Thesis submitted for the degree of
Doctor of Education at the
UNIVERSITY OF LEICESTER

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October 2003

## Abstract

*Integrating Information and Communications Technology (ICT) into Pre-Service Science Teacher Education: The Challenge of Change in a Turkish Faculty of Education*

*Nedim ALEV, EdD Thesis, August 2003*

Developments in Information and Communications Technology (ICT) and its applications in teaching and learning science are calling for teachers to integrate ICT into science curriculum and instruction. This requires a strategic ICT training for prospective teachers. The literature suggests that integrating ICT into Initial Teacher Education (ITE) is the only option to accomplish the intended change in developing prospective teachers.

This thesis focuses on exploring the process of integrating ICT into pre-service secondary science teacher education programmes (Physics, Chemistry and Biology) and its emerging challenges in a Faculty of Education (FE) in Turkey. In this thesis, qualitative dominant case study design was adopted as a result of a pragmatic reasoning. The analysis of data revealed that integrating ICT into ITE science programmes is yet to be accomplished. The data revealed that the participants, both the lecturers and student teachers, have positive attitudes towards ICT and considerable knowledge and positive understanding of ICT and its potential in teaching and learning science. However, the Faculty fails to provide appropriate ICT-training courses for student teachers to develop their technical ICT skills. Having said this, there are crucial examples of horizontal integration; that is, the lecturers provide opportunities for the student teachers to use ICT in meaningful contexts. The data suggest that there is a relationship between the practitioners' stages of concern and stages of adoption, which can be described as follows: the personal level of concern moves from the 'self-concerns' to 'task and impact-concerns', the personal adoption level is also likely to move from entry to invention. Although the participants and the researcher identified some crucial factors that has prevented the lecturers and student teachers from using ICT in teaching and learning, among these the institutional ones such as lack of proper access to ICT resources, overcrowded-classrooms, lack of technical and pedagogical support are more influential on the integration process.

Dedication

To my family

**Acknowledgement**

I am grateful to my supervisor, Mr. Laurence Rogers, for his generous support and critical comments throughout my study. I also would like to thank Dr. Marlene Morrison for her support and valuable comments before her move to another university and all members of the staff of Leicester University School of Education for their support and encouragement.

I am also grateful to the participants, the lecturers and student teachers, in this study and the administrators of Fatih Faculty of Education, Karadeniz Technical University, for their support during data collection process.

I am indebted to the citizens of the Republic of Turkey, and I am grateful to them for their support via the Turkish Government to study in England.

I would like to thank my parents back in Turkey and my family. Special thanks must go to my wife, Nagihan, for her incredible support and understanding throughout my study in England, particularly for giving me the dearest gift of my life, my daughter, ALMILA.

Finally, I would like to thank my friends and research fellows, Zuhal and Taner Altun, Ismail Acun and many others research fellows at University of Leicester and University of Nottingham, for sharing their ideas about my study and many other subjects and for sharing moments with me in social life during our studies in England. I also would like to thank my friend, Mehmet Yildirim, for sharing moments with me in social life in Leicester.

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**Abbreviations:**

ICT: Information and Communications Technology
ITE: Initial Teacher Education
PSTEP: Pre-service Science Teacher Education Programmes
FE: Faculty of Education
FSA: Faculty of Science and Art
MNE: Ministry of National Education
Int.: Interview
ST(s): Student Teacher(s)
PT: Physics Trainee teachers
CT: Chemistry Trainee teachers
BT: Biology Trainee teachers
CLS: Computer Laboratory School
CES: Computer Experiment Schools

# 1. INTRODUCTION

## 1.1. Introduction

Selinger (2001c) points out that

> "ICT is found in all sectors of the workplace in developed countries, and it is becoming increasingly used in the developing world. Children of today, at the very least, need to become aware of the potential of new technologies in all aspects of their lives. The benefits for learning are increasingly being demonstrated and teachers' roles in the information age ought to be both expanding and changing to embrace these resources and to harness their potential for the future of children in developing countries"
> (http:\\www.imfundo.org/papers/ict_in_s.doc/)

Turkey is a developing country and nearly for twenty years there have been some attempts to introduce ICT to the educational institutions as well as to other parts of social life. 1980s were the period of change in economic policy towards free-market economy or liberal economy. Limited availability of computer technology and a computer illiterate work-force became a crucial impediment to boosting the economy. Since then there have been a number of projects to educate new generations with the required knowledge and skills to satisfy present-day job market needs (Schware and Jaramillo, 1998). However, as it is the case for any innovation introduced to education, teacher training has always been an issue that affects the change process directly. This particular study focuses on exploring the current state of integrating Information and Communications Technology (ICT) into Initial Teacher Education holistically in a Faculty of Education (FE) in Turkey.

This chapter first provides a short overview of the introduction of ICT to education around the world. After that brief information about Turkish context in regard to the teacher education in general and the developments in integrating ICT into teacher education in particular will be provided. This chapter also provides information about the general aims of the study. Finally, each chapter of this thesis is described.

## 1.2. The New Context of Teaching and Learning in the Information Age: bringing about the change

Fullan (1991:350) defines the difficulties of change as follows;

> "Change is difficult because it is riddled with dilemmas, ambivalences, and paradoxes. It combines steps that seemingly do not go together: to have a clear vision and be open-minded; to take initiative and empower others; to provide support and pressure; to start small and think big; to expect results and be patient and persistent; to have a plan and be flexible; to use top-down and bottom-up strategies; to experience uncertainty and satisfaction. Educational change is above all a very personal experience in a social, but often impersonal, setting."

The introduction of ICT into education has proved how difficult the integration of ICT into education is for almost thirty years around the world. In addition to difficulties of the process of an educational change, the ICT as an innovation in education has its own dilemmas itself. The tools of the 1980s have been replaced with new ones or improved due to everlasting developments in technology. Pachler (2001:15) points out that technologic developments, "in particular interactive multimedia and the internet, brought about an information revolution", reshaping "the way we work, study, play, form relationships and communicate". In order to prepare future generations to live in an emerging society, which is and will be highly technology-oriented, they need to be educated appropriately in accordance with the requirements of the information age. It is also evident that technology provides a new form of learning, and therefore of education, which is occurring out of schools. However, "school-based education remains vital in ensuring that future generations of young people are well prepared for adult life in a world strongly influenced by new technologies" (Pachler, 2001:15). In a Commonwealth Secretariat's report (1991:8-9), four main reasons at a national level for introducing ICT into schools are given as follows:

1. to build a resource of people who are highly skilled in the use of ICT,
2. to equip all students for a future in which technological awareness and basic computer skills will be increasingly important for greater number of citizens,
3. to use technology to enhance the existing curriculum and to improve the way in which is delivered, and
4. to promote change in education by moving towards a more relevant curriculum and a new definition of the teachers' role.

Robinson (1997) discusses the three phases of ICT innovation as follows. In the early stage, the ICT initiatives in schools were technology centred. In this phase, the notion of ICT adoption was that as long as facilities are available and teachers are trained in having basic ICT skills, adoption is inevitable. Nevertheless, learning how to use ICT in the classroom entails more than training in hardware and software use. Thus it became obvious that having access to hardware and software alone was inadequate to secure successful uptake. The reasons for the failure of these early stage efforts in implementing ICT might be the *lack of understanding* (Williams et al., 1998) of ICT as a pedagogic tool (i.e. its value in teaching and learning), *lack of clarity* or *uncertainity* (Fullan, 1991) of people perceptions and expectations from ICT innovation in education, and ignoring *individual* or *internal commitment* or *ownership* (Goodson, 2001).

As a result of this unsuccessful period of adoption, the following efforts to make use of ICT in teaching and learning tended to focus on pedagogy rather than technical matters in the second phase. This phase includes pedagogic understanding of what computer assisted learning applications are trying to do and what the hardware and software have potential (Robinson, 1997).

In the last phase of this long run innovation in education, practitioners themselves have been seen as an important issue, and increasing attention is therefore being paid to human and institutional as well as technological and pedagogic issues (Fullan, 1991; Robinson, 1997). Robinson (1997) and many others point out that teachers are highly conservative as a professional group, and they see innovations in education as a threat. He states that "teachers need to understand the process of change, be able to locate their place in it and then be able to act (p.42)". However, teacher resistance in many cases might be inevitable due to natural complexity and uncertainty of any change (Fullan, 1991). What is important here is to plan the implementation process very sensitively. This plan must include strategies which make people (i.e. teachers, students and other staff in an educational setting) feel confident on using ICT in teaching-learning activities and personal needs, and which make them acquire positive attitudes towards ICT by balancing pressure and support harmoniously.

Newton and Rogers (2001) describe the dilemmas of implementing ICT in education. They point out that "there is diversity and sometimes conflict of expectations of what ICT can achieve in education" (p.5) among people who are involved in the process. In formal education, teachers and teacher educators are at the centre of the implementation of ICT. They are the practitioners who are expected to exploit the potential of ICT. There are many studies that illustrate that ICT has been used in education to support traditional classroom practices; that is, ICT is used as tools to improve the quality of what teachers have already been doing (OTA, 1995; Williams, 2000; Mumtaz, 2000). Kozma and Anderson (2002:389), on the other hand, describe what ICT can achieve in education other than supporting the *old* teaching methods.

