in Internet tasks as: limited

Internet access and use and delay in entering Internet at schools. Some of statements on these issues are as follow:

> As to Internet, it is said that so many schools have Internet connection, but the question of 'how many computers at schools have Internet connections?' is not answered. However, when you go to school, there are 15-20 computers; only two of them are connected to Internet. These are bad mistakes" (AC-1) and "regarding entering Internet into Turkey, that is, a delay is point at issue compared to other countries, which may be affected (PM-2).

One of the participants noted the nonexistence of Internet-related content in the 2003 curriculum stating that, "actually Internet is seen as existing in previous programs, but children do not apply it … Internet oriented education is not given in programs … an Internet oriented education in school is not given by us, which is true" (PI).

One participant focused on other possible reasons for the low self-confidence, such as unawareness of the Internet, its nonfunctional or purposeless use, and students, parents and teachers' perceptions about the Internet and its use. According to the participant, they perceive the Internet as illegal or dangerous due to a lack of security and are afraid of its limits (PI). In addition to these, another participant indicated the preparation for the central examination, OKS (Ortaöğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı), as a reality for Turkish students at the end of the compulsory education. Note that this central examination is chance for vertical movement in social class. There are some practices, such as forbidding, abolishing or limiting Internet use due to that central examination. He gave an example about such practices: "for example, we did not abolish computer use, but arranged times that were limited to an hour in a day, but many family completely abolish it, some students abolish it by themselves" (PM-3). Such limitations could impede students in improving their self-confidence in Internet tasks.

There are several suggestions on how to improve low self-confidence in Internet-related tasks, but they seem to be insufficient compared to the issues related above. Two participants recommended the functional use of the Internet as an educational tool through integrating it into the curriculum, sharing resources and experiences between students and teachers, accessing information and motivating students with social, cultural and educational activities through the Internet. More specifically, one of the participants stated his recommendations by saying:

> Using the Internet as educational tools should be emphasized. Internet, its communication facilities, such as sound and video and their high motivation should be exploited in doing homework, accessing information … teachers at same subjects and can share their troubles and experiences, questions in exams through using Internet at province level … students can be directed to Internet, a sibling school can be selected, students share their homeworks or music with students from sibling school (PM-1).

Most of the participants commented on Turkish students' self-confidence in high level computer tasks. One of them contended persistently, at different times, that the relatively better position of Turkey in self-confidence in high level tasks was due to the fact that some questions from the survey are likely to lead to better results compared to the new EU member group. These questions involve using Microsoft PowerPoint, Excel software applications and preparing multimedia presentation. He supported his claim by saying:

> As if we were better, the reason for this is actually the PowerPoint part in multimedia … PowerPoint is taught at schools very frequently, which leads to close the difference … I think that the questions 4-5-6 should not be perceived as high level, since this 4-5-6 causes better results (AC-2).

Another participant talked about two other dimensions of self-confidence in high level tasks. They are related to the content of self-confidence in high level tasks, and approaches to this content. The first dimension depends largely on individual interest and curiosity in the 2003 conditions in Turkey. Teachers and students not feeling the need to perform high level computer tasks is the second dimension. She explained her opinions on these dimensions as:

> These items at basic level did not exist in the curriculum in 2003, these were at the advanced level education, that is, if you took computer education, they existed, I mean, if students were specialized [at vocational or technical high schools], they existed. Similarly with teachers, if teachers were not computer teachers, since they were not in the curriculum in such detail, teachers did not feel the need to learn, they were not given to students, as well. However, if students had a special interest and curiosity, they learned that time (PI).

Two of the participants also tried to clarify why Turkish students' self-confidence in high level tasks are lower than the EU member group. They rationalized this with relating to nonexistence of related content in the curriculum in 2003. They expressed, "in order to interpret these, I think, the curriculum should be looked, that is, I think, such things do already not exist at this level" (PM-2) and "for example, such getting rid of virus such and such are not exist very much, that is, high level use does not exist very much" (PI). Another participant recommended that promotion should be given to students who perform successfully computer related high level tasks in their homeworks and projects (PM-1).

### 4.2.4 Perceiving both the EU Groups regarding ICT

Three of the participants explained their perceptions about students' ICT proficiency level in the EU member group and the new EU member group. Two of them perceived the EU education system as better than Turkey's saying the following:

> That is to say, their education system, education conception is more meaningful, it is not oriented to solve tests, but it is oriented to acquire a life philosophy … a

> good educational infrastructure, a good education terminology, transformation of education into a science" (PM-1) and "education in the EU is more controlled, planned and has a certain program (PM-2).

In this context, one of the participants recommended that rather than focusing specifically on producing any product, the process of producing any product through functional use of ICT as a tool in the other subjects should be focused on, to close the gap between the EU and Turkey through using ICT (PM-1). Another participant elucidated the common practice of subject teachers' using ICT as an educational tool in the EU. The same participant also remarked that there is no curriculum with computers as a separate subject and no computer teachers at schools in the EU (AC-3).

Two participants drew attention to the better economic welfare status of the EU member group. One of them was of the opinion that economic power is a very strong factor affecting educational environments and their richness in providing alternatives for children. He commented on this situation as saying the following:

> It is the normal, expected position of the EU member group due to their income, environments, educational background in each field. Development or underdevelopment as a roller snowball, you can not think anything on such underdevelopment situation, it is not possible to say that I am in the underdeveloped country, but I am a developed man … This affects all dimensions (PM-1).

The same participant also indicated that being a developed country is related to many interrelated dimensions, such as socio-cultural structure, educational history and cultural accumulation. Another participant focused specifically on the economic parameters and their effects on the results of ICT aspects (AC-2). Furthermore, four participants emphasized that using ICT is an integral part of routine life in the EU member group. Moreover, one of the participants explained his perceptions about nonprofessional ICT use of high level tasks in the new EU member group, as is the case in Turkey, contrary to the EU member group (PM-1).

### 4.2.5 Relationships between PRGUSE, HIGHCONF and ESCS with MATHLIT and PROBSOL

Five participants gave their opinions on the relationships between students' socioeconomic background and ICT aspects with mathematical and problem solving literacy performance within the context of path analytic models. Their comments can be categorized into the negative relationships of program/software use and self-confidence in high level tasks with students' performance, and the positive relationships of students' socioeconomic and cultural status with students' performance. The negative relationship between program/software use and students' mathematical performance was explained by a participant as “why children can not do mathematics, for example, they do arithmetical calculations with calculators in computers, which leads to regression in children’s arithmetical calculations” (PM-2).

In order to explain the relatively larger negative relationship between self-confidence, high level tasks and performance of Turkish students, two alternative hypotheses were proposed by two academicians (AC-2,3). First, one of them assigned the reasons of this negative relationship to the fact that students may not arrange a time schedule for their study and computer use in country groups (AC-3). She emphasized the technological novelty effects on this time arrangement problem due to the fact that computer technology is relatively new in Turkey. She stated these issues as:

> Children spare very much time to these jobs [high level tasks], therefore, it can be concluded that children do not attach importance to mathematics or problem solving, namely, courses. There are such children, perhaps they are all, child creates webpage, play videos, takes, brings, makes something, programming. Such a child’s course is getting worse. This is matter of time, that is, each student has a certain time. Student should arrange his/her time and study. The more spare time to it, of course the higher self-confidence, but his/her performance decreases. Student can not arrange this. Actually, there is a similar case in other countries; of course, more exist in Turkey, maybe, this may be originating from [technology’s] being newer in Turkey (AC-3).

Second, the other participant tried to explain the negative relationship between low self-confidence in high level tasks and students’ performance. He explained that high level tasks are too structured and that they require students to be more specialised and to solve problems monotonously, which involves non-holistic thinking. He expressed this by saying:

> The more you specialize students, the more you teach students to think straightforward monotonous; students can not solve problem, which is this much simple. High level tasks make students to do these. If these are specialization, I think, result of these negatively reflects on both problem solving and mathematics model (AC-2).

On the other hand, three participants emphasized the positive relationship between the economic, social and cultural status of students with students’ mathematical and problem solving literacy performance. One of the participants explained her perceptions on the positive, direct effects of parents’ education and income level on children’s self-confidence; in this way, she said, children who have high self-confidence are more inclined to solving problems. Another participant also emphasized the positive reflections of the socioeconomic and cultural status of students on their performance. He expressed this in his open ended responses as:

> When this [socioeconomic and cultural status of students] increases, there should be positive reflections, that is, this actually necessary condition, is it enough? No

… in order to start, it is enough. This is sufficient; rather it is necessary condition, but not enough (AC-2).

Another participant concentrated on the positive relationship between the economic level of parents and the educational possibilities for their children. He commented that the greater the income of parents, the more attention they pay to the education of their children and the more inquiry-based education is promoted by parents (PM-2).

## 4.3 Summary of the Results

### 4.3.1 Summary of Quantitative Phase

#### 4.3.1.1 Summary of MANCOVA and ANCOVA

All the statistical analyses of MANCOVA and univariate ANCOVA are statistically significant, but the practical significance of the results is quite low. Nevertheless, pairwise comparisons were conducted to find out whether there were significant differences in the adjusted mean scores between country groups in the ICT indexes, or not. As shown in Table 4.25, there are significant adjusted mean score differences between Turkey and the EU member group for all ICT indexes. In other words, Turkey and the EU member group are different from each other in terms of INTUSE, PRGUSE, ROUTCONF, INTCONF, HIGHCONF and ATTCOMP controlling for ESCS and ATTCOMP (only ESCS for ATTCOMP).

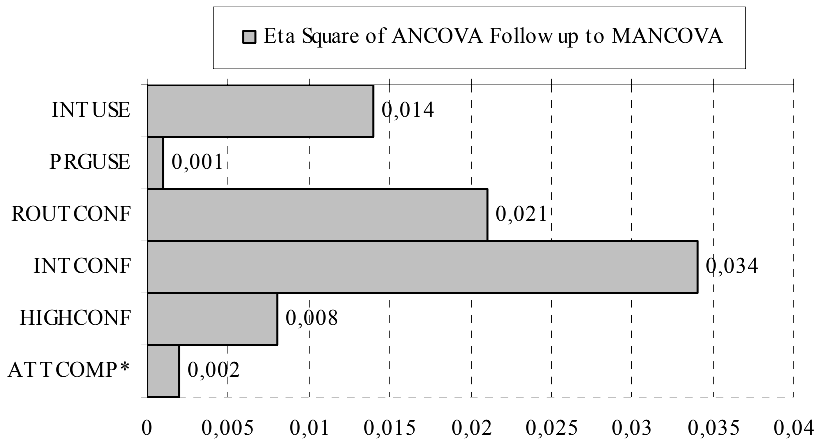
Table 4.25 Pairwise Comparison Results of ANCOVAs that are the follow-up of MANCOVA and of Univariate ANCOVA

| **Pairwise comparisons of ANCOVAs follow-up to MANCOVA*** ** | | | | | | | | | | | | | | | **Univariate ANCOVA**** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INTUSE | | | PRGUSE | | | ROUTCONF | | | INTCONF | | | HIGHCONF | | | ATTCOMP | | |
| | 2 | 3 | | 2 | 3 | | 2 | 3 | | 2 | 3 | | 2 | 3 | | 2 | 3 |
| 1 | * | * | 1 | * | * | 1 | * | * | 1 | * | * | 1 | * | * | 1 | - | * |
| 2 | | * | 2 | | * | 2 | | * | 2 | | - | 2 | | * | 2 | | * |

*: there is significant difference between related groups. -: there is no significant difference between related groups. ** In ANCOVA for ATTCOMP, only ESCS is taken as covariate. *** In MANCOVA for ICT indexes, ESCS and ATTCOMP are taken as covariates. 1: EU Member Group, 2: New EU Member Group, 3: Turkey

The other finding of pairwise comparisons is that both EU groups have statistically different adjusted mean scores in all ICT indexes, except for the ATTCOMP index (see Table 4.25). This means that both EU groups show similar pattern in ATTCOMP when ESCS is controlled for. There are also significant adjusted mean score differences between Turkey and the new EU member group in all ICT indexes, except for INTCONF.

Considering the country groups with respect to MANCOVA and ANCOVA results, INTUSE, ROUTCONF and INTCONF are more distinctive indexes based on the eta square values yielded by ANCOVAs, as illustrated in Figure 4.13. This means that, when ATTCOMP and ESCS are held constant for all the country groups, INTUSE, ROUTCONF and INTCONF are more prominent than PRGUSE, HIGHCONF, and ATTCOMP in the distinction between country groups.

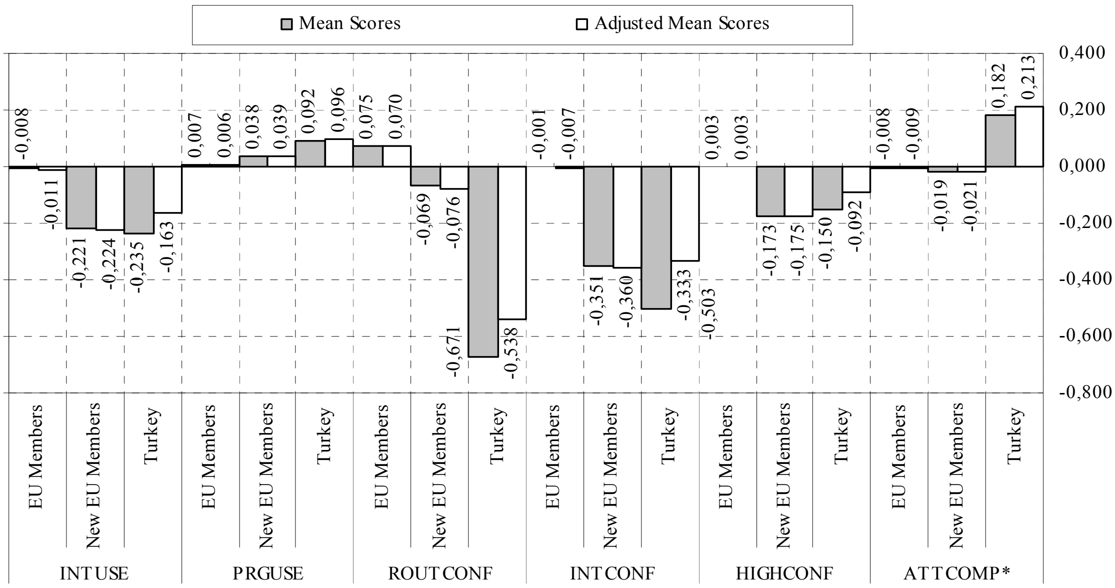



* In ANCOVA for ATTCOMP, only ESCS is taken as covariate. In MANCOVA for ICT indexes, ESCS and ATTCOMP are taken as covariates.

Figure 4.13 Eta Squares of ANCOVA that are follow-ups to MANCOVA and of Univariate ANCOVA for ICT Indexes

Eliminating the effects of ESCS and ATTCOMP on the ICT indexes does not remove the differences between country groups in terms of ICT use and self-confidence in ICT. This result denotes that the distinction between country groups do not depend only on ESCS and ATTCOMP. That is to say, there may be other reasons underlying this result, e.g. characteristics peculiar to individual and countries, such as ICT policies, implementations, integration, the educational system, and GNI per capita etc.

Figure 4.14 demonstrates mean and adjusted mean scores for all ICT indexes comparatively. In all self-confidence in ICT indexes, the EU member group has the highest mean scores and adjusted mean scores among the country groups, holding ATTCOMP and ESCS constant.




* In ANCOVA for ATTCOMP, only ESCS is taken as covariate. In MANCOVA for ICT indexes, ESCS and ATTCOMP are taken as covariates.

Figure 4.14 Mean and Adjusted Mean Scores in MANCOVA in ICT Indexes for Country Groups

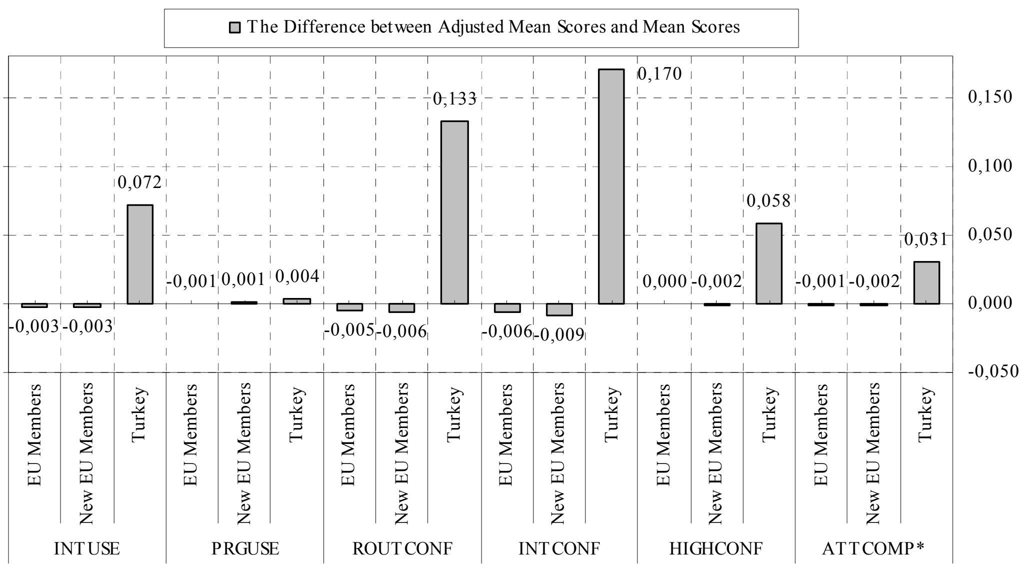
Table 4.26 The Negative-Positive Distribution of Country Groups' Mean and Adjusted Mean Scores in ICT Indexes.

| | | Country Groups | | | | | |
|---|---|---|---|---|---|---|---|
| | | EU Member Group | | New EU Member Group | | Turkey | |
| | | *M* | *M*[a] | *M* | *M*[a] | *M* | *M*[a] |
| ICT Indexes | PRGUSE | + | + | + | + | + | + |
| | INTUSE | - | - | - | - | - | - |
| | ROUTCONF | + | + | - | - | - | - |
| | INTCONF | - | - | - | - | - | - |
| | HIGHCONF | + | + | - | - | - | - |
| | ATTCOMP | - | - | - | - | + | + |

+: above the PISA 2003 international mean. -: below the PISA 2003 international mean. $M^a$: Adjusted mean score.

Zero is the international mean across the 41 participant countries for all ICT indexes in PISA 2003. Regardless of mean scores, adjusted mean scores or country groups, some ICT indexes are aggregated at positive -meaning above the international mean- (PRGUSE) or negative –meaning below the international mean– (INTUSE and INTCONF) sides and some are in both sides (ROUTCONF, HIGHCONF and ATTCOMP). The negative-positive distribution of country groups' mean and adjusted mean scores in ICT indexes is given Table 4.26.

The mathematical difference between adjusted mean scores and mean scores is important in understanding the question "to what extent do ESCS and ATTCOMP confound students' ICT use and self-confidence in ICT level in country groups?" As seen in Figure 4.15, Turkey has the biggest differences between adjusted mean scores and mean scores. Therefore, the relationship between ESCS, ATTCOMP and ICT use and self-confidence in ICT seems to be stronger in Turkey. Especially, the mean of ESCS index is relatively very small compared to both EU groups. Thus the effect of the ESCS is more prominent as a covariate than ATTCOMP. This leads us to understand discrepancies in most ICT indexes of Turkey and the other country groups, to some extent.




* In ANCOVA for ATTCOMP, only ESCS is taken as covariate. In MANCOVA for other ICT indexes, ESCS and ATTCOMP are taken as covariates.

Figure 4.15 The Difference between Adjusted Mean Scores (in MANCOVA and a Univariate ANCOVA) and Mean Scores

It is important to note that all the index means of Turkey increased considerably, but that those of both EU groups decreased a little bit when they were adjusted by controlling for ESCS and ATTCOMP, as seen in Figure 4.15.

As seen in Table 4.27, the country groups are in a different order in the ICT indexes when their mean and adjusted mean scores are ranked. The EU member group came first in INTUSE, ROUTCONF, INTCONF, and HIGHCONF indexes, but it is the last in PRGUSE. The mean scores of the new EU member group is in the second place in the PRGUSE, INTUSE, INTCONF and ROUTCONF indexes, but it is last in the HIGHCONF and ATTCOMP indexes. The mean scores of Turkey come first in the PRGUSE and ATTCOMP indexes, but last in the INTUSE, ROUTCONF and INTCONF indexes. Once ESCS and

ATTCOMP are held constant, only the adjusted mean scores' ranking of INTUSE and INTCONF indexes go up from the last to the second place for Turkey, and vice versa for the new EU member group. In this sense, the EU member group save its consistency in mean and adjusted mean scores, however, the new EU member group regresses and Turkey progresses in adjusted mean scores for INTUSE and INTCONF indexes, when ESCS and ATTCOMP are held constant.

Table 4.27 The Ranked Country Groups in terms of Mean and Adjusted Mean Scores in ICT Indexes

| ICT Indexes | Country Groups | | | | | |
|---|---|---|---|---|---|---|
| | EU Member Group | | New EU Member Group | | Turkey | |
| | *M* | $M^a$ | *M* | $M^a$ | *M* | $M^a$ |
| INTUSE | **1** | **1** | 2 | 3 | 3 | 2 |
| PRGUSE | 3 | 3 | 2 | 2 | **1** | **1** |
| ROUTCONF | **1** | **1** | 2 | 2 | 3 | 3 |
| INTCONF | **1** | **1** | 2 | 3 | 3 | 2 |
| HIGHCONF | **1** | **1** | 3 | 3 | 2 | 2 |
| ATTCOMP | 2 | 2* | 3 | 3* | **1** | **1*** |

* In ANCOVA for ATTCOMP, only ESCS is taken as covariate. In MANCOVA for ICT indexes, ESCS and ATTCOMP are taken as covariates. 1: First, 2: Second, 3: Third. $M^a$: Adjusted mean score.

### 4.3.1.2 Summary of Path Analytic Models

After presenting the results of the mathematical and problem solving literacy performance models for country groups, the values and patterns belong to the final mathematical and problem solving literacy performance models in terms of their fit indexes, squared multiple correlation, direct and total effects, are summarized in this subsection.

The values of fit indexes for mathematical and problem solving literacy performance models for all country groups met the criteria of the fit indexes, except for chi-square. Since the chi-square measure is sensitive to sample sizes and very sensitive to departures from multivariate normality of the observed variables, the chi-square index is not taken into consideration in evaluating the models for all country groups (Jöreskog & Sörbom, 1996-2001, p. 28). The values of the fit indexes for country groups are same or very close in point of mathematics and problem solving literacy performance models as shown in Table 4.28.

As seen from Table 4.29, the observed exogenous variables in mathematical and problem solving literacy performance models for the EU member group, the new EU member group and Turkey explain the percentages of variance in the endogenous variables, ATTCOMP in both models (0.32, 0.26 and 0.25 respectively), MATHLIT (0.26, 0.28 and 0.32 respectively) and PROBSOL (0.24, 0.23 and 0.29 respectively).

Table 4.28 The Fit Index Values of Mathematical and Problem Solving Literacy Performance Models for All Country Groups

| Fit Indexes | Criteria | Country Groups | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mathematical Literacy | | | Problem Solving Literacy | | |
| | | 1 | 2 | 3 | 1 | 2 | 3 |
| Chi Square | Non-significant | 85.63 $p$ = .000 | 4.49 $p$ = .03401 | 8.84 $p$ = .0029 | 85.63 $p$ = .00 | 4.49 $p$ = .03401 | 8.84 $p$ = .00294 |
| Goodness of Fit Index (GFI) | > 0.9 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Adjusted Goodness of Fit Index (AGFI) | > 0.9 | 0.99 | 1.00 | 0.98 | 0.99 | 1.00 | 0.98 |
| Root Mean Square Error (RMSEA) | < 0.5 | 0.038 | 0.012 | 0.047 | 0.038 | 0.012 | 0.047 |
| Standardized Root Mean Square Residual (S-RMR) | < 0.5 | 0.0035 | 0.0012 | 0.005 | 0.0034 | 0.0012 | 0.0049 |

1: EU Member group, 2: New EU Member group, 3: Turkey

Table 4.29 Squared Multiple Correlations of Endogenous Variables for Mathematical and Problem Solving Literacy Performance Models for All Country Groups

| Endogenous Variables | $R^2$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | Mathematical Literacy | | | | Problem Solving Literacy | | |
| | 1 | 2 | 3 | | 1 | 2 | 3 |
| ATTCOMP | .32 | .26 | .25 | ATTCOMP | .32 | .26 | .25 |
| MATHLIT | .26 | .28 | .32 | PROBSOL | .24 | .23 | .29 |

1: EU Member Group, 2: New EU Member Group, 3: Turkey

The relationships among the exogenous variables and ATTCOMP are the same in both the mathematical and problem solving literacy performance models for each country group. Thus, there is no difference in explanation of variance for ATTCOMP for both models. According to the Cohen’s classification rubric, ATTCOMP in both models, MATHLIT and PROBSOL have a high squared multiple correlation or a large effect size for all country groups. There are small differences in explanation of the variance for MATHLIT and PROBSOL. Although the EU member group has the most explanatory model in explanation of ATTCOMP, Turkey has the most explanatory model in explanation of

MATHLIT and PROBSOL in both models. However, the new EU member group is in the middle in explanation of variance for ATTCOMP and MATHLIT, for both models.

When the amount of variance of mathematical and problem solving literacy performance in the models are compared, the effect size (.32) of Turkey for MATHLIT is the largest effect size in all models. It can be said that the mathematical literacy performance model is more effective than the problem solving literacy performance model in explanation of the variances in student performance in all country groups. Thus, ICT related factors and ESCS explain variance in mathematical literacy performance better than variance in problem solving performance.

When the standardized path coefficients in mathematical and problem solving literacy performance models are examined (Table 4.30), the direct and total effect from exogenous variables to ATTCOMP are naturally the same in the two models of each country group, since the same variables are related to ATTCOMP in both models. The direct and total effects of all exogenous variables on ATTCOMP in all country groups, except for ESCS, are positive. Although ROUTCONF, INTCONF and ESCS have positive direct and total relationships with MATHLIT and PROBSOL in all country groups, INTUSE, PRGUSE and HIGHCONF have negative direct and total relationships with MATHLIT and PROBSOL. Moreover, in terms of the direction of exogenous variables, ROUTCONF and INTCONF have consistent positive, direct and total impacts on ATTCOMP, MATHLIT and PROBSOL in all country groups, but the others are inconsistent in all country groups. An intriguing finding is that the direction and size of the relationships between exogenous and endogenous variables in both literacy performance models indicates a similar pattern, irrespective of country groups.

Path coefficients generally have from small to medium relationships on ATTCOMP, MATHLIT and PROBSOL for all country groups. Especially, ROUTCONF and ESCS have a medium impact on MATHLIT and PROBSOL for all country groups. The relationships of direct and total effect from INTUSE to ATTCOMP indicate positive and almost medium effects on ATTCOMP for both models in all country groups. Direct and total path coefficients for ROUTCONF have positive effects (more than small, but less than medium) on ATTCOMP for both models in all country groups. Whereas direct and total path coefficients for PRGUSE, INTCONF and HIGHCONF have positive small effects on ATTCOMP for both models in all country groups, ESCS has negative small effects. It is interesting that although the direct and total effects of HIGHCONF on MATHLIT and PROBSOL have small and almost small negative effects in the EU member group and the new EU member group, respectively, it has medium negative effects on MATHLIT and PROBSOL in Turkey.

Table 4.30 Standardized Path coefficients for Mathematical and Problem Solving Literacy Performance Models for All Country Groups

| | | Endogenous Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MATHLIT | | | PROBSOL | | | ATTCOMP | | |
| | | Mathematical Literacy Performance Model | | | Problem Solving Literacy Performance Model | | | Mathematical and Problem Solving Literacy Performance Models | | |
| | | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Direct Effect | INTUSE | -0.05 | -0.12 | -0.04* | -0.09 | -0.13 | -0.10 | 0.31 | 0.25 | 0.20 |
| | PRGUSE | -0.12 | -0.08 | -0.15 | -0.09 | -0.08 | -0.12 | 0.10 | 0.09 | - |
| | ROUTCONF | 0.30 | 0.32 | 0.35 | 0.29 | 0.27 | 0.34 | 0.18 | 0.22 | 0.25 |
| | INTCONF | 0.11 | 0.10 | 0.22 | 0.09 | 0.13 | 0.17 | - | - | 0.11 |
| | HIGHCONF | -0.09 | -0.08 | -0.34 | -0.19 | -0.15 | -0.27 | 0.13 | 0.11 | 0.07 |
| | ESCS | 0.35 | 0.36 | 0.34 | 0.35 | 0.34 | 0.34 | -0.10 | -0.12 | -0.07 |
| | | Endogenous Variables | | | | | | | | |
| | | MATHLIT | | | PROBSOL | | | ATTCOMP | | |
| | | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Total Effect | INTUSE | -0.07 | -0.13 | -0.06 | -0.11 | -0.14 | -0.11 | Same as the direct effect since there are no mediator variable for this variable. | | |
| | PRGUSE | -0.13 | -0.08 | -0.15 | -0.10 | -0.09 | -0.12 | | | |
| | ROUTCONF | 0.29 | 0.31 | 0.33 | 0.28 | 0.26 | 0.33 | | | |
| | INTCONF | 0.11 | 0.10 | 0.21 | 0.09 | 0.13 | 0.16 | | | |
| | HIGHCONF | -0.10 | -0.09 | -0.35 | -0.20 | -0.16 | -0.27 | | | |
| | ESCS | 0.36 | 0.37 | 0.35 | 0.36 | 0.35 | 0.34 | | | |

-: There is no path from exogenous variable to endogenous one. *: a path having non-significant t-value. 1: EU Member Group, 2: New EU Member Group, 3: Turkey

### 4.3.2 Summary of Qualitative Phase

In the light of the qualitative research questions, interviews were conducted to understand Turkish policy makers' perceptions on issues such as ICT policy, its implementations, and their perceptual evaluations of the quantitative phase of this study. The results of the data analysis indicate that there are interrelated concepts, constructs, patterns and/or variables that may affect each other. In order to maximize understanding of phenomenon, the results were presented with relevant quotations. Data analysis result in the following four main themes: (1) issues in and (2) suggestions for ICT policy and implementations in Turkey, participants' perceptual evaluation of (3) ICT aspects and (4) relationships between student performances and program/software use, self-confidence in high-level tasks and students' socioeconomic and cultural background.

