Information and Communication Technology Innovation in Education: The Case of Turkey

Emrah Orhun
Computer Science Department, Troy University Montgomery Campus
Montgomery, AL, USA
eorhun@troy.edu

Abstract

Turkey has initiated a number of projects to improve the quality of education and to provide students with knowledge and skills needed for the job market through the integration of information and communication technology (ICT) into education during the last twenty-five years. This paper is an overview of those initiatives of ICT in education in Turkey. It is argued that more attention is needed to what teachers think about the innovation and how they may be more involved. Some of the lessons learned are also discussed.

Introduction

Turkey first introduced computers into secondary education in 1984 through the Ministry of National Education (MONE). Since then MONE has initiated a number of projects to improve the quality of education and to provide students with the knowledge and skills needed for the information-based economy job market by integrating information and communication technology (ICT) into education. Major steps in this endeavor include the Computer-Aided Education Project (1989-1991), Computer Experimental Schools and Computer Laboratory Schools Project (1993-1997), Basic Education Program (1999-2007), and Secondary Education Project (2006-2010). This paper describes what has been done in those projects regarding ICT provision and its integration into education. Some of the relevant research is also surveyed to identify the major issues in ICT innovation in education in Turkey. What teachers do and think about the innovation and what school characteristics are conducive to successful implementation are explored through a study the author conducted in Izmir of the Computer-Aided Education Project, additionally what lessons can be drawn from Turkey's experience are discussed.

ICT in Education Projects in Turkey

Computer Education Project (1984-1988)

Computers were first introduced into secondary education in 1984 with the establishment of the "Specialized Commission on Computer Education at Secondary Schools" by MONE. During this initial phase, the aim was "to spread computer literacy" and "[c]omputers were seen as one tool to compensate for the poor quality and persistent deficiencies of suitable teachers" [1]. Project activities included preparation of the curriculum; software design; training the teachers; and incentives for local hardware and components production. In the academic year 1985-86, 1,111 computers were provided for 101 high schools and 130 computers were provided for some vocational schools. A total of 2,400 computers were purchased for secondary and vocational schools between 1985-1987 [2]. During 1985-1990, 48 training programs were organized and 2,240 teachers trained in computer literacy and programming [1, p.107]. Some of the issues identified in this phase included the incompatibility of the software with the curriculum, inadequacy of training, inappropriate hardware and software, and unsuccessful teacher involvement [3].

Computer-Aided Education (CAE) Project (1989-1991)

The early stage, which focused on hardware and teachers' learning the Basic programming language, evolved into the pilot project of 1988-1989, supported by a loan from the World Bank. MONE invited private computer companies to develop courseware for 37 subjects as well as providing further training, and purchased 1,178 computers for 58 schools. Several universities were contracted to train 750 teachers in programming and computer literacy [3]. The issues identified included lack of appropriate courseware, inadequate pre-service and in-service teacher training, insufficient hardware, and maintenance problems.

CAE Advisory Council meetings organized by MONE in 1989 and 1990 brought together academicians, teachers, and other educators, and MONE officers to discuss issues related to the implementation model, teacher training, hardware and software, and planning of the investments. The main CAE project was initiated in 1990-1991 as part of the World Bank National Education Development Project. As part of a number of measures planned to strengthen the education infrastructure in Turkey, this project included a program for introducing computer literacy and computer-aided instruction in grade 10 of selected secondary schools. In 1990-1991 MONE placed approximately 6,500 computers in 396 secondary schools and trained 250 teacher trainers and 5,000 teachers. MONE commissioned the development of courseware in the national language for 141 secondary and vocational school topics [4, p.26].

MONE established the General Directorate of Computer Education and Services (BILGEM) in 1992 to coordinate the integration of IT in education and oversee the various projects. An assessment of the developments in the CAE field in a World Bank Country Study [1] indicated that "[c]omputer penetration in these schools remains extremely low; and computer:pupil ratios are discouragingly high." In 1991, there were a total of 9,068 computers in vocational and secondary schools with a computer:pupil ratio of 1:218. The study stated that "Turkey lags significantly behind comparator and OECD countries." The World Bank study identified two implementation obstacles. First, the available software had not been integrated with curriculum developments. Second, there was a severe shortage of suitably trained teachers. These obstacles prevented the use of hardware in the originally intended manner [1, p.107]. The study pointed to the "needs to accelerate diffusion of general informatics skills in the workforce" and recommended "[m]ore aggressive implementation of the Computer Assisted Education (CAE) program with greater emphasis on: (a) teacher training; (b) curriculum development; and (c) relevant software availability" [1, p.202].