- promote active and independent learning in which students take responsibility for their own learning, set their own learning goals, create their own learning activities, and/or assess their own progress and/or the progress of other students.
- provide students with competencies and technological skills that allow them to search for, organise, and analyse information, and communicate and express their ideas in a variety of media forms.
- engage students in collaborative, project-based learning in which students work with others on complex, extended, real-world-like problems or projects.
- provide students with individualised instruction, customised to meet the needs of students with different entry levels, interests, or conceptual difficulties.
- address issues of equity for students of different genders or ethnic or social groups and/or provide access to instruction or information for students who would not have access otherwise because of geographic or socio-economic reasons.
- 'break down the walls' of the classroom-for example, by extending the school day, changing the organisation of the class, or involving other people (such as parents, scientists, or business professionals) in the education process.
- improve social cohesiveness and understanding by having students interact with groups and cultures that they would not interact with otherwise.

All these above actually occur in a constructivist teaching and learning environment. In a constructivist learning environment, it is evident that ICT requires changes in practitioners' beliefs, understandings, roles, attitudes and skills to accomplish the intended change. Therefore, teachers need to be trained to integrate ICT into their teaching activities and to create opportunities for students to construct their own knowledge.

As stated earlier, teacher training is a central issue for the success of the change. Each country has trained their practising teachers via in-service training courses and prospective teachers in ITE programmes. However, integrating ICT into classrooms in both ITE and schools is yet to be accomplished around the world and in Turkey as a developing country. For this reason, this study focuses on integrating ICT into Preservice Science Teacher Education Programmes (PSTEP) in a Faculty of Education in Turkey to explore and understand how ICT is integrated into preservice teacher education in that particular case. Next, an overview of ITE in Turkey and the developments related to phenomenon will be provided. It is believed that this brief information will provide some insights for the reader in which context this study was carried out.

## 1.3 An Overview of Initial Teacher Education

As the first president, Mustafa Kemal Ataturk led the country in constructing a politically and economically independent, secular and social state. During that challenging period, Ataturk emphasised education as a driving force to create a new and modern society, and teachers as the key element of the reforms (Murray, 1988). In 1924, Ministry of National Education (MNE) was established, and with the Law on Unification of Education, all educational institutions and activities in the country were unified under the responsibility and administration of MNE (Gursimsek, Kaptan and Erkan, 1997). From the *Darulmuallimin-i Aliye*, which was the first contemporary teacher education institutions, of the Ottoman Empire to the current Faculty of Education of Turkey, there have been many changes and developments in teacher education in Turkey (for more information about these changes, see Gursimsek et al., 1997; Arayici, 1999; MNE, 1995; Altan, 1998; YOK, 1998a).

In 1981, with the Higher Education Reform in Turkey, the responsibility and administration of teacher education had been given to the universities (Altan, 1998). In 1989 and 1991, secondary teacher education programmes, pre-school and primary teacher education programmes respectively were extended to four years. Many faculty members of Faculty of Science and Arts (FSA), especially from the Departments of Mathematics, Physics, Chemistry, Biology, History and Western Languages, have been transferred to the Faculties of Education (FE) and gained administrative positions (Altan, 1998). There is no doubt that these new staff of FE were well-qualified in their own subject, such as in Physics, Chemistry, History, and so on. However, as Altan (1998) and YOK (1998a) assert, they were not specialised and educated about teaching-learning and teacher education. As an inevitable result of this, FE has been turned into FSA. Inaccurately, student teachers have been educated as specialists in their subject areas, and pedagogy has been neglected (Altan, 1998; YOK, 1998a). According to YOK (1998a) report, this kind of misdirection has been particularly a serious issue in the secondary teacher education departments. On the other hand, the academic staff have not produced research about education, rather they have carried on doing research in their own specialist subject areas (Altan, 1998; YOK, 1998a), except for primary education and educational management (Altan, 1998).

Students who were placed in different teacher education departments, after taking university entrance exams, of the Faculties of Education were prepared for the teaching profession through courses mainly in three different fields: a) Knowledge and skills concerning general culture (covers approximately 12% of the curriculum) b) Special subject knowledge (approximately 63% of the curriculum) c) Pedagogical formation and methodology (covers approximately 25% of the curriculum) (Gursimsek, et.al., 1997). The process of teacher education was criticised in relation to quality and content of the courses, and inefficiency of practical training period (four weeks in the fourth year of the programme) (Gursimsek, et.al., 1997; YOK, 1998a).

Due to the fact that academic staff and administrators came from FSA, they strove to establish new teacher education programmes for secondary schools/high schools. Thus they neglected to educate enough teachers for pre-school education, primary and junior high schools/second stage of primary education. To fill the gap MNE has appointed new teachers among all university graduates regardless of their subject areas, providing some intensive courses for them within very limited periods (YOK, 1998a).

Thus, the recent development in ITE in Turkey was about two main objectives, requiring some structural changes in consideration of what has been happening elsewhere in the world; to educate more teachers in some levels or subject areas; to educate all prospective teachers better. One of the most crucial points in re-structuring was the drastic change in secondary teacher education. With this change, teachers for secondary schools will be educated in the 'master without thesis' programmes, sharing many features of PGCE programmes in the UK. Thus, the consecutive model of teacher education was adopted for secondary level, as illustrated in Figure 1.1.

YOK (1998a) report discusses the main reasons for the consecutive model.

> Secondary school teachers, alongside powerful subject knowledge and skills, need to have a strong pedagogical formation (p. 29)... Special attention will be paid to subject teaching methods and the time allocated for this purpose will be extended (p. 30)... The relationships between Faculties of Education and Practicing Schools will be based on a more systematic, active and regular basis (p. 30).

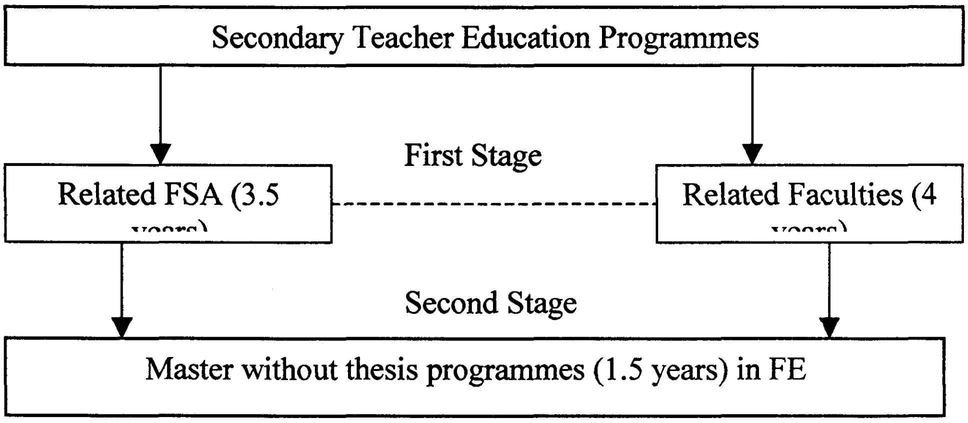



Figure 1.1 Secondary teacher education programmes: the consecutive model

In the YOK report it was mentioned that before *teaching practice* student teachers would have the opportunity to visit *practice schools*. In schools *master teachers* and *teacher educators* in Faculties together would be given the duty of teaching the courses of special teaching methods and practising in order to strengthen and maintain the close and good relationship with schools. In the new programmes topics such as classroom management, communication, motivation and learning will be covered since it is thought that these phenomena would influence the effectiveness of teachers within classrooms, focusing on more practical solutions rather than providing some theoretical knowledge. On the other hand, in the new programmes, courses about Information and Communications Technology and its uses in teaching and learning will be provided to improve the quality of teachers. In short, the curriculum of each ITE programme was reformed, from theory-laden courses to more practice-based courses. The structural and curriculum changes were based on the assumption that, to improve ITE, STs should be given the opportunities to practise what they have learned through university-based courses and to reflect on their practices, *integrating the theory with the practice* (Kirk, 1999; William and Soares, 2002).

It is understood that the models and basics of re-structuring derived from well-planned preliminary examinations and observations of how ITE has taken place in other countries. It is widely accepted that teaching practice in ITE is crucial. As seen in many countries, with the re-structuring it was intended to improve the quality of student teachers' practice, allocating more time for student teachers' involvement with schools (Brisard and Hall, 2001; Maynard, 2001; Jones, 2001; Hallinan and Khmelkov, 2001) "on the assumption that teachers should not only demonstrate a theoretical understanding of teaching but should also demonstrate their capacity to perform competently in real settings" (Kirk, 1999:900). As Kirk (1999) and Williams and Soares (2002) argue, schools' contribution to the process of teacher education has gained prominence, and this requires integration between school-based and university-based activities. In its extreme, in England schools were allowed to provide ITE independently through school-centred initial teacher training scheme (Williams and Soares, 2002; Calderhead and Shorrock, 1997).

The latest reform in ITE in Turkey illustrates some common features of different countries' models of teacher education, especially of *articled teacher scheme* (Calderhead and Shorrock, 1997) in the UK, in which a partnership is essential between Universities, Schools and Local Education Authorities. In this sense the fundamental theory of educating prospective teachers shifted from traditional behaviorist approach (university-based) to more constructivist approach (more school-based and practice-based). Apart from allocating more time for teaching practice and school experience, this shift can be seen in the reformed curriculum as well. Almost each course has theoretical and practical portions. Figure 1.2 illustrates the new partnership model.