Issues in ICT policy and implementations in Turkey appeared as the first theme, including conflicts in the existence of the ICT policy in operation, insufficient financial resources, curriculum and teacher training. According to a majority of participants, the issue of ambiguity in the presence or absence of ICT policy in operation is indicated as the most serious barrier to develop and implement ICT related implementations. Insufficient financial recourses to serve a huge target audience in terms of hardware and software distribution is the other issue that was indicated as requiring the power authority to take responsibility for allocating sufficient money from the budget. Participants point to curricular issues, involving not using ICT across the curricula, slow change, no extracurricular activities, and being too spiral. Having no sustainability of teacher training is the final major issue emphasized by participants. Contrary to these issues, suggestions for ICT policy and implementations in Turkey emerged as a second theme. Participants articulated some properties of ICT policy that provide continuity in ICT policy and its implementations, such as being sound, definite and free from political intervention. Some participants emphasized the importance of using a system approach to integrate ICT into K-12 schools. Furthermore, it was advised that knowing the ICT-related reality of Turkey through conducting research gives a chance to take measures and solve the problems peculiar to Turkey. Moreover, the need for evaluation of the ICT policy and implementations after their completion is also recommended, in order to understand their effects.

Participants' perceptual evaluation of ICT aspects is another theme, including students' attitudes toward computers, type of ICT use and self-confidence in ICT. The results show that, comparing students across country groups, they have relatively higher positive attitudes toward computers in Turkey although there are difficulties in computer and Internet access. Participants generally relate this situation to the cultural characteristics of the Turkish nation, a stronger inclination to technology than in others places, and low economic conditions. As to the type of ICT use, the lower position of Turkish students in Internet/entertainment use is related by participants to inaccessibility of the Internet due to low welfare in Turkey. However, a relatively better position of Turkish students in program/software use is associated with computer courses in the curriculum and the existence of computer teacher in Turkey. In connection with self-confidence in ICT, Turkish students generally have low self-confidence in ICT-related tasks, namely routine, Internet and high-level tasks. Although participants set forth diverse reasons why Turkish students have such a low self-confidence in each ICT related task, they are aggregated into the following categories: lack of functional computer and Internet use due to the low access rate at school, not having home computers due to the low SES, lack of internalization of computer use, and a general low self-confidence in other subjects.

Participants' perceptual evaluation of relationships among students' program/software use, self-confidence in high-level tasks, socioeconomic and cultural background and their mathematical and problem solving literacy performances (results of path analytic models) is the final theme. Participants only interpret the possible influence of students' socioeconomic and cultural background on student performance and the reasons for the inverse relationship between self-confidence in high-level computer tasks and student performance. A few points are emphasized by the participants concerning the positive effects of the socioeconomic and cultural background of families on the mathematical and problem solving literacy performances of their children.

Giving qualitative results through displaying different representations (in diagrammatic, graphic or tabular form) is likely to facilitate their understanding and interpretation in a conceptual framework. In this sense, the relational representation of qualitative results is given in the Table 4.31.

Table 4.31 Summary of Qualitative Results

| MAIN THEMES AND SUB-THEMES | |
|---|---|
| **Issues in ICT policy and implementations in Turkey** | |
| • Conflicts in existence of ICT policy in operation<br>• Insufficient financial resources<br>• Curriculum<br>• Teacher training | |
| **Suggestions to ICT policy and implementations in Turkey** | |
| • Sound and certain decision on policy<br>• Free from political intervention<br>• Continuity in policy and its implementations<br>• Followed strictly to policy and its implementations<br>• Evaluation of completed policy implementations<br>• Filling the gap arising from social, economic and cultural of students through giving ICT education at school | • Systems approach in ICT integration into education<br>• Knowing reality of Turkey and taking measures peculiar to Turkey through researches<br>• Curriculum<br>• Teacher training<br>• Employing CEIT graduates for software development |
| **Participants' perceptual evaluation of the relationships in the models** | |
| • Regression of students' arithmetical calculations due to frequent ICT use<br>• Allocating much more time for improving self-confidence in high level tasks<br>• The newer technology, the more time spared to it, as is the case in TR<br>• Self-confidence in high level tasks involves more specialized, straightforward, monotonous and non-holistic thinking | • The better economic, social and cultural status, the better mathematical and problem solving literacy performance<br>  • As parents' economic, social and cultural status increases, their care on education of their children also increases<br>  • The more economic, social and cultural status, the more inquiry based education promoted by parents |

Table 4.31 Continued.

**MAIN THEMES AND SUB-THEMES**

**Participants' perceptual evaluation of ICT aspects**

- ***Internet / Entertainment use***
  - Negative effects of inaccessibility due to low welfare of Turkey
- ***Program / software use***
  - Reflecting content of curriculum
  - Positive effects of computer teacher on Program / software use in Turkey
- ***Self confidence in ICT***
  - Having direct relation to functional computer use
  - Reflection of Turkish students' general low self confidence on other subjects
  - Focusing only on chat and game
  - Lack of internalization of computer use
- ***Self confidence in routine tasks***
  - In contradiction with Program / software use
  - The better income and education level of parents, the more self confidence and conscious and productive computer use
- ***Self confidence in Internet tasks***
  - Depending directly on individual Internet use
  - Requiring basic computer competencies by oneself
  - The better income, the more Internet use regardless of country groups
  - Nonexistence of self-confidence in Internet related items in the curriculum in 2003
  - Unawareness of Internet and its nonfunctional (purposeless) use
  - Limited Internet use or delay in Internet access at schools
  - Perceiving internet as illegal and dangerous by students and parents & teachers respectively
  - Forbidding, abolishing or limiting internet by parents or themselves due to the OKS
  - Functional use of Internet as educational tool through integrating internet into curriculum (suggestion)
- ***Self confidence in high level tasks***
  - Better position of TR due to Excel and PowerPoint related tasks
  - Depending largely on individual interest and curiosity in 2003
  - Not feeling the need to use computer for high level tasks in 2003 by subject teachers
  - Promotion to homework and projects involving high level tasks (suggestion)
- ***Attitudes toward computers***
  - Cultural characteristics
  - Low economic conditions
    - Hungriness to computer
  - Attaching importance to positive attitudes
    - Taking advantage of positive attitudes in improving other ICT aspects (suggestion)
    - Readiness to ICT use

# CHAPTER 5

# DISCUSSION, CONCLUSIONS AND IMPLICATIONS

In this chapter, major findings pertaining to the research questions are discussed in the light of related literature, and conclusions are drawn. Then, implications and suggestions for further research and practice are presented.

## 5.1 Comparison of Turkey and the EU Concerning ICT Aspects

### 5.1.1 Type of ICT Use

There are two categories of types of ICT use in PISA 2003. The first category, Internet/entertainment use (INTUSE), involves using computers both for educational use (looking up information and communication) and for entertainment. The second category, program/software use (PRGUSE), involves using computer both for general purpose programs (like word processing or spreadsheets) and as educational software.

**Internet/entertainment Use:** Considering the comparison of country groups in Internet/entertainment use, the statistical analysis (follow-up ANCOVA to MANCOVA) yielded a statistically significant result, but its practical significance could be accepted as small. Students in the new EU member group and Turkey use Internet at a very similar level, but less than students in the EU member group. When the effects of students' socioeconomic and cultural status and attitudes toward computers are taken into consideration, the adjusted mean of Internet/entertainment use of students in Turkey gets higher and approaches the international mean (OECD average) -compared to its real mean- but that of both EU groups goes down a little bit.

In the qualitative part, participants' responses gave a relatively lower position for Turkish students in Internet/entertainment use, stemming from a lack of access to computers and Internet facilities due to the country's insufficient financial resources.

**Program/software Use:** As to program/software use, statistical analyses also yielded significant results, but adjusted mean differences are not meaningful. All country groups have close adjusted means of program/software use that are above the OECD average. What is intriguing is that Turkish students' frequency of program/software use is slightly higher than both EU groups, in spite of a striking inequality in the computer access rate at home and at school in favor of both EU groups.

Participants explained this finding as the existence of content of program/software use in the curriculum, and existence of computer teachers working in Turkish schools.

**Discussion of type of ICT use:** In 2003, 69% of students in the EU member group had Internet access at home, while 28.5% of those in the new EU member group and only 14.4% of those in Turkey had home access (OECD, 2006c). Similarly, in 2005, 93% of schools in the EU member group, 86% in the new EU member group, had an Internet connection while only 40% in Turkey had an Internet connection (World Bank, 2008). MONE initiated the Fast Internet Connection to Schools project in December 2003. Thus, until this initiative was to take effect, there was a lack of, or slow, Internet connections at schools (Akbaba-Altun, 2006) and the curriculum of computer courses generally did not include the objectives of Internet-related tasks in 2003 (MONE, 1994, 1998, 2000). On the contrary, parallel to their high Internet penetration at school, both EU groups generally have Internet related objectives in the curriculum (Eurydice, 2001a, 2004). The common point for the country groups is the similar proportion of students having access to computers in other places. Accessing computers -and most probably also the Internet- in other places appears to be somehow independent of the welfare of country groups. Using computers or Internet in other places reminds existence of "Internet cafés" in 2003 in Turkey. Nevertheless, since students have to pay money to use the Internet in such cafés, the prevalence of Internet use may be negatively affected in Turkey, due to the low economic conditions. Relatively lower computer and Internet access at home and at school in the new EU member group and in Turkey make their students' Internet use similar, and below the international mean, with a quarter of standard deviation, whereas the EU member group is almost in the international mean.

Taking the discrepancy between students' socioeconomic and cultural status in Turkey and both EU groups into consideration, the low socioeconomic and cultural status in Turkey seems to be a barrier limiting the level of Internet/entertainment use. Obviously, rather than the social and cultural status of Turkish students, the primary cause of this situation appears to be low economic conditions negatively affecting access to computers and Internet at home, at school and in other places, in 2003. Since GNI per capita in Turkey is considerably lower than in both EU groups (World Bank, 2008; Yıldırım, 2006), there is a very low access rate to computers and Internet, especially at home and school, for students in Turkey (OECD, 2006c). Furthermore, there are relationships between GNI per capita, population, and possession and utilization of ICT (OECD, 2006c; Eurydice, 2004; Göktaş, 2003). It can be said that there is a positive relationship between GNI per capita and possession/utilization of ICT, but there is a negative relationship between population, and possession/utilization of ICT. Considering the lower GNI per capita, the larger population size and the population growth rate of Turkey (World Bank, 2008), it could be said that Turkish students seem to be in a disadvantageous position in terms of access to and use of computers and the Internet. Moreover, there is a trend that the more access there is to computers at home, the more access there is to computers at school (Eurydice, 2004). In other words, as family income increases, access to computers and Internet at home and school increases.

Considering the large number of students in primary and secondary education in Turkey, students generally go to IT rooms for one or two hours a week in K-12 schools and usually more than one student has to share one computer for program/software and/or Internet-related tasks or activities. Along with common problems of technical support and maintenance of IT rooms, use of one computer by more than one student brings about critical problems such as classroom management for teachers and lack of individual computer and Internet use for a majority of students. In this case, even if all of the students are likely to be aware of what is happening in an IT room, only a minority of them will have the chance to use computers or the Internet individually, while the majority has no or little chance.

As regards similar level of program/software use across country groups, this may be related to two possible causes. Firstly, ICT is in the primary and secondary school curriculum in most of the EU countries (Eurydice, 2001a, 2004) and Turkey (MONE, 1994, 1998, 2000). When collecting PISA 2003 data, most of the students (97.5%) were attending upper secondary schools in Turkey. Therefore, most probably those students were taking courses such as Computer 1-2 or Information Technology 1-2. The relatively higher position of Turkey in program/software use may be related to content of these courses, which include word processing, spreadsheets, and drawing and graphic programs (see MONE, 1994, 2000). As Göktaş (2003) proposes, primary school curricula should include ICT as a must course.

Secondly, all country groups generally employ ICT specialist teachers (i.e. computer teachers) to reach ICT related objectives in the curriculum (YÖK, 1998; Eurydice, 2001a, 2004). Eurydice (2001a) informs that specialist ICT teachers teach students ICT as a separate subject in secondary schools in most European countries. With the restructuring of teacher education programs by YÖK in 1998, CEIT departments were opened to provide primary and secondary schools with computer teachers in Turkey (YÖK, 1998). CEIT graduates work as computer teachers in primary and secondary schools to teach students ICT skills in optional courses in the curricula. Most probably, similar policies to employ computer teachers to provide students with ICT knowledge and skills across country groups result in similar frequencies of program/software use in these groups with reference to the OECD average.

The result of program/software use for Turkey is similar to that of the other groups, and is above the OECD average, which can be interpreted as an indicator of ICT familiarization for Turkish students. Note that only 54% of Turkish students reported that they have computer access at school in PISA 2003 (OECD, 2006c). This result shows that IT rooms are used more with an increase in employment of computer teachers (Yalçınalp & Yıldırım, 2006).

### 5.1.2 Self-confidence in ICT Tasks

Self-confidence in ICT related tasks has three categories formed by PISA 2003 experts. The first category, self-confidence in routine tasks (ROUTCONF), is related to routine tasks on a computer, such as opening, saving, deleting, or copying files. The second category, self-confidence in Internet tasks (INTCONF), is related to Internet tasks on a computer, such as downloading files or music, or sending e-mail with an attachment file. The final category, self-confidence in high-level tasks (HIGHCONF), is related to advanced computer tasks, such as creating multimedia presentations, preparing a Web page, programming, or using software to remove computer viruses.

**Self-confidence in Routine Tasks:** When students are compared in self-confidence in routine tasks (ROUTCONF) across country groups, follow-up ANCOVA indicates a significant result. Although its practical significance is relatively higher than that of analyses comparing ICT use and attitudes toward computers, it could be nevertheless also accepted as small. The variance in students' self-confidence in routine tasks that could be attributed to the status of a country group in the EU is small: 2.1%, when the effects of students' socioeconomic and cultural status and attitudes toward computers are held constant in the country groups. Students in both EU groups are substantially more self-confident in routine tasks than those in Turkey. Turkish students' self-confidence in routine tasks was, on average, negatively differentiated from the students' mean in both EU groups and the international mean of the OECD. Indeed, Turkish students are less confident in routine computer tasks than 72% of all students internationally. As is the case in Internet/entertainment use, when students' socioeconomic and cultural status and attitudes toward computers are held constant, the adjusted mean of Turkish students' self-confidence in routine tasks rises from -0.671 to -0.538, while that of students in both EU groups fall a little. This considerable increase in the Turkish students' mean could be attributed to removing the effect of their socioeconomic and cultural background. This means that the low socioeconomic and cultural status of Turkish students negatively influences their self-confidence in basic computer tasks.

Some participants related Turkish students' low self-confidence in routine ICT tasks to the low level of parental education and income in Turkey when compared to students in both EU groups. They also emphasized that the higher the level of parental education and income, the higher the self-confidence in routine tasks and the more conscious and functional computer use.

**Self-confidence in Internet Tasks:** When the practical significance of follow up ANCOVA is considered (.034), self-confidence in Internet tasks (INTCONF) is the most differentiating ICT index across country groups. The EU member group is at the OECD average in self-confidence in Internet tasks, meaning that students in the EU member group are more self-confident than 50% of the students internationally. Students in the new EU member group are more self-confident in Internet tasks than 38% of the students internationally. As to Turkey, here the average is -0.503 for self-confidence in Internet tasks, which is better than 33% of all students in PISA 2003. After the effects of students' socioeconomic and cultural status and attitudes toward computers are removed, the adjusted mean difference in students' self-confidence in Internet tasks across country groups is significant. However, in Turkey, the negative effect of students' low socioeconomic and cultural status is still seen on self-confidence in Internet tasks, as well. Because when the effects of students' socioeconomic and cultural status and attitudes toward computers are removed, the adjusted means of Turkish students' self-confidence in Internet tasks approaches the OECD average (it rises from -0.503 to -0.333).

In the qualitative phase of this study, most participants attributed the negative differentiation of Turkish students in self-confidence in Internet tasks to a low level of individual access to and use of the Internet, due to the poor economic conditions of Turkey in 2003, the lack of basic computer competencies, the nonexistence of Internet related content in the curriculum in 2003, the delay in introducing Internet at schools, the limited Internet infrastructure at schools and the students' limited Internet use due to the central examination necessary to enter high schools (OKS).

**Self-confidence in High-Level Tasks:** Since the practical significance of statistical analysis (follow-up ANCOVA) is very small, the differences in the adjusted mean of self-confidence in high-level tasks (HIGHCONF) across country groups are not meaningful. In other words, the country groups could be regarded as homogeneous in students' self-confidence in high-level tasks. When the adjusted means of country groups are compared descriptively, it is seen that the EU member group has the highest adjusted mean score, which is on the OECD average, and Turkey and the new EU member group are in the second and third place respectively, but their means are relatively close to each other and below the OECD average.

In the qualitative phase, participants related the lower position of Turkish students in self-confidence in high-level tasks to the nonexistence of high-level computer tasks in the school curriculum in 2003, not feeling the need for advanced computer use by teachers and/or students, depending largely on individual access to computers and the Internet, and on personal interest and curiosity about advanced computer tasks.

**Discussion of self-confidence in ICT tasks:** The items of self-confidence in routine tasks exist more in the computer courses' curricula offered until 2003 than in other ICT indexes in Turkey (see Table 2.1). Ironically, Turkish students have the lowest mean in self-confidence in routine computer tasks. The World Bank (2004) also claims that there is no evidence of students gaining computer literacy in Basic Education Project phase I. This could be explained by two limitations of computer courses in Turkey. First, the curricula of computer courses include objectives not related to using computers in a meaningful way, yet objectives, such as "Show the printer" (MONE, 1998), and "Apply file menu options and procedures" (MONE, 2000) for general software programs such as word processor are common in the curriculum of computer courses. Second, as mentioned under the Internet/entertainment use part, most of the Turkish students have little or no chance to access and use a computer individually at school or at home, due to low economic conditions. In such a case, it seems to be illogical to expect Turkish students to develop high self-confidence in routine computer tasks.

Turkish students' higher use of program/software and lower self-confidence in routine ICT tasks, compared to both EU groups with reference to the international mean seem to be conflicting results. If they really use program/software more frequently, they should have already developed self-confidence in routine ICT tasks. However, due to a lack of access to ICT resources at home in 2003 conditions and inflexible curricula, students most probably use programs/software within computer courses, either with instructions given by their computer teachers or in cooperation with their classmates who share the same computer during lessons in IT rooms. This means that they do not engage in self-determined, conscious, purposeful and meaningful computer use individually. The researcher claims that without self-determined, conscious, purposeful and meaningful use of ICT facilities individually, it is difficult to develop and improve self-confidence in using ICT. Turkish students most probably had marked higher frequencies for program/software use items in the ICT questionnaire because of their routine visits to IT rooms for computer courses. Yet, when answering self-confidence related items, Turkish students could not be sure that they were able to do certain tasks by themselves, such as opening a file, saving a file or deleting a file. Since ICT facilities did not become widespread and ICT was not integrated across the curriculum, most Turkish students could not practise what they had learned in computer courses; thus these tasks were not their routine activities yet. Therefore such a result is expected.

Another reason for this conflict could be due to the fact that each ICT index represents a different frequency distribution internationally. It is reported that confidence in routine ICT tasks has a right skewed distribution (OECD, 2006c). In fact, the majority of students (at least 75%) across the OECD are comfortable and familiar enough with ICT to have a self-confidence in routine ICT tasks (OECD, 2006c). Thus, Turkish students' self-confidence in routine tasks is relatively low compared to the OECD average.

As regards self-confidence in Internet tasks, there were no objectives related to the Internet in the curriculum of computer courses (MONE, 1994, 1998). The only exceptions are some objectives like searching for information on the Internet and using an e-mail program at a basic level in the Computer 1 course (MONE, 2000). Furthermore, the Internet connections at schools were very limited and even if they existed, they were very slow (TBŞ, 2002; Akbaba-Altun, 2006) until the Fast Internet Connection project was launched in December 2003. On the contrary, students' computer and Internet access rate in primary and secondary schools in both EU groups are considerably higher than that of students in Turkey (see Eurydice, 2004; OECD, 2006c; World Bank, 2008). Under these conditions, it is an expected result that Turkish students have relatively lower self-confidence in Internet tasks than students in both EU groups.

As to self-confidence in high level tasks, Turkish students are below the OECD average and the EU member group. Yalçınalp and Yıldırım (2006) also state that Turkish students in PISA 2003 feel least confident in some high level computer tasks like using antivirus programs, designing web pages and programming, while they feel most confident in some routine computer tasks like starting games, playing games and drawing picture with the mouse. The relatively higher mean of self-confidence in high level tasks compared to the other two types of self-confidence could then, be due to preparing presentations, using spreadsheet programs and using database programs, all of which took place in the curriculum of computer courses (MONE, 1998, 2000). Thus, Turkish students' self-confidence in high level tasks that is closer to the OECD average than that of self-confidence in Internet tasks can be understood.

Developing self-confidence in ICT tasks involves engaging students in more meaningful and purposeful ICT-related authentic tasks which should be undertaken by oneself. This is also related to the computer access rate and integration of ICT into subjects across the curriculum. Firstly, there is no comparison between the access rates of students in the EU member group and that of the students in Turkey. In fact, there is a positive relationship between countries' prosperity and the development of home and school computer facilities (Eurydice, 2004). As GNI per capita increases, home and school computer possession indicators also increase. It is known from the World Bank (2008) that GNI per capita was 23,173 for the EU member group, 4,414 for the new EU member group and 2,980 for Turkey in 2000 (in US dollars). In 2005, GNI per capita increased to 34,648, 8,634, and 4,750, respectively. Then, the discrepancy in GNI per capita underlies the primary reason of inequality in computer and Internet access rate. Indeed, ICT penetration at home and at school is relatively lower in Turkey compared to both EU groups due to her low GNI per capita. Thus, Turkish students had little or no chance to access computers, so they hardly ever worked individually in computer courses or in other courses in IT rooms. Similarly, after having analyzed 31 countries' PISA 2000 data, Sweet and Meates (2004) conclude that when considering differences between high and low achievers, inequality of access to ICT resources at home is more important factor than at school regardless of prosperity level of a country. The same trend is also detected in PISA 2003 data (OECD, 2006c). Sweet and Meates (2004) propose that schools should have the mission of providing low achievers (those having less ICT resources at home) with ICT resources.

Secondly, parallel to increasing access to computers and the Internet, integration of ICT into the curriculum is carried out in the EU member group with the aim of using ICT in an interdisciplinary manner. Using ICT as a tool to enhance knowledge and skills in other subjects is notably more common in the EU member group (Eurydice, 2001a, 2004). Yet Turkish curriculum in operation in 2003 did not cover using ICT as a tool in teaching other subjects. Such attempts appeared first with the curriculum reform initiated in 2004 (TTKB, 2004).

For these two major reasons, Turkish students' self-confidence in ICT tasks drastically negatively deviates from the international average and that of both EU groups, especially from the EU member group. These comparisons in self-confidence in ICT indicate that both EU groups make more ICT related investments in K-12 schools than does Turkey. Indeed, the EU member group has made earlier and greater investment in ICT integration into the school system in terms of money, time and effort than the new EU member group and Turkey (Eurydice 2001a, 2004).

### 5.1.3 Attitudes toward Computers

Attitudes toward computers is a construct in PISA 2003 consisting of the items of feelings about computers on importance, fun, interest and loosing track of time.

Statistical analyses indicate that there are significant differences between Turkey and both EU groups when the effects of socioeconomic and cultural status of students are eliminated. However, there are no meaningful differences in the adjusted means of students' attitudes toward computers across country groups due to the very small practical significant. When the adjusted means are descriptively evaluated, Turkish students have the biggest mean score of attitudes toward computers while students in both EU groups have relatively smaller means that are close to each other around the international mean.

The majority of the participants made causal explanations as to why Turkish students have more positive attitudes toward computers than students in both EU groups. Generally, most participants related Turkish students' more positive attitudes toward computers to cultural characteristics and to poor economic conditions. More specifically, participants commented on Turkish students' perceptions about computers as entertainment and gratification. Furthermore, it is stated that Turkish students are more inclined to computers than students in both EU groups. Moreover, Turkish students have an extra aspiration, interest and curiosity about computers due to hungriness for technology and the image of computers in Turkish society in 2003 conditions.

**Discussion of attitudes toward computers:** Contrary to Turkish students' lower level of self-confidence in ICT tasks and Internet/entertainment use; they have more positive attitudes toward computers than do students in both EU groups. Since there is one proficiency level difference in the means of mathematics and problem solving achievement between Turkey (at level 2) and both EU groups (at level 3) in PISA 2003, Turkish students on average can be considered as "lower achievers" compared to students in both EU groups. Sweet and Meates (2004) also report a similar pattern for low achievers in PISA 2000 data: low achievers' perceived confidence and competence in using ICT are generally lower than their reported attitudes toward computers. This is actually as the case in the present study for Turkish students.

## 5.2 Relationships between ICT Aspects and Student Performance

### 5.2.1 Mathematical Literacy Performance Modeling

All the fit indexes were considered adequate to interpret significant relationships in the path analytic models of the mathematical literacy performance for the country groups. Exactly the same pattern was observed in the mathematical literacy performance models of both EU groups. In the models, the effect size ($R^2$) for mathematical literacy performance is .26 for the EU member group, .28 for the new EU member group and .32 for Turkey. According to Cohen et al. (2003), these effect sizes are large, since they are greater than .25. This means that the 26% of variance seen in mathematical literacy performance in the EU member group is accounted for by the linear combination of ICT indexes and the socioeconomic and cultural status of students. This explained ratio is 28% for the new EU member group, and 32% for Turkey.

When the degree of relationship between ICT indexes and mathematical literacy performance are concerned, the standardized path coefficients yielded by the models could be interpreted as a correlation between the variables. According to Cohen's classification, .10, .30 and .50 are respectively small, medium and large levels for standardized path coefficients.

**Overall ICT use:** This ICT aspect consists of Internet/entertainment use (INTUSE) and program/software use (PRGUSE) indexes. Both of these indexes have negative and small relationships with students' mathematical literacy performance for all county groups. This means that high achievers tend to use ICT less frequently than do low achievers, but this is only a weak association.

One of the participants emphasizes the negative effect of using calculators in arithmetical operations on mathematical performance. Using calculators in arithmetic may lead to regression of students' performance requiring arithmetical operations. Since computers and Internet technologies are generally invented in foreign countries and imported from them, there is a delay in arrival of these technologies in Turkey. Another participant commented that Turkish students spend too much time using computers and Internet technologies that are new for students in Turkey but not in the EU. In other words, these technologies are routine for students in both EU groups, but they are new for Turkish students, and therefore Turkish students spend too much time and energy with these technologies. Consequently, this can be considered as negative effect of novelty in technology on students' mathematical literacy performance.

The negative relationship between overall ICT use and students' mathematical literacy performance could be explained by four major reasons. Firstly, low achievers could be encouraged by their teachers to use some educational software in the format of drill and practice, or tutorials, to improve and/or compensate for their performances at school (Pelgrum & Plomp, 2002; Sweet & Meates, 2004; OECD, 2006c). However, there are studies concluding that ICT intervention used for remedial purposes with low achieving students is less effective than traditional teacher-centered interventions especially for the basic difficulties that students encounter (Kroesbergen & Van Luit, 2003).

Secondly, computers may actually distract students from learning since students devote much of their time to non-educational computer and Internet use, such as entertainment and communication (Fusch & Woessmann, 2004; OECD, 2006c, Tuti, 2005). Thirdly, current educational software used to supplement student learning is either not effective (Fusch & Woessmann, 2004) or not used appropriately (Kulik, 2003). Balanskat, Blamire and Kefala (2006) state that ICT is effective in improving the achievement of students aged 7-16 in English, Science, and Design and Technology courses, but not in Mathematics, particularly for primary schools in the EU. However, Kulik (2003) points to a conditional positive effect of computers on mathematics achievement in the USA. According to his meta-analysis, causal comparative studies propose a positive effect of ICT on mathematics achievement, but this is limited to tutorial-based programs (Kulik, 2003). Conflicting results from recent reviews and meta-analysis studies lead to infer that it is too early to conclude definitely that ICT has a positive or a negative impact on mathematics achievement. Finally, the use of educational software as a method of CAI is not common in mathematics yet (Pelgrum & Plomp, 2002). For Turkey, computer facilities at school, mostly in IT rooms, are only used for computer literacy courses and are not used in other courses in a regular manner (Aşkar & Olkun, 2005; MONE, 2004). It appears that all of these reasons may be influential in the negative and weak association between ICT use and mathematical literacy performance.