Project on the Development of National Education (1990-1999)

Within the context of this project implemented with World Bank support, MONE conducted two projects with the purpose of expanding the use of computers and computer-assisted education [5]. In the Curriculum Laboratory Schools (CLS) project, 208 schools from seven regions were equipped as curriculum laboratories to test the new curricula and teaching materials. The equipment included PCs, laptops, printers, data projectors, fax machines, modems, scanners, TV sets, video cameras, overhead projectors, projectors, cameras, and materials for physics, chemistry, biology and life sciences. MONE provided in-service training to the school principals, teachers, and inspectors in order to facilitate effective usage of the resources. MONE stated that by establishing the CLS schools, providing the equipment needed and training the personnel, the CLS project had achieved its aims, although the evaluation of CLS had not been completed at that time.

The CLS project also included models for school performance evaluation and development. Performance Management Model for School introduced a new model for the evaluation process to "save the evaluation process from its centralist structure and enable the members of the school community to take place in this process." The Planned School Development Model was a management model that set up a strategic plan and established an understanding of a "sharing school" model. In 1999, school development studies in all the educational institutions were conducted in accordance with this model [6].

The Computer Experimental Schools (CES) project aimed to use 53 schools as an experimental platform, to test the new curricula and teaching materials, where information technology would be integrated with the teaching-learning process. The CES schools received computer hardware, software, teacher training and facility renovation, as well as a computer-mediated communication network linking. A computer laboratory in these schools contained 20 monitors, with one server, a printer, and a modem. Nearly half the number of schools also participated in the CLS project, which provided them with additional audio-visual equipment. Software consisted of network software; applications programs; educational software for science and technology, games, authoring systems for teachers; and instructional software for English, math, biology, physics, and chemistry [7]. The project trained 250 teachers with

140 formators (teacher trainers) in the use of computers and educational software. Eleven months after the implementation, the evaluators found that administrators, teachers and students were all enthusiastically and creatively using the equipment and software. Schware & Jaramillo [7] mention the absence of relevant software in the Turkish language and the inadequate level of difficulty of the courseware for some selective schools (Anatolian schools) and the problem of teacher workload for those who were trained to be formators as the major challenges faced by the CLS project. The wide geographic dispersion of the CES schools posed difficulties in providing enough support and follow-up to each individual school all the time. The CES project was evaluated by an international group of experts in 1996, and was found successful in integrating IT into learning and engaging community involvement in the initiative [8].

The National Education Development Project also included a Pre-service Teacher Education component, which was implemented between 1994 and 1999 by the Turkish Higher Education Council. This component designed new teacher education curricula in thirteen subject areas based on a student-centered and constructivist approach to student learning [9].

Basic Education Program

In 1995, the Turkish Government requested the World Bank's assistance in preparing a project to support universal basic education. In 1997, Parliament approved a new Basic Education Law which established the timetable for implementing universal eight-year basic education and provided major budget resources [8, p.5]. In 1998, the World Bank approved the first of two loans of USD300 million each to support implementation of the Basic Education Program.

Basic Education Program Phase I (1998-2003)

The original objectives of the project included the capacity expansion of basic education schools; training of teachers, school principals and inspectors; development of central and provincial implementation capacity to carry out the program; and creation of a mechanism to monitor and evaluate the outcomes of the program. In 2003 the project development objectives were amended to include improving basic education quality by providing ICT classrooms and educational materials to schools [8, p.3].

The project procured computer hardware/software and peripheral equipment for 22,854 rural schools, overhead projectors for 18,517 rural schools, and 6,255 data projectors for 2,802 basic education schools installed with ICT classrooms. The project also purchased 1,500 notebooks for master formators, primary education inspectors, and 130 notebooks for the inspectors.

The Basic Education Program trained 221,000 teachers in ICT literacy. 2,058 IT formators were trained in IT coordination; 250 formators received master IT formator training; 250 master formators received refresher courses. Additionally, 405 teachers were trained in active learning and special learning methods; 3,781 received training for candidate principals; and 150 MONE staff received English language training. 2,956 inspectors received training in active learning and teaching strategies and use of material; and 861 inspectors received training in active learning and special education methods [8, p.23].