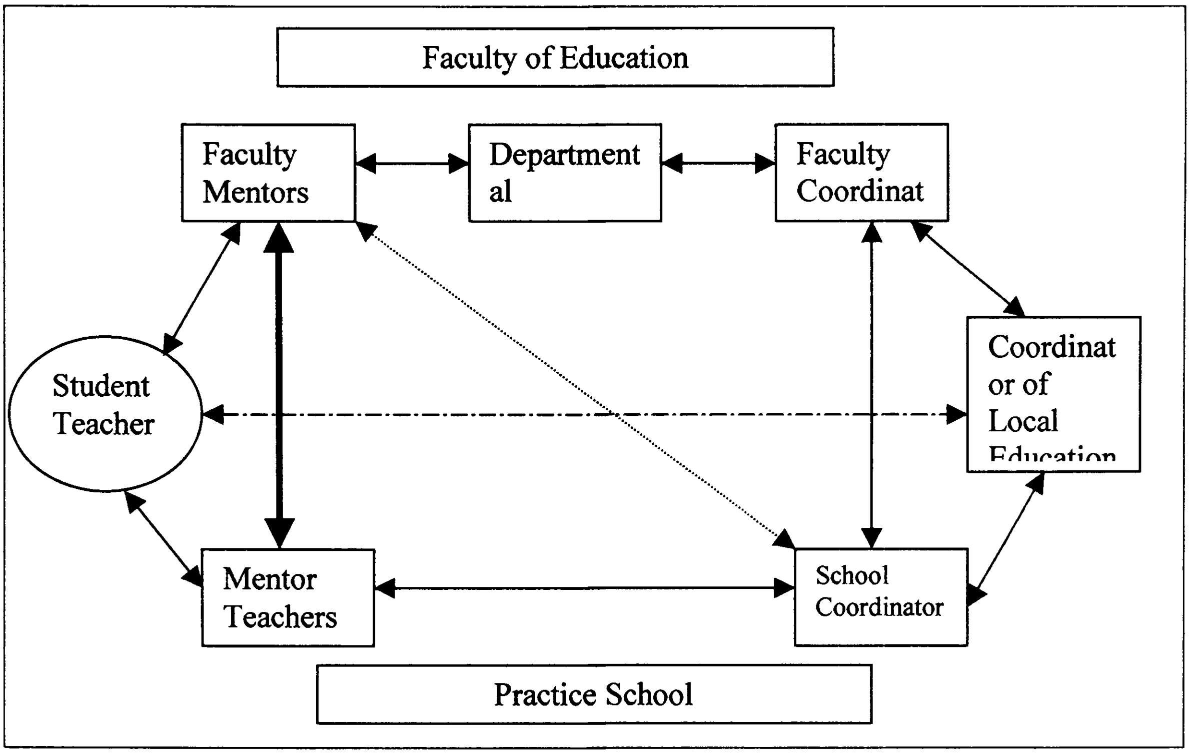



Figure 1.2 Faculty of Education – Practice Schools Partnership Model (YOK, 1998b p. 4)

## 1.4 Attempts to Integrate ICT in Turkish Education System

To understand the ICT policy and its implementation, some brief information might be necessary about Turkish educational context. The educational system of Turkey is centrally directed, controlled and in the case of state schools, funded by the Ministry of Education (Yedekcioglu, 1996). Centralisation is the degree to which power and control in a system are concentrated in the hands of relatively few individuals (Bayram and Seels, 1997). According to Rogers (1995), centralisation is usually negatively associated with innovation because the more centralised an organisation is, the less innovative that organisation tends to be. Bayram and Seels (1997) states that "centralisation and bureaucratic patterns have produced formalisation and lack of interconnectedness in Turkey" (p. 116). The education system continues to have tradition of rote learning and memorisation. As a consequence, the structure of Turkish educational system is traditional teacher centred, and thus integrating ICT into education in Turkey requires fundamental changes in practice.

Ozar and Askar (1997) interviewed 15 key policy makers in the National Ministry of Education to identify their opinions in terms of present and future uses of technology. They found that almost all of the participants expressed the view that the Turkish education system as a whole is not ready to incorporate ICT because it is based on the classical understanding in terms of curriculum, teaching methods and context of the courses. The majority of the participants stated that attempts made since 1980s to integrate ICT into the schools failed because they were not planned carefully. The other impediments mentioned by participants were inappropriate physical condition of the schools, overcrowded-classrooms, lack of experienced teachers in ICT, lack of supporting staff and software for subject teaching.

The main aims of integrating computers into education were; to introduce new technology to new generations, and to use new technology in order to improve teaching and learning activities (METARGEM, 1991). In the 1980s, computer courses have been offered as an elective course in secondary schools. The main focuses in these courses are some applications of DOS, word processing, database, BASIC and PASCAL programming languages, but lack of well trained teachers caused the failure of these courses (Ozar and Askar, 1997). The Ministry of Education initiated a project, called Computer Aided Education (CAE) in 1984. The main components of the project were: preparing and integrating curricula; software design and development; training of teachers; acquiring hardware; and incentives to produce and components locally (Yedekcioglu, 1996). In the academic year 1985-86, as part of the CAE project 1111 computers were bought for 101 high schools; 10 for students and one for teachers in each school, and then in 1989, computer labs were established for 58 more schools (Yedekcioglu, 1996). In the World Bank report (1993) it is pointed out that;

> "The CAE project appears to have run into certain implementation obstacles. First, the available software has not yet been integrated with curriculum developments. Second, there is a severe shortage of suitably trained teachers. Third, a number of the potential vendors dropped out complaining of excessive bureaucracy and inadequate terms of reference and project definition. Although program implementation is continuing, it is at reduced growth rate and with significantly reduced expectations." (Quoted from Yedekcioglu, 1996:5)

In 1992, two new projects, named Curriculum Laboratory Schools (CLS) and Computer Experiment Schools (CES), were initiated by the Ministry of Education with the financial support of the World Bank (EARGED, 1995). Teachers were trained to use information and communications technology in their subject teaching. To help teachers to cope with the change either technically or pedagogically, co-ordinator teachers for each school and formator teachers for each city were trained by the Ministry of Education about the CLS pilot model, computer and resource use, material development (EARGED, 1995). In the CES project, 53 schools located in different regions of Turkey "were to receive computer hardware, software, teacher training and minor facility renovation where required"

(Schware and Jaramillo, 1998:29). Schware and Jaramillo (1998) state that a mid-term evaluation illustrated that technology was used in these schools successfully. As a second group of schools, there were 208 CLS schools from 7 regions and 23 cities of Turkey. In a recent study of Altun (2002:15), investigating teachers' change in classroom practice due to introduction of ICT in these CLS schools, he points out that these schools were selected "as an experimental platform to explore how far new educational approaches and ICT supported education can facilitate instruction and provide tools to improve both teaching and learning". Altun (2002) found that the majority of the teachers are at the early stages of technology adoption and pedagogical integration of ICT is yet to be accomplished in these CLS schools even though there was an improvement in the use of technology in general.

In the 1985-86 academic year, first IT laboratories were established in 101 pilot secondary schools, and two teachers from each school were trained in an in-service programme. Since then over 100,000 teachers have been trained in in-service courses. In these inservice courses teachers were trained in order to develop their knowledge and technical ICT skills rather than application skills (Alev, 1997). Alev (1997) found that, investigating teachers' use of ICT in the CESs, most of the Physics teachers entered in-service courses at least once (104 out of 142) mentioned that there were not any applications about using ICT in subject teaching (101 out of 104). The majority of the teachers, however, had a positive attitude towards ICT and mentioned that ICT could improve the quality and effectiveness of teaching and learning. As a result of this study, although most of the teachers in these schools have joined in-service courses, they did not incorporate ICT into classrooms (Alev, 1997).

With the latest restructuring of ITE in Turkey, a new teacher education programme was established in each FE, called Computer and Instructional Technologies Teacher Education Programme. This actually shows that there is a substantial concern over integrating technology into education in the country. Future ICT coordinators are educated through these programmes. As Altun (2002) puts it, the aim of these programmes is to train graduates as educational technology experts and ICT coordinators for state schools. The literature suggests that technical and pedagogical support for practising teachers is crucial for teachers to integrate ICT into their teaching. Thus, in Turkey the introduction of these new ITE programmes hopefully will be a contribution to the efforts for integrating ICT into curriculum and instruction.

On the other hand, since the beginning of the 1990s each pre-service teacher training programme has tried to train the student teachers on ICT. However, up until the re-structuring of ITE in Turkey there were not any standards for the contents of these courses, and each university had tried to train their student teachers in view of their perspectives. With the latest reform in ITE, FEs provide a new course to improve student teachers' ICT capabilities. However, integrating ICT into ITE needs to be investigated. There is limited research about teacher educators' uses of ICT in ITE in Turkey.

## 1.5 Aims of the Study

This study was about the integration of Information and Communications Technology (ICT) into Pre-service Science Teacher Education Programmes (Physics, Chemistry and Biology) (PSTEP) in a Turkish Faculty of Education. Thus the main purpose of this study was to *understand* and *explore* the integration process of ICT into PSTEP, using a case study design.

Having reviewed a great deal of literature related to the research subject area: using ICT in education, in general, and integrating ICT into teacher education/training in particular, the researcher has sought answers to the main research question throughout this thesis. The main research question was "What are the factors affecting the process of integrating ICT innovation into Pre-service Science (Physics, Chemistry and Biology) Teacher Education Programmes?" To find answers the following sub-questions were developed through the literature review and ongoing academic dialogue with supervisors and other colleagues. The sub-research questions were as follows:

1. What is the aim of ICT related training in pre-service science teacher training?
2. What are the student teachers' ICT capabilities, and how confident they feel about using ICT?
3. What are the lecturers' capabilities on using ICT as teaching-learning and professional development tools?
4. What are the student teachers and lecturers' attitudes towards using ICT as teaching tools?