Remember that the relationship between students' mathematical literacy performance with program/software use and Internet/Entertainment use is negative, but quite small. This result corroborates studies in the literature concluding that frequency of students' computer use is not linked to their performance in mathematics (e.g. Wittwer & Senkbeil, 2008). Similarly, the level of overall computer use by low achievers in reading literacy is not significantly different from that of higher achiever students in PISA 2000 for most countries (Sweet & Meates, 2004). However, Erbaş (2005) reveals that there is a positive relationship between Turkish students' frequency of Internet use and scientific literacy achievement in PISA 2003. Yet, in his study, students' socioeconomic background was not taken into consideration, and the Internet use includes only looking up information and downloading music from the Internet. When all the items related to Internet/entertainment use in the ICT questionnaire are considered -as is the case in this study-, the relationship between mathematical literacy performance and frequency of overall Internet use becomes negative.

As regards the effects of ICT use at home and at school, once the effects of students' socioeconomic and cultural status are eliminated, the relationship between home computer use and mathematical achievement diminishes for German students (Wittwer & Senkbeil, 2007), and even becomes negative when countries' PISA 2000 data are reanalyzed (Fusch & Woessmann, 2004). Only some conditional positive relationships between computer access at home and student achievement are detected, if computers are used for education and communication purposes (Fusch & Woessmann, 2004) and for problem-solving activities in a self-determined way (Whitter & Senkbeil, 2008). Similarly, when the effects of school characteristics are strictly eliminated, the relationship between access to computers at school and achievement becomes insignificant (Fusch & Woessmann, 2004). Yet a conditional relationship exists at school: computer use is associated with student achievement only at a middle frequency, not at the highest or lowest frequency (Fusch & Woessmann, 2004; Aşkar & Olkun, 2005). This infers that more ICT use does not necessarily mean better student performance (OECD, 2006c). Considering the relationships reported in the literature between student achievement and ICT access at home and school, it can be concluded that how students use, which ICT facilities they use, and for what purposes may be determinants of the impact of ICT on student achievement.

**Self-confidence in ICT tasks:** As to self-confidence in ICT tasks, self-confidence in routine and Internet tasks have positive relationships, while self-confidence in high level ICT tasks has a negative relationship with students' mathematical literacy performance for all country groups. Self-confidence in routine tasks, such as opening and saving a computer document or file, has a positive and medium relationship with students' mathematical literacy performance (around .30). This finding is consistent with some inferences in the literature. The OECD also deduces that self-confidence in routine computer tasks is a fairly strong predictor of student performance by explaining 10% of the variance in mathematics scores on average across the OECD countries (OECD, 2006c). Similarly, Turkish high achiever students in science tend to have more basic computer skills than low achievers (Erbaş, 2005).

Self-confidence in Internet tasks also has a positive relationship with students' mathematical literacy performance, but at a low level for both EU groups (around 0.10), and a small-medium level for Turkey (0.22). The higher association between self-confidence in Internet tasks and mathematical literacy performance in Turkey could be explained by two major reasons. Firstly, although the effect of students' socioeconomic and cultural status is controlled at the individual level in the models, students' access to Internet and their ability to use it were highly related to school characteristics and out of school activities, such as extra curricular activities and ICT facilities for students in the 2003 conditions. Thus, this result could be a reflection of school characteristics and out of school activities. Out-of-school activities provided by families with high SES are considerably wealthier, more various, and more likely to affect students' cognitive development than those provided by the families with lower SES. Note that the economical, social and cultural status of Turkey is considerably lower than that of both EU groups, on average. Such a difference in socioeconomic and cultural status, of course, reflects on the quality and wealth of the school and out-of-school environments that students engage in for leisure time activities. Secondly, the novelty effect of the Internet on Turkish students' mathematical literacy performance could increase the strength of relationship between self-confidence in Internet tasks and student mathematical literacy achievement. This effect is proposed by İş Güzel and Berberoğlu (2005) to explain relatively high association of use of technology in school and student performance for Brazilian students when compared to that for Japanese and Norwegian students.

Self-confidence in high level ICT tasks, such as using antivirus programs and constructing a web page, has a negative relationship with students' mathematical literacy performance for country groups in this study. This association is small for both EU groups, but it is larger in Turkey (-0.34). It indicates a negative and medium relationship between self-confidence in high level ICT tasks and Turkish students' mathematical literacy performance.

In order to explain this finding, one of the participants calls attention to students' failure in scheduling their study time due to spending too much time on computer tasks requiring advanced use. Naturally, students have a certain time to study. If they spend most of the time on advanced computer use, their mathematical literacy performance is likely to be affected negatively. This seems to be a matter of time allocated to study, and how and on what it is spent. Another participant focuses on the content of advanced computer use and its negative effects on thinking and learning. Advanced computer use involves students being more specialized and thinking non-holistically; so, they become specialists in advanced computer use, but not good at other academic fields.

Similarly, there are international studies in the literature indicating a tendency of low achievers to engage in computer programming more frequently (Sweet & Meates, 2004). However, the OECD (2006c) reports that there is a positive significant association between self-confidence in high level tasks and improvement in mathematical literacy performance for most of the countries in PISA 2003, though this association is not as great as in self-confidence in routine computer tasks and self-confidence in Internet tasks. This negative association could be explained by two possible reasons. Firstly, gaining confidence in performing high level computer tasks demands a considerable amount of time, which limits students' time for studying other courses, including mathematics. This means that students who feel confident in high level computer tasks may neglect to study for their courses and devote their study time to advanced computer use, due to their personal interest or curiosity. Secondly, objectives towards improving self-confidence in high level computer tasks are generally not placed in school curricula in both EU groups and Turkey (Eurydice 2001a, 2004). In Turkey, they take place only in the Computer 2 optional course and some courses at VET programs. Berberoğlu (2005) detected significant differences in student achievement between two groups of schools in Turkey in the PISA 2003 data: (1) schools having low achievers: general high schools, vocational high schools, Anatolian vocational high schools and basic education schools, (2) schools having high achievers: science lycées, Anatolian high schools, and police colleges. Most probably, students of VET who specialized in high level computer tasks and students of general high schools could already be low achievers in mathematics due to the low quality education offered in these schools and their poor academic background. On the other hand, students in the second group of schools could already have high achiever backgrounds, deal with academic disciplines more and not get involved in learning computer programming or other advanced computer tasks. This contrast among schools could be more apparent in the Turkish education system, which strengthens the relationship between self-confidence in high level ICT tasks and mathematical literacy performance.

It can be expected that the more students have self-confidence in any field, such as math, the more they feel self-confident in any other field, such as ICT. However, having self-confidence in any field requires students to spend time and energy in that field. Therefore, students can not feel self-confident at the same level in all or most fields. At this point, developing self-confidence in ICT tasks and its effects on student academic performance should be investigated, which is a gap in the reviewed literature.

**Attitudes toward computers:** There is a negative and very small relationship between attitudes toward computers and mathematical literacy performance in all country groups. A similar result is reported by Erbaş (2005) for the relationship between science literacy performance and attitude toward computers in the PISA 2003 data.

**Economic, social and cultural status (ESCS):** Students' socioeconomic and cultural status has a positive and medium relationship to their mathematical literacy performance, around 0.35 for all country groups.

Most participants touch on the positive effects of students' socioeconomic and cultural status on their academic performance. Students in high level socioeconomic and cultural status groups have more opportunity to have a better formal and informal education than those in lower level groups. The difference in students' mathematical literacy performance may be reflecting this situation, that is, as students' economic, social and cultural status rises, so too does mathematical literacy performance increase, and vice versa.

This result is consistent with the literature showing a medium relationship of around 0.30 between students' socioeconomic background and achievement (Yang, 2003). In the mathematical literacy performance model for each country group, this relationship is slightly larger than in the literature. This could be due to the fact that school-level factors and out-of-school activities were not taken into consideration due to the scope of the present study. Thus, the effect of school characteristics and out-of-school activities as a reflection of economic, social and cultural status could be slightly increasing the association between this variable and mathematical literacy performance.

When the means of mathematical literacy performances in PISA 2003 are compared, both EU groups are at proficiency Level 3, which is the OECD average as well, while Turkey is at proficiency Level 2. The EU member group only having invested in time and money and spent efforts in ICT infrastructure and professional development of teachers since the mid 1990s, it is intriguing to find similar patterns that emerged in the models for all country groups. Considering the similar patterns in the models, it is difficult to conclude that the higher mathematical literacy performance of students in both EU groups is because of overall ICT use, including ICT use in mathematics teaching and learning.

Indeed, this study indicates a negative and small effect of overall ICT use on student mathematical and problem solving literacy performance, regardless of country groups. High achievers tend to use ICT less frequently than low achievers do. This result means that ICT is not commonly used in improving mathematical and problem solving knowledge and skills at home, at school or in other places. It is also known from the literature that ICT is not commonly used as an instructional tool in mathematics lessons (Pelgrum & Plomp, 2002). In other words, instructional methods in teaching and learning mathematics still seem not to employ ICT.

### 5.2.2 Problem Solving Literacy Performance Modeling

The values of fit indexes are sufficient to interpret the relationships between students' economic, social and cultural status, ICT indexes and problem solving literacy performance in the path analytic models of problem solving literacy performance for the country groups. In these models, 24% of the variance in student problem solving performance for the EU member group, 23% for the new EU member group and 29% for Turkey are explained. Their sizes are almost large for both EU groups and large for Turkey.

It should be noted that there is exactly the same pattern of relationships among the variables in mathematical and problem solving literacy performance models for all country groups. This pattern could be explained by the strong relationship between mathematical and problem solving literacy performance (OECD, 2005b, p. 189). In this sense, the interpretations made for the relationships in mathematical literacy performance models are also valid for those in the problem solving literacy performance models. The only difference is that practical significance and the strength of relationships slightly decrease in problem solving literacy performance models for all country groups.

## 5.3 Issues in and Suggestions for ICT-in-education Policy Making and Implementations in Turkey

Only reviewing the literature about ICT policy and implementations and interpreting the quantitative findings of this study are not sufficient to understand the issues in ICT policy making and practice in Turkey. The quantitative part of the study drew a picture about the perceived ICT literacy of students in the country groups. This picture led us compare the Turkish and EU students in terms of ICT use, self-confidence in ICT, and attitudes towards computers. On the other hand, the qualitative part of this study investigated the real reasons of why students are similar or different in ICT aspects from the view of policy makers. This phase also contributed to an understanding of "what really happens" in schools, in MONE and in departments of CEIT for the improvement of ICT-in-education policies and practices. This phase was necessary in order to understand what have been done up to now and what to do from now on in Turkey. Özar (1996) conducted a qualitative study to investigate policy makers' opinions on the use of IT in education. He specified major issues in IT integration. The qualitative phase of this study revealed that most of these issues still exist after 11 years. Possible solutions to these issues are sought with the qualitative inquiry.

The most striking finding of the qualitative phase is the nonexistence of a policy document explicitly written for schools describing "how to integrate ICT into the curriculum". This gap should be closed through a large commitment and consensus in the education sector. Another disappointing finding is that PISA 2003 ICT questionnaire data were not taken into consideration in the curriculum reform that began in 2004. The results of that questionnaire should have been examined and the curriculum of computer courses should have been updated, based on the results of that questionnaire. Luckily, the present study shed light on this issue.

**Issues in ICT-in-education Policy Making and Implementations:** There are four main issues in ICT-in-education policy and implementations that emerged in the qualitative phase of this study. They are (1) conflict in the ICT policy in operation (2) insufficient financial resources, (3) curriculum issues and (4) teacher training issues.

Firstly, conflict in existence of an ICT policy in operation is the most clearly apparent issue to emerge from the data. According to the majority of participants, the issue of ambiguity in the presence or absence of the ICT policy in operation is considered as the most serious barrier to develop and implement ICT policies. Participants relate such an ambiguity to a lack of cultural accumulation in developing and implementing ICT policies. ICT policies and implementations are often interrupted by authority, which leads to a lack of evaluation of and discontinuity in ICT policies and implementations. Not understanding the importance of ICT and the conservatism of policy makers result in deficiencies in developing and implementing ICT policies and lack of monitoring mechanism for the implementations. This result is supported by the World Bank (2004) report which states that MONE had not prepared and updated the IT policy paper and had not formulated a strategy to integrate IT into curricula and teacher training before the closure of BEP I. Indeed, the early IT projects in Turkey were not well-planned (Özar, 1996); thus they become unsuccessful in realizing their aims (Uşun, 2004). Similar to this, Addo (2001) claims a lack of written national information technology policies as one of the barriers to utilization of information technology in education in developing countries.

The major deficiencies in developing and implementing ICT policies are: too much emphasis on hardware, not considering research findings in the decision-making process, and using imported solutions instead, the insufficiently active role of universities and the private sector, and groundless and baseless solutions due to focusing on only one component of the education system. Corruption in ICT projects results in outdated IT rooms, hardware and software incompatibility; thus, IT rooms can not be utilized efficiently. This indicates a lack of supervision and monitoring in the ICT policy and practices in the Turkish education system. Such a monitoring could be provided by inspectors regularly visiting schools, but Akbaba-Altun (2006) claims that there is a lack of appropriate supervision of IT rooms and ICT integration. Focusing largely on pedagogical and organizational issues rather than on technological ones, and using a holistic approach are necessary for ICT-in-education policies and implementations in Turkey (Bhullar, 2005).

In order to overcome deficiencies in developing and implementing ICT policies, school-based solutions are often suggested in the literature (Özar, 1996; Bhullar, 2005; Aşkar, Usluel & Mumcu, 2006). Having a policy document or a plan for the integration of ICT into schools is a necessity for successful integration (Gülbahar, 2007; Özar, 1996; Reynolds, Treharne & Tripp, 2003; Şahinkayası & Şahinkayası, 2004; Bhullar, 2005). In fact, the literature reveals that there is a need for clear guidelines on how to integrate technology into the curriculum among teachers and administrative staff (Gülbahar, 2007). After having examined IT-in-education policies of many countries all over the world, and investigated issues on IT integration into schools in Turkey from the view of key policy makers, Özar (1996) indicates the need for developing a policy document to be used in schools. This document should address long-term and short-term goals, resource management, technical support, staff development, and student entitlement etc. Furthermore, as he states, this policy document should be revised regularly to keep up with recent developments. Bhullar (2005) also proposes that each school should create an ICT vision and strategy, and prepare its own ICT implementation plan with the participation of all stakeholders. Bhullar (2005) suggests that schools should have some autonomy in selecting the ICT resources that are most suitable for the needs of teachers and students, as well. Similarly, Reynolds, Treharne and Tripp (2003) state that if a school has a strong whole-school ICT policy in common, led by an expert in ICT, its teachers are more confident in using ICT for teaching because they feel the necessary technical support exists. This suggestion recalls the importance of CEIT graduates in schools as ICT experts and change agents. Aşkar, Usluel and Mumcu (2006) also suggest that school-based solutions, especially for in-service training, are more realistic in successful diffusion of ICT in schools besides nationwide solutions.

Secondly, insufficiency in financial resources is another main issue in ICT-in-education policy and implementations. Since the Turkish education system is huge in terms of students, teachers, other staff, buildings and land area etc. when compared to most EU countries, much greater financial resources are needed for the provision of ICT equipment, software, and their support and maintenance to schools, teachers and students. Therefore, this issue requires the power authority to allocate sufficient money from the budget or to create new national and international financial resources. This issue is supported by Yıldırım (2006), Uşun (2004) and Göktaş (2003). The problems of the Turkish education system are directly related to the size of the education system with respect to students served and staff working in the system (Yıldırım, 2006). Furthermore, Turkey has many challenges to its ICT policy and implementations in the education system, such as the high number of students and teachers, the large land area, a very large education system, poor economic conditions, and insufficient technologies (Göktaş, 2003). Mostly due to insufficient financial resources, inadequate number of computers, slow Internet connections and maintenance problems often emerged as factors in previous studies (e.g. Yıldırım, 2006; Akbaba-Altun, 2006; Uşun, 2004; TBŞ, 2002; Çağıltay et al., 2001; Akkoyunlu, 1995). In addition, schools need technical support personnel for the integration of technology into the curriculum (Çağıltay et al., 2001). Despite large investments in hardware for basic education schools in BEP I, only 17% of primary and secondary schools had computerized in 2002 (TBŞ, 2002). This was the first large-scale project to provide basic education schools with IT rooms. Yıldırım (2006) states that the ideal student to computer ratio is 6:1. This ratio in Turkey was reported as 81:1 in the early 2000s (TBŞ, 2002) and has been lowered to 27:1 through ICT investments in various projects, as of 2006. According to Yıldırım (2006), Turkey has to go on to invest in ICT. Çağıltay et al. (2001) and Yıldırım (2006) propose especially that ICT should be put into the classrooms with Internet connections. As regards maintenance problems, MONE is not successful in managing, maintaining, updating and upgrading IT rooms at schools (Yıldırım, 2006). In fact, the responsibility for finding financial resources to maintain ICT facilities is left to schools, but basic education schools do not have their own budget (Akbaba-Altun, 2006).

The notion of putting computers into schools, i.e. high emphasis on hardware investments, is not a solution itself, as is often stressed in the literature (Özar, 1996; Bhullar, 2005). However, Bhullar (2005) states that hardware provision is not an issue peculiar to Turkey, but also the dominant objective in ICT-in-education policies around the world. While often giving priority to hardware procurement, human resources, curriculum change, technical and pedagogical support and maintenance are often neglected. Work on these areas and the budget allocated to them are inadequate or mostly ignored so far. Therefore, ICT-in-education policies emphasizing the distribution of hardware -and to some extent in-service training for administrative staff and teachers- result in failure due to lack of leadership in ICT integration into the curriculum (Yıldırım, 2007; Akbaba-Altun, 2006). Akbaba-Altun (2006) deduces that school principals interpret the laws and regulations about ICT implementations according to their perceptions, and implement them based on their own interpretations. She also states that school principals do not support ICT integration in schools. In fact, the importance of strong leadership in implementations of ICT policies, projects and initiatives at school level is often emphasized in the literature (Yıldırım, 2007; Bhullar, 2005; Akbaba-Altun, 2006).

Thirdly, the participants mentioned ICT-related curriculum issues that are related to the curriculum of ICT courses, and a lack of an interdisciplinary approach in teaching ICT competencies. The curriculum for the ICT courses is much too spiral, and not responsive to developments in technology and pedagogy. ICT courses do not include extracurricular activities, either. ICT related objectives in the school curricula take place only in separate ICT courses and ICT is not used as an instructional tool to enhance the learning and teaching of other subjects.

There are many studies in the literature stressing the inconvenience or inflexibility of the curriculum structure when it comes to integrating ICT into education (Çağıltay, et al., 2001; Yıldırım, 2007; Göktaş, 2003; World Bank, 2004) until the 2004 curriculum reform efforts. Low-quality or inappropriate software for the curriculum and local needs are the other critical issues in ICT integration into the curriculum (Aydın & McIsaac, 2004; Akbaba-Altun, 2006; Akkoyunlu, 1995). The software available to teach other subjects at schools is often criticized (e.g. Aydın & McIsaac, 2004; Akbaba-Altun, 2006; Akkoyunlu, 1995) for its poor quality or inappropriateness to the curriculum and local needs. One of the policy makers also stated that software is not given importance in the 2004 curriculum reform.

The importance of needs analysis to identify local needs before purchasing or developing software is emphasized in the literature (Özar, 1996; Aydın & McIsaac, 2004; Akbaba-Altun, 2006). Aydın and McIsaac (2004) underline the cultural dimension of technology integration into education. They indicate the necessity of analyzing the needs, problems and characteristics of society and adapting IT to the properties of society instead of applying imported IT solutions as-it-is from developed countries. They state that IT solutions tailored to the culture's needs diffuse better. Ready-to-use interventions have never been successful in Turkey, particularly in the education system since most CAI initiatives offered solutions that were not applicable to Turkish culture (Aydın & McIsaac, 2004). According to Yıldırım (2006), if ICT is correctly and sufficiently used on time and in place, especially for some of the problems peculiar to Turkey, it could be an effective solution tool. As Yıldırım states, in order to take advantage of ICT as a solution, turning the ICT investments into a product and added value is needed. In order to achieve this, the most needed hardware should be provided, a Turkish content should be developed with the leading role of universities and this content should be delivered through this hardware (Yıldırım, 2006).

Finally, problems related to training teachers on the use of ICT in teaching is the last major issue stated by the participants. The complete lack of sustainable teacher training after graduation, and problems in preservice teacher training are particularly emphasized. Similarly, inadequate and low quality in-service training concerning integration of ICT into the curriculum has been emphasized in almost every study on ICT integration in Turkey, as well (Yıldırım, 2007; Akbaba-Altun, 2006; Aşkar, Usluel & Mumcu, 2006; Çağıltay et al., 2001). Highly centralized and infrequent and/or irregular training events for teachers away from the schools do not address the real needs of teachers (Akbaba-Altun, 2006; Aşkar, Usluel & Mumcu, 2006). Thus, that kind of training in ICT is evaluated as not effective.

The in-service training of teachers is under the responsibility of MONE. On the other hand, one policy maker blamed universities for graduating teachers not trained in how to use technology in their courses. Göktaş (2006) comes to the conclusion that teachers' perceived ICT competencies are not high enough, even though they feel that ICT related courses in their preservice teacher training are beneficial and effective. He suggests that ICT related courses should be redesigned to have teachers acquire a competency in teaching with ICT. In other words, in ICT-related courses more opportunities should be provided to preservice teachers to integrate ICT into their own subject areas (Göktaş, 2006).

Because there is a lack of incentives for teachers to utilize ICT in their teaching, the ICT facilities at school are not utilized by subject teachers (Yıldırım, 2007; MONE, 2004). Yıldırım (2007) points out the lack of collaboration among Turkish teachers in using technology. However, the literature emphasizes the necessity of incentives and collaboration among teachers for successful ICT integration (Mumtaz, 2000). Turkish teachers use Instructional software less frequently than any other professional uses of computers and they feel least competent in using instructional software (Yıldırım, 2007).

**Suggestions for ICT-in-education Policy Making and Implementations:** The suggestions made by participants concerning ICT-in-education policy and implementations can be categorized into four main themes. These are (1) properties of a sound ICT policy and implementation, (2) knowing the reality of Turkey and taking measures peculiar to Turkey through conducting research, (3) curriculum, and (4) teacher training.

Firstly, participants specify the major properties of a sound ICT-in-education policy. A nationwide long-term (10-15 years) ICT policy should include macro goals, what the needs are, what decisions are to be taken, what kind of research should be conducted and what should be done. Furthermore, ICT policy and implementations should be free from political intervention; thereby ICT policies can be put into practice and related implementations can be evaluated after their completion. In this way, continuity in policy and its implementations can be possible on the basis of evaluation results. ICT policy should consider all the components of the education system within a systems approach. Besides, ICT policy should aim to close the gap in the socioeconomic and cultural status of Turkish students through ICT education and integrating ICT into other subjects at school. For this purpose, schools should provide computer and Internet access to all students.

The importance of developing ICT policies and strategies both nationwide and at school level is stated in the literature (Bhullar, 2005). Both at ministry level and at school level, ICT policy should explicitly describe the goals and objectives and prescribe how to use of ICT in teaching and learning by teaching staff and students in the form of documents, ICT integration plans as mentioned.

Secondly, in order to develop and implement ICT policy and overcome problems peculiar to Turkey, participants advise cooperation between MONE, research institutions and universities, to conduct research focusing on local problems in Turkey. Furthermore, universities, MONE, and research institutions should share the responsibility of planning, implementing and researching ICT policies in coordination. In fact, experts from universities should be given a more active role in planning ICT-related initiatives and projects. Participants are aware of the fact that overcoming problems in developing and implementing ICT policies takes time, and requires a transformation of the power authority's perspective.

The importance of research is often stressed in the literature as an indispensible component of ICT policy and practices, as well (Bhullar, 2005, Aydın & McIsaac, 2004; Uşun, 2004; Addo, 2001). Especially, developing countries need to develop a strong commitment to research and to take advantage of local knowledge through its own research for utilize ICT effectively and efficiently (Addo, 2001; Aydın & McIsaac, 2004).

The need for collaborative work between MONE and universities and the private sector is also underlined in the literature (Özar, 1996; Yıldırım, 2006). Özar (1996) stresses the lack of communication and cooperation on ICT integration in MONE as an important obstacle for successful IT integration into schools. He also states that MONE should cooperate with universities and the private sector in the ICT integration process. Indeed, universities should play a leading role in integrating ICT into schools (Yıldırım, 2006; Özar, 1996), guiding MONE to determine courseware standards, helping MONE in producing and evaluating software (Yıldırım, 2006; Özar, 1996), and providing in-service and preservice teacher training (Özar, 1996). In addition to universities, the private sector should develop the necessary instructional software, and help MONE financially or provide apprenticeship facilities with students in VET (Özar, 2006).

Thirdly, participants make some suggestions concerning an ICT-related curriculum. According to one participant, students successfully completing compulsory education should have ICT competencies as a qualification, like mathematics or reading literacy. The participants proposed that the weight of ICT courses as a separate subject, should be increased in the curriculum and the curriculum of ICT courses should be prepared so as to associate virtual and real life activities. Furthermore, most of the participants emphasize the importance of integrating and utilizing ICT as a tool across the curriculum through curricular reform. For successful ICT integration, the need for curriculum reform or revision was also stressed in the literature (Özar, 1996; Akkoyunlu, 1992). Putting computers into classrooms, transforming the role of computer teachers into coordinator teachers to support teaching activities with ICT, developing and sharing instructional materials with ICT facilities at schools, promoting functional ICT use through engaging students in doing ICT-related homework and projects, and introducing ICT in pre-primary education are the participants' primary suggestions to facilitate ICT integration into the curriculum. Özar (1996) also proposes that objectives and implementations concerning ICT in education should be revised to take advantage of IT facilities.

Note that once students' ICT knowledge and skills come to a certain level, ICT can be integrated into whole curricula (Reynolds, Treharne & Tripp, 2003). Kulik (2003) points out that ICT has been used more efficiently since the 1990s than in earlier years, since technology has advanced and become user-friendly, and teachers and students have become more ICT- literate. However, Aydın and McIsaac (2004) contend that schools in Turkey are not able to offer learning environments in which the young generation can learn how to use the constructive power and potentials of ICT. They also claim that the digital divide is getting wider, and only a small proportion of people have access to computers and the Internet in Turkey. In order to integrate ICT successfully into the curriculum, Özar (1996) and Bhullar (2005) state that the roles of teachers and students should be reconsidered in teaching and learning.

Finally, participants advise on the matter of training teachers in ICT. Professional development in ICT should be increased for teachers. Sharing educational experiences and resources among teachers, and orienting subject teachers toward using computers as a complete management tool in their profession are the participants' some suggestions to improve teachers' ICT utilization. Preservice teachers should acquire ICT qualifications in the school of teacher education programs.

The need for a more effective in-service training system for teachers is often mentioned in the literature (Yıldırım, 2007; Aşkar, Usluel & Mumcu, 2006; Akbaba-Altun, 2006; Göktaş, 2003; Çağıltay et al., 2001; Addo, 2001). A well-planned and up-to-date, high quality, on the job and ongoing training system that meets adult learner characteristics and real needs is required (Yıldırım, 2007; Aşkar, Usluel & Mumcu, 2006; Akbaba-Altun, 2006;

Göktaş, 2003; and Çağıltay et al., 2001). In Özar's study, key policy makers stressed that a first priority has to be given to in-service training for teachers, and preservice education programs should include IT courses, to integrate IT into the curriculum (Özar, 1996). Addo (2001) proposes that the quality of in-service training is crucial and more important than the nature of the hardware and software used in ICT integration into schools. In fact, not only teachers, but also inspectors, school administrators and ICT coordinators should be trained for a successful ICT integration (Akbaba-Altun, 2006).

The professional development system for teachers should involve some components to increase teachers' use of technology in their teaching. First of all, teachers' beliefs about teaching and learning play a crucial role in integrating ICT into schools (Reynolds, Treharne & Tripp, 2003; Mumtaz, 2000). Indeed, teachers need to believe that ICT will improve their teaching and their students' learning (Reynolds, Treharne & Tripp, 2003). Access to ICT resources, quality of software and hardware, ease of use, incentives to change, support and collegiality at school, school and national policies, commitment to professional learning and background in formal computer training are factors affecting teachers' decision to use technology in their teaching (Mumtaz, 2000). Besides having ICT literacy, preservice teachers need training on how to utilize ICT in their subjects (Göktaş, 2003).

Policy makers do not seem to give importance to the policies and implementations of integration of ICT into schools in any real sense. The human factor is still neglected, but it is as crucial as the financial, social and organizational costs of using ICT in education (Reynolds, Treharne & Tripp, 2003). The future of IT in Turkey is related to the extent of increase in infrastructure, general Internet access, and training opportunities for teachers (Aydın & McIsaac, 2004). In fact, the more infrastructures, access to Internet technologies and in-service training on ICT use for teachers, the more possibilities there are for economic, social and educational development in Turkey (Aydın & McIsaac, 2004).