The World Bank's overall assessment of the project was unsatisfactory. Enrollments in basic education increased by 1.5 million since the start of the Program, raising the gross enrollment ratio for eight-year basic education from 85.6 percent in 1997 to 96.6 percent in 2001 [10, p.2]. However, this was still low compared to other middle income countries, which on average were at around 100 percent. The World Bank also noted that in recent international assessments, such as TIMSS and PIRLS, Turkish students were still well behind most of their counterparts in student learning. Although the project had improved access to ICT, both access and educational use of the technologies was very limited when compared to OECD countries [10, p.12].

Major training activities were carried out under MONE's budget and the World Bank did not attempt to review the effectiveness of the training conducted by MONE. The World Bank identified the following deficiencies in the project in connection with the ICT objective: Insufficient software; IT courses focusing on basic computer skills; lack of training in how to integrate computers into subject teaching; lack of an IT policy paper and a strategy to integrate IT into the curriculum and teacher training; and the ICT impact study not completed [10, pp.8-9]. The lessons learned by World Bank included the need for the Bank and the borrower to agree on outcomes and monitorable performance measures for ICT investments [10, p.20].

Basic Education Program Phase II (2002-2007)

The objective of the second phase was to support implementation of the Basic Education Program by extending the actions supported under the first phase, by supporting the development of preschool education as an integral part of basic education, and expanding special needs education. Activities supported through the second phase were to concentrate on increasing coverage and improving quality of education particularly among the children of low-income families and children with special needs. The following outputs were achieved under the components related to ICT [10, p.26]:

- 3,000 schools were provided with 4,002 computer laboratories providing access to ICT to more than 2.4 million students. The laboratories included computers, servers, printers, scanners, multimedia projectors, interactive whiteboards, air conditioning units, appropriate furniture, etc. In school selection, preferences were given to schools without ICT equipment located in low income areas.
- 70 special need education schools were equipped by computer equipment in 44 provinces.
- 40 primary education classrooms within hospitals received computers and printers.
- A wide variety of materials, including educational software for various subjects, were supplied to the schools.
- ICT in-service training was provided to tutors (trainers or "formators") to provide teachers with basic computer skills and to assist them in using ICT to improve instruction, to inspectors to assist them provide pedagogical ICT support to schools, and to assist computer instructors in using the existing ICT classrooms to their full potential. About 550 ICT tutors were trained in the area of new technology and design. 600 ICT tutors were trained as master formators. Over 73,000 teachers were trained in the area of new curriculum in 80 provinces.
- An education portal was developed by MONE using other resources.

The World Bank's overall rating of the project's performance was at "Moderately Satisfactory" level due to some shortcomings, which included limited project impact on increasing basic education coverage, partial achievement of the project targets for selected outputs, and delays in implementation followed by postponed impact analysis. The World Bank report commented on the complexity of project design, stating that "implementing such a complex project with large scale civil works would require an implementation period longer than 3.5 years" and "the complexity of project design was not counterbalanced by a comprehensive set of mitigations and arrangements" [10, p.7]. The World Bank complained about the poor assessment of project risks. The Monitoring and Evaluation Component of the project financed studies on the impact of in-service teacher training on students' performance, the impact of education materials on learning achievements, and ICT integration study [10, p.28]. However, the studies designed to collect baseline information in the respective areas were conducted closer to the project completion, and follow-up studies were never implemented.

The outcomes of the project were assessed using a Beneficiary Survey and Stakeholder Workshops [10, p.12]. The beneficiary survey was conducted in Autumn 2007. In total, 1,825 interviews were conducted with headmasters, teachers, parents, and students from schools supported under the project in 12 provinces. On the national level, meetings and interviews were conducted with officials of key MONE Directorates involved in the project as well as officials from the State Planning Organization and project staff. The evaluation indicated that providing students and teachers with educational materials, providing access to ICT for students and assisting in developing basic computer literacy, and training teachers contributed, together with the other interventions, to increasing quality of education process and educational outputs [10, p.16]. Students and teachers reported greater opportunities for accessing ICT for computer lessons, as well as teaching and learning other subjects and performing extracurricular activities (i.e. developing web-sites). Computer labs were extensively used for improving students' computer literacy. There were positive examples of ICT use to support new curriculum, and students' independent learning [10, p.18]. All target groups reported that students used all educational materials provided under the project, especially computer equipment and materials for preschool education. The survey showed that students demonstrated improvements in knowledge and skills after they used the new educational materials. School visits and meetings with teachers demonstrated that most of the teachers' demands for formal training in ICT literacy, and support in using ICT for teaching were met locally, outside the project. Ongoing support to teachers in ICT use was provided by tutors trained under the project. Local communities also appreciated the ICT equipment installed in schools.