5. What challenges do the student teachers and lecturers face during their use of ICT in schools and at faculty?
6. Why do/ Why do not the lecturers and student teachers use ICT as teaching tools?
7. What are the lecturers' and student teachers' perceptions about the use of ICT in science teaching and learning? How does ICT affect their practices and roles?
8. How ICT is integrated into pre-service teacher training?
9. What are the lecturers and student teachers' views about ways of moving forward in developing student teachers' ICT skills?

Here in this thesis *innovation* is used to describe the introduction of ICT into educational contexts in general. *Integration*, on the other hand, refers to the degree of involving ICT in teaching and learning processes as tools of education. It is believed that the answers sought to these sub-questions were sufficient to draw the picture of the case under investigation as right as possible to embrace the main research question.

## 1.6 Format of the Thesis

This thesis consists of five chapters. The first chapter is the Introduction, which provides brief information about the context of the research, and outlines the aims of the study.

The second chapter is the Review of the Literature, which justifies the aims and the focus of this thesis. It includes sub-sections, reviewing the related literature about educational change, using ICT in education, integration models, evaluation models of ICT adoption, use of ICT in teaching and learning Science and factors associated with the ICT integration processes.

The third chapter is Methodology, which explains theoretical base of the methodology applied to this research and describes the actual field-work process, including sample selection. It also provides discussions about the issues related to the quality and ethics of educational research and the role of the researcher. Finally, it finishes with a description and explanation of data collection procedure and data analysis procedure.

The fourth chapter is Analysis and Discussion, which presents and discusses the findings of this research. This chapter consists of sub-sections such as information about the participants' backgrounds and the case; the participants' ICT capabilities, understandings and attitudes; the ICT integration process in the case; the lecturers' stages of concerns and adoption; change in the lecturers' teaching styles; and other factors affecting the integration process.

The fifth chapter is Conclusion, which summarises the main findings and implications of this thesis, recommends a model for action and finishes with suggestions for further research.

# 2. REVIEW OF THE LITERATURE

## 2.1 Introduction

In this chapter there are three main sections. The first section explores the process of educational change and factors facilitate the implementation of any educational change.

The second section examines the processes of integrating ICT into education and evaluating the practitioners' level of use and state of concern.

The final section examines two distinct approaches to teaching/learning regarding teacher education and use of ICT. Throughout this final section the use of ICT in science teaching/learning and factors affecting the implementation of ICT will be elaborated.

Finally, a summary of the literature will be provided.

## 2.2 Understanding Educational Change and the Implementation Process

There is a broad agreement that education has a key role in ensuring economic, social and political development (Iredale, 1996). However, the conditions and needs at the societal, institutional and individual levels have changed over time, and they will change in the future. Educating people in the light of these new conditions and needs plays a crucial role at all three levels. As a result of this necessity, many changes have taken place in education (i.e. the structure of education systems, the curricula, the way to teach and learn, and so forth). On the other hand, the processes themselves, through which educational changes take place, have changed (Goodson, 2001; Hall, 1995; Hord, 1995). Goodson (2001:45) discusses three parts of educational change processes- the internal, the external and the personal.

> "Internal change agents work within school settings to initiate and promote change within an external framework of support and sponsorship; external change is mandated in top-down manner, as with the introduction of national curriculum guidelines or new state testing regimes; personal change refers to the personal beliefs and missions that individuals bring to the change process."

Fullan (1993), Goodson (2001) and many others argue that individual understanding, commitment and ownership of any innovation or educational change are the critical point in change process; with Fullan's (1993:13) saying, "each and every educator must strive to be an effective change agent". So much more attention must be paid to individual participation and contribution to an educational change process.

> "In the new millennium it is argued that, as well as internal and external segments, increasing attention will need to be paid to the personal missions and purposes which underpin commitment to change processes. Without a fully conceptualized notion of how the internal, external and personal will interlink, existing change theory remains underdeveloped and of progressively less use." (Goodson, 2001:45)

In the following part, brief information about what educational change is and its stages, and factors influencing an educational change process will be given. In this part the issues of individual understanding of educational change, and the individual commitment and contribution to educational change will be taken into consideration throughout the other discussions.

### 2.2.1 Innovations in Education

"In theory, the purpose of educational change presumably is to help schools accomplish their goals more effectively by replacing some structures, programmes and/or practices with better ones" (Fullan, 1991:15). Hall (1995) describes change as a *process*, indicating that it should not be perceived as an *incident* that simply can be occurred in a set period of time to accomplish. However, Fullan (1991:30) points out that people have been so familiar with changes that they "rarely stop to think what change really means as it is experienced at the individual level", and also for other people involved in change situations. That means each individual may see and understand the reality of change in a different way. This leads to a very considerable question with regard to theoretical definition of educational change: is replacing innovation better than previous one; or is it worth to put an innovation into practice in view of its value, its goal, implementation?

According to Fullan (1991:36), "the extent to which proposals for change are defined according to only one person's or one group's reality (policy maker's or administrator's) is the extent to which they will encounter problems in implementation". However, he states that "this is not to say that subjective realities *should* define what is to change, but only that they are powerful constraints to change or protections against undesirable or thoughtless change. Ultimately the transformation of subjective realities is the essence of change" (p.36).

According to Crotty (1998) social reality is a function of shared meanings. In the social and educational settings, the meaning of any reality is constructed, sustained and reproduced by the people or groups involved in this setting. The interaction between individuals or groups produces phenomena, such as change programme, policies. Socially constructed meaning of the phenomena exists for each individual or groups as objective reality. Fullan (1991:37) emphasises the danger that "the objective reality is only the reflection of the procedures of change and thus simply a glorified version of their subjective conceptions". Atkin (2000) states that a main goal of all educational changes is to influence the beliefs, skills and general perspectives of the individual teacher as practitioner. In conjunction with the above discussion, Fullan (1991) concludes that

> "...the real crunch comes in the relationships between these new programs or policies and the thousands of subjective realities embedded in people's individual and organizational contexts and their personal histories. How these subjective realities are addressed or ignored is crucial for whether potential changes become meaningful at the level of individual use and effectiveness. It is perhaps worth repeating that changes in actual practice along the three dimensions-in materials, teaching approaches, and beliefs, in what *people do and think*- are essential if the intended outcome is to be achieved" (p.43).

In practice people or practitioners have to become clear about new educational practices that are to be implemented or adopted. The more people in a change setting become clear about the new practices and posses them, the more successful this change will be. Askew and Carnel (1998) state that sufficient change encompasses change at both the individual and social levels, and the relationship between these two levels is complicated. People are able to choose and create different kinds of social relationships in the individual level, and there are some "constraints imposed by structures, institutions and social processes (p.55)" affecting the social interaction. The relationship is illustrated as it is in Figure 2.1 by the two-way arrow.

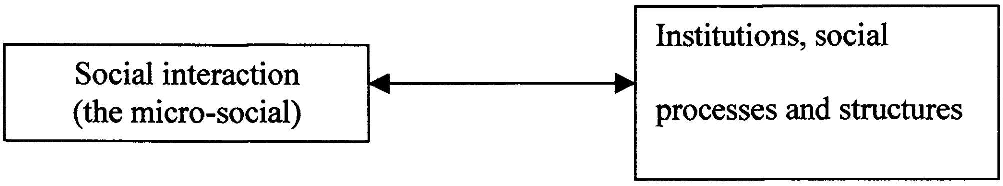



Figure 2.1 The relationship between social interaction and social structures (adopted from Askew and Carnell, 1998:55).

As can be seen from Figure 2.1, both levels have their effect on the other. Thus the individual understanding, experience and perceptions of a change has its own effect on implementation process.

It would be better, if people understand the educational change process in the light of the questions 'what', 'why' and 'how'. According to Hord (1995) while much attention is given to the 'what to change', much less attention is given to 'how to change'. He mentions that change is about each and every individual involved in implementing new policies, programmes and processes, rather than structures and strategies, and also it is about the individuals who facilitate the practitioners in a change process. To do so, at first the characteristics of educational and social change must be established in terms of its sources and purposes (Fullan, 1991). Levin and Riffel (2000:178) point out that "...the strongest drivers of change in schools are changes in the larger social environment".

Agreeing with Levin, Fullan (1991) states that the pressures of educational policy change may arise: through natural disasters, through external forces, through internal contradictions

Whatever the reason is, he points out that for educational change two critical considerations ought to be kept in mind: the value and technical quality of the change.

Actual implementation of the change

| Value and technical | | YES | NO |
|---|---|---|---|
| | YES | I | II |
| | NO | III | IV |

Figure 2.2 Types of implementation outcomes of adopted changes (adopted from Fullan, 1991)

As it can be seen from Figure 2.2, there might be four possible outcomes of an actual implementation, referring to whether there has been a real change, or not. Type I represents the actual implementation of a quality change that is valued. The question here is 'how do we know if a particular change is valuable, and who decides?'. Fullan's (1991) explanation to this question is that:

> "...a change is good depending on one's values, whether or not it gets implemented, and with what consequences. Some people blindly support certain changes that they value, oblivious to questions of implementation and consequences. Others are unsure of the value of change because they are only too well aware of the lack of clarity and uncertainity that permeates the transition from values to goals, to adoption, through implementation, to outcomes... It is mainly that no matter how honorable the motives, each and every individual who is necessary for effective implementation will experience some concerns about the meaning of new practices, goals, beliefs, and means of implementation. Clear statements at the outset may help, but do not eliminate the problem; the

> psychological process of learning and understanding something new does not happen in a flash... It is at the individual level that change does or does not occur" (p.45).

Type II is not in action due to some certain reason even if it illustrates a valued and technically sound programme. However, types III and IV are not appreciated.