## 5.4 Implications and Suggestions for Further Research and Practice

**Suggestions for MONE and YÖK**

In order to lessen the digital divide regarding overall ICT use and self-confidence in ICT tasks within Turkey and between Turkey and the EU, MONE should take measures to diffuse ICT at school, to develop sound ICT policies and projects to integrate ICT across the curriculum, and to give clear prescriptions about how to implement that policy-not only at national level, but also at local and school levels.

More specifically, the following suggestions for ICT-in-education policy and implementations can be made:

1. Considering the ICT-related policies and implementations of European partners, there is a need for a national short- and long-term ICT-in-education policy in a written format for K-12 schools, as has emerged from this study. A long-term and a short-term ICT-in-education policy document for K-12 schools should be developed “not solely by political authority” but “through agreement of all stakeholders in the education sector”, such as policy makers and policy implementers in MONE, universities, local administrators, public and private school administrators, teachers, students, non-governmental organizations, and parents to give ICT literacy to students and integrate ICT into all curricula. These policies should include ICT-related goals and objectives, benchmarks for students in each grade, and prescriptive information on how to use ICT across the curriculum and be rationalized through conducting needs analyses of teachers and students at schools in Turkey.

2. The ICT-in-education policy should include public and private initiatives and projects regarding the provision of ICT infrastructure like Internet connections, ICT equipment and software, integration of ICT across the curriculum, teacher training, pedagogical and technical support and maintenance, and research.

3. An “ICT Task Force” should be established within MONE. This task force should be responsible for developing ICT-in-education policies, and monitoring and evaluating implementations, and it should have also authority in the procurement of, and distribution of ICT facilities to schools. Furthermore, this task force should be responsible for providing classrooms in all K-12 schools with one projector and at least a computer linked to the Internet, through cooperating with private sector.

4. Each school should have an “Instructional Technology” plan developed by all school-based stakeholders, in order to integrate ICT into schools and to utilize it effectively and efficiently. Each school should be given autonomy to meet its own peculiar needs for software and ICT facilities, within the framework of the instructional technology plan for the school. For guidance on such plans, not only national, but also regional/school level ICT integration policies should be specified and published.

5. An "ICT Support Center" should be established in each K-12 school to develop instructional materials across the curriculum, with the help of the computer teacher in charge of this unit. This center should employ VET trainees as technical support personnel to support teachers in provision of ICT equipment and facilities and in using these materials. Considering the financial burden of employing a full-time computer technician at school, students in computer-related departments at VET schools should be assigned as trainees, within their apprenticeships, to help teachers in the case of any breakdown or technical problem in classrooms or IT rooms. In this way, just-in-time technological support would be provided for teachers.

Because of Turkish students' relatively low Internet use and self-confidence in ICT tasks compared to both EU groups, the following suggestions are made:

6. The ICT diffusion policy into primary and secondary schools should be continued. All schools should be provided with secure, fast Internet connections. Besides, establishing IT rooms in each school, each classroom should also be provided with a multimedia computer, Internet connection and a projector, to facilitate integration of ICT across the curriculum. In this way, Turkish students can develop self-confidence in ICT tasks through individually engaging in learning environments with ICT.

7. The policy of employing computer teachers in primary and secondary schools should be continued, but the roles and duties of computer teachers should be redefined. They should not only teach students computer competencies in separate computer courses –which is what they are mainly supposed to do at school at present-, they should also be ICT coordinators acting as change agents and consultants in the integration of ICT into the whole curriculum.

8. The curriculum of computer courses should be updated regularly in accordance with technological and pedagogical developments. For instance, with the emerging importance of the Internet in daily life, more objectives related to learning "how to use the Internet effectively and efficiently" should be added to the curricula. The approach of teacher-centered instruction and the objectives of the curriculum including how to use menu options should be excluded. Rather, a more authentic, learner-centered and problem-based learning should be given priority in giving ICT literacy to students. The objectives of ICT related courses should be meaningful for

students and in accordance with their developmental stages. These courses should be compulsory courses in the K-12 curriculum.

**9.** The ICT related objectives should not be part of separate ICT courses only; they should also exist in the curriculum of other subjects. For instance, homework or projects to be prepared in other subjects through utilizing ICT facilities like the Internet should be promoted with bonus points, as long as students are provided with ICT facilities to do homework. In this way, ICT competencies will be acquired through authentic tasks and use of ICT will enhance student learning in other subjects.

**10.** The student-to-computer ratio should be minimized to one-to-one in computer courses. In order to achieve this, classes can be divided into two sections and one section can take another course concurrently while the other section is taking an ICT- related course in the IT room. Also, number of ICT related courses in a week should be increased; besides number of students in a course can be reduced by dividing them into two or three sections for ICT-related laboratory activities, so as to give opportunity to students to use ICT individually.

**11.** IT rooms should be kept open to students, not only during computer courses, but also at lunch breaks, after school, and at weekends. In this way, students will have the opportunity to practise their computer skills without any cost. VET trainees can be employed for operation and maintenance of IT rooms under the supervision of computer teachers for out-of lesson hours.

**12.** Not only computer teachers but also subject teachers should be encouraged to use ICT facilities and IT rooms for their lessons. For this aim, ongoing professional development programs meeting the real needs of teachers should be planned and implemented at schools, where they work in order to influence teachers' attitudes and beliefs about technology in teaching and learning. Computer teachers can also work as coordinators of professional development for ICT integration into curricula in every school.

**13.** In order to increase the contribution of computer teachers to, and the participation of teachers in in-service training, some incentives such as an increase in salary and/or promotion should be given.

**14.** A nationwide portal should be developed to share experiences and best examples on ICT implementations across the curriculum for K-12 school teachers. Through this portal, instructional materials developed in ICT Support Centers and the most effective instructional methods for different subjects would also be shared by teachers at different schools. The responsibility for service, maintenance and updating of this portal should be given to the "ICT Task Force" with the consultation of teacher education departments in universities.

**15.** The government should make regulations concerning reducing taxes on computers and Internet connections to increase the diffusion of ICT at home.

Due to Turkish students' relatively positive attitudes toward computers, the following suggestion can be made:

**16.** The more positive attitudes toward computers of Turkish students can be exploited in the affective domain of pedagogy across the curriculum. More specifically, students with low motivation toward learning can be encouraged through educational computer games to learn other subjects. Besides, basic computer skills can be acquired by pupils through computer games.

Based on the results of mathematical and problem solving literacy performance models, the following suggestions could be made:

**17.** The results indicate a negative and small correlational relationship between students' mathematical and problem solving literacy performance with their overall ICT use. Since both very frequent and rare ICT uses in teaching and learning affect student learning negatively, the use of ICT in education should be adjusted to a medium frequency at school.

**18.** Subject teachers should be trained in "how to use and evaluate instructional software in their own fields" in preservice and in-service teacher training programs. They should practise these skills in their preservice education.

**19.** Since there are negative relationships between students' self-confidence in advance ICT tasks and mathematical and problem solving literacy performances at moderate level, objectives related to advanced ICT tasks should be limited in compulsory curricula in order not to negatively affect students' academic performance.

**Suggestions for further research:**

**1.** Since this is a macro level study, that is, it is very large in terms of scope, content, and sample, more studies at a micro level should be conducted in order to understand the specific reasons underlying the results of this study and to verify or falsify the results of this study. Such micro level studies should be supported with the qualitative research methods of interview, observation and document analysis.

**2.** Since data on ICT aspects, and socioeconomic and cultural status are completely based on the perceptions of students in the comparison of students in the EU and Turkey regarding ICT, more observational and/or experimental studies need to be designed and conducted for more causal results, instead of correlational ones. Therefore, the next logical step in forwarding this research is to conduct more micro level causal-comparative studies based on experimental and observational data. In this sense, in order to understand the direct effects of students' ICT use, self-confidence in ICT, attitudes toward computers, and socioeconomic and cultural status on mathematical and problem solving literacy performance, more experimental studies investigating the effects of ICT on student performance need to be conducted at a micro level for different school types, ages, and regions etc.

**3.** The overall use of ICT represents a negative and small relationship with students' mathematical and problem solving literacy performance. At this point, the questions of how students use ICT and what students do with ICT gain importance and should be answered in order to specify the real impact of ICT on student performance. Drawing a profile of high-achieving students' ICT use format may indicate how ICT should be used for students with similar circumstances.

**4.** Since computers, especially ICT facilities are relatively new as educational technologies, in order to integrate ICT successfully in mathematics teaching and learning new pedagogical approaches need to be investigated.

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# APPENDIX A

# THE DESCRIPTIVE STATISTICS OF EACH ICT AND ESCS INDEX FOR COUNTRY GROUPS

Table A.1 Descriptive Statistics of Each ICT and ESCS Index for the EU Member Group

| | | EU Member Group | | | | | |
|---|---|---|---|---|---|---|---|
| | Observed Item | Max | Min | Mean | SD | Skewness | Kurtosis |
| INTUSE | The Internet to look up information about people, things, or ideas | 5,00 | 1,00 | 3,4626 | 1,17828 | -0,553 | -0,488 |
| | Games on a computer | 5,00 | 1,00 | 3,3544 | 1,37578 | -0,401 | -1,089 |
| | The Internet to collaborate with a group or team | 5,00 | 1,00 | 2,4974 | 1,36362 | 0,378 | -1,145 |
| | The Internet to download software | 5,00 | 1,00 | 2,8365 | 1,51353 | 0,076 | -1,469 |
| | The Internet to download music | 5,00 | 1,00 | 3,1043 | 1,58072 | -0,175 | -1,525 |
| | A computer for electronic communication (e.g. e-mail or “chat rooms”) | 5,00 | 1,00 | 3,3623 | 1,50186 | -0,431 | -1,263 |
| PRGUSE | Word processing (e.g. Microsoft Word or Word Perfect | 5,00 | 1,00 | 3,3311 | 1,13722 | -0,523 | -0,447 |
| | Spreadsheets (e.g. Lotus 1-2-3 or Microsoft Excel | 5,00 | 1,00 | 2,3060 | 1,23358 | 0,500 | -0,916 |
| | Drawing, painting or graphics programs on a computer | 5,00 | 1,00 | 2,5989 | 1,29757 | 0,281 | -1,084 |
| | Educational software such as mathematics programs | 5,00 | 1,00 | 1,8705 | 1,12080 | 1,104 | 0,175 |
| | The computer to help you learn school material | 5,00 | 1,00 | 2,6876 | 1,29483 | 0,104 | -1,181 |
| | The computer for programming | 5,00 | 1,00 | 2,2641 | 1,37363 | 0,668 | -0,906 |
| ROUTCONF | Start a computer game. | 4,00 | 1,00 | 3,8590 | 0,44420 | -3,651 | 14,722 |
| | Open a file. | 4,00 | 1,00 | 3,8893 | 0,40960 | -4,336 | 20,789 |
| | Create/edit a document. | 4,00 | 1,00 | 3,7410 | 0,62294 | -2,647 | 6,810 |
| | Scroll a document up and down a screen. | 4,00 | 1,00 | 3,8135 | 0,57689 | -3,460 | 11,905 |
| | Copy a file from a floppy disk | 4,00 | 1,00 | 3,6678 | 0,68412 | -2,120 | 3,844 |
| | Save a computer document or file. | 4,00 | 1,00 | 3,8606 | 0,47527 | -3,914 | 16,225 |
| | Print a computer document or file. | 4,00 | 1,00 | 3,8701 | 0,45937 | -4,062 | 17,567 |
| | Delete a computer document or file. | 4,00 | 1,00 | 3,8630 | 0,47124 | -3,972 | 16,806 |
| | Moves files form one place to another on a computer. | 4,00 | 1,00 | 3,6895 | 0,64524 | -2,227 | 4,649 |
| | Play computer games. | 4,00 | 1,00 | 3,8954 | 0,40335 | -4,510 | 22,391 |
| | Draw pictures using a mouse. | 4,00 | 1,00 | 3,8162 | 0,51913 | -3,174 | 10,455 |

Table A.1 Continued.

| | Observed Item | EU Member Group | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Max** | **Min** | **Mean** | **SD** | **Skewness** | **Kurtosis** |
| **INTCONF** | Get on to the Internet. | 4,00 | 1,00 | 3,8740 | 0,45313 | -4,088 | 17,660 |
| | Copy or download files from the Internet. | 4,00 | 1,00 | 3,5752 | 0,73470 | -1,684 | 2,043 |
| | Attach a file to an email message | 4,00 | 1,00 | 3,3349 | 0,88804 | -1,124 | 0,211 |
| | Download music from the Internet. | 4,00 | 1,00 | 3,4784 | 0,79481 | -1,342 | 0,762 |
| | Write and send emails. | 4,00 | 1,00 | 3,6945 | 0,67148 | -2,257 | 4,384 |
| **HIGHCONF** | Use software to find and get rid of computer viruses. | 4,00 | 1,00 | 2,9803 | 0,94483 | -0,385 | -1,016 |
| | Use a database to produce a list of addresses. | 4,00 | 1,00 | 3,2105 | 0,94003 | -0,993 | -0,027 |
| | Create a computer program (e.g. in Logo, Pascal, Basic) | 4,00 | 1,00 | 2,6438 | 0,95257 | -0,125 | -0,927 |
| | Use a spreadsheet to plot a graph | 4,00 | 1,00 | 3,1010 | 0,97010 | -0,763 | -0,519 |
| | Create a presentation (e.g. using <Microsoft PowerPoint>). | 4,00 | 1,00 | 3,1487 | 0,98118 | -0,864 | -0,404 |
| | Create a multi-media presentation (with sound, pictures, vide. | 4,00 | 1,00 | 2,9928 | 0,90991 | -0,451 | -0,784 |
| | Construct a Web page. | 4,00 | 1,00 | 2,8479 | 0,87004 | -0,205 | -0,808 |
| **ATTCOMP** | It is very important to me to work with a computer. | 4,00 | 1,00 | 3,2799 | 0,78100 | -0,813 | -0,057 |
| | To play or work with a computer is really fun. | 4,00 | 1,00 | 3,4004 | 0,70021 | -1,042 | 0,893 |
| | I use a computer because I am very interested. | 4,00 | 1,00 | 3,1985 | 0,82829 | -0,682 | -0,430 |
| | I lose track of time, when I am working with the computer. | 4,00 | 1,00 | 3,0440 | 0,91313 | -0,492 | -0,831 |
| **ESCS** | Highest parental occupational status | 90 | 16 | 48,87 | 16,444 | 0,293 | -0,578 |
| | Highest parental education in years of schooling | 17 | 0 | 13,01 | 3,596 | -1,397 | 2,432 |
| | Index of home possessions (WLE) | 1,94 | -3,79 | 0,09 | 0,93 | 0,055 | 0,292 |

Table A.2 Descriptive Statistics of Each ICT and ESCS Index for the New EU Member Group

| | Observed Item | New EU Member Group Max | Min | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| **INTUSE** | The Internet to look up information about people, things, or ideas | 5,00 | 1,00 | 3,1140 | 1,22661 | -0,310 | -0,872 |
| | Games on a computer | 5,00 | 1,00 | 3,4501 | 1,30941 | -0,475 | -0,916 |
| | The Internet to collaborate with a group or team | 5,00 | 1,00 | 2,5874 | 1,36464 | 0,244 | -1,247 |
| | The Internet to download software | 5,00 | 1,00 | 2,3886 | 1,39595 | 0,505 | -1,114 |
| | The Internet to download music | 5,00 | 1,00 | 2,5800 | 1,46732 | 0,305 | -1,355 |
| | A computer for electronic communication (e.g. e-mail or "chat rooms") | 5,00 | 1,00 | 2,9451 | 1,43048 | -0,091 | -1,343 |
| **PRGUSE** | Word processing (e.g. Microsoft Word or Word Perfect | 5,00 | 1,00 | 3,1398 | 1,20701 | -0,374 | -0,798 |
| | Spreadsheets (e.g. Lotus 1-2-3 or Microsoft Excel | 5,00 | 1,00 | 2,5321 | 1,23279 | 0,236 | -1,062 |
| | Drawing, painting or graphics programs on a computer | 5,00 | 1,00 | 2,8057 | 1,23201 | 0,104 | -0,992 |
| | Educational software such as mathematics programs | 5,00 | 1,00 | 2,1188 | 1,20589 | 0,749 | -0,569 |
| | The computer to help you learn school material | 5,00 | 1,00 | 2,5791 | 1,28520 | 0,209 | -1,153 |
| | The computer for programming | 5,00 | 1,00 | 2,1442 | 1,32913 | 0,800 | -0,684 |
| **ROUTCONF** | Start a computer game. | 4,00 | 1,00 | 3,8354 | 0,46803 | -3,263 | 11,730 |
| | Open a file. | 4,00 | 1,00 | 3,8500 | 0,48055 | -3,732 | 15,020 |
| | Create/edit a document. | 4,00 | 1,00 | 3,6390 | 0,72777 | -2,153 | 4,058 |
| | Scroll a document up and down a screen. | 4,00 | 1,00 | 3,8001 | 0,57125 | -3,240 | 10,653 |
| | Copy a file from a floppy disk | 4,00 | 1,00 | 3,5683 | 0,77597 | -1,762 | 2,207 |
| | Save a computer document or file. | 4,00 | 1,00 | 3,7601 | 0,60614 | -2,800 | 7,723 |
| | Print a computer document or file. | 4,00 | 1,00 | 3,6509 | 0,70497 | -2,103 | 3,796 |
| | Delete a computer document or file. | 4,00 | 1,00 | 3,7634 | 0,60805 | -2,841 | 7,914 |
| | Moves files form one place to another on a computer. | 4,00 | 1,00 | 3,6069 | 0,72777 | -1,899 | 2,954 |
| | Play computer games. | 4,00 | 1,00 | 3,8698 | 0,45787 | -4,115 | 18,303 |
| | Draw pictures using a mouse. | 4,00 | 1,00 | 3,8450 | 0,49700 | -3,701 | 14,505 |

Table A.2 Continued.

| | Observed Item | New EU Member Group | | | | | |
|---|---|---|---|---|---|---|---|
| | | Max | Min | Mean | SD | Skewness | Kurtosis |
| INTCONF | Get on to the Internet. | 4,00 | 1,00 | 3,6637 | 0,72166 | -2,164 | 3,803 |
| | Copy or download files from the Internet. | 4,00 | 1,00 | 3,3787 | 0,84783 | -1,168 | 0,367 |
| | Attach a file to an email message | 4,00 | 1,00 | 3,0783 | 0,95905 | -0,670 | -0,657 |
| | Download music from the Internet. | 4,00 | 1,00 | 3,2689 | 0,89119 | -0,934 | -0,198 |
| | Write and send emails. | 4,00 | 1,00 | 3,5186 | 0,81737 | -1,605 | 1,564 |
| HIGHCONF | Use software to find and get rid of computer viruses. | 4,00 | 1,00 | 2,9247 | 0,98897 | -0,356 | -1,090 |
| | Use a database to produce a list of addresses. | 4,00 | 1,00 | 3,2468 | 0,90996 | -1,045 | 0,167 |
| | Create a computer program (e.g. in Logo, Pascal, Basic) | 4,00 | 1,00 | 2,5064 | 0,96248 | 0,027 | -0,958 |
| | Use a spreadsheet to plot a graph | 4,00 | 1,00 | 3,0740 | 0,98535 | -0,714 | -0,637 |
| | Create a presentation (e.g. using <Microsoft PowerPoint>). | 4,00 | 1,00 | 2,7287 | 1,09700 | -0,290 | -1,242 |
| | Create a multi-media presentation (with sound, pictures, vide. | 4,00 | 1,00 | 2,7120 | 0,98813 | -0,183 | -1,033 |
| | Construct a Web page. | 4,00 | 1,00 | 2,7919 | 0,91652 | -0,171 | -0,920 |
| ATTCOMP | It is very important to me to work with a computer. | 4,00 | 1,00 | 3,2196 | 0,78701 | -0,661 | -0,351 |
| | To play or work with a computer is really fun. | 4,00 | 1,00 | 3,3523 | 0,68448 | -0,858 | 0,616 |
| | I use a computer because I am very interested. | 4,00 | 1,00 | 3,2457 | 0,77183 | -0,701 | -0,235 |
| | I lose track of time, when I am working with the computer. | 4,00 | 1,00 | 3,0917 | 0,85913 | -0,509 | -0,707 |
| ESCS | Highest parental occupational status | 90 | 16 | 49,91 | 15,683 | 0,297 | -0,463 |
| | Highest parental education in years of schooling | 17 | 0 | 13,64 | 2,344 | -0,371 | 2,186 |
| | Index of home possessions (WLE) | 1,94 | -3,79 | -0,11 | 0,83 | 0,033 | 0,551 |

Table A.3 Descriptive Statistics of Each ICT and ESCS Index for Turkey

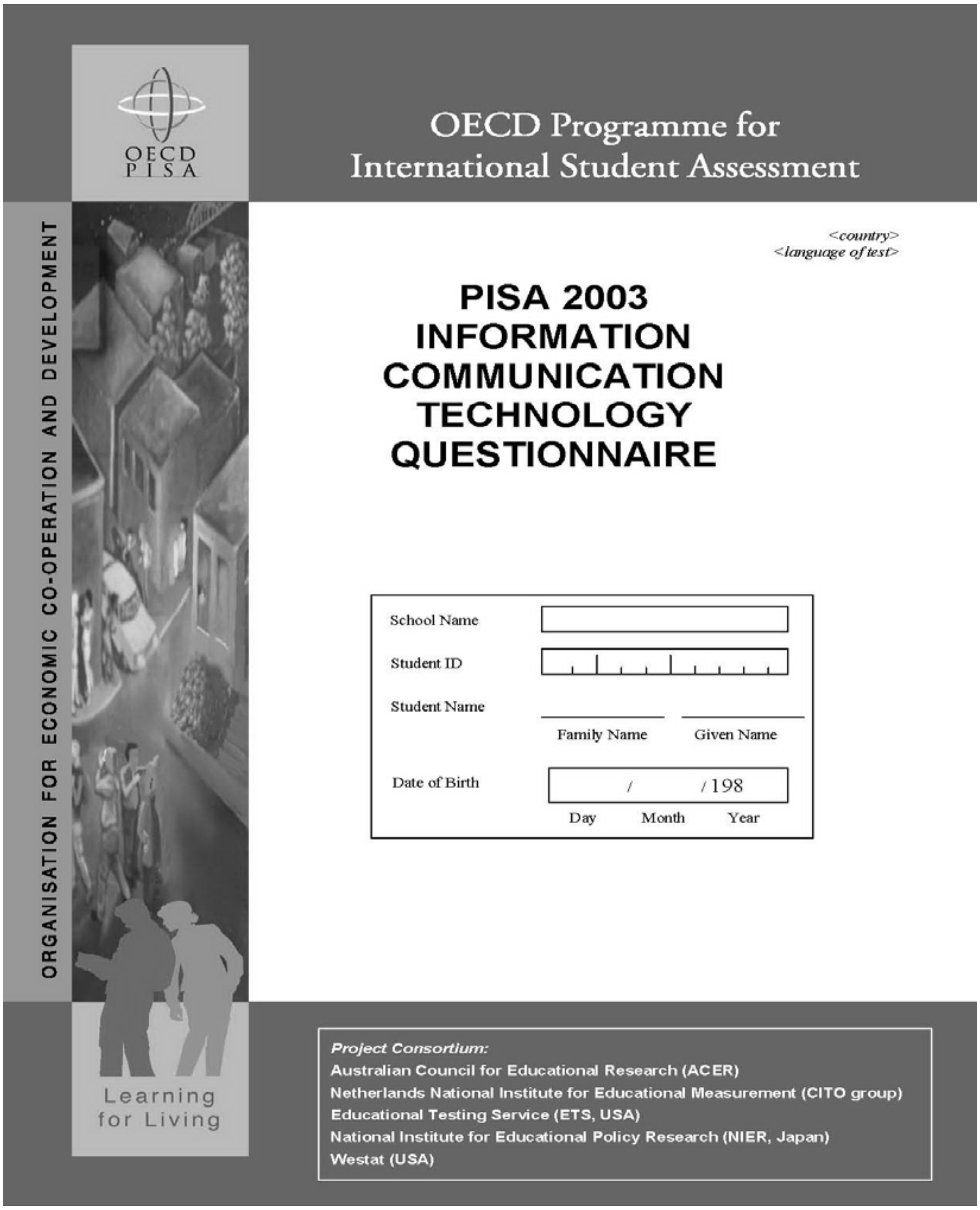
| | | Turkey | | | | | |
|---|---|---|---|---|---|---|---|
| | **Observed Item** | **Max** | **Min** | **Mean** | **SD** | **Skewness** | **Kurtosis** |
| **INTUSE** | The Internet to look up information about people, things, or ideas | 5,00 | 1,00 | 2,7787 | 1,42762 | 0,050 | -1,386 |
| | Games on a computer | 5,00 | 1,00 | 3,3870 | 1,29984 | -0,534 | -0,847 |
| | The Internet to collaborate with a group or team | 5,00 | 1,00 | 2,4059 | 1,39853 | 0,419 | -1,264 |
| | The Internet to download software | 5,00 | 1,00 | 2,8136 | 1,44772 | 0,022 | -1,427 |
| | The Internet to download music | 5,00 | 1,00 | 2,9994 | 1,48956 | -0,141 | -1,433 |
| | A computer for electronic communication (e.g. e-mail or “chat rooms”) | 5,00 | 1,00 | 2,8643 | 1,52745 | 0,005 | -1,517 |
| **PRGUSE** | Word processing (e.g. Microsoft Word or Word Perfect | 5,00 | 1,00 | 2,9147 | 1,42101 | -0,126 | -1,382 |
| | Spreadsheets (e.g. Lotus 1-2-3 or Microsoft Excel | 5,00 | 1,00 | 2,4865 | 1,40422 | 0,300 | -1,364 |
| | Drawing, painting or graphics programs on a computer | 5,00 | 1,00 | 3,0358 | 1,33607 | -0,216 | -1,185 |
| | Educational software such as mathematics programs | 5,00 | 1,00 | 2,3286 | 1,36995 | 0,522 | -1,124 |
| | The computer to help you learn school material | 5,00 | 1,00 | 2,4950 | 1,42956 | 0,335 | -1,341 |
| | The computer for programming | 5,00 | 1,00 | 2,6780 | 1,47599 | 0,177 | -1,454 |
| **ROUTCONF** | Start a computer game. | 4,00 | 1,00 | 3,7127 | 0,63929 | -2,600 | 6,952 |
| | Open a file. | 4,00 | 1,00 | 3,6172 | 0,74481 | -2,108 | 3,909 |
| | Create/edit a document. | 4,00 | 1,00 | 3,2042 | 0,93773 | -1,032 | 0,120 |
| | Scroll a document up and down a screen. | 4,00 | 1,00 | 3,5011 | 0,86044 | -1,720 | 1,973 |
| | Copy a file from a floppy disk | 4,00 | 1,00 | 3,4032 | 0,88289 | -1,423 | 1,088 |
| | Save a computer document or file. | 4,00 | 1,00 | 3,3905 | 0,91097 | -1,404 | 0,921 |
| | Print a computer document or file. | 4,00 | 1,00 | 3,2969 | 0,92462 | -1,209 | 0,487 |
| | Delete a computer document or file. | 4,00 | 1,00 | 3,4463 | 0,89079 | -1,571 | 1,447 |
| | Moves files form one place to another on a computer. | 4,00 | 1,00 | 3,4294 | 0,86993 | -1,491 | 1,313 |
| | Play computer games. | 4,00 | 1,00 | 3,6945 | 0,71811 | -2,554 | 5,886 |
| | Draw pictures using a mouse. | 4,00 | 1,00 | 3,6467 | 0,75498 | -2,277 | 4,449 |

Table A.3 Continued.

| | Observed Item | Turkey | | | | | |
|---|---|---|---|---|---|---|---|
| | | Max | Min | Mean | SD | Skewness | Kurtosis |
| INTCONF | Get on to the Internet. | 4,00 | 1,00 | 3,5450 | 0,81420 | -1,823 | 2,470 |
| | Copy or download files from the Internet. | 4,00 | 1,00 | 3,2314 | 0,92638 | -1,058 | 0,178 |
| | Attach a file to an email message | 4,00 | 1,00 | 3,0434 | 0,98876 | -0,775 | -0,458 |
| | Download music from the Internet. | 4,00 | 1,00 | 3,3825 | 0,89627 | -1,368 | 0,889 |
| | Write and send emails. | 4,00 | 1,00 | 3,2234 | 0,97944 | -1,077 | 0,029 |
| HIGHCONF | Use software to find and get rid of computer viruses. | 4,00 | 1,00 | 2,6853 | 0,95035 | -0,323 | -0,793 |
| | Use a database to produce a list of addresses. | 4,00 | 1,00 | 3,0891 | 0,95550 | -0,862 | -0,195 |
| | Create a computer program (e.g. in Logo, Pascal, Basic) | 4,00 | 1,00 | 2,7693 | 1,03145 | -0,435 | -0,946 |
| | Use a spreadsheet to plot a graph | 4,00 | 1,00 | 3,0181 | 0,99554 | -0,732 | -0,542 |
| | Create a presentation (e.g. using <Microsoft PowerPoint>). | 4,00 | 1,00 | 2,9859 | 1,04457 | -0,698 | -0,732 |
| | Create a multi-media presentation (with sound, pictures, vide. | 4,00 | 1,00 | 2,9565 | 0,99074 | -0,659 | -0,600 |
| | Construct a Web page. | 4,00 | 1,00 | 2,8251 | 0,98604 | -0,525 | -0,714 |
| ATTCOMP | It is very important to me to work with a computer. | 4,00 | 1,00 | 3,3894 | 0,75966 | -1,082 | 0,548 |
| | To play or work with a computer is really fun. | 4,00 | 1,00 | 3,5158 | 0,66795 | -1,397 | 2,013 |
| | I use a computer because I am very interested. | 4,00 | 1,00 | 3,1221 | 0,89442 | -0,673 | -0,507 |
| | I lose track of time, when I am working with the computer. | 4,00 | 1,00 | 3,3779 | 0,80624 | -1,214 | 0,843 |
| ESCS | Highest parental occupational status | 88 | 16 | 43,51 | 15,707 | 0,429 | -0,241 |
| | Highest parental education in years of schooling | 16 | 0 | 9,65 | 4,181 | -0,011 | -0,848 |
| | Index of home possessions (WLE) | 1,94 | -3,79 | -0,57 | 0,99 | 0,103 | 0,583 |

**APPENDIX B**

**PISA 2003 ICT QUESTIONNAIRE**



OECD PISA

OECD Programme for International Student Assessment

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

*<country>*
*<language of test>*

**PISA 2003 INFORMATION COMMUNICATION TECHNOLOGY QUESTIONNAIRE**

| | |
|---|---|
| School Name | |
| Student ID | |
| Student Name | Family Name / Given Name |
| Date of Birth | / /198 (Day Month Year) |

Learning for Living

*Project Consortium:*
Australian Council for Educational Research (ACER)
Netherlands National Institute for Educational Measurement (CITO group)
Educational Testing Service (ETS, USA)
National Institute for Educational Policy Research (NIER, Japan)
Westat (USA)

**In this <section> you are being asked about <information communication technology>. There are no 'right' or 'wrong' answers. Your answers should be the ones that are 'right' for you.**

You may ask for help if you do not understand something or are not sure how to answer a question.