Secondary Education Project (2006-2010)

The Secondary Education Project was approved by the World Bank in March, 2005, for a loan of USD104 millions. The objective of the project originally was "to improve the quality, economic relevance, and equity of secondary education to support lifelong learning" [11, p.12]. The ICT part of the project had the aim of "[p]roviding information and communications technology training as a core competency for youth to function in a modern knowledge economy, improving instruction by using information and communications technology to expand access to learning opportunities, and supporting better management of learning and administrative processes, and assess the educational impact of the information and communications technology investments."

As a result of the increased "emphasis on foreign language teaching to improve the skills of Turkish citizens so that Turkey can compete more effectively in a global economy and be better prepared for EU accession," the original project development objective was revised in 2007. The current project objective is "to support the Government's reform of general secondary and vocational education by improving conditions for student learning, establishing a career guidance system and enhancing foreign language teaching" [10, p.3]. The ICT subcomponent is to finance ICT classrooms in 322 schools as well as training of teachers in these schools in order to improve the competency of students to function in a modern knowledge economy. It covers development of multi-media learning tools, consultant services, goods and materials to utilize ICT to improve instruction and access to on-line educational content [10, p.8]. As of October 2, 2009, there had been limited progress in implementation. Currently the closing date of the project is December 31, 2010 [12].

The ICT projects described above are parts of ongoing educational reforms in Turkey to improve educational attainment and quality as part of EU integration efforts. They include reforms in curriculum, assessment, teacher professional development and the expansion of ICT, all of which require a long-term effort to yield the expected outcomes. These efforts aim at realizing a vision of "Turkey, a country of information society, growing in stability, sharing more equitably, globally competitive and fully completed her coherence with the European Union" [13]. Through these projects, the use of ICT in schools has become widespread and curriculum improvement activities have been accelerated. Although important enhancements have been accomplished in the population's access to education and the education level of the labor force, the levels of access and quality have continued to remain low compared to the EU average and the education system is insufficient to meet the requirements of the labor market. The problem of quality in education still remains an important issue according to the Ninth Development Plan (2007-2013) [13, p.49]. Accordingly, increasing quality and coverage of basic and secondary education will continue to be official objectives of MONE, as reflected in the current national Five Year Development Plan. Turkey recognizes that "[i]n order to increase the quality of education there is the continual requirement to improve the physical infrastructure, equipment and qualifications of teachers, use of resources allocated for education more effectively and in harmony with the renewed curriculum programs and teaching methods [13, p.98].

Research on ICT in Education in Turkey

ICT in education initiatives taken in Turkey during the last 25 years can be characterized by a lack of sufficient research into the options for policies and strategies and the impact of the actions taken [13]. Evaluation has been the weakest element of the projects, and limited information has been produced about the extent of computers in teaching and learning, the factors affecting use of computers, the quality or inadequacies of courseware developed, or effectiveness of the in-service programs. Yet MONE has continued to initiate new projects with loans from the World Bank to invest more resources into hardware, software and training without fully understanding the impact and complexities of the previous initiatives. In other words, the initiatives appear to be interventions based on a simple conceptualization of a complex world. In several project documents, the initiatives are considered as reforms; however, there are almost no references to theories of educational change or innovations. Several international and national studies as well as theories of educational change point to the central role of teachers in the implementation of educational change in general and in the integration of information technology into teaching, in particular. According to Fullan: "Educational change depends on what teachers do and think—it's as simple and as complex as that" [15, p.117]. The problem faced in Turkey in trying to implement the ICT innovation in education has been that we have simply not known enough about what the 'teachers do and think' about the computer innovation(s) they have been introduced to [14].

Several academic studies during the last two decades have shown that the actual use of ICT in education in Turkey has been less effective than expected in all of the projects [e.g. 14, 16, 17]. Some studies have aimed at studying ICT initiatives as educational innovations and gaining further understanding of how school teachers in

Turkey perceive computer innovation in their schools [e.g. 14, 16, 17, 18, 19, 20]. These studies indicate that the chance of successful implementation of the ICT innovations depends on teachers' involvement in the change process.