> "In Type III a change that is not technically well developed or is not valued... In short, a bad change is being introduced... Type IV, interestingly, is a form of success in that a poorly which is poorly valued or poorly developed change is being rejected in practice (Fullan, 1991:18)".

In the next part, the process of educational change will be discussed.

### 2.2.2 Educational Change Process

Fullan (1991) mentions that most researchers consider that any change process has four extensive phases.

1- *Initiation* is the process that leads up to a decision to proceed with a change;

2- *Implementation* includes the initial experiences of attempting to put a notion or innovation into practice ;

3- *Continuation* represents the state of ongoing innovative process, referring to whether the idea or innovation is sustained. In a way is an extension of implementation phase; and

4- *Outcome* depends on the early specified objectives of the innovation.

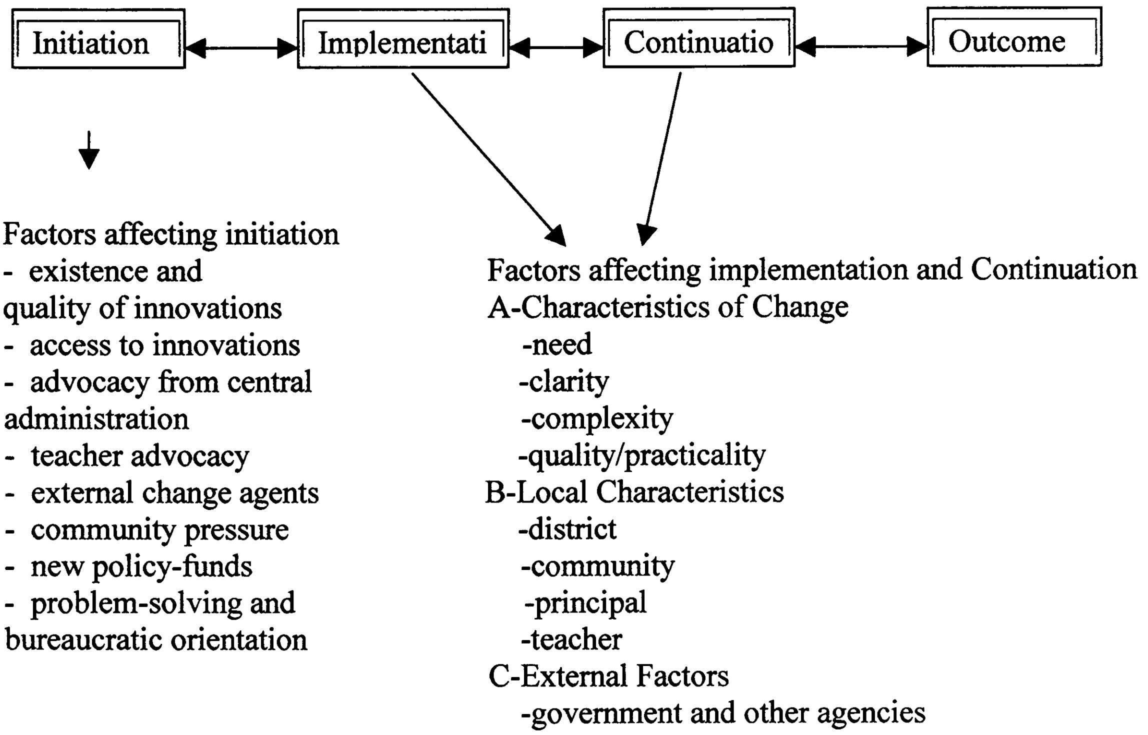



Figure 2.3 A Simplified Overview of the Change Process (Adopted from Fullan, 1991:48-50-68)

As can be seen from the Figure 2.3, there is a two-way arrow between each phase, implying that this is not a linear process. In each phase you can review the previous phase by getting feedback and change the decision(s) made at previous phase. Figure 2.3 illustrates that there always are some potentially profound variables affecting a change programme in its initiation, implementation and continuation stages. There might be many variables influencing the change process, which are not mentioned in the Figure 2.3.

Economic conditions, for instance, have a great influence on educational policies. House (2000) points out that there are at least four possible economic concerns which affect educational policies. First, economic conditions strongly affect educational spending due to government budget. Second, in education, policies are mostly formulated to decrease costs and increase the productivity of schools. Third, education and economic development are presumed to be closely connected. The assumption here is that better education leads to improve technological capabilities and better jobs. And finally, educational concepts and metaphors permeate educational thinking, and educators are urged to create and respond to markets (Brennan and Noffke, 2000).

In the initiation phase, according to Fullan (1991), the combination of three R's of relevance, readiness and resources are best for any educational change as initial considerations. Here relevance encompasses "the interaction of need, clarity of innovation (and practitioner's understanding of it), and utility, or what it really has to offer teachers and students" (p.63). Readiness, on the other hand, includes the practical and conceptual capacity of practitioners and the setting in which change will take place to initiate and develop a preferred innovation. The final R, resources, "involves the accumulation of and provision of support as a part of the change process" (p.64).

Here it is not aimed to look at each variable in a detailed way, yet there is plenty of literature about these variables influencing a change process in all its stages (see Fullan and Hargreaves, 1992; Hargreaves and Fullan, 1998a; Bascia and Hargreaves (eds.), 2000; Altrichter and Elliott (eds.), 2000; Hargreaves and Evans, 1997; Hargreaves and

Fullan, 1998b; Carter and O'Neill (eds.), 1995). Having said this, giving some information about how a change could be successfully implemented could be more useful here.

**2.2.3 Implementing an Educational Change**

Implementation of a change is not an easy process. According to Fullan (1991),

> "Educational change is technically simple and socially complex. While the simplicity of the technical aspect is no doubt overstated, anyone who has been involved in a major change effort will intuitively grasp the meaning of and concur with the complexity of the social dimension. A large part of the problem of educational change may be less a question of dogmatic resistance and bad intentions (although there is certainly some of both) and more a question of the difficulties related to planning and coordinating a multilevel social process involving thousands of people" (p.65).

Hord (1995:92) summarises the last 3 decades in the light of facilitating change as follows: during the 1970s, there were many studies "focusing on adoption of innovation, and connecting potential users with new information or programmes". These studies showed that this approach to change was a success as long as there was a person who is ready to provide required information, ongoing support and assistance to the individuals involved in the change process.

'Hero principals' (Hord, 1995:92) were in the main role in the 1980s instead of '1970s-linking agents'. From 1980s- studies, Hord (1995) says, the six sets of behaviours which could characterise actions needed for change has revealed as practicable for reform in education. These six strategies to facilitate the change process represent forms of pressure and support for encouraging and motivating individuals to change.

In the 1990s there were some drastic changes in the change process itself. Hord (1995) states that privilege and authority have moved from central government to schools, and from heads to be shared with teachers. By doing so teachers have been involved in decision-making, planning and implementation more than ever. This requires some profound strategies to support and facilitate change, and in the next part these strategies will be reviewed in the light of support and pressure.

*Developing and communicating a shared vision:* Here vision entails the mental picture of what a programme or practice might seem in a preferred image of the future, and this clear vision is a starting point of a change (Hord, 1995). However, the quality of interaction between leaders and staff matters. Leaders must take part in the new activities for the success of change. By doing so, people feel an obligation to contribute, and when they contribute, they can see themselves as part of the context, contributors to it, and they feel ownership (Bascia and Hargreaves, 2000). Pressing people indirectly for involvement can make them also feel valued and supported (Hord, 1995). In this sense, according to Evans (2000:190), "changing the image of change, by presenting it as a challenge, rather than a threat, would be a step towards achieving these more positive attitudes". Hargreaves (1997) states that individuals or institutions ought to know where they are heading and they ought to be agreed on that through interaction. He prefers to use the word "moving mission" instead of "shared vision" as a principle of positive educational change. He points out that pursuing their own inspiring mission together is what can most help teachers to improve the school. Hargreaves (1997) makes it clear, saying missions or visions are best thought as a shared journey, not destination- always open to revision and review.

*Planning and Providing Resources:* Hord (1995) states that leaders who have the responsibility for the implementation phase of an educational change can lure the teachers and other people into the change setting by offering plenty of resources. By resources he means not only material resources, but also time and energy. His proposal to balance the pressure and support during the implementation of the innovation is that teachers who have made a contribution to the implementation process are rewarded and others who have not acted in accordance with implementation are encouraged by withholding resources until compliance occurs. This balancing act can be very subtle, open to staff interpretation. In a successful change process, the leaders should visit the classroom and observe the process of implementation. By doing so, they are more informed and can more appropriately supply required resources to support staff in the implementation phase.

*Investing in Continuous Staff Development:* Teacher development is an important issue in any implementation process in education. Many efforts might result in disappointment since practitioners have not been trained in new skills required for new innovations. Oliver (1994) points out that the task of instructing and helping teachers to understand and adopt new approaches must involve large scale changes to the teachers' content and pedagogical knowledge. Adoption of an innovation into classroom teaching requires new curriculum approaches and practice. Many leaders shows their commitment and support of staff by taking part in training programmes with teachers from planning to evaluating staff development (Hord, 1995). Macmillan (2000) and many others argue that successful implementation of educational change also requires effective leaders who involve teachers integrally and meaningfully as part of the implementation.

*Assessing Progress:* Hord (1995) points out that implementing a change never proceeds as planned, no matter how well the planning is done. This is due to some unexpected issues in the implementation process. It is crucial to monitor the change process. Monitoring any change will create the opportunity to turn the implementation around by providing extra-input to the change process, such as more training (support), new resources, and so forth, if necessary. Effective leaders regularly and frequently check on the people in the implementation process to solicit and inquire 'how things are going'. Change leaders and researchers gather data through formal observation and instruments. They also use informal methods, such as having casual conversation with staff, visiting departments and their meetings. All these formal and informal assessment activities can help the change leaders to move forward, providing more appropriate environment for the planned change.