**Your answers will be combined with others to make totals and averages in which no individual can be identified. All your answers will be kept confidential.**

*The following questions ask about computers: This does not include calculators or games consoles like a <Sony PlayStation™>.*

**Q1 Is there a computer available for you to use at any of these places?**

*(Please <tick> one box on each row.)*

| | *Yes* | *No* |
|---|---|---|
| a) At home ........................................................ | ☐ 1 | ☐ 2 |
| b) At school ...................................................... | ☐ 1 | ☐ 2 |
| c) At other places ............................................ | ☐ 1 | ☐ 2 |

**Q2 Have you ever used a computer?**

| *Yes* | *No* |
|---|---|
| ☐ 1 | ☐ 2 |

If you use a computer in any setting, please continue.

If you do not, please stop here. <Instructions>

**Q3 How long have you been using computers?**

*(Please tick only one box.)*

| | |
|---|---|
| Less than one year. ................. | ☐ 1 |
| One to three years. ................. | ☐ 2 |
| Three to five years. ................. | ☐ 3 |
| More than five years. ............ | ☐ 4 |

## Q4 How <u>often</u> do you use a computer at these places?

*(Please <tick> one box on each row.)*

| | *Almost every day* | *A few times each week* | *Between once a week and once a month* | *Less than once a month* | *Never* |
|---|---|---|---|---|---|
| a) At home | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| b) At school | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| c) At other places | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

## Q5 How <u>often</u> do you use:

*(Please <tick> one box on each row.)*

| | *Almost every day* | *A few times each week* | *Between once a week and once a month* | *Less than once a month* | *Never* |
|---|---|---|---|---|---|
| a) the Internet to look up information about people, things, or ideas? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| b) games on a computer? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| c) Word processing (e.g. <Word ® or WordPerfect®>)? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| d) the Internet to collaborate with a group or team? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| e) spreadsheets (e.g. <Lotus 1 2 3 ® or Microsoft Excel®>)? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| f) the Internet to download software (including games)? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| g) drawing, painting or graphics programs on a computer? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| h) educational software such as Mathematics programs? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| i) the computer to help you learn school material? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| j) the Internet to down-load music? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| k) the computer for programming? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| l) a computer for electronic communication (e.g. e-mail or "chat rooms")? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**Q6 How well can you do each of these tasks on a computer?**

*(Please <tick> one box on each row.)*

| | *I can do this very well by myself.* | *I can do this with help from someone.* | *I know what this means but I cannot do it.* | *I don't know what this means.* |
|---|---|---|---|---|
| a) Start a computer game. | ☐1 | ☐2 | ☐3 | ☐4 |
| b) Use software to find and get rid of computer viruses. | ☐1 | ☐2 | ☐3 | ☐4 |
| c) Open a file. | ☐1 | ☐2 | ☐3 | ☐4 |
| d) Create/edit a document. | ☐1 | ☐2 | ☐3 | ☐4 |
| e) Scroll a document up and down a screen. | ☐1 | ☐2 | ☐3 | ☐4 |
| f) Use a database to produce a list of addresses. | ☐1 | ☐2 | ☐3 | ☐4 |
| g) Copy a file from a floppy disk. | ☐1 | ☐2 | ☐3 | ☐4 |
| h) Save a computer document or file. | ☐1 | ☐2 | ☐3 | ☐4 |
| i) Print a computer document or file. | ☐1 | ☐2 | ☐3 | ☐4 |
| j) Delete a computer document or file. | ☐1 | ☐2 | ☐3 | ☐4 |
| k) Move files from one place to another on a computer. | ☐1 | ☐2 | ☐3 | ☐4 |
| l) Get on to the Internet. | ☐1 | ☐2 | ☐3 | ☐4 |
| m) Copy or download files from the Internet. | ☐1 | ☐2 | ☐3 | ☐4 |
| n) Attach a file to an e-mail message. | ☐1 | ☐2 | ☐3 | ☐4 |
| o) Create a computer program (e.g. in <Logo, Pascal, Basic>). | ☐1 | ☐2 | ☐3 | ☐4 |
| p) Use a spreadsheet to plot a graph. | ☐1 | ☐2 | ☐3 | ☐4 |
| q) Create a presentation (e.g. using <PowerPoint>). | ☐1 | ☐2 | ☐3 | ☐4 |

| | I can do this very well by myself. | I can do this with help from someone. | I know what this means but I cannot do it. | I don't know what this means. |
|---|---|---|---|---|
| r) Play computer games. ........................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| s) Download music from the Internet. ...... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| t) Create a multi-media presentation (with sound, pictures, video). ............... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| u) Draw pictures using a mouse. ............... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| v) Write and send e-mails. ......................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| w) Construct a web page. ........................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |

**Q7** *Thinking about your experience with computers:* **To what extent do you agree with the following statements?**

*(Please <tick> one box on each row.)*

| | Strongly agree | Agree | Disagree | Strongly disagree |
|---|---|---|---|---|
| a) It is very important to me to work with a computer. ...................................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| b) I think playing or working with a computer is really fun. ................................ | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| c) I use a computer because I am very interested. ..................................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |
| d) I lose track of time when I am working with the computer. ....................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 |

**Q8 Who taught you <u>most</u> about how to use COMPUTERS?**

*(Please <tick> only one box.)*

My school. .................................................... ☐1

My friends. ................................................... ☐2

My family. .................................................... ☐3

I taught myself. ........................................... ☐4

Others. ......................................................... ☐5

**Q9 Who taught you <u>most</u> about how to use the INTERNET?**

*(Please <tick> only one box.)*

I don't know how to use the Internet. .......... ☐1

My school. .................................................... ☐2

My friends. ................................................... ☐3

My family. .................................................... ☐4

I taught myself. ........................................... ☐5

Others. ......................................................... ☐6

# APPENDIX C

## INTERVIEWER SCHEDULE – INTERVIEWER

### GÖRÜŞME REHBERİ – GÖRÜŞMECİ

| **Görüşülen** | | **Görüşen** | |
|---|---|---|---|
| Adı Soyadı: | ____________________ | Adı Soyadı: | ____________________ |
| Kurumu: | ____________________ | Kurumu: | ____________________ |
| Birimi: | ____________________ | Birimi: | ____________________ |
| Görevi: | ____________________ | Görevi: | ____________________ |
| Unvanı: | ____________________ | Unvanı: | ____________________ |
| Tarih: | ____________________ | | |

Zaman: Başlama:________Bitiş:________

**I. Giriş**

Merhaba, benim adım Yunus Şahinkayası. ODTÜ, Eğitim Fakültesi, Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümünde Araştırma Görevlisiyim ve doktora yapmaktayım. OECD tarafından 2003 yılında aralarında Türkiye'nin de bulunduğu "Uluslararası Öğrenci Değerlendirme Programı (PISA)" adlı bir proje gerçekleştirildi. Bu proje kapsamında öğrencilerin algıladıkları bilgi ve iletişim teknolojileri (BİT) bilgisi, becerisi ve tutumu incelendi. Ben, bu proje kapsamında öğrencilerin BİT boyutu sonuçları ve BİT boyutu ile matematik ve problem çözme başarıları arasındaki ilişkileri gösteren modelleri Avrupa Birliği üyeleri ve yeni üyeleri ile Türkiye açısından karşılaştırmalı bir araştırma yapıyorum. Bu anlamda, politika oluşturanlarla görüşüyorum ve BİT politikalarıyla ilgili düşüncelerinizi öğrenmek istiyorum. Özellikle, BİT politikalarıyla ilgili kişisel algılarınız, deneyimleriniz, görüşleriniz ve yorumlarınızla ilgileniyorum. Görüşmemiz yaklaşık bir saat sürecektir. Araştırma sonuçları yayınlanırken sizin kimliğiniz kesinlikle gizli kalacaktır. Bu arada sizce bir sakıncası yoksa, görüşmenin daha sağlıklı analizi için görüşmeyi kaydedebilir miyim? Bu çalışmaya katıldığınız için çok teşekkür ederim. Görüşmeye başlamadan önce herhangi bir sorunuz var mı?

Öncelikle mesleğinizle ilgili bazı sorularım olacak.

**II. Gelişme**

**A. Genel Demografik Bilgi**

1. Hangi üniversiteden, hangi bölümden ne zaman mezun oldunuz?
2. Ne zamandan beri bu kurumda çalışıyorsunuz?
3. Ne zamandan beri bu birimde çalışıyorsunuz?
4. Uzmanlık alanınız nedir?

**B. PISA 2003 BİT Boyutu Sonuçları, Önerilen Model ve BİT Politikaları**

Şimdi, size daha önce ulaşmış ve sizin incelemiş olduğunuz PISA 2003 BİT boyutu sonuçları, önerilen model ve BİT politikaları ile ilgili bazı sorularım olacak.

**1.** Daha önce size verilen ve incelemiş olduğunuz PISA 2003 BİT boyutu Türkiye ve Avrupa Birliği üyeleri ve yeni üyeleri sonuçlarını ve Türkiye için önerilen modeli nasıl değerlendiriyorsunuz?

**a.** Algılanan BİT kullanım çeşidi
- i. İnternet/Eğlence kullanımı
  - a. ANCOVA / MANCOVA
- ii. Program/Yazılım kullanımı
  - a. ANCOVA / MANCOVA

**b.** Algılanan BİT kullanım öz güveni
- i. İnternet kullanımında kendine güven
  - a.ANCOVA /MANCOVA
- ii. Rutin kullanımda kendine güven
  - a.ANCOVA / MANCOVA
- iii. İleri düzey kullanımda kendine güven
  - a.ANCOVA / MANCOVA

**c.** Bilgisayara yönelik tutum
- a. Univariate ANCOVA

**d.** Önerilen modeller

**2.** Bu çalışmanın BİT boyutu sonuçlarını genel olarak nasıl buluyorsunuz, yorumlayabilir misiniz?

**3.** PISA 2003 BİT boyutu Türkiye sonuçları, eğitimde BİT politikalarını etkiledi mi? Nasıl?

*Alternatif Soru:*
Eğitimde BİT politikaları oluşturulurken PISA 2003 Türkiye BİT boyutu sonuçları dikkate alındı mı? Politika değişikliğine gidildi mi? / Yeni bir politika oluşturuldu mu? Nasıl?

**4.** Bu çalışmanın Türkiye BİT boyutu sonuçları, BİT' ye bakış açınızda herhangi bir değişime yol açtı mı?

**a.** Bilgisayar
**b.** Yazılım
**c.** Donanım
**d.** Teknik alt yapı
**e.** Teknik destek
**f.** Okullardaki bilgisayar yeterliği
**g.** Bilgisayara ulaşılabilirlik
**h.** İnternet'e ulaşılabilirlik
**i.** Pedagojik konular
**j.** BİT' nin programla bütünleştirilmesi

**5.** Eğitimde BİT politikası oluşturulması ve uygulanması sürecinde sorunlarla karşılaşıyor musunuz? Karşılaştığınız sorunlarla bu çalışmanın sonuçları ne ölçüde örtüşüyor? Bu sorunlarla nasıl başa çıkıyorsunuz?

**6.** PISA 2003 çalışması gibi uluslar arası çalışmaların sonuçlarını dikkate alınırsanız, kişisel deneyimlerinize dayanarak Türk BİT politikasının geliştirilmesine ve uygulamasına yönelik önerileriniz nelerdir?

**7.** Eklemek istediğiniz herhangi bir şey var mı?

**III. Kapanış**

**A.** Görüşülenlerin özetlenmesi

**B.** Görüşmeye katıldığınız ve katkıda bulunduğunuz için çok teşekkür ederim. Konuştuklarınızın dışında, BİT kullanımı ve BİT politikalarıyla ilgili görüşleriniz varsa, lütfen söyleyiniz.

**C.** Eğer sizinle tekrar görüşme ihtiyacı hissedersem, sizi tekrar arayabilir miyim? Tekrar teşekkür ederim.

# APPENDIX D

# INTERVIEW SCHEDULE – BEFORE AND DURING INTERVIEW

## GÖRÜŞME ÖNCESİ-SIRASI REHBER-GÖRÜŞÜLEN ve GÖRÜŞEN

Uluslararası Öğrenci Değerlendirme Programı (PISA), Ekonomik İşbirliği ve Kalkınma Örgütü (OECD)'nün 2000'de başlattığı ve öğrenci performanslarını uluslararası arenada karşılaştırmalı olarak değerlendirmeye imkan veren bir projedir. Bu projenin amacı, temel eğitimini tamamlamak üzere olan öğrencilerin "matematik", "fen bilgisi" ve "okuma ve anlama" gibi alanlar açısından gerçek hayata ne kadar hazırlandıklarını araştırmaktır. Dolayısıyla, bu proje 15 yaş grubu öğrencilerin matematik, fen bilgisi ve okuma ve anlama alanlarındaki bilgi ve becerilerini periyodik (üç yıllık) olarak bir alana yoğunlaşarak ölçer (2000'de okuma ve anlama, 2003'de matematik ve 2006'da fen bilgisi). PISA projesi 2003 yılında, bu alanların yanı sıra, "problem çözme" alanında da öğrencilerin bilgi ve becerilerini ölçmüştür. Ayrıca, PISA 2003 uygulamasında, öğrencilere ait bilgi ve iletişim teknolojileri ile ekonomik, sosyal ve kültürel durum bilgileri de demografik veri olarak toplanmıştır.

Bu araştırma, özellikle PISA 2003 çalışmasına Avrupa Birliği üyeleri ve yeni üyeleri ile Türkiye'den (ülke grupları) katılan öğrencilerin, ***matematik ve problem çözme*** performans verileri ile öğrencilerin ***bilgi ve iletişim teknolojileri*** (BİT), ***ekonomik, sosyal ve kültürel durum*** (ESKD) verilerine yoğunlaşmaktadır. Bu bağlamda, ülke gruplarının BİT değişkenlerindeki durumları incelenmiştir. Ayrıca, ESKD değişkeni ve BİT değişkenleri ile öğrencilerin matematik ve problem çözme performansları arasındaki ilişkilere dayanan modeller önerilmiştir. Ülke grupları, bunları oluşturan üyeler ve BİT değişkenleri Tablo 1'de verilmiştir.

**Tablo 1.** Ülke Grupları, Üyeleri ve BİT Değişkenleri

| AB Üyeler | | | | AB Yeni Üyeler | | Türkiye |
|---|---|---|---|---|---|---|
| Almanya<br>Avusturya<br>Belçika | Danimarka<br>Finlandiya<br>İngiltere | İrlanda<br>İsveç<br>İtalya | Portekiz<br>Yunanistan | Çek Cumhuriyeti<br>Macaristan<br>Letonya | Polonya<br>Slovakya | Türkiye |
| 1. İnternet / Eğlence Kullanımı<br>2. Program / Yazılım Kullanımı | | | 3. Rutin Kullanım Öz Güveni<br>4. İnternet Kullanım Öz Güveni | | 5. İleri Düzey Kullanım Öz Güveni<br>6. Bilgisayara İlişkin Tutum | |

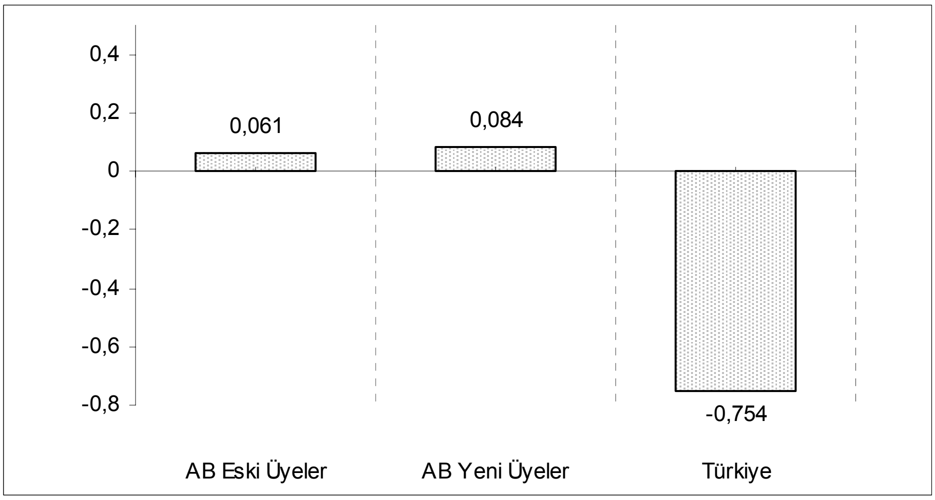
Takip eden sayfalarda sırasıyla, ülke gruplarının ESKD ve Bilgisayara İlişkin Tutum değişkeni ortalamaları, BİT değişkeninin adı, BİT değişkenini oluşturan maddeler, ülke gruplarının ilgili BİT değişkenindeki ortalamaları ve genel olarak ülke gruplarının bütün BİT değişkenlerindeki ortalamaları vardır. Daha sonra, ülke grupları için önerilen matematik ve problem çözme modelleri, modellerde bulunan değişkenler arası (ayrı ve genel olarak) ilişki büyüklükleri ve yönleri verilmiştir.

**Not:** Bu araştırmada, ülke grupları arası karşılaştırmalar yapılabilmesi için, standardize edilmiş (standartlaştırılmış) BİT değişkenleri kullanılmıştır.

## EKONOMİK, SOSYAL ve KÜLTÜREL DURUM

**Değişkenleri Oluşturan Bileşenler**

1. Anne ve babanın eğitim durumu
2. Anne ve babanın iş durumu
3. Ailenin gelir durumu
4. Evdeki kitap sayısı

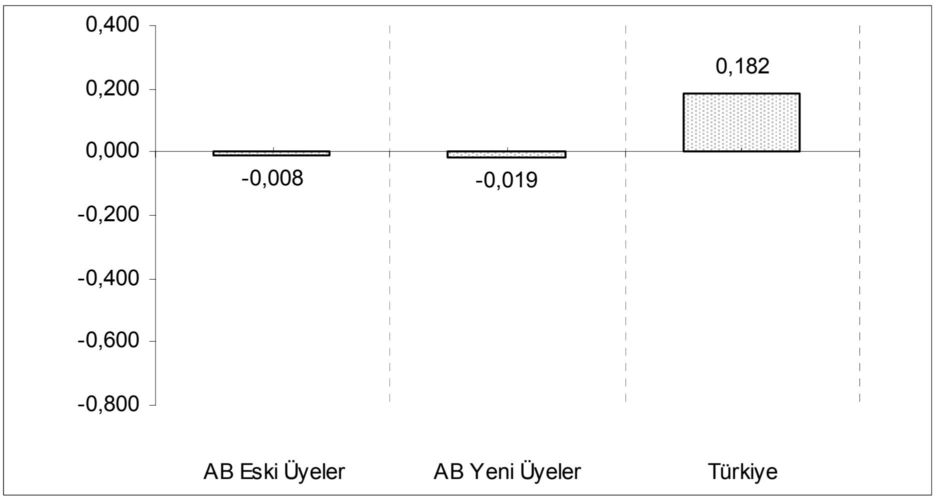



Ülke gruplarının Ekonomik, Sosyal ve Kültürel Durum ortalamaları.

## BİLGİSAYARA İLİŞKİN TUTUM

**Değişkeni Oluşturan Maddeler**

1. Bir bilgisayarla çalışmak benim için çok önemlidir.
2. Bir bilgisayarla oynamanın ya da çalışmanın gerçekten eğlenceli olduğunu düşünüyorum.
3. Bir bilgisayarı kullanıyorum çünkü çok ilgileniyorum.
4. Bilgisayarla çalışırken zamanın nasıl geçtiğini anlamıyorum.

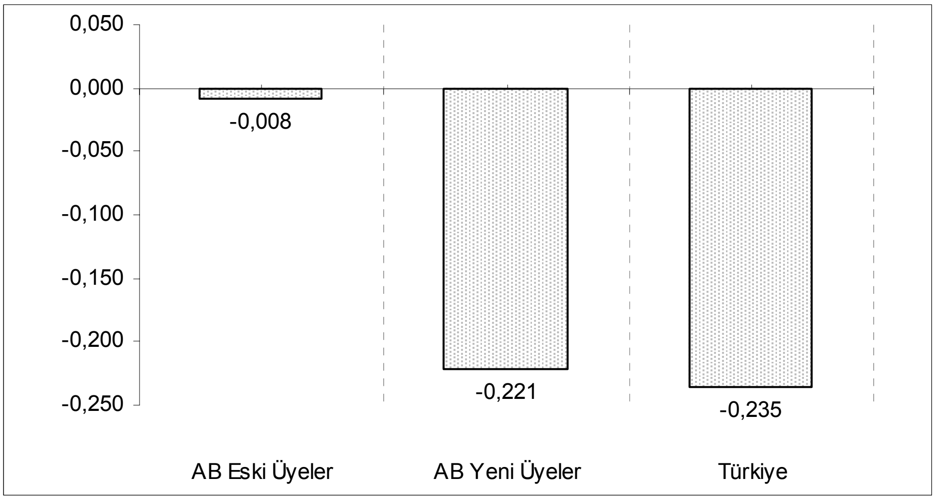



Ülke gruplarının Bilgisayara İlişkin Tutum ortalamaları.

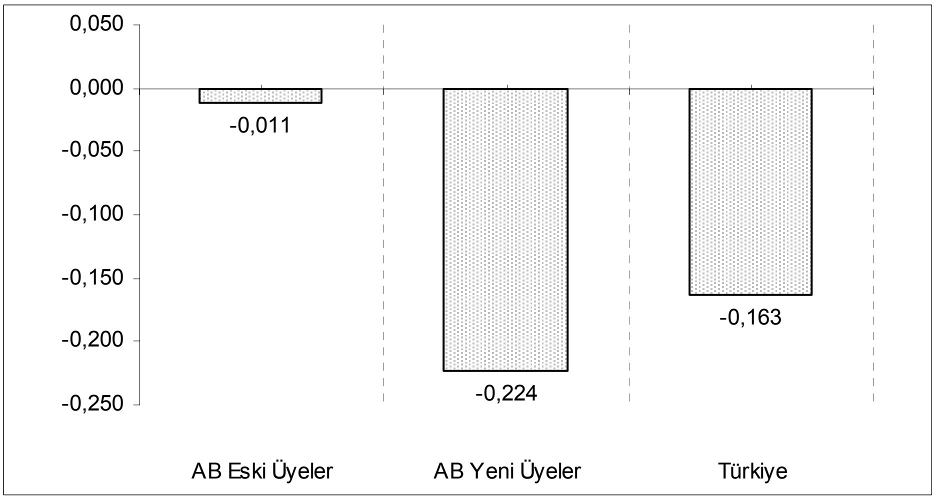
## 1. INTERNET / EĞLENCE KULLANIMI

**Değişkeni Oluşturan Maddeler**

1. İnsanlar, nesneler ya da düşünceler hakkında bilgi aramak için İnternet.
2. Bilgisayar oyunları.
3. Bir grup veya ekip ile birlikte çalışmak için İnternet.
4. İnternet'ten yazılım indirmek (oyunlar dahil).
5. Müzik parçası indirmek için İnternet.
6. Elektronik haberleşme için bilgisayar (Örneğin: e-posta ya da sohbet siteleri).




Ülke gruplarının Internet / Eğlence Kullanım ortalamaları.

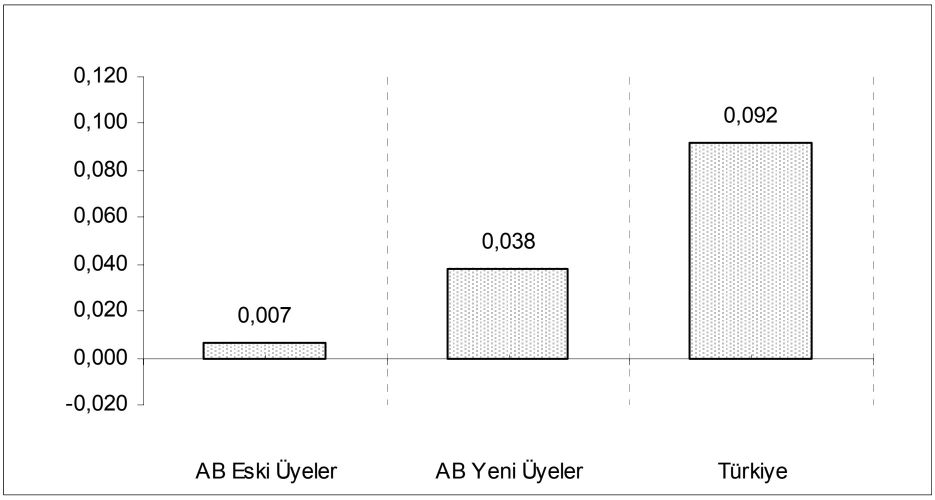



Öğrencilerin ekonomik, sosyal ve kültürel durumları ile bilgisayara ilişkin tutumlarının sabitlenmesi durumunda, ülke gruplarının Internet / Eğlence Kullanım ortalamaları.

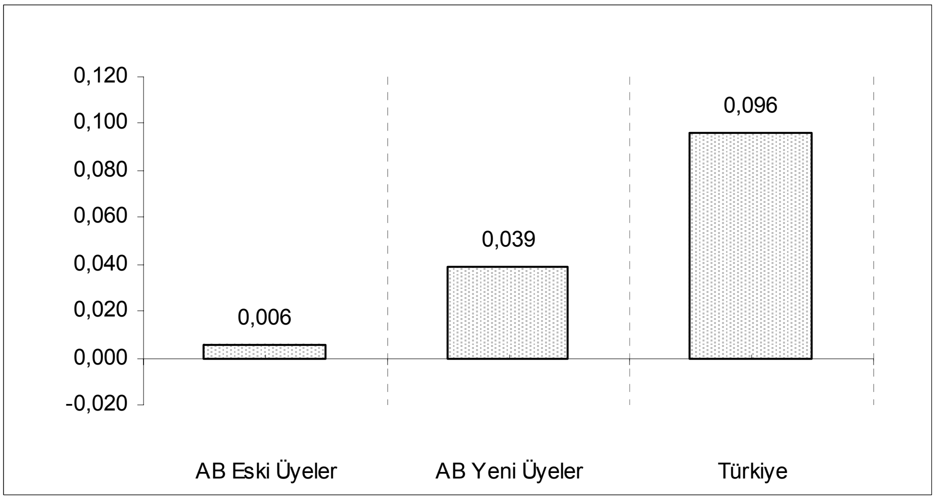
## 2. PROGRAM / YAZILIM KULLANIMI

**Değişkeni Oluşturan Maddeler**

1. Yazım programları (Word® veya Word Perfect®).
2. Tablo ve grafik programları (Örneğin: Lotus 1-2-3® ya da Microsoft Excel®).
3. Bilgisayarda çizim, resim yapma ya da grafik programları.
4. Matematik programları gibi Eğitim yazılımları.
5. Okul materyallerini öğrenmenize yardım etmek için bilgisayar.
6. Program yazmak için bilgisayar.




Ülke gruplarının Program / Yazılım Kullanım ortalamaları.