Computer-Based Cognitive Tools for Learning and Teaching: The COG-TECH Projects

To explore how computers could be integrated into teacher education programs, an international collaboration initiative was developed by the COG-TECH (Cognitive Technologies for Problem Solving and Learning) Network, which aims to foster collaboration among the European and the Mediterranean countries in the field of information technologies in education. The initiative included three projects (MED-CAMPUS Project B-359 and C-359, 1993-1995, and INCO Project 973367, 1998-2001) coordinated by the author under the auspices of the European Commission. The main purpose of these projects was to train teacher educators in the teacher education institutions of the Mediterranean countries to use computers as effective pedagogical tools.

The main assumption of the training programs had been that the role of information technologies in education should be as a tool for learning rather than a vehicle for knowledge transmission. The training activities of the projects included international summer schools and national follow-up workshops that introduced the participants to a set of computer-based cognitive tools. One of the goals of the summer schools was to train some of the participants to a level sufficient for conducting similar training in their countries. Three summer schools and five workshops entitled "Computer-Based Cognitive Tools for Teaching and Learning" were organized between 1994 and 2001 in Turkey, and one workshop in Jordan. Altogether, 110 educators from 16 countries took part in the summer schools and 140 teachers were trained in the workshops. A workshop entitled "Information Technology Implementation in Schools" was organized to inform school administrators, computer coordinators, and ministry officials in Turkey about issues in information technology implementation in schools.

The content of the summer schools and workshops, as well as results of their evaluation, are described in two articles by the author [22, 23]. The impact analysis showed that the training activities had a significant impact on the teaching and practice of many educators by exposing them to new approaches and helping them acquire knowledge and skills needed for using computer and information technologies as effective teaching and learning tools. Changes in how technology is viewed in the teaching and learning process had been most significant.

Information Technology Innovation in Turkish Schools: An Investigation of Some Schools in _zmir

As part of the MED-CAMPUS C-359 project, the author conducted a study in 1994-1995 to gain an understanding of how secondary school teachers perceived computer innovation during the Computer-Aided Education (CAE) project that was initiated in 1991. Drawing upon the work of Fullan [15], Huberman and Miles [24], and Grunbeg and Summers [25], a conceptual framework was developed for formulating research questions and guiding data collection [26]. The framework was organized around *relevance* (need for innovation, clarity, practicality, congruence, instrumentality, cost/benefit ratio), *readiness* (commitment, compatibility with culture, front-end training, materials, other change efforts, planning, coordination time, prior relevant experience, provision for debugging, skills, understanding), and *resources* (central administration support, in-service support, school administration support). The study sought to determine whether; the innovation was *relevant*, the teachers were *ready* for the innovation, and the *resources* were provided. For implementation, the following key factors were hypothesized in the conceptual framework: innovation characteristics, teacher factors, school characteristics, and external characteristics.

The research can be characterized as multiple case studies with *school* as the unit of analysis. The qualitative phase was guided by the results of a preceding quantitative phase, which involved a survey of 39 schools in _zmir. Data collection was done in 1994-1995 and the schools were revisited in 1996. The case studies were of three schools: two state schools which had participated in the CAE project, and one private school which had been involved in its own programs of ICT innovation. The first state school was a selective high school (*Anadolu Lisesi*) while the second one was a selective vocational school (*Anadolu Meslek Lisesi*). All three schools delivered instruction partly in English with the private school conducting most teaching in English. The within-case sample consisted of the school principal, the computer coordinator or school-based teacher trainer, and one or two teachers who had received some in-service training for using computers.

The study found that the extent of the implementation of ICT innovation in secondary schools in Izmir was rather limited five years after its initiation. Most of the use of computers in teaching was *teaching about computers*. *Learning with computers* was very limited and mostly took place in vocational schools. Although MONE had

provided the schools involved in the CAE project with computer laboratories and instructional software, and trained teachers, not all of the conditions supporting successful initiation were present at the state schools studied. The externally mandated innovation which had "no aims" was introduced into schools in which neither the teachers nor the students had time for an extra activity and the teachers were without adequate knowledge and skills. In the private school, where the innovation was internally developed, the conditions supporting successful initiation were present as a result of a longer initiation process supported with significant amounts of external funds.