*Providing Ongoing Assistance:* Support and assistance are ongoing needs of people in any change setting. Hord (1995) states that the success of an intended change depends on appropriate assistance and its quality. Assistance may be provided by arranging released time for teachers to meet and share their experiences regularly in the change process. In many educational change processes, teachers do not have enough knowledge and experience, and even most of them do not know what they do not know about the planned change process. Ongoing assistance may close the gap between teachers, and provide opportunities for teachers to keep pace with each other.

*Creating an Atmosphere for Change:* Change leaders take actions to create some norms in the change setting. These facilitative norms are a norm of continuous improvement, a widely shared vision, and a norm of involvement in making decisions (Hord, 1995). In order to do these, leaders can take actions to stimulate teachers to create and introduce innovative notions, and to initiate improvement efforts. Teachers must share their ideas with their peers. Finnan and Levin (2000) state that

> "Most schools share a similar design for classrooms and common areas, organise the day in predictable ways and develop regognisable patterns for relationships among the students and adults. Despite these similarities, it is easy to recognise the differences and uniqueness of each school. Even the casual observer will recognise that each school feels, looks, sounds and smells different from any other school. It is the culture of schooling and the culture of each school that account for the common and the unique" (p.87).

Here school culture, which describes both the sameness and the uniqueness of each school (Finnan and Levin, 2000:87), is a profound part of any educational change process. Unfortunately, school culture is viewed as a resistant force and not one that might be used for transformation (Finnan and Levin, 2000). However, when schools are provided with both pressures for change and the tools to transform their culture, exceptional changes in school culture can take place. In this situation, the people who have their responsibilities in the school can use school culture as a force to support the change process, rather than as a barrier to change. For change leaders, creating an atmosphere for change is a challenging thing, but an important issue in respect to success of the implementation.

### 2.2.4 Conclusion

As Fullan (1991) and Hord (1995) discuss, change is a process, not an incident that simply can be mandated in a set period of time to accomplish. "In theory, the purpose of educational change presumably is to help schools accomplish their goals more effectively by replacing some structures, programmes and/or practices with better ones" (Fullan, 1991:15). Each individual may see and understand the reality of change in a different way. This leads to a very considerable question in regarding with theoretical definition of educational change: is replacing innovation better than older practice; or is it worth to put it into practice. Successful change to education systems should be based on a thorough and accurate understanding of existing conditions [what to change], the advantages and disadvantages of available alternatives [why to change], and positive experiences in similar learning contexts [how to change].

Throughout this literature review, it is evident that the successful implementation of an innovation in education is not easy because there are a lot of factors which affect the change process and which must be taken into consideration. However, there is the human factor in any change process, which plays the most crucial role. In other words, individual understanding, commitment and contribution to educational change make the implementation process proceed successfully or fail.

As a long run example of innovations in education, ICT has been used throughout the last two technologically fast-changing decades. And it has had a great impact, leading to some deep changes in society in terms of patterns of employment and methods of communication, and at the level of intellectual discipline, ICT has had a deep effect on the cultural practices associated with every academic discipline (Ridgway, 1997). Having given brief information about the strategies to support and facilitate change, one of the most profound innovations, Information and Communications Technology (ICT), in the last quarter of 20$^{th}$ century will be discussed in the light of change process in the next section.

## 2.3 Information and Communications Technology (ICT) as an Innovation in Education

The use of Information and Communications Technology (ICT) encompasses a range of new technologies and their applications, including all aspects such as the knowledge, skills and understanding of the use of computers, microelectronics devices, satellite and communications technology (QCA, 1998; CS, 1991). ICT has been used in social and educational areas, particularly throughout the last two technologically fast-changing decades. It has had a great impact, leading to some deep changes in society in terms of patterns of employment and methods of communication, and at the level of intellectual discipline, ICT has had a deep effect on the cultural practices associated with every academic discipline (Ridgway, 1997). Briefly stated, ICT, which offers enormous potential to improve effectiveness of services in society such as education, health, economics, politics, is replacing classical technologies, and bringing fundamental changes into all aspects of human life (Altun, 1996a).

As illustrated in *Figure 2.1* (relationship between the micro-social and the macro-social) in the first section, the relationship between social changes and educational changes, in this case ICT as an innovation in education, can be shown as in *Figure 2.4* by the two way arrow. That means changes at the societal level have their effects on education by leading up to innovations, and thus it is inevitable that the outcomes of these innovations influence the level and quality of social changes.


Figure 2.4. The relationship between social/technical change and educational change.

However, almost all countries in general and all families in particular have a fear and concern that their children may fall behind all those developments and changes. From this point which has a great pressure on society, the issue of educating people with necessary knowledge and skills of using or exploiting the positive potential of ICT has became profound as its being in all aspects of human life. The impact of ICT on all areas of education raises challenges for policy makers, administrators, teachers and students. Underpinning the awareness of the potential of ICT to improve educational practices is a series of pedagogical and practical challenges (Wooley and Booker, 2001

### 2.3.1 ICT for Shaping the Future of Education

The world is shrinking by means of ICT. The next generation should be prepared to cope with the requirements of the information age. The most obvious use of ICT in the classroom is to prepare students for the increasingly technological world they will face when they leave school (OTA, 1988), and the other is to use ICT in teaching and learning activities in other subjects (Bennett and Daniel, 1999; Greene and Zimmerman, 1999).

Davis and Tearle (1999) state that there is a widespread acknowledgement that ICT can be used to enhance learning and teaching. As a learning tool, ICT gives some good opportunities in terms of the learning efficiency and quality. It provides opportunities for greater flexibility, interactivity and accessibility for engaging teaching and learning at the individual, community, and societal levels (Visher and Jain, 1997). Crawford (1997) notes that students can learn dynamically how knowledge is obtained and organised because they actively inquire through ICT while learning how to use ICT. ICT has a unique and unusual place in the classroom as an educational innovation (Oliver, 1994). ICT can create an opportunity to change classroom practices from traditional teacher-centred applications to student-centred ones, and ICT promotes sharing and collaboration (Underwood and Underwood, 1990; McCoy, 1999; Grabe and Grabe, 1998).

According to Tagg (1995:1) "many educators are aware of the way the changes in technology and consequent changes in society are having profound implications for the type of education schools should be providing, and how this provision should be organised". To gain all those positive outcomes mentioned here, there are some inevitable problems that should be overcome by educational institutions and people who are responsible for the implementation process of this innovation (Eraut, 1991; Whiteman, 1991). What is important here is to consider how ICT will be integrated into education, or should be, in order to take advantage of its potential. This is a big question and requires more space to explore and explain in detail because there are many dimensions, which must be taken into account seriously, of integrating ICT into education. One of the most profound emerging issues is to educate teachers (i.e. in-service and pre-service) who are expected to be part of this change process (Zhang, 1997). Teachers are the bosses in the classrooms, and they will be, even if once there were some fears in this profession that ICT would take their places in the classrooms and decrease the job opportunities by more high-tech applications (Apple, 1992).

From the beginning of introducing ICT in education, teacher education in the light of requirements for ICT integration has been, and will be, the main issue. For practising teachers in-service training programmes has been arranged in all countries, which their governments have the persistence to benefit from ICT as much as possible. However, many studies shows that ICT use in education is still insufficient and disappointing (OTA, 1995; Fisher, 1996; Thomas et al., 1996; Williams et al, 1998; Coverdale, 1998; Jager and Lokman, 1999; Williams, 2000; Lang, 2000; Mumtaz, 2000; Pedersen and Yerrick, 2001; Ofsted, 2002). This slow uptake, more or less, is the same in every country (Davis, 1992; Owston, 1995; Grandbastien, 1995; Downes et al., 1995; Hijarnaa and Bollerslev, 1995; Sakamoto and Gardner, 1995; Gorny, 1995; McDonald and Davis, 1995; Jin, 1996; Lang, 2000; Watson, 2001). Most of the studies show that there is a vicious circle in the process of integrating ICT into education because of the barriers to this challenging innovation. Almost every related research shows that there are some certain barriers to the implementation of ICT innovation. OTA's (1995) report indicates that this slow utility is a result of five current barriers; teacher time, access, vision or rationale for technology use, training and support, current assessment practices. Factors affecting the implementation process of integrating ICT into education will be detailed in the next section.

Muddux (1994) states that "until teachers of all subjects at all levels incorporate ICT successfully into their teaching, it will continue to remain a relatively unimportant and ineffective adjunct to teaching and learning (p.129)". However, the main concern is not only the teachers' familiarity with ICT, but also their pedagogical approaches to integrate ICT into teaching and learning activities are more crucial (OTA, 1995; Cornu, 1995; Hodgson, 1995; Tearle et al., 1998; McCoy, 1999; Russell et al., 2000; Newton and Rogers, 2001 Ofsted, 2002). According to OTA (1995) and OFSTED (2002) reports, there is a gap between having ICT resources in the schools and using them effectively. ICT requires changes in teaching styles (see OTA, 1995; Somekh and Davis (eds), 1997), and it is evident that implementing this kind of innovation is complicated and hard (Ridgway, 1997). These pedagogical issues will also be elaborated in detail in the next section.