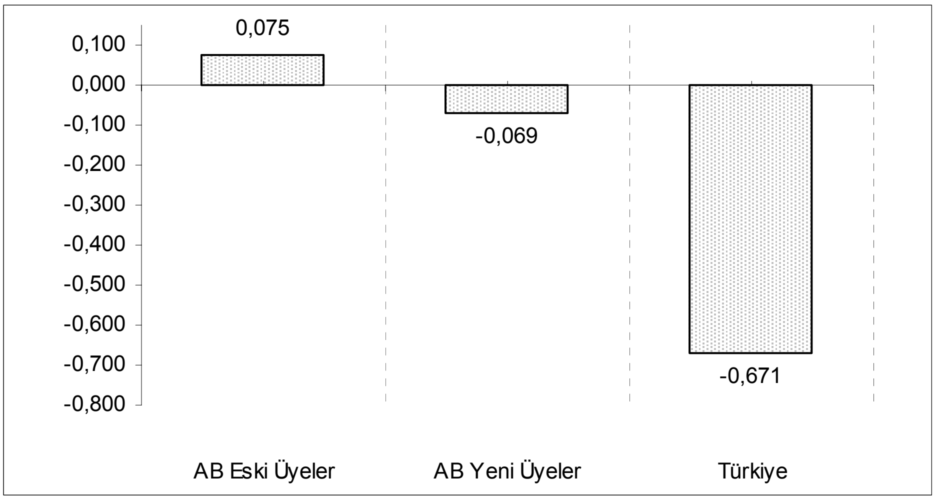



Öğrencilerin ekonomik, sosyal ve kültürel durumları ile bilgisayara ilişkin tutumlarının sabitlenmesi durumunda, ülke gruplarının Program / Yazılım Kullanım ortalamaları.

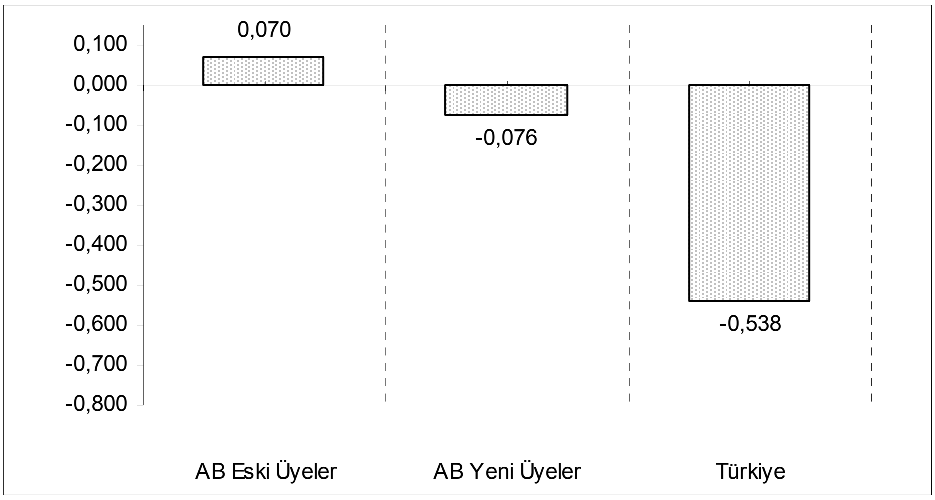
## 3. RUTİN KULLANIM ÖZ GÜVENİ

**Değişkeni Oluşturan Maddeler**

1. Bir bilgisayar oyununu başlatmak.
2. Bir dosya açmak.
3. Bir dokümanı oluşturmak/düzenlemek.
4. Ekranda bir dokümanı aşağı ve yukarı kaydırmak.
5. Bir disketten bir dosyayı kopyalamak.
6. Bir bilgisayar dokümanını veya dosyasını kaydetmek.
7. Bir bilgisayar doküman veya dosyasını yazdırmak.
8. Bir bilgisayar doküman veya dosyasını silmek.
9. Bilgisayardaki dosyaları bir yerden diğerine taşımak
10. Bilgisayar oyunları oynamak.
11. Bir mouse (fare) kullanarak resim yapmak.




Ülke gruplarının Rutin Kullanım Öz Güveni ortalamaları.

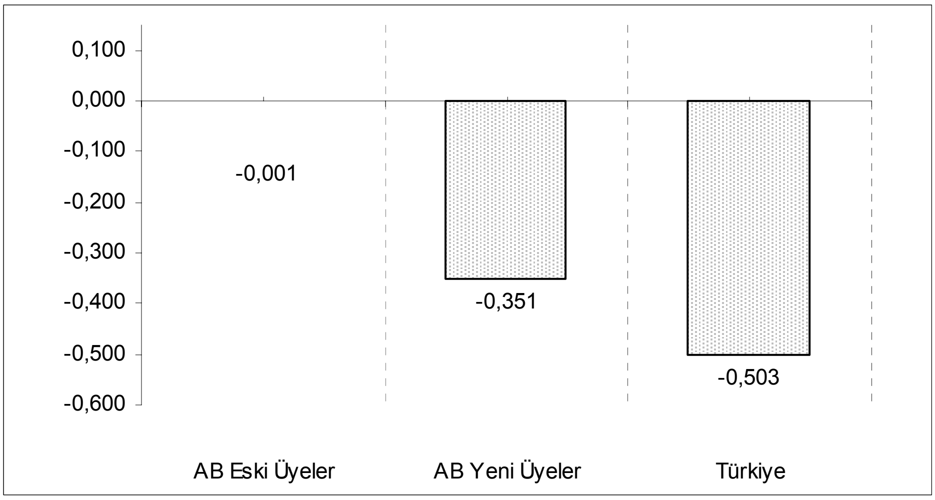



Öğrencilerin ekonomik, sosyal ve kültürel durumları ile bilgisayara ilişkin tutumlarının sabitlenmesi durumunda, ülke gruplarının Rutin Kullanım Öz Güveni ortalamaları.

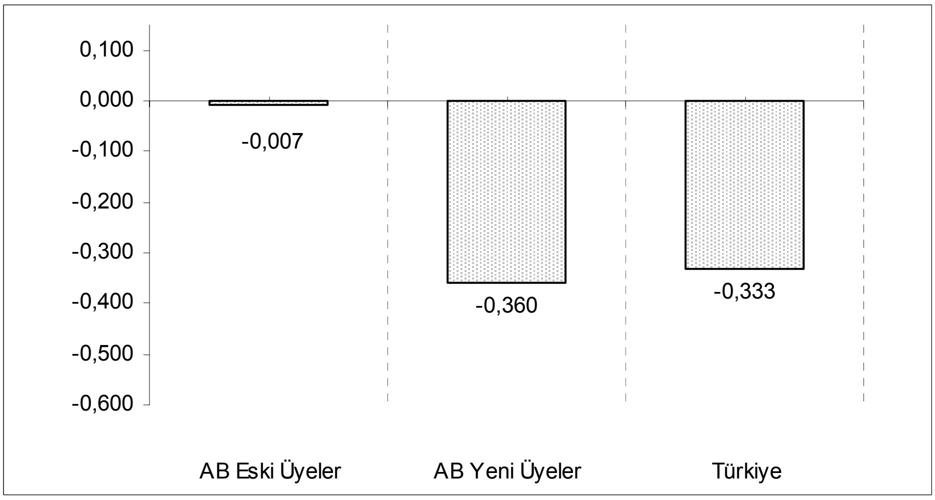
## 4. İNTERNET KULLANIM ÖZ GÜVENİ

**Değişkeni Oluşturan Maddeler**

1. İnternet'e girmek.
2. İnternet'ten dosyaları indirmek veya kopyalamak.
3. Bir e-posta mesajına dosya eklemek.
4. İnternet'ten müzik parçası indirmek.
5. E-posta mesajları yazmak ve göndermek.




Ülke gruplarının İnternet Kullanım Öz Güveni ortalamaları.

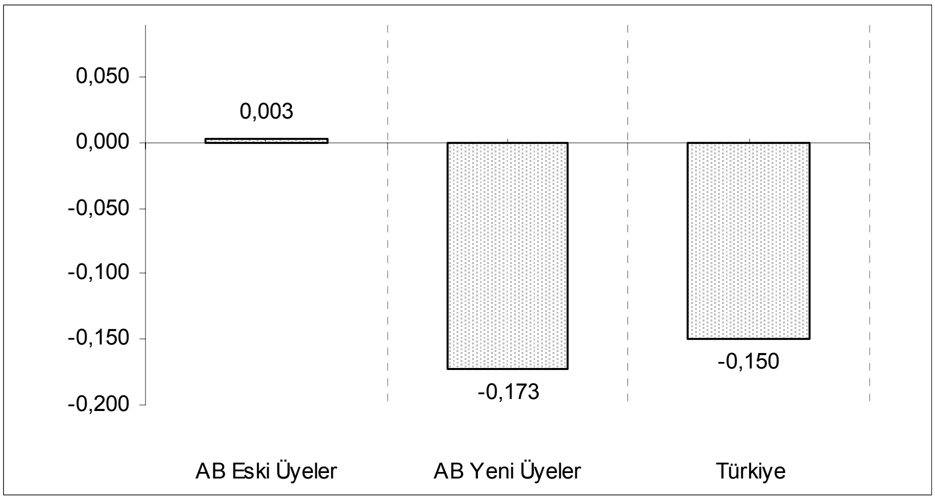



Öğrencilerin ekonomik, sosyal ve kültürel durumları ile bilgisayara ilişkin tutumlarının sabitlenmesi durumunda, ülke gruplarının İnternet Kullanım Öz Güveni ortalamaları.

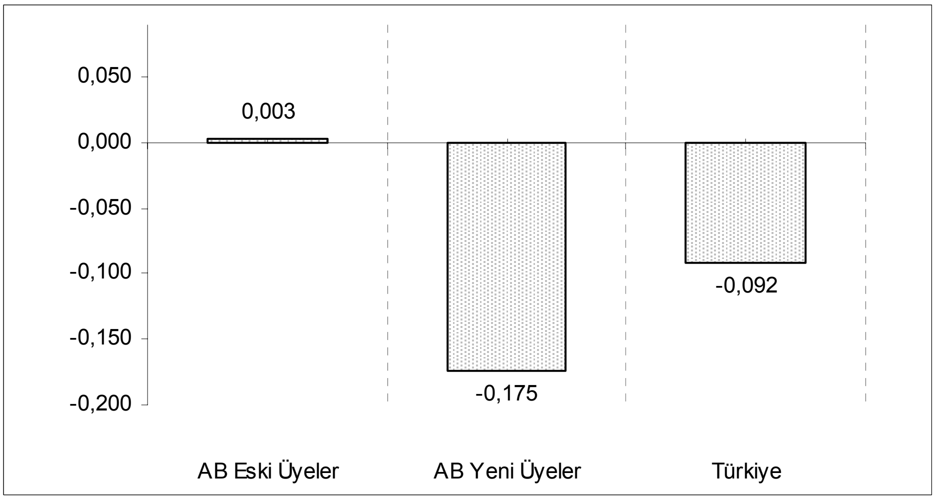
## 5. İLERİ DÜZEY KULLANIM ÖZ GÜVENİ

**Değişkeni Oluşturan Maddeler**

1. Bilgisayar virüslerini bulmak ve onlardan kurtulmak.
2. Bir adres listesi oluşturmak için veritabanı kullanmak.
3. Bir bilgisayar programı yazmak (Örneğin: Logo, Pascal, Basic de).
4. Bir grafik çizmek için bir tablolama programı kullanmak.
5. Bir sunu hazırlamak (Örneğin: Microsoft PowerPoint kullanarak).
6. Çoklu-ortam sunusu hazırlamak (sesle, resimle, video ile).
7. Bir web sayfası oluşturmak.




Ülke gruplarının İleri Düzey Kullanım Öz Güveni ortalamaları.

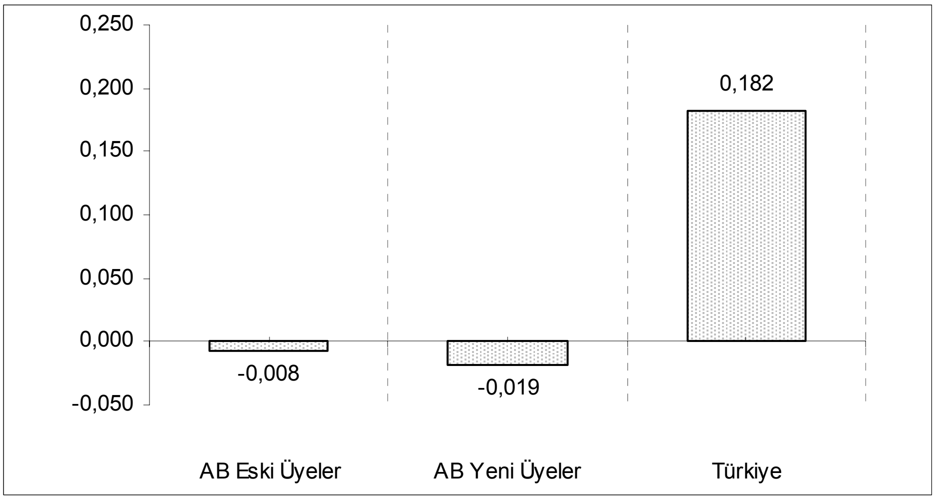



Öğrencilerin ekonomik, sosyal ve kültürel durumları ile bilgisayara ilişkin tutumlarının sabitlenmesi durumunda, ülke gruplarının İleri Düzey Kullanım Öz Güveni ortalamaları.

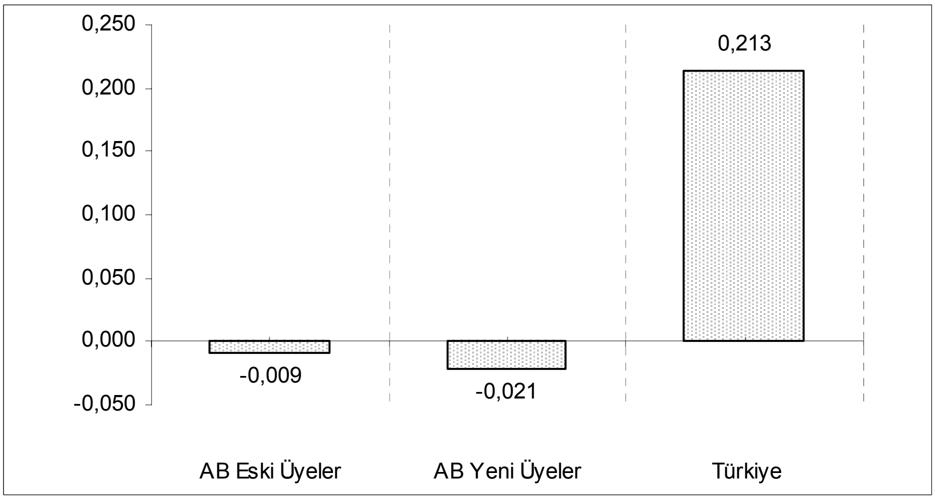
## 6. BİLGİSAYARA İLİŞKİN TUTUM

**Değişkeni Oluşturan Maddeler**

1. Bir bilgisayarla çalışmak benim için çok önemlidir.
2. Bir bilgisayarla oynamanın ya da çalışmanın gerçekten eğlenceli olduğunu düşünüyorum.
3. Bir bilgisayarı kullanıyorum çünkü çok ilgileniyorum.
4. Bilgisayarla çalışırken zamanın nasıl geçtiğini anlamıyorum.

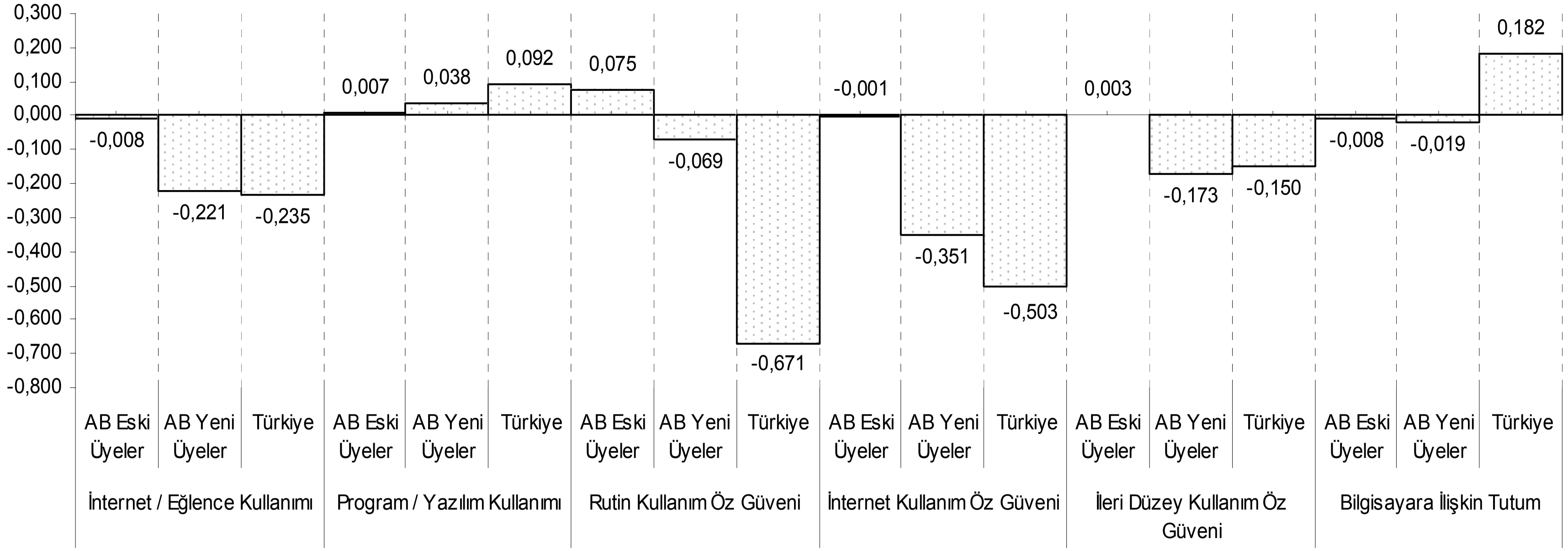



Ülke gruplarının Bilgisayara İlişkin Tutum ortalamaları.



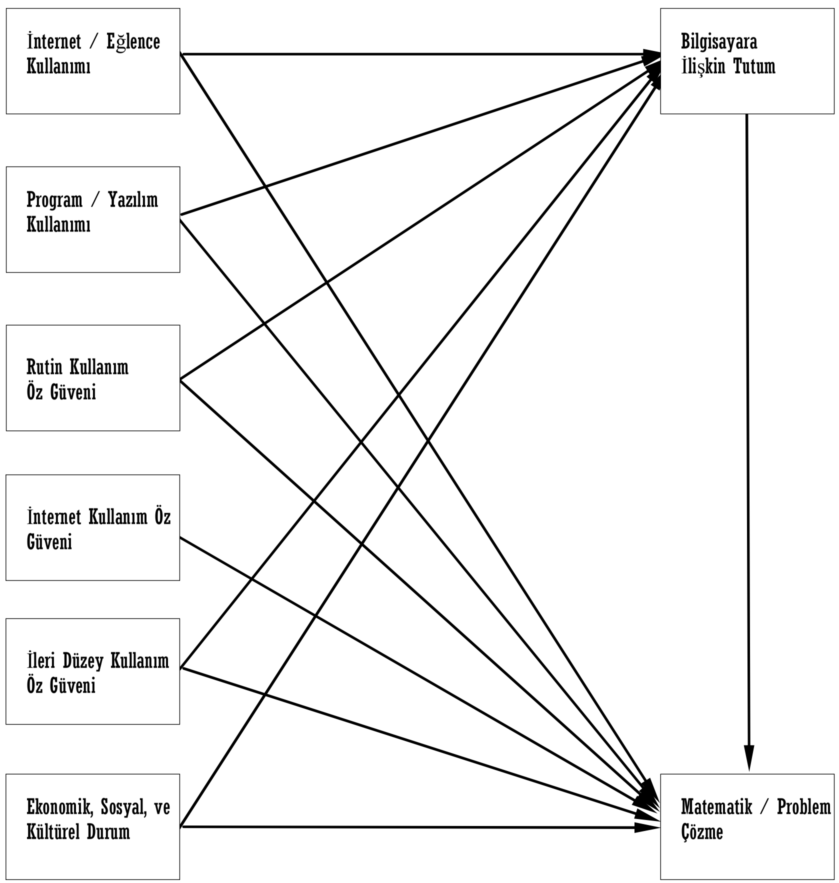

Öğrencilerin ekonomik, sosyal ve kültürel durumlarının sabitlenmesi durumunda, ülke gruplarının Bilgisayara İlişkin Tutum ortalamaları.

**ÜLKE GRUPLARI BİT ORTALAMALARI**

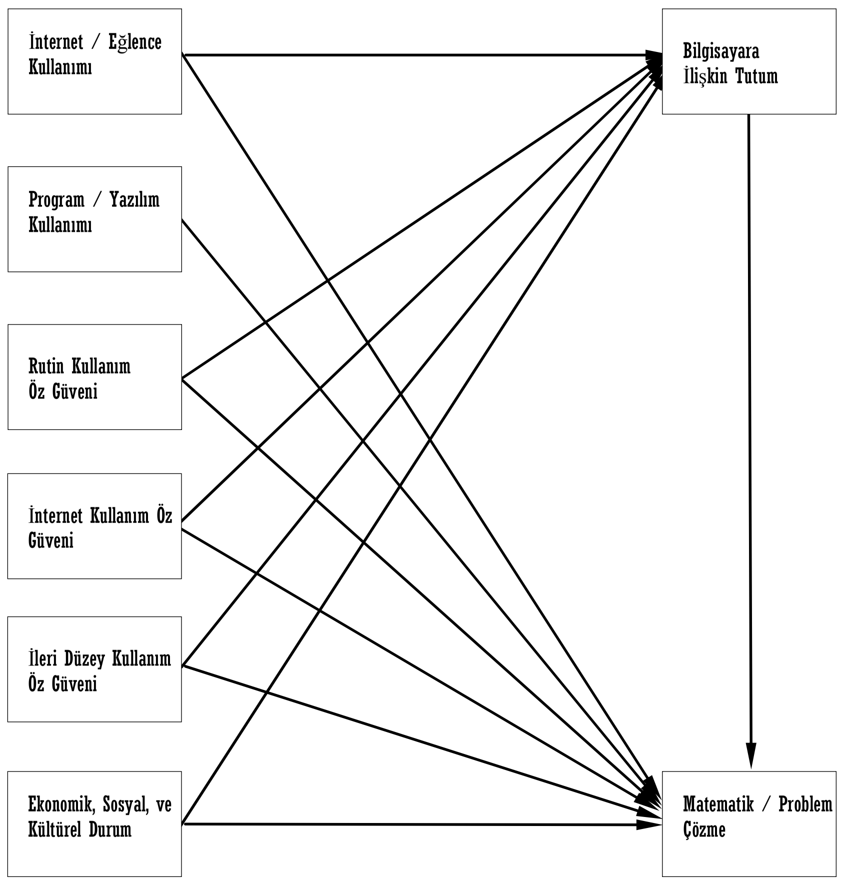



Bu çalışma kapsamında bütün BİT değişkenleri genel olarak dikkate alındığında, AB üyeler PISA 2003 uluslar arası ortalamaya en yakın; AB yeni üyeler PISA 2003 uluslar arası ortalamadan biraz daha uzaklaşan; Türkiye ise PISA 2003 uluslar arası ortalamadan en çok uzaklaşan ülke grubudur. AB üyelerde yaşayan öğrenciler, BİT'i daha sık kullanmaktadırlar ve BİT kullanım özgüvenleri daha yüksektir. Bu bağlamda, ülke gruplarının ortalamadan uzaklaşma büyüklüğü, uluslar arası ortalamadan ne kadar ayrıştığını gösterir.

## MATEMATİK ve PROBLEM ÇÖZME MODELLERİ




AB Üyeleri ve Yeni Üyeler İçin Önerilen Matematik ve Problem Çözme Modelleri




Türkiye İçin Önerilen Matematik ve Problem Çözme Modelleri

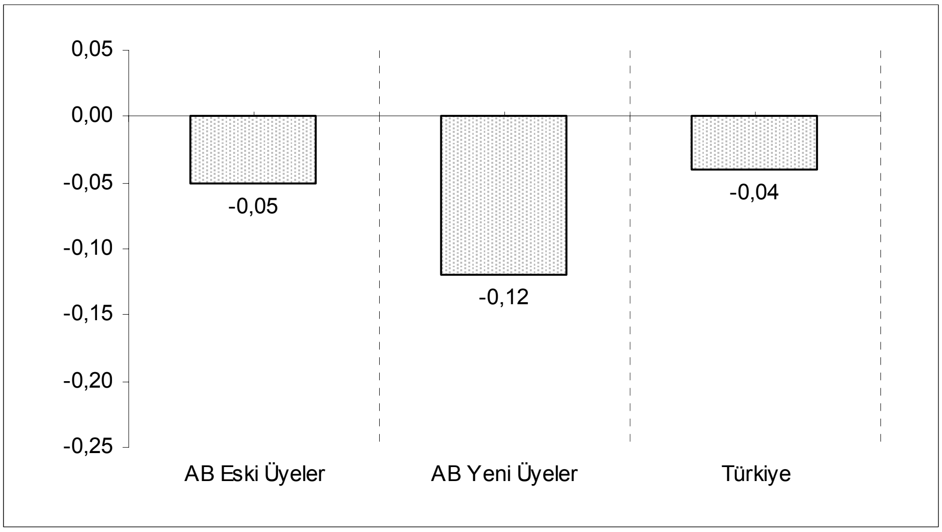
Öğrencilerin ekonomik, sosyal ve kültürel durum ve BİT değişkenleri ile matematik ve problem çözme performansları arasındaki ilişkileri gösteren modeller.
Bu modeller, öğrencilerin matematik ve problem çözme performans varyanslarını açıklamaya çalışmaktadır.

## INTERNET / EĞLENCE KULLANIMI

**Değişkeni Oluşturan Maddeler**

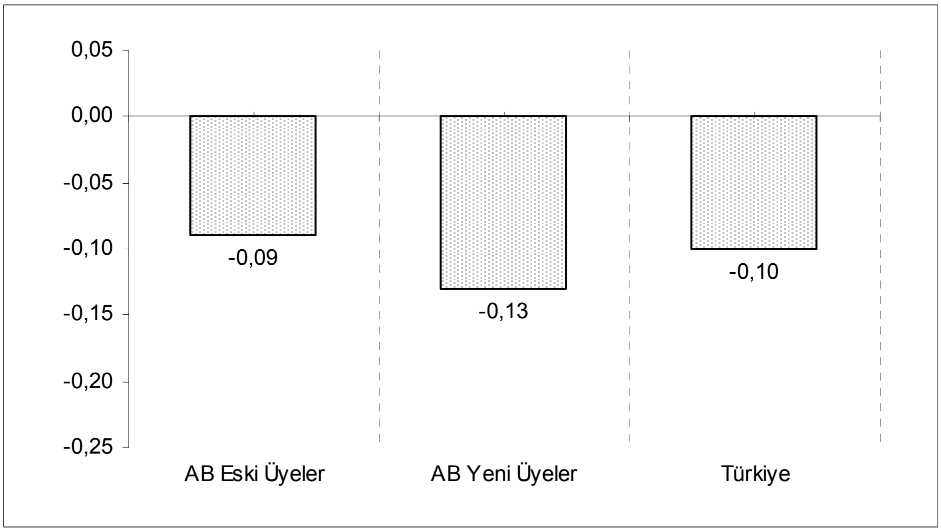
1. İnsanlar, nesneler ya da düşünceler hakkında bilgi aramak için İnternet.
2. Bilgisayar oyunları.
3. Bir grup veya ekip ile birlikte çalışmak için İnternet.
4. İnternet'ten yazılım indirmek (oyunlar dahil).
5. Müzik parçası indirmek için İnternet.
6. Elektronik haberleşme için bilgisayar (Örneğin: e-posta ya da sohbet siteleri).

**Matematik Modeli**




İnternet / Eğlence Kullanımı ile Matematik performansı arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

**Problem Çözme Modeli**




İnternet / Eğlence Kullanımı ile Problem Çözme performansı arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

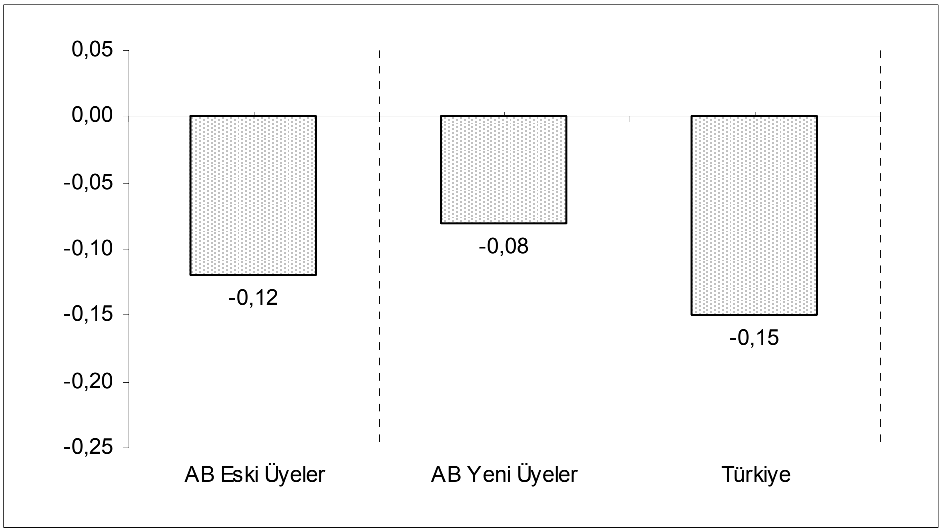
Bütün ülke grupları için, öğrencilerin İnternet/Eğlence kullanımı ile matematik ve problem çözme performansları arasında negatif ve küçük düzeyde ilişki vardır. Bir başka deyişle, İnternet/Eğlence kullanımı arttıkça matematik ve problem çözme performanslarının azaldığı söylenebilir.

## PROGRAM / YAZILIM KULLANIMI

**Değişkeni Oluşturan Maddeler**

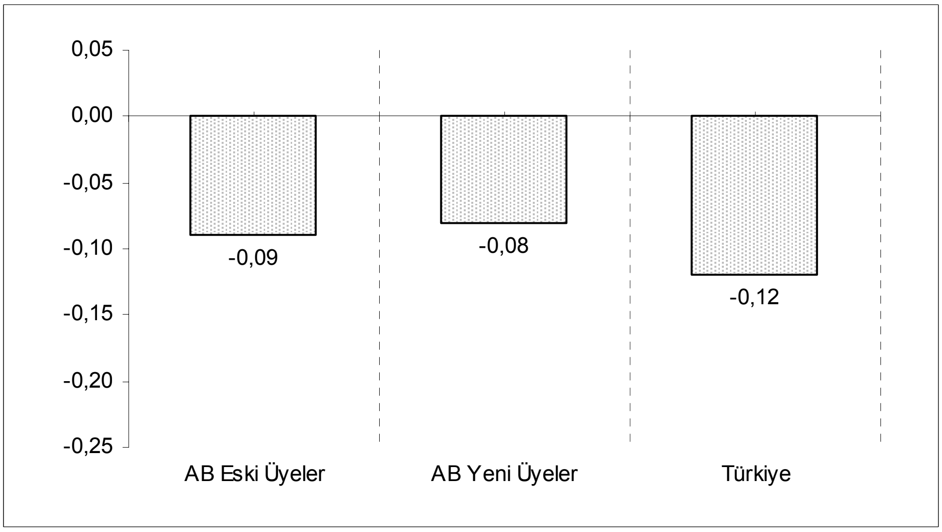
1. Yazım programları (Word® veya Word Perfect®).
2. Tablo ve grafik programları (Örneğin: Lotus 1-2-3® ya da Microsoft Excel®).
3. Bilgisayarda çizim, resim yapma ya da grafik programları.
4. Matematik programları gibi Eğitim yazılımları.
5. Okul materyallerini öğrenmenize yardım etmek için bilgisayar.
6. Program yazmak için bilgisayar.

**Matematik Modeli**




Program / Yazılım Kullanımı ile Matematik arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

**Problem Çözme Modeli**




Program / Yazılım Kullanımı ile Problem Çözme arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

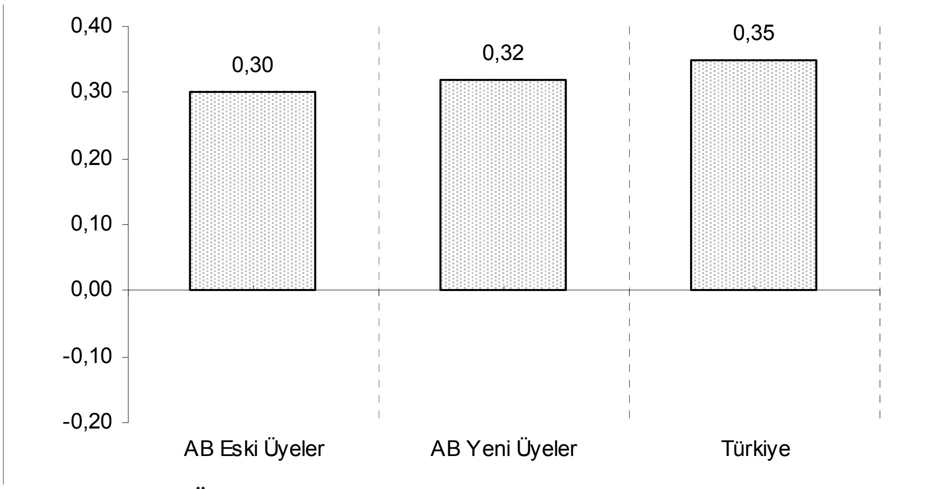
Bütün ülke grupları için, öğrencilerin Program/Yazılım kullanımı ile matematik ve problem çözme performansları arasında negatif ve küçük düzeyde ilişki vardır. Bir başka deyişle, Program/Yazılım kullanımı arttıkça matematik ve problem çözme performanslarının azaldığı söylenebilir.

## RUTİN KULLANIM ÖZ GÜVENİ

### Değişkeni Oluşturan Maddeler

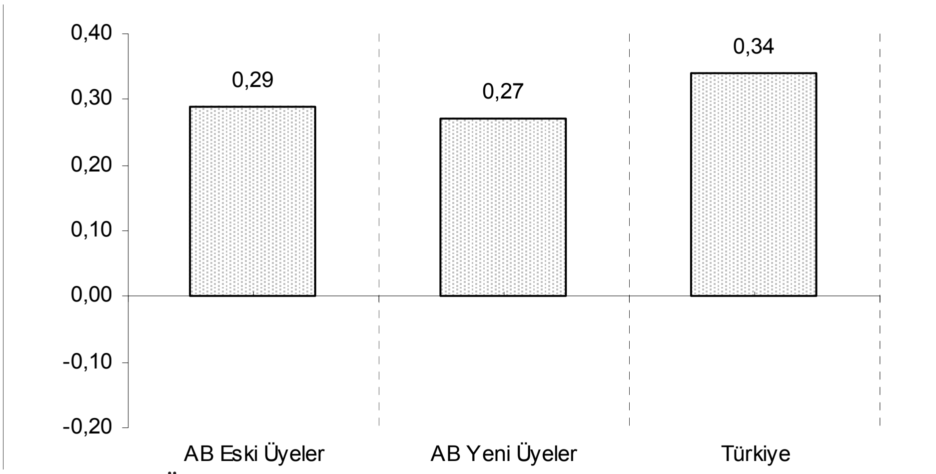
1. Bir bilgisayar oyununu başlatmak.
2. Bir dosya açmak.
3. Bir dokümanı oluşturmak/düzenlemek.
4. Ekranda bir dokümanı aşağı ve yukarı kaydırmak.
5. Bir disketten bir dosyayı kopyalamak.
6. Bir bilgisayar dokümanını veya dosyasını kaydetmek.
7. Bir bilgisayar doküman veya dosyasını yazdırmak.
8. Bir bilgisayar doküman veya dosyasını silmek.
9. Bilgisayardaki dosyaları bir yerden diğerine taşımak
10. Bilgisayar oyunları oynamak.
11. Bir mouse (fare) kullanarak resim yapmak.

**Matematik Modeli**




Rutin Kullanım Öz Güveni ile Matematik arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

**Problem Çözme Modeli**




Rutin Kullanım Öz Güveni ile Problem Çözme arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

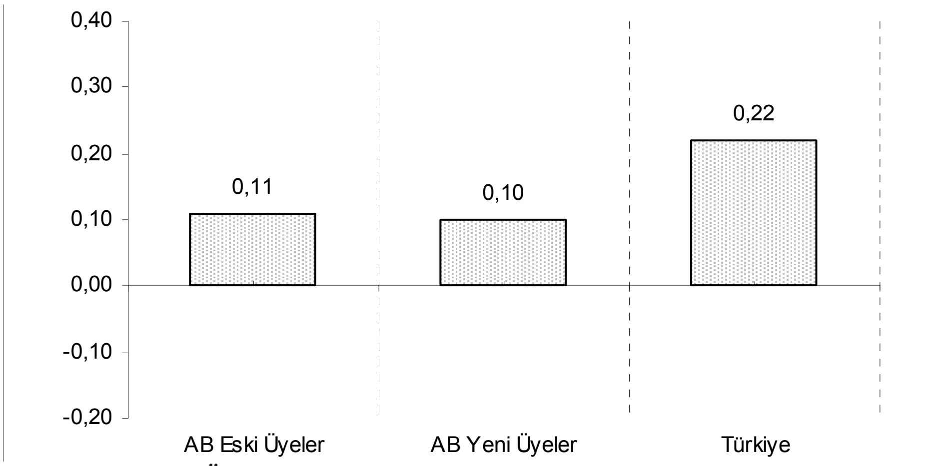
Bütün ülke grupları için, öğrencilerin Rutin Kullanım Öz Güveni ile matematik ve problem çözme performansları arasında pozitif ve orta düzeyde ilişki vardır. Bir başka deyişle, Rutin Kullanım Öz Güveni arttıkça matematik ve problem çözme performanslarının da arttığı söylenebilir.

## İNTERNET KULLANIM ÖZ GÜVENİ

**Değişkeni Oluşturan Maddeler**

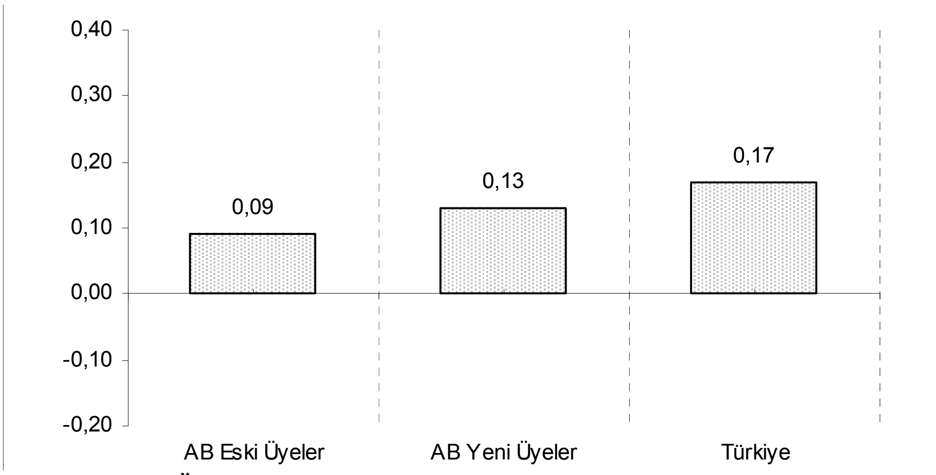
1. İnternet'e girmek.
2. İnternet'ten dosyaları indirmek veya kopyalamak.
3. Bir e-posta mesajına dosya eklemek.
4. İnternet'ten müzik parçası indirmek.
5. E-posta mesajları yazmak ve göndermek.

**Matematik Modeli**




İnternet Kullanım Öz Güveni ile Matematik arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

**Problem Çözme Modeli**




İnternet Kullanım Öz Güveni ile Problem Çözme arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

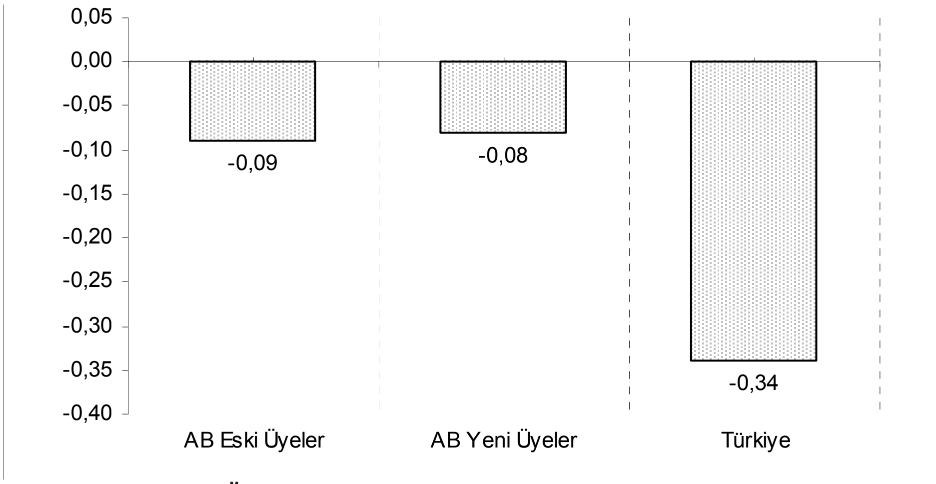
AB üyeleri ve yeni üyeler için, öğrencilerin İnternet Kullanım Öz Güveni ile matematik ve problem çözme performansları arasında pozitif ve küçük düzeyde ilişki varken, Türkiye için pozitif ve küçük-orta düzeyde ilişki vardır. Bir başka deyişle, İnternet Kullanım Öz Güveni arttıkça matematik ve problem çözme performanslarının da arttığı söylenebilir.

## İLERİ DÜZEY KULLANIM ÖZ GÜVENİ

**Değişkeni Oluşturan Maddeler**

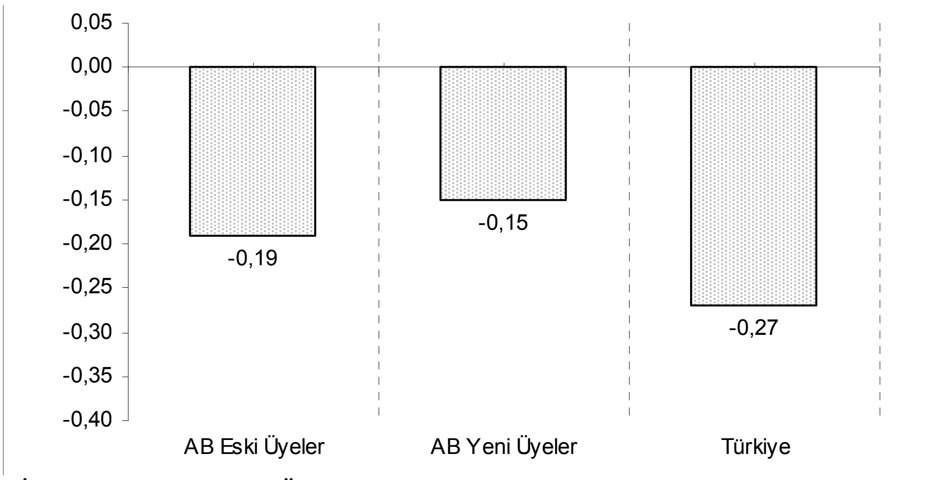
1. Bilgisayar virüslerini bulmak ve onlardan kurtulmak.
2. Bir adres listesi oluşturmak için veritabanı kullanmak.
3. Bir bilgisayar programı yazmak (Örneğin: Logo, Pascal, Basic de).
4. Bir grafik çizmek için bir tablolama programı kullanmak.
5. Bir sunu hazırlamak (Örneğin: Microsoft PowerPoint kullanarak).
6. Çoklu-ortam sunusu hazırlamak (sesle, resimle, video ile).
7. Bir web sayfası oluşturmak.

**Matematik Modeli**




İleri Düzey Kullanım Öz Güveni ile Matematik arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

**Problem Çözme Modeli**




İleri Düzey Kullanım Öz Güveni ile Problem Çözme arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

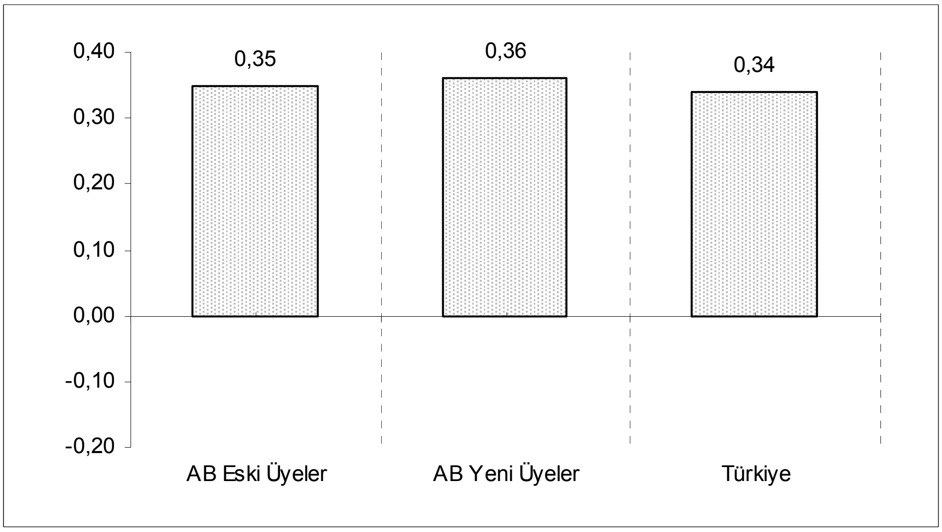
AB üyeler ve yeni üyeler için, öğrencilerin İleri Düzey Kullanım Öz Güveni ile matematik ve problem çözme performansları arasında negatif ve küçük düzeyde ilişki varken, Türkiye için negatif ve orta düzeyde ilişki vardır. Bir başka deyişle, İleri Düzey Kullanım Öz Güveni azaldıkça matematik ve problem çözme performanslarının da azaldığı söylenebilir.

## EKONOMİK, SOSYAL ve KÜLTÜREL DURUM

**Değişkenleri Oluşturan Bileşenler**

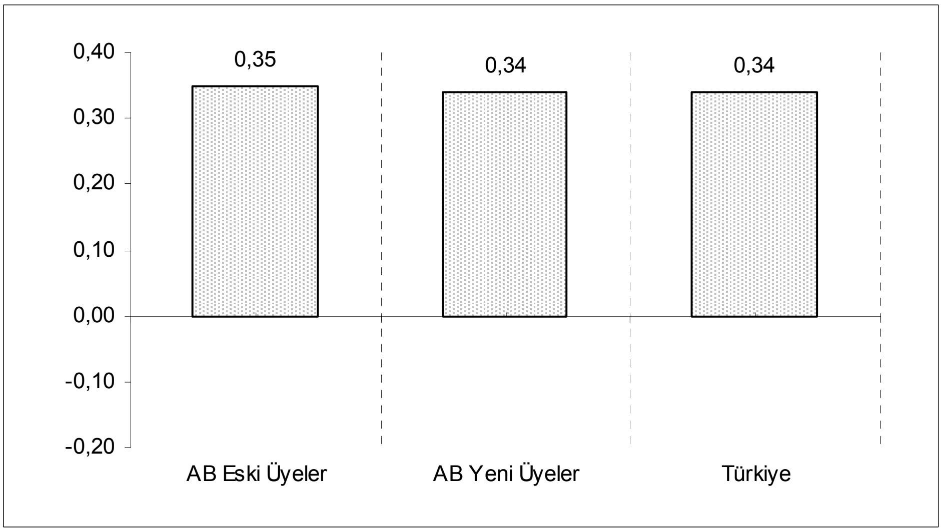
1. Anne ve babanın eğitim durumu
2. Anne ve babanın iş durumu
3. Ailenin gelir düzeyi
4. Evdeki kitap sayısı

**Matematik Modeli**




Ekonomik, Sosyal ve Kültürel Durum ile Matematik arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

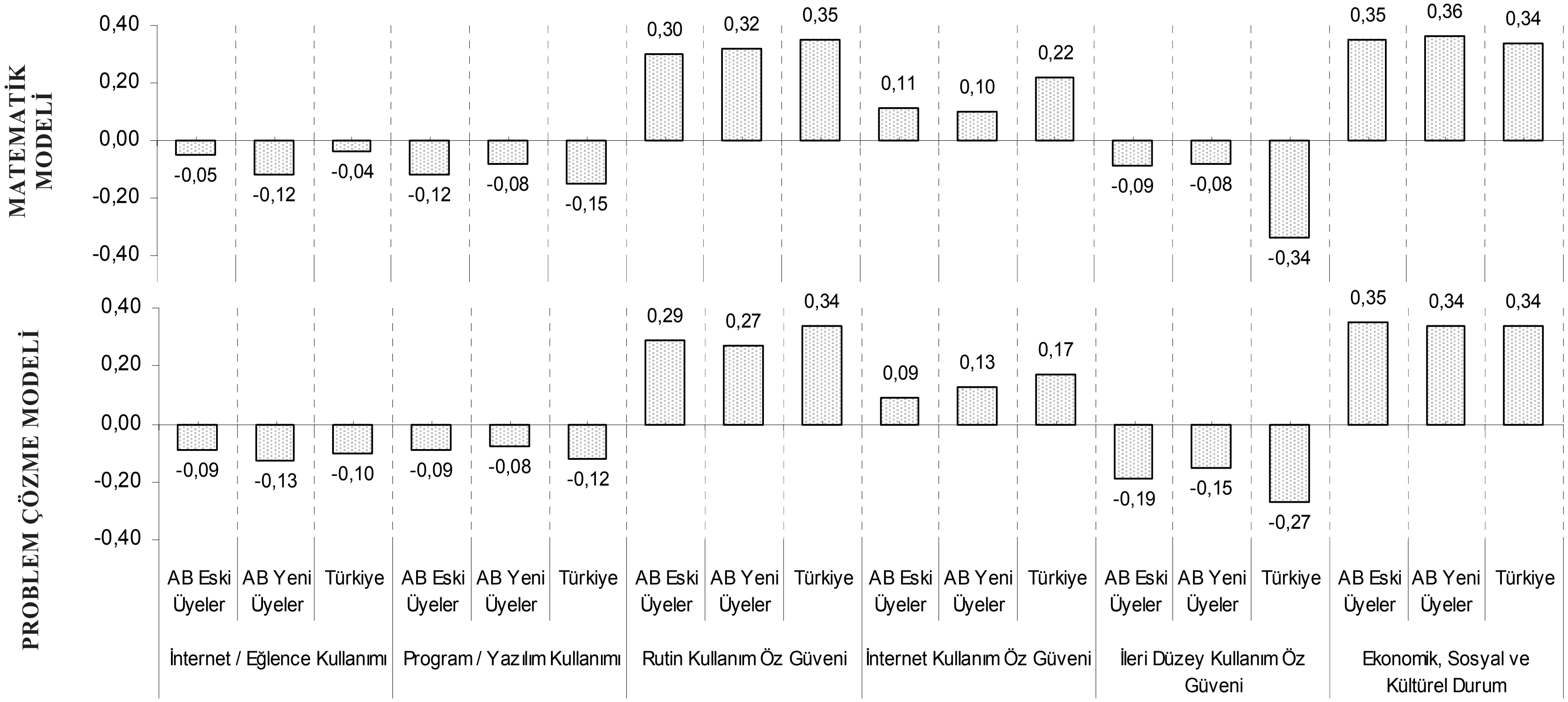
**Problem Çözme Modeli**




Ekonomik, Sosyal ve Kültürel Durum ile Problem Çözme arasındaki ilişkinin ülke gruplarındaki büyüklükleri ve yönleri.

Bütün ülke grupları için, öğrencilerin Ekonomik, Sosyal ve Kültürel Durumu ile matematik ve problem çözme performansları arasında pozitif ve orta düzeyde ilişki vardır. Bir başka deyişle, Ekonomik, Sosyal ve Kültürel Durum arttıkça matematik ve problem çözme performanslarının da arttığı söylenebilir.

## MODELLERDEKİ DEĞİŞKENLERİN İLİŞKİ BÜYÜKLÜKLERİ VE YÖNLERİ




Değişkenler, ilişki yönü ve büyüklükleri açısından ülke grupları için genel olarak karşılaştırıldığında matematik ve problem çözme modeli paralellik göstermektedir. Bunun anlamı, yapılacak yorumlar her iki model için de geçerlidir. Değişkenlerin hepsi dikkate alındığında, öğrencilerin matematik ve problem çözme performanslarıyla bu değişkenlerin arasındaki ilişkiler küçük-orta düzeyde ve pozitif ya da negatif olduğu gözlenmektedir.

# APPENDIX E

# THE PERMISSION DOCUMENT

**O.D.T.Ü.**
**FEN BİLİMLERİ ENSTİTÜSÜ**
**YÖNETİM KURULU KARARI**

**Tarih: 22.05.2007**
**Sayı: FBE:2007/25**

**GÖREVLENDİRME VE İZİN**

Bilgisayar ve Öğretim Teknolojileri Eğitimi EABD doktora programı öğrencisi Yunis Şahinkayası'nın, tezi ile ilgili "Uluslararası Öğrenci Değerlendirme Proğramında (PISA) Avrupa Birliği Eski, Yeni Üye Ülkeleri ve Türkiye'nin Bilgi ve İletişim Teknolojilerinde (BİTE) ve Matematik ve Problem Çözme Modellerinde Karşılaştırılması" başlıklı çalışmasına ilişkin Milli Eğitim Bakanlığına bağlı ekli listede belirtilen kurumların karar veren yöneticileri ile uygulama yapmak için görevlendirme başvurusu incelenmiş; ilgili EABD Başkanlığı'nın görüşüne dayanarak adı geçen öğrencinin isteği doğrultusunda görevlendirilmesine oybirliği ile karar verilmiştir.

Canan Özgen

**Prof. Dr. Canan Özgen**
*FBE Müdürü*

**Prof. Dr. R.Sezer Aygün**
*FBE Müd. Yard.*

**Prof.Dr.Ali Kalkanlı**
*FBE Müd. Yard.*

**Prof. Dr. Cahit Eralp**
*Üye*

V.Toprak

**Prof. Dr. Vedat Toprak**
*Üye*

**Doç.Dr.Gülden Berkman**
*Üye*

# APPENDIX F

# QUALITATIVE CODING SYSTEM

Table F.1 The Qualitative Coding System: Categories and Sub-categories

| | Categories and Sub-categories | 1(PM1) | 2(AC1) | 3(PI) | 4(PM2) | 5(PM3) | 6(AC2) | 7(AC3) | F |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **Issues in ICT policy and implementations in Turkey** | | | | | | | | |
| 1.1 | Conflicts in existence of ICT policy in operation | | 286 | 287 | 288 | 289,293, 295,296 | | 496 | 5 |
| 1.1.1 | Lack of cultural accumulation | 323 | | | | | | | 1 |
| 1.1.1.1. | Negative effect of political intervention | | 286,340 | | | | 2x335 | | 2 |
| 1.1.1.1.1. | Discontinuity | | 286,326 | | | | 2x345 | | 2 |
| 1.1.1.1.2. | Lack of evaluation and monitoring | | 286 | | | | 345 | | 2 |
| 1.1.1.2. | Not understanding of importance | 3x323 | 2x286 | 52 | | | | | 3 |
| 1.1.1.3. | Traditionalism | 323 | | | | | | | 1 |
| 1.1.2. | Lack of monitoring mechanism in implementation process | | 286 | 25 | | | | | 2 |
| 1.1.2.1. | Not operating IT rooms very well | | 11,32 | 25 | | | | | 2 |
| 1.1.2.2. | Corruptions | | 340 | | | | | | 1 |
| 1.1.2.3. | Hardware and software incompatibility | | 11,326 | | | | | | 1 |
| 1.1.2.4. | Outdated IT rooms | | 11 | | | | | | 1 |
| 1.1.3. | Deficiencies in developing and implementing ICT policies | | | | | | | | |
| 1.1.3.1. | Using imported solutions | | | | | | 2x335 | | 1 |
| 1.1.3.2. | Insufficient active role of universities and private sector | | 286,326 | | | | | | 1 |
| 1.1.3.3. | Not considering research findings including ICT dimension of PISA 2003 study | 266,285 | | 287 | | 289 | | | 3 |
| 1.1.3.4. | Emphasis on distribution of hardware | | 286 | 25 | | | | 488 | 3 |
| 1.1.3.5. | Groundless and baseless solutions due to focusing only on one competent of system | 104,319 | | | | | | | 1 |
| 1.2. | Insufficient financial resources | | 326,3x340 | | 328 | 4x329 | | | 3 |
| 1.2.1. | Role of power authority | | 326,340 | | | | | | 1 |
| 1.2.2. | Need to hardware distribution to schools, teachers and students | | | 3x341 | 328 | 329 | | | 3 |
| 1.2.3. | Serving to huge target audience | | | | 328 | | | | 1 |
| 1.3. | Curriculum | | | | | | | | |
| 1.3.1. | Too much spiral | | 2x326 | | | | | | 1 |
| 1.3.2. | Slow change | | 2x326 | | | | | | 1 |
| 1.3.3. | No extracurricular activities | | 326 | | | | | | 1 |
| 1.3.4. | Low ICT readiness level due to low rate of preprimary education, giving ICT introduction to escs of families | 41 | | | 26 | | | | 2 |
| 1.3.5. | Lack of interdisciplinary approach | 323 | | | | | | | 1 |
| 1.3.5.1. | ICT as a separate subject | 323 | | | | | 48 | 383 | 3 |
| 1.3.5.2. | No using ICT as a tool | 323 | | | | | | | 1 |
| 1.3.5.3. | Not giving importance to software in new curriculum | | | | 302 | | | | 1 |
| 1.4. | Teacher training | | | | | | | | |
| 1.4.1. | Blaming universities on unqualified teachers | 285,324 | | | | | | | 1 |
| 1.4.2. | No sustainability of teacher training after graduation | | 286 | 327,341 | | | | | 2 |

Table F.1 Continued.

| | Categories and Sub-categories | 1(PM1) | 2(AC1) | 3(PI) | 4(PM2) | 5(PM3) | 6(AC2) | 7(AC3) | F |
|---|---|---|---|---|---|---|---|---|---|
| **2** | **Suggestions to ICT policy and implementations in Turkey** | | | | | | | | |
| 2.1. | Sound and certain decision on policy | | | | | | 2x345 | | 1 |
| 2.1.1. | Making a long term ICT policy through setting macro goal for 10-15 year | | | | 342 | | | 2x496 | 2 |
| 2.1.1.1. | What to be done | | | | | | | 496 | 1 |
| 2.1.1.2. | What decisions to be taken | | | | | | | 496 | 1 |
| 2.1.1.3. | What kind of researches to be conducted | 325 | | | | | | 496 | 2 |
| 2.1.1.4. | What are the needs | | | | | | | 496 | 1 |
| 2.2. | Free from political intervention | | | | | | 345 | | 1 |
| 2.3. | Continuity in policy and its implementations | | | | | | 2x345 | | 1 |
| 2.4. | Followed strictly to policy and its implementations | | | | | | 345 | | 1 |
| 2.5. | Evaluation of completed policy implementations | | | | | | 2x345 | | 1 |
| 2.6. | Filling the gap arising from social, economic and cultural of students through giving ICT education at school | 13 | | | | | 337 | 488 | 3 |
| 2.6.1. | Providing computer and internet availability at schools | | | | | | 114 | 488 | 2 |
| 2.7. | System approach in ICT integration into education | 171,3x319 | | | 270 | | | | 2 |
| 2.7.1. | Revising the components of education system (curriculum, teacher education, school structure and learning environments) | 104 | | | | | | | 1 |
| 2.8. | Knowing TR reality and taking measures peculiar to TR through researches | | | | | | 337 | | 1 |
| 2.8.1. | Cooperation between MONE, research institutions and universities | 325 | 326 | | 342 | | 337 | | 4 |
| 2.8.2. | Charging experts in ICT related tasks | | 326,340 | | | | | | 1 |
| 2.8.3. | Sharing responsibilities | 323 | | | 342 | | | | 2 |
| 2.8.4. | Planning, implementing and researching | | | | | | | 500 | 1 |
| 2.8.5. | Requiring transformation | 323 | | | | | 335 | | 2 |
| 2.8.6. | Taking time | | | | | | 335 | | 1 |
| 2.9. | Curriculum | | | | | | | | |
| 2.9.1. | Requiring ICT as qualification in compulsory education | 76,171 | | | | | | | 1 |
| 2.9.2. | ICT integration across curriculum | | | | | | | | |
| 2.9.2.1. | Utilizing ICT as a tool through reforming the all curriculum | 9,50,76, 2x319,323 | | 2x341 | 288 | | 66,337 | 488,492,496 | 5 |
| 2.9.2.2. | Putting computers into classrooms | 50 | | | | | | 488 | 2 |
| 2.9.2.3. | Necessity of teachers graduated from CEIT to integrate ICT | | | | | | | 496 | 1 |
| 2.9.2.3.1. | Transforming role of computer teacher into coordinator teacher to support teachers and develop instructional materials | | | | | | | 488 | 1 |
| 2.9.2.4. | Incentives to functional computer use in homework and projects | 10,39,50 | | | | | | | 1 |
| 2.9.2.5. | Increasing rate of preprimary education in order particularly to introduce ICT in a sound way | 41 | | | 26 | | | | 2 |
| 2.9.3. | Improving ICT course as a separate subject | | | | | | | | |
| 2.9.3.1. | Increasing computer course number or hours in the curriculum | 8,39 | | | | | | | 1 |
| 2.9.3.2. | Preparing a computer curriculum associating virtual and real life | | | 140, 341 | | | | | 1 |

Table F.1 Continued.

| | Categories and Sub-categories | 1(PM1) | 2(AC1) | 3(PI) | 4(PM2) | 5(PM3) | 6(AC2) | 7(AC3) | F |
|---|---|---|---|---|---|---|---|---|---|
| 2.10. | Teacher training | | | | | | | | |
| 2.10.1. | In-service | | | | | | | | |
| 2.10.1.1. | Sharing educational experiences and resources through online interaction at province level | 76 | | | | | | | 1 |
| 2.10.1.2. | Increasing teacher training | 8,39,339 | | 341 | | | | | 2 |
| 2.10.1.3 | Orienting toward computer use as complete management tool by subject teachers | | | | | | | 496 | 1 |
| 2.10.2 | Preservice | | | | | | | | |
| 2.10.2.1. | Employing teachers with ICT qualifications by universities | 17,3x339 | | | | | | | 1 |
| 2.11. | Positive effects of CEIT graduates on software development | | 2x326 | | | | | 383 | 2 |
| **3** | **Perceptual Evaluation of ICT Aspects** | | | | | | | | |
| 3.1. | Attitudes toward computers | | | | | | | | |
| 3.1.1. | Cultural characteristics | | | | | | | | |
| 3.1.1.1. | Reminiscent of entertainment and gratification | 50 | | 106 | 107 | 108 | | | 4 |
| 3.1.1.2. | More inclination to technology than others | 39 | | | | | 114 | | 2 |
| 3.1.1.2.1. | Learning technology by trial-error approach | | | | | | 114 | | 1 |
| 3.1.1.2.2. | No fear of using computer | | | | | | 120 | | 1 |
| 3.1.1.2.3. | Rapidly adaptation to computer | | | | | | 120 | | 1 |
| 3.1.1.2.4. | Likeness to computer | | | | | 108 | | 401 | 2 |
| 3.1.2. | Low economic conditions | | | | | | | | |
| 3.1.2.1. | Hungriness to computer | 13,39 | 2x135 | | | 108 | 110,114 | | 4 |
| 3.1.2.1.1. | Extra aspiration | 7,8 | 135 | 269 | | 108 | 110,114 | 480 | 6 |
| 3.1.2.1.2. | Extra interest & curiosity to imported and popular technology | 104 | | 24,79,2x105 | | 108 | 114 | 447 | 5 |
| 3.1.2.1.3. | Image of computers in society | 7,9,104 | 11 | 24 | | | 130,114,112 | | 4 |
| 3.1.2.1.4. | Still perceiving computer use as indicator of social class | | | | 107 | | | | 1 |
| 3.1.2.1.5. | Not routine, prevalence and available, but still luxury | | 135 | | | | | | 1 |
| 3.1.3. | Attaching importance to positive attitudes | | | | | | | | |
| 3.1.3.1. | Taking advantage of positive attitudes in improving other ICT aspects | 16, 17,39,76, 104,139 | 267 | | | | | | 2 |
| 3.1.3.2. | Readiness to ICT use | | 267 | | | | | | 1 |
| 3.2. | ICT use | | | | | | | | |
| 3.2.1. | Internet / Entertainment use | | | | | | | | |
| 3.2.1.1. | Negative effects of inaccessibility due to low welfare of TR | 17 | | | | | 4x31 | | 2 |
| 3.2.2. | Program / software use | | | | | | | | |
| 3.2.2.1. | Reflecting content of curriculum | | 267 | | | 47 | 3x48,184 | 383,492 | 4 |
| 3.2.2.2. | Positive effects of computer teacher on prguse use in TR | | | | | | | 383,496 | 1 |

Table F.1 Continued.

| | Categories and Sub-categories | 1(PM1) | 2(AC1) | 3(PI) | 4(PM2) | 5(PM3) | 6(AC2) | 7(AC3) | F |
|---|---|---|---|---|---|---|---|---|---|
| 3.3. | Self confidence in ICT | | | | | | | | |
| 3.3.1. | Having direct relation to functional computer use | 5x50 | | 52 | | | | | 2 |
| 3.3.2. | Reflection of Turkish students' general low self confidence on other subjects | | | | | 212 | | 2x391 | 2 |
| 3.3.3. | Focusing only on chat and game | 50 | | 52,106 | 107 | | | | 3 |
| 3.3.4. | Lack of internalization of computer use | | | 2x105 | | | 72 | | 2 |
| 3.3.4.1. | Not feeling purpose, need and reason to use computer | | | 52,9 | | | 66 | | 2 |
| 3.3.4.2. | Insufficient computer education on functional computer use by oneself | 50,9,134 | | 2x24,52, 90,2x269 | | 55,2x56 ,57,2x81 | 64,66,84 | 488 | 5 |
| 3.3.4.3. | High ratio of students to computer at schools (lack of computer use by oneself) | | | | | 2x57,2x81 | 2x60,72,74 | | 2 |
| 3.3.4.4. | Not having home computer due to the low SES | | | 24 | | | 66 | | 2 |
| 3.3.5. | Self confidence in routine tasks | | | | | | | | |
| 3.3.5.1. | Contradiction with prguse | | | | 51 | | 2x58 | 2x391 | 3 |
| 3.3.5.2. | The better income and education level of parents, the more self confidence and conscious and productive computer use | | | 52,79 | | | | | 1 |
| 3.3.6. | Self confidence in internet tasks | | | | | | | | |
| 3.3.6.1. | Reasons of low self confidence in intconf | | | | | | | | |
| 3.3.6.1.1. | Depending directly on individual internet use | | | | | | 2x84 | | 1 |
| 3.3.6.1.2. | Requiring basic computer competencies by oneself | | | | 80 | | 84 | | 2 |
| 3.3.6.1.3. | The better income, the more internet use regardless of country groups | | | 24,52 | | | 31,84 | | 2 |
| 3.3.6.1.4. | Nonexistence of intconf items in the curriculum in 2003 | | | 2x77 | | | 84 | | 2 |
| 3.3.6.1.5. | Unawareness of internet and its nonfunctional (purposeless) use | | | 2x24,7x77 | | | | | 1 |
| 3.3.6.1.6 | Limited internet use or delay in internet access at schools | | 11 | 2x77 | 80 | | | | 3 |
| 3.3.6.1.7. | Perceiving internet as illegal and dangerous by students and parents & teachers respectively | | | 2x77 | | | | | 1 |
| 3.3.6.1.8. | Forbidding, abolishing or limiting internet by parents or themselves due to the OKS | | | | | 28 | | | 1 |
| 3.3.6.2. | Suggestions to improve intconf | | | | | | | | |
| 3.3.6.2.1. | Functional use of internet as educational tool through integrating internet into curriculum | 76 | | | | | 86 | | 2 |
| 3.3.6.2.1.1. | Sharing resources and accessing information | 76 | | | | | | | 1 |
| 3.3.6.2.1.2. | Motivating students with social, cultural and educational online interactions | 76 | | | | | | | 1 |
| 3.3.6.3. | Self confidence in high level tasks | | | | | | | | |
| 3.3.6.3.1. | Better position of TR due to Excel and PowerPoint related task | | | | | | 94,2x96,98, 100,102 | | 1 |
| 3.3.6.3.2. | Depending largely on individual interest and curiosity in 2003 | | | 90 | | | | | 1 |
| 3.3.6.3.3. | Not feeling the need to use computer as highconf tasks in 2003 by subject teachers | | | 90 | | | | | 1 |
| 3.3.6.3.4. | Reasons of low self confidence in highconf | | | | | | | | |
| 3.3.6.3.4.1. | Nonexistence of highconf in curriculum in 2003 | | | 90 | 91 | | | | 2 |
| 3.3.6.3.5. | Promotion to homeworks and projects involving highconf tasks | 88 | | | | | | | 1 |

# APPENDIX G

## MATHEMATICAL AND PROBLEM SOLVING LITERACY MODELS WITH T-VALUES FOR COUNTRY GROUPS

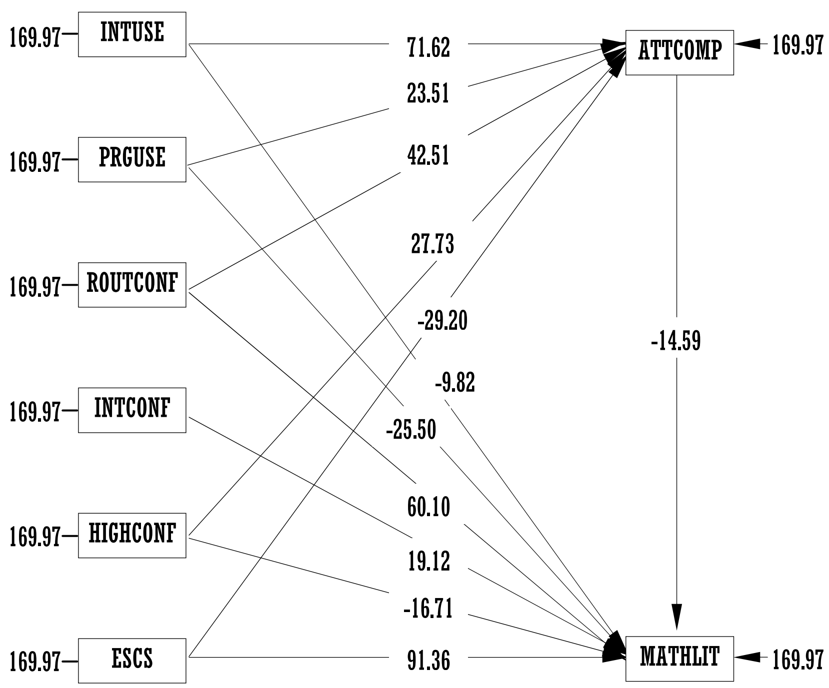



Figure G.1 Structural Model of Mathematical Literacy for the EU Member Group (t-values)

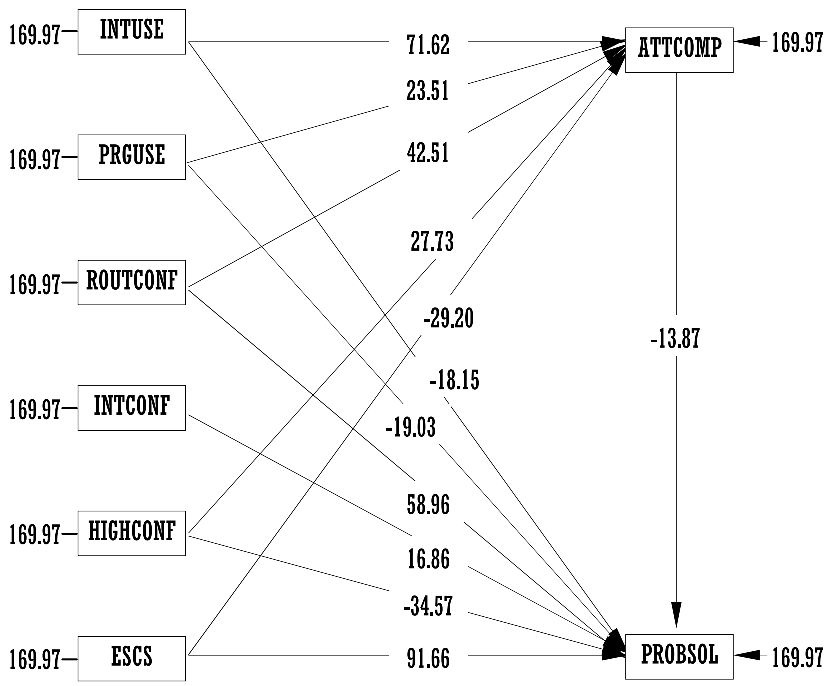



Figure G.2 Structural Model of Problem Solving Literacy for the EU Member Group (t-values)

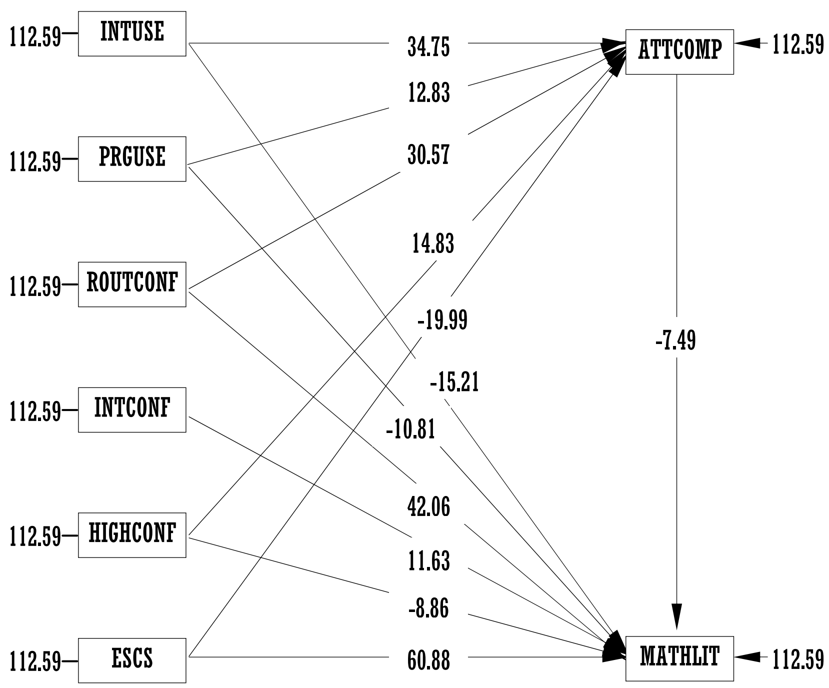



Figure G.3 Structural Model of Mathematical Literacy for the New EU Member Group (t-values)

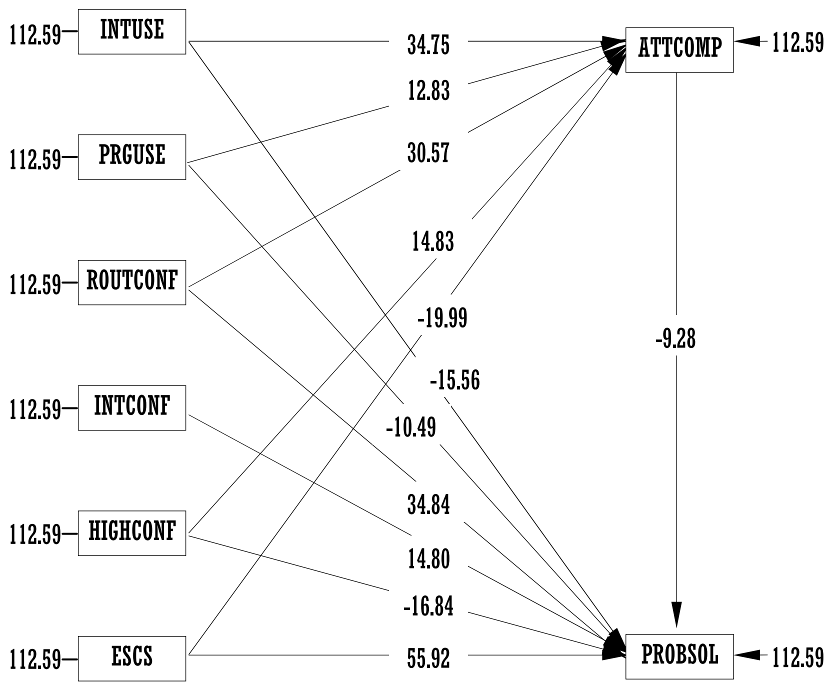



Figure G.4 Structural Model of Problem Solving Literacy for the New EU Member Group (t-values)

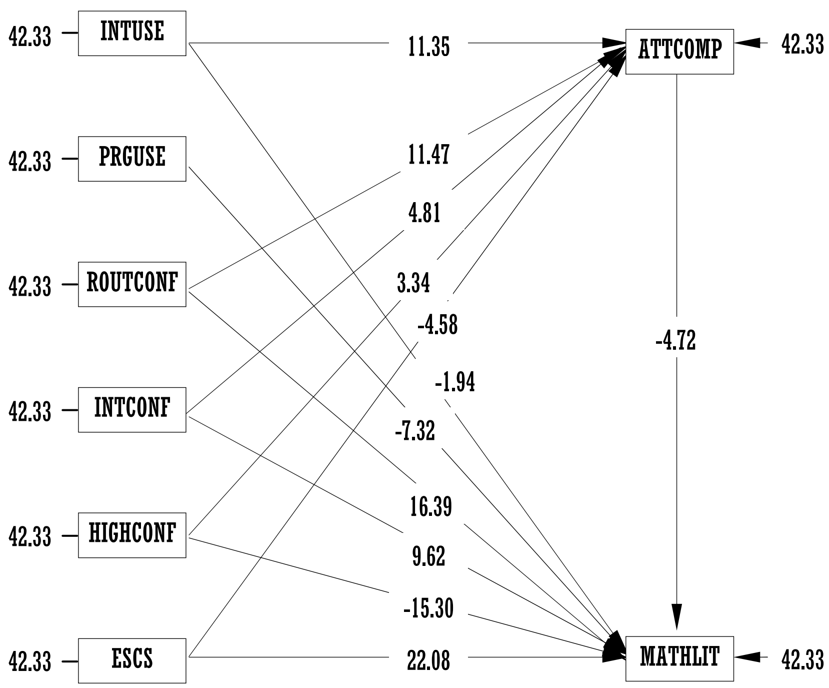



Figure G.5 Structural Model of Mathematical Literacy for Turkey (t-values)

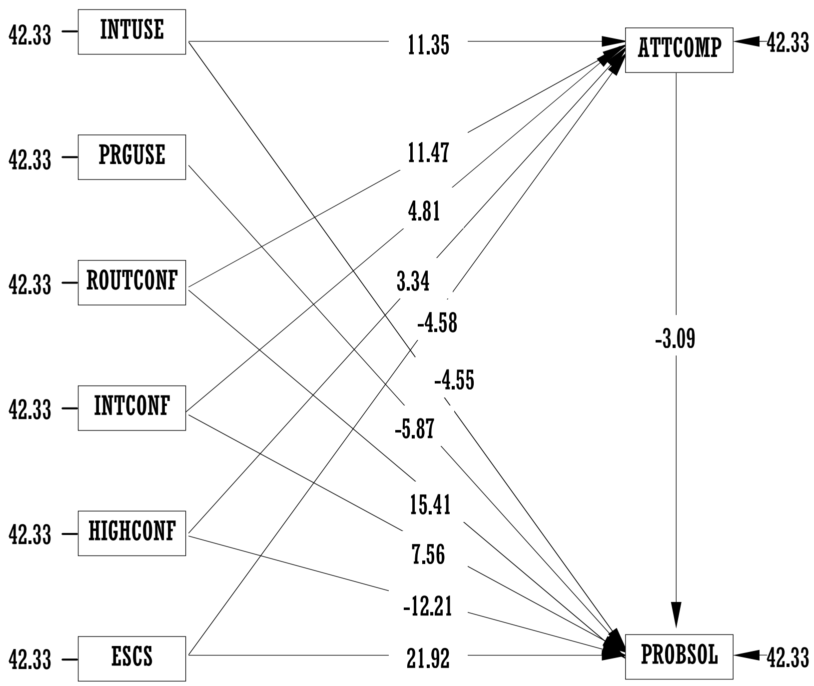



Figure G.6 Structural Model of Problem Solving Literacy for Turkey (t-values)

# APPENDIX H

# THE SIMPLIS SYNTAXES FOR THE MATHEMATICAL LITERACY MODELS FOR COUNTRY GROUPS

### THE SIMPLIS SYNTAX FOR THE MATHEMATICAL LITERACY MODEL FOR THE EU MEMBER GROUP

```
PATH MODEL FOR THE EU MEMBER GROUP

Observed Variables
INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH

Covariance Matrix from file: old_math.cov
Sample Size = 57787

Relationships
PV1MATH = INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
ATTCOMP = INTUSE PRGUSE ROUTCONF HIGHCONF ESCS

Path diagram
Method of Estimation: Maximum Likelihood
Lisrel Output: EF RS MI SC WP
End of Problem
```

### THE SIMPLIS SYNTAX FOR THE MATHEMATICAL LITERACY MODEL FOR THE NEW EU MEMBER GROUP

```
PATH MODEL FOR THE NEW EU MEMBER GROUP
Observed Variables
INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH

Covariance Matrix from file: new_math.cov
Sample Size = 25359
Relationships
PV1MATH = INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
ATTCOMP = INTUSE PRGUSE ROUTCONF HIGHCONF ESCS

Path diagram
Method of Estimation: Maximum Likelihood
Lisrel Output: EF RS MI SC WP
End of Problem
```

**THE SIMPLIS SYNTAX FOR THE MATHEMATICAL LITERACY MODEL FOR TURKEY**

```
PATH MODEL FOR TURKEY
 Observed Variables
INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
PV1MATH PV2MATH PV3MATH PV4MATH PV5MATH

Covariance Matrix from file: turkey_math.cov
Sample Size = 3590

Relationships
PV1MATH = INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
ATTCOMP = INTUSE INTCONF ROUTCONF HIGHCONF ESCS

Path diagram
Method of Estimation: Maximum Likelihood
Lisrel Output: EF RS MI SC WP
End of Problem
```

# APPENDIX I

# THE SIMPLIS SYNTAXES FOR THE PROBLEM SOLVING LITERACY MODELS FOR COUNTRY GROUPS

## THE SIMPLIS SYNTAXES FOR THE PROBLEM SOLVING LITERACY MODEL FOR THE EU MEMBER GROUP

PATH MODEL FOR THE EU MEMBER GROUP

Observed Variables
INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
PV1PROB PV2PROB PV3PROB PV4PROB PV5PROB

Covariance Matrix from file: old_prob.cov
Sample Size = 57787

Relationships
PV1PROB = INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
ATTCOMP = INTUSE PRGUSE ROUTCONF HIGHCONF ESCS

Path diagram
Method of Estimation: Maximum Likelihood
Lisrel Output: EF RS MI SC WP
End of Problem

## THE SIMPLIS SYNTAX FOR THE PROBLEM SOLVING LITERACY MODEL FOR THE NEW EU MEMBER GROUP

PATH MODEL FOR THE NEW EU MEMBER GROUP
Observed Variables
INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
PV1PROB PV2PROB PV3PROB PV4PROB PV5PROB

Covariance Matrix from file: new_ prob.cov
Sample Size = 25359

Relationships
PV1PROB = INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
ATTCOMP = INTUSE PRGUSE ROUTCONF HIGHCONF ESCS

Path diagram
Method of Estimation: Maximum Likelihood
Lisrel Output: EF RS MI SC WP
End of Problem

**THE SIMPLIS SYNTAX FOR THE PROBLEM SOLVING LITERACY MODEL FOR TURKEY**

```
PATH MODEL FOR TURKEY

Observed Variables
INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
PV1PROB PV2PROB PV3PROB PV4PROB PV5PROB

Covariance Matrix from file: turkey_ prob.cov
Sample Size = 3590

Relationships
PV1PROB = INTUSE PRGUSE ROUTCONF INTCONF HIGHCONF ATTCOMP ESCS
ATTCOMP = INTUSE INTCONF ROUTCONF HIGHCONF ESCS

Path diagram
Method of Estimation: Maximum Likelihood
Lisrel Output: EF RS MI SC WP
End of Problem
```

# CURRICULUM VITAE

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| High School | Buca Vocational High School, İzmir | 1986-1990 |

**WORK EXPERIENCE**

| **Year** | **Place** | **Enrollment** |
|---|---|---|
| 2000-present | METU | Research Assistant |
| 1999-2000 | Mustafa Kemal University | Research Assistant |
| 1998-1999 | The Ministry of National Education | Classroom Teacher |
| 1997-1998 | Bak Ambalaj | Operator |
| 1990-1992 | Tufan Elektrik | Electrician |

**FOREIGN LANGUAGES**

English

**PUBLICATIONS**

1. Kuzu, A., Şahinkayası, Y., Çakır, R. (2002). Öğretmenler İçin Hizmet-içi Amaçlı Web Tabanlı Öğretim Modeli Önerisi, Uluslararası Katılımlı Açık ve Uzaktan Eğitimi Sempozyumu, Anadolu Üniversitesi, 23-25 Mayıs 2002.

2. Şahinkayası, Y., & Şahinkayası, H. (2004). Okullar için öğretim teknolojisi planı (ÖTP) ve öğeleri. Paper presented at XIII. Ulusal Eğitim Bilimleri Kurultayı, 6-9 Temmuz 2004, İnönü Üniversitesi, Eğitim Fakültesi, Malatya.

3. Şahinkayası, H., & Şahinkayası, Y. (2004). Bilgisayar ve Öğretim Teknolojileri Eğitimi (BÖTE) Bölümü Lisans Programında Bulunan "Öğretim Teknolojileri ve Materyal Geliştirme" Dersinin Analizi. Paper presented at XIII. Ulusal Eğitim Bilimleri Kurultayı, 6-9 Temmuz 2004, İnönü Üniversitesi, Eğitim Fakültesi, Malatya.
4. Şahinkayası, Y. (2008). Comparison of Turkey and EU Members Regarding ICT Use, Self-confidence in ICT and Attitudes toward Computers. Proceedings of VIII. International Educational Technology Conference, Anadolu University, 6-9 May 2008, Eskişehir, Turkey.
5. Şahinkayası, Y. (2008). Modeling the ICT Related Factors with the Mathematical Literacy and Problem Solving Skills of the Students in the PISA 2003. Proceedings of VIII. International Educational Technology Conference, Anadolu University, 6-9 May 2008, Eskişehir, Turkey.

**HOBIES**

Playing basketball, saz, and folk dance, tennis and movies.