Both the quantitative and the qualitative components of the study indicated that teachers' overall attitudes towards the use of computers in education were positive, but lack of self-confidence towards computers was common. Teachers' lack of knowledge and skills in using computers for instructional purposes was the most important obstacle in implementing computer use in teaching. Lack of time, lack of relevant software, insufficient training opportunities, insufficient expertise/guidance and help for instructional use, insufficient technical assistance, and insufficient number of computers available were the other important obstacles for implementing computer use in teaching. The survey results indicated that pedagogical/instructional aspects were not neglected in the in-service training teachers had received, in contrast to the findings of the IEA study [27]. A significant portion of the teachers in the survey sample had received more than 60 hours of training which was not considered sufficient. Interviews also showed that extensive training was necessary to reach a sufficient level of confidence and knowledge. In the survey results gender differences appeared in connection with training received and level of use. There were fewer females with higher levels of training. The majority of the non-users were also found to be female.

The qualitative component of the study pointed to additional factors which affected the implementation process. The university entrance examination and the resulting need to attend a preparatory school emerged as the most crucial factor in determining whether the innovation will be accepted or not. The results suggested a variety of themes that may be associated with success in the implementation phase. It was clear that the coordinator/teacher trainer had a key role in that process, probably more important than the principal. The stronger position of the private school in satisfying successful initiation conditions and the progress achieved during implementation with significant amounts of financial support indicated the need for larger investment in training and materials and for ongoing support.

Discussion

One of the lessons the World Bank drew from the Second Phase of the Basic Education Program is that "it is important to learn lessons, obtain evidence to evaluate performance and achievements from previous operations before asking the Government to commit resources for next operation" [10, p.41]. The ICT in education projects in Turkey have so far produced limited information and lessons that may be useful to consecutive projects. Various academic studies such as the COG-TECH study which had aimed at this can be examined to draw some lessons.

The COG-TECH study concluded that the initiation and implementation of ICT innovation in education needs better planning, more and better resources for the schools, and relevant and adequate upfront training, and is a much longer process than envisioned. Even in the context of the small COG-TECH projects, some confirmation of the proposed model for teacher training spanned a period stretching over seven years. It is interesting that the planner and lender of ICT projects in Turkey (i.e. MONE and the World Bank) envisioned projects of 3-4 years of duration that could have measurable impact.

The COG-TECH study also found that teachers' lack of knowledge and skills about using computers for instructional purposes was the most important obstacle for implementing computer use in teaching. These findings emphasized the importance of training for the teachers. Although MONE provided extensive in-service training, what was offered was not sufficient and not available in a form that can be useful to teachers. The World Bank's mention of "lack of training in how to integrate computers into subject teaching; lack of an IT policy paper and a strategy to integrate IT into the curriculum and teacher training" [10] in 2008 shows that the progress has been inadequate. The COG-TECH study's observation, that interaction among teachers may be as important as training, and that time for informal as well as more structured arrangements such as workshops must be provided for, needs to be considered in planning in-service training.

The COG-TECH projects had developed and implemented a model for training teacher educators and practicing teachers in using ICT as teaching and learning tools in 1994, and trained several MONE members; however, no direct influence has been reported on the in-service training programs MONE offered. Turkey was able to develop a new teacher education curricula based on a student-centered and constructivist approach to student learning only in 1999, 15 years after the first introduction of computers into education as part of the National Education Development Project funded by the World Bank. It is in a way sad that the retirement of large number of teachers

recruited in the 1960-1980 period, "gives an unparalleled opportunity" for the educational system in Turkey to benefit from "newly qualified teachers" who "will be trained by teacher educators who have ushered in the reform" [9]. This may be admitting that the most important aspect of the ICT innovation has not received enough attention until very recently, causing waste of not only material resources but a whole generation of human resources as well.

The COG-TECH study found gender differences appeared in connection with training received and level of use. There were fewer females with higher levels of training. The majority of non-users were also found to be female. These findings should be considered carefully for developing policies which might prevent further extension of existing social inequalities and negative effects of limited role models on students.

The multiple-choice university entrance examination and the resulting need to attend a preparatory school define a framework which may be the most crucial factor in determining whether an innovation will be accepted or not. This framework may undermine the current educational system especially in the state schools as most teachers' main professional concern is oriented towards supplementing their salaries with private lessons to prepare students for the entrance examination. Within the current system, ICT has only a limited potential for supporting knowledge acquisition and problem-solving in connection with preparing for the university entrance examination to the extent it can provide this support more effectively and efficiently compared to the other existing means. Aspirations for a student-centered and constructivist approach to student learning are in sharp contradiction with the reality of the test-driven education of today.