It has been attempted to make the current use of ICT and challenges clear so far in this section, but as it is the main focus of this thesis, integrating ICT into preservice teacher education programmes will be discussed in the following part. As Hodgson (1995) suggested, successful integration of ICT in education demands a new generation of teachers, "open-minded with respect to technology and having more diverse competencies, both from a disciplinary and a pedagogical point of view (p34)". Having said this, he does not mean to give up in-service teacher education. On the contrary, he points out that concrete actions must be taken in both at the inservice and preservice levels, paying extra attention to the preservice teacher education.

### 2.3.2 Integrating ICT into Pre-service Teacher Education

Visser and Jain (1997) point out that for initiating any kind of innovation in education, teacher education programmes, both in-service and pre-service, are natural starting points, and should be. In the case of ICT innovation, all teachers, as practitioners, are the most crucial keys to reach the expectations from ICT in education. Throughout the last 20 years, ICT has become an integral part of education at all levels, primary, secondary and higher education. This situation requires an enhancement in pre-service teacher education as well as in in-service training. Thus, prospective teachers should be prepared for the challenges they will most probably face in their future practice. By doing so, thousands of new teachers may not be re-trained in in-service courses at least for the basic ICT skills and understanding of ICT. However, "teacher education has been slow to respond to the changes in schools in relation to the use of new technologies" (Oliver, 1994:138).

Many studies illustrate that newly qualified teachers do not improve the current state of ICT use in education (Thomas et al. 1996; NCATE, 1997; MEET, 1998; Murphy and Greenwood, 1998; McCoy, 1999; Pederson, 2000; Brush et al., 2002; Zheng, 2002) even though they possess satisfactory technical skills and a strong desire to use ICT in their teaching activities in the classroom (Norton, 1994; Oliver, 1994; LaMaster, 1999; Ertmer and Lewandowski, 2002; Haslam, 2002; Nonis and O'Bannon, 2002). The use of ICT in pre-service teacher education has tended to mirror what has occurred in schools (Oliver, 1994)

Maddux (1994) states that a great deal of studies on curriculum integration of ICT is dedicated to persuade the reader that *integration* is a desirable alternative for schools. He emphasises that "indeed, it is the only alternative we have if we are to succeed in making ICT a valuable part of teaching and learning (p.129)" and 'the primary reason is that in the majority of cases we still have failed to integrate ICT into the school curriculum (p.129)'. However, it is evident that "the integration of ICT in teaching practice provides a challenge for pre-service educators" (Brown, 2002:1252). Throughout the last two decades, many countries have been coping with the difficult decision of whether to include the teaching of ICT as a separate subject or to encourage the integration of ICT across the curriculum (Cox, 1997). Integrating ICT in pre-service teacher education is the only option to succeed this long running innovation, but the big question is "how?". Crawford (2001) examined ICT use in English schools by using case study approach. He described three distinct models of integrating ICT into secondary schools; a) Discrete ICT; b) Cross-curricular ICT; and c) Hybrid ICT.

**2.3.2.1 Integrating ICT as a Separate Subject: Vertical Integration**

Discrete ICT (Crawford, 2001), or add-on or addition (Cornu, 1995; Runyon and Lund 2002), or vertical integration (Yeomans at al, 1995; Stevenson, 2000), is the first model of ICT integration, in which ICT is taught as a separate specialist subject. In this vertical ICT integration model, ICT courses are "added to the curricula" (Cornu, 1995:4). A computer room is added to the other rooms, and "time is allocated on the school timetable for ICT in the same way that it is allocated for other subjects" (Crawford, 2001:10).

If schools adopt the policy of teaching ICT as a separate subject, they only have to persuade and effect the change in pedagogical practice of a small minority of teachers (Cox, 1997), and they have to train these specialist teachers, given the responsibility of teaching ICT courses.

Yeomans et al (1995) and Cox (1997) emphasise on the potential advantage and disadvantage of the vertical ICT integration. They point out that teaching ICT as a separate subject might profit students' technical ICT capability, but it will deprive students of the opportunities to improve their ICT skills using ICT in the learning activities of other subjects, as Crawford (2001) puts it, "the teaching of ICT in irrelevant and meaningless contexts (p.10)".

Vertical integration of ICT into preservice teacher education mirrors the state of vertical integration of ICT into secondary schools (Norton, 1994; Murphy and Greenwood, 1998; Russell et al., 2000). Norton (1994) states that, as some courses provided in preservice teacher training, teaching ICT as a separate subject holds little promise for promoting educational change expected. Thus, he claims that teacher education about technology requires new approaches, and teachers need to be exposed to more than just an ICT literacy course. "Clearly, the growing increase in teachers' technical skills is insufficient to guarantee the effective use of technology in the classroom" (Ertmer and Lewandowski, 2002:1314). However, there are many studies indicating that these separate ICT courses do not provide some ICT masters. If it is intended to prepare student teachers for integrating ICT in their teaching practice, they need to model their future practice during their preservice education period to make what they have learned about technology meaningful and satisfactory. To make this happen, they need to experience ICT integrated courses, in which ICT resources are used to deliver the subject by both teacher educators and student teachers, rather than just a single separate ICT course. In this sense, studies illustrate that teacher educators or lecturers do not model the use of technology in teaching their courses (Bell and Coultas, 1995; Breegle and Stamper, 2002). As a result of this, the skills student teachers gained from the separate ICT course(s), may not be useful regarding their prospective use of technology in their teaching.

Crawford (2001) stresses another disadvantage of vertical ICT integration as ICT resources are often placed in a small number of ICT rooms, and students "may have adequate access to computers during ICT lessons but very limited access at other times" (p.11).

**2.3.2.2 Integrating ICT across the Curriculum: Horizontal Integration**

Crawford (2001) defines cross-curricular ICT or '*horizontal ICT integration*' (Stevenson, 2000; Yeomans et al., 1995) as teaching ICT only in other core subjects, for instance, science, mathematics etc. The horizontal ICT integration model does not require time allocation on the timetable specifically for lessons in ICT as a separate subject. "It is assumed that the teaching of ICT will take place entirely in other National Curriculum subjects" (Crawford, 2001:11).

In this ICT integration model, the majority of teachers in each school have to change their pedagogical practice to make appropriate use of ICT within their teaching activities (Cox, 1997), so teacher educators in preservice teacher education programmes should do likewise. Studies show that teacher educators do not use ICT as a teaching tool and do not encourage STs to make use of it (Downes, 1993; Chen, 1997; Bennett and Daniel, 1999; Brown, 2002). For the horizontal integration model, Crawford (2001) recommends different strategies to ensure that ICT is delivered effectively. The first one is to divide ICT into sub-themes, such as communicating information, handling information, controlling, measuring and modelling sub-themes, and these sub-themes are given to different subjects, as he proposes English, Geography, Design Technology, Science, and Mathematics, respectively. Crawford's second strategy for the horizontal model is to "design a number of coursework tasks that, taken together, cover the ICT National Curriculum programmes of study" (p.11). The third strategy is *team teaching*, with other subjects' teachers and ICT specialists delivering curriculum together. ACOT (Apple Classrooms of Tomorrow) project is a good example for this strategy (ACOT, 1993), a long running project, revealed that professional development was accelerated in contexts where teachers worked as teams focused on the development of new learning processes which they can use in their classrooms. Obviously, this model creates an extra burden for teachers in addition to their own subject teaching. There are many studies illustrating that teachers' ICT capability is an important issue to incorporate ICT across the curriculum (Yeomans et al., 1995; Kortecamp and Croninger, 1996; Underwood et al., 1996; Murphy, and Greenwood, 1998; Bennett and Daniel, 1999; Davies and Tearle, 1999; Mumtaz, 2000; Brown, 2002). Other subject teachers' time, their beliefs and understanding of ICT and their attitudes towards ICT are indicated as impediments in the ICT implementation process (Somekh, 1996; Lawson and Comber, 1999; Niederhauser and Stoddart, 2001). Crawford (2001) argues that the cross-curricular approach is rarely entirely successful because of the barriers mentioned so far, and some practical and structural issues, as distributed ICT resources may prevent the teaching of ICT skills to whole classes, as well as individualising students' learning of other subjects with ICT.

It is clear that the *horizontal* or *cross-curricular* integration model requires a complex planning and put some extra burden on all other subject teachers' shoulders. Stevenson (2000) points out that in horizontal ICT integration model ICT competence and confidence become part of teachers' pedagogical capabilities. In this sense teacher education becomes crucial for successful delivery of ICT across the curriculum.

Moreover, in practice the main aim of ICT integration must be outlined clearly and made relevant to teachers and students; horizontal ICT integration to develop the students' ICT capability, to make use of ICT to improve teaching and learning in other subjects, or both. Each of these choices may require a different and complex strategy, but the shared barrier and/or value is the teacher.

For educating teachers to integrate ICT across the curriculum, some strategies have been put into action. OTA (1995) argues two different strategies to educate and train current teachers. One of them is the *train the trainers* strategy, described as a few teachers in a site are trained and given the responsibility of teaching and training their colleagues. The second one is to develop an *onsite expert*, such as ICT coordinator, who can support teachers and keep the school progressing on integrating ICT.

#### 2.3.2.3 The Hybrid ICT Integration: Vertical to Horizontal Integration

Crawford (2001) describes the hybrid ICT integration model as the combination of vertical and horizontal ICT integration models. The hybrid model is the most common model applied to the schools (OTA, 1995; Yeomans et al., 1995; DfEE, 1998a) and preservice teacher education programmes (Murphy and Greenwood, 1998; McCoy, 1999; LaMaster, 1999; Russell et al, 2000; Ofsted, 2002). McCoy (1999) points out that to adequately educate teachers to use ICT, it must be integrated all aspects of the teacher education programmes. Besides a separate ICT courses in teacher education programmes, there are many studies shows that student teachers' skills improved as they used ICT resources in their courses (LaMaster, 1999; Duran, 2001). According to Ofsted (2002) report, "initial teacher training has provided a strong emphasis on the use of ICT across the curriculum. As a result, newly qualified teachers accept ICT as an integral part of their professional life (p.4)" in the UK.

Other than obtaining some skills of ICT, Leh (2002) states that teacher education programmes are required to prepare prospective teachers to understand their new role, use new approaches, and have new attitudes for teaching in the information age. Lecturers' use of ICT across the curriculum in the PSTEPs will help the STs to improve their skills (technological and pedagogical) and their understanding of ICT, making their learning meaningful because, as Franklin and Beach (2002) argue, STs need to observe appropriate modelling throughout their university course work. As McCoy (1999) states, teachers teach the way they were taught, so teacher educators need to change the way they teach and model appropriate use of ICT because it is assumed that teacher educators are responsible for developing student teachers' ICT capability. Bennett and Daniel (1999) found that having only a single course in ICT (vertical integration model) is insufficient to adequately prepare teachers to incorporate ICT in their classroom teaching activities. As stated earlier, using ICT across the curriculum (horizontal integration model) creates some extra issues for other subject teachers. Duran (2001) points out that for better preparation of prospective teachers regarding incorporating ICT into teaching and learning process, three experiences are essential (Hybrid ICT model): a) a core ICT course prior to methods and content courses; b) technology-proficient faculty who provide appropriate models of technology usage in their classrooms; c) technology-enriched field experiences.

Teacher education programmes have attempted to integrate ICT into preservice teacher education. Even if there has been a slight improvement in school and university levels in respect to incorporating ICT in the teaching and learning process, the majority of the cases are still struggling to fully integrate ICT. Means et al. (1993) point out that

> "the challenge of integrating technology into schools and classrooms is much more human than it is technological. What's more, it is not fundamentally about helping people to operate machines. Rather, it is about helping people, primarily teachers, integrate these technologies into their teaching as tools of a profession that is being redefined through the .... process" (quoted in OTA, 1995:28).

OTA (1995) describes the approaches, has been used in American schools, to the implementation of ICT use in order to make teachers impose new technologies as much as possible. These approaches are;

*Developing technology-rich classrooms or schools;

*Training master teachers, who can serve as resources for their colleagues or train their colleagues;

*Providing expert resources people from other staff, such as ICT coordinators;

*Giving every teacher a computer, training, and time to develop personal confidence and expertise;

*Training administrators, who can support the teachers in their schools.

According to the OTA (1995) report, in most cases, schools combine some of these approaches, and there is no significant evidence which illustrates that one of them works better than the others. It was also noted that the majority of teacher education faculty attempted to integrate ICT as a separate subject (*vertical model*). Teacher educators do not model the use of technology in their teaching, nor do they teach STs how to use ICT for instruction, which is still an issue in different countries (See Downes, 1993; Chen, 1997; Bennett and Daniel, 1999; Brown, 2002).

As noted earlier, the nature of ICT innovation is complex, and it requires some changes in understanding and practising teaching and learning process. ICT itself is not the only challenge to be dealt with by the practitioners in education (policy makers to students). It leads to some changes in teacher education, the way to teach and learn, and creates new challenges for practitioners. Integrating ICT into education has been a long and slow process. In this process, many studies show that teachers' ICT capability, understanding of ICT, concerns about ICT, and actual use of ICT change, and teachers go through stages, which will be elaborated next.

### 2.3.3 Stages of Teacher Technology Adoption and Concern

Comber, Lawson and Hargreaves (1998) point out that the failure of ICT integration was due to the fact that "teachers were uncertain about how ICT could be integrated into the curriculum, and were anxious about its use" (p. 372). According to Hall (1995) implementation of a change has to be assessed at the individual level. Use of an innovation is an individual practice and use has an array of levels, rather than simply being there or not there. From this point of view, he defines eight patterns of use of an innovation at the individual level. Three different non-user and five user patterns are defined in the Table 2.1.

| |
|---|
| • **VI Renewal**: State in which the user re-evaluates the quality of the use of the innovation, seeks major modifications of, or alternatives to, present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system. |
| • **V integration**: State in which the user is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence. |
| • **IVB Refinement**: State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short- and long-term consequences for clients. |
| • **IVA Routine**: Use of innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences. |
| • **III Mechanical use**: State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks require to use the innovation, often resulting in disjointed and superficial use. |
| • **II Preparation**: State in which the user is preparing for first use of the innovation. |
| • **I Orientation**: State in which the user has recently acquired or is acquiring information about the innovation and/or has recently explored or is exploring its value orientation and its demands upon user and user system. |
| • **O Non use**: State in which the user has little or no knowledge of the innovation, no involvement with the innovation, and is doing nothing toward becoming involved. |

Table 2.1 Levels of the use of an innovation. (Adopted from Hall, 1995:118)

Likewise, once teachers realize the potential for improving learning through the effective use of technology, and as they strive to become competent or even proficient technology users, they begin to change the way they teach. The ACOT report revealed that teachers go through stages as they learn to infuse technology into teaching and learning (Dwyer, Ringstaff and Sandholtz, 1990), as it is illustrated in Table.2.2.

| Stages | Examples of what teachers do |
| --- | --- |
| **Entry** | Learn the basics of using the new technology |
| **Adoption** | Use new technology to support traditional instruction |
| **Adaptation** | Integrate new technology into traditional classroom practice. Here they often focus on increased student productivity and engagement by using word processors, spreadsheets, and graphics tools. |
| **Appropriation** | Focus on cooperative, project-based, and interdisciplinary work—incorporating the technology as needed and as one of many tools. |
| **Invention** | Discover new uses for technology tools (for example, developing spreadsheet macros for teaching algebra or designing projects that combine multiple technologies). |

Table 2.2. Stages of teacher technology adoption (cited from Dwyer, Ringstaff and Sandholtz, 1990).

As it is seen in both models given above, the higher level teachers occupy in using ICT, the more possible benefits of ICT will be gained. There are some other identified stages similar to these technology or innovation adoption stages (see Mevarech, 1997; Russell, 1996 and Dawes, 2001). Comber et al. (1998) combined Hall and Hord's (1987) models, Level of Use (LoU), Stages of Concern (SoC) and Galton, Comber and Hargreaves' (1996) three stages, as it can be seen in Table 2.3.

**Affective/attitudinal** | **Behavioural/practical**

| | **Stage of Concern** | *Nature of concern* | **Level of Use** | *Nature of Use* |
|---|---|---|---|---|
| Familiarisation | 1. Informational | *Lack of information/skill* | | |
| | | | | |
| | 2. Personal | *Personal impact* | | |
| | | | 1. Mechanical | *Developing basic skills &knowledge* |
| Utilisation | 3. Management | *Effect on time &resources* | | |
| | | | 2. Routine | *Practice, established pattern of use* |
| | 4.Consequence | *Impact on students learning* | | |
| | | | 3. Refinement | *Exploring educational potential* |
| Adaptation | 5. Collaboration | *Ability to work with/relate to others* | | |
| | | | 4. Integration | *Developing collaborative activities* |
| | 6. Refocusing | *Reevaluation of aims and objectives* | | |
| | | | 5. Renewal | *Developing innovative strategies* |

Table 2.3 The relationship between Level of Use and Stages of Concern (cited from Comber et al., 1998:375)

As it can be seen from Table 2.3, teachers' level of concern may have an impact on the use of innovation (in this case, the level of ICT use) (Benzie, 1999;Persichitte and Bauer, 1996; Comber et al., 1998). Comber et al. (1998) point out that determining teachers' current concerns and level of use, "allows for appropriate intervention strategies to be introduced at any given point during a project, in order to promote the optimum conditions for moving teachers forward" (p. 379). They claim that, for teachers, these models have implications for the development of their students also, and assist them to develop more effective learning programmes.

### 2.3.4 Conclusion

Many countries have embarked on a range of development programmes to stimulate the use of ICT in education. Nevertheless, progress in effective and appropriate use of ICT in education has been slow and resulted in as failure or disappointment. Throughout the last two decades, as technology itself has changed rapidly, the patterns of use of ICT in education have been altered also, basically from technology-centric to a combination of equally technology-pedagogy-practitioner sensitive phase. Likewise, as it can be understood from the literature, the development programmes at institutional level, at all levels of education, including teacher education, have also been changed in framework, from vertical ICT integration models to more horizontal ICT integration models and/or a combination of both, hybrid model.

Throughout implementation processes of these three types of ICT integration model, in the early ICT adoption stage very few people in a school were carrying the full responsibility or burden of ICT integration. In the very new form of ICT integration all individuals, e.g. ICT teachers, other subjects teachers, educators and administrative staff, have the responsibility of their own students to make sure the full potential of ICT is exploited. From this point of view, it is evident that individuals' understanding, beliefs and concerns are crucial as well as their level of ICT use. In this section, it has been made clear that the practitioners go through stages in time as they learn to incorporate technology into teaching and learning. For researchers, policy-makers, administrators, and also for teachers, knowing about the level of ICT use and level of concern may help them to move forward, and to some extent it gives an opportunity for evaluation about what has been done.

To sum up, the individuals matter more than technology to reach the target, potential benefits of ICT in education. Thus, they, from student to administrators, need to be well-educated so that the effective and appropriate use of ICT in education is achieved. Otherwise, the gap between what has been said about the potentials of ICT and what really is going on in using ICT in current education context will be bigger.

## 2.4 Teacher Education and Teaching and