The results of the COG-TECH study suggested a variety of themes that may be associated with success in the implementation phase. The stronger position of the private school in satisfying successful initiation conditions and the progress achieved during implementation with significant amounts of financial support indicate the need for larger investment in training and materials and for ongoing support. At the same time, building a capacity for innovation by creating a culture of "cooperative interaction" in the school may be equally important. The apparently more limited understanding of the innovation observed in the state schools may be related to the lack of interaction with MONE. It may also be related to the more "hierarchical," "top-down" organization of the state schools compared to the "cooperative interaction" culture of the private school. This "cooperative interaction" culture seems necessary for creating a capacity for change in a school. The implementation of an innovation requires a change process that cannot be prescribed and must be worked out step by step by the community involved with it. A "bottom-up mechanism" which allows the teachers to shape the direction of the innovation appears to be an essential part in such a process. Development of such cooperative interaction cultures in schools may also be important for alleviating the disbelief in the continuity of innovation that emerged in the state schools.

The projects conducted by MONE with the guidance and support of the World Bank appear to be interventions based on simple conceptualizations of a complex change process, although over the decades those conceptualizations have evolved. The early conceptualizations gave a prominent place to hardware and assumed simple causal relations between some obstacles and the use of hardware: "Second, there was a severe shortage of suitably trained teachers. These obstacles prevented the use of hardware in the originally intended manner" [1, p.107]. Although later projects were seen as "complex project[s] with large scale civil works" [10] and the initiatives are referred to as *reforms* in several project documents, there are hardly any references to *educational change*. The projects emphasize objectives and outputs (typically in terms of equipment provided to the schools and number of teachers trained), but fall short of specifying a process or providing a description of educational change model(s) assumed. There are no references in project documents to the theories of educational change or innovations, as exemplified in UNESCO's ICT Planning Guide [28]. One or more educational change models based on several decades of research should provide guidance particularly in managing change and innovation.

The COG-TECH study found that teachers and schools had limited interaction and negotiation with MONE concerning the innovation beyond MONE's request for teacher participation in training and establishment of computer laboratories. In general the projects have lacked systematic dialogue and consultation with teachers, which is "fundamental to the process" [29]. The teachers were not involved in policy formulation, which has prevented the development of a sense of ownership of the innovation initiatives that is essential to successful implementation. Even recent major projects such as The Second Phase of the Basic Education Program fell short of involving the teachers as the planned Stakeholder workshop was not conducted [10, p.34]. One of the lessons the World Bank took from this project was: "It is essential that Bank teams not only carry out dialogue on policy aspects of the education sector, but also pay close attention to the political, social and institutional aspects of education reforms and have consultations with a broad range of stakeholders to improve the relevance and design of projects" [10, p.41]. It is not clear from this statement to what extent teachers' involvement in policy formulation is recommended for future projects. Grossman et al. [9] have found in their study of the Pre-service Teacher Education reform in Turkey that even participation in the implementation of a reform was insufficient to offset concerns about the top-

down nature of the reform effort in the teacher education community. Aligned with recommendations of organizations such as OECD, recent academic research on ICT in education in Turkey has focused on developing better national information on teachers. Such research is considered "important not only for improving the knowledge base for teacher policy, but also as a way of introducing new information and ideas to schools and ensuring that teachers engage more actively with new knowledge" [29]. We may hope that such research will also point to how teachers may go beyond the passive adopter role to become active participants in defining and developing innovations.

We cannot claim that our comprehension of the complex dynamics of educational change is deep enough. Fullan [30, p.ix] notes that our understanding of the "change forces" has gone beyond key concepts such as vision, strategic planning, and strong leadership, which have "contributed to superficial thinking". New ways of thinking provided by complexity and evolutionary theories are offering "liberating and inspiring possibilities for individuals at all levels of the system to understand better and to act much effectively" in this era of "chaos and disillusionment" [30, p.12]. The capability of learning is crucial to coping with the changing world. In order to survive as an institution, the school must become a learning organization and a member of the community of learners, which includes state and local authorities as well as parents [30, p.61]. As Egan [32, p.32], points out, "The problem is not with the school necessarily but with the way we conceive what the school is supposed to do." ICT innovation has offered Turkey as well as other countries an opportunity to reconsider what education is supposed to do. The further realization of ICT innovation's expected impact and its sustainability will depend on continuing efforts for enhanced partnerships between schools and universities, and other factors, some of which may be identified through research and reflecting on our collaborative activities.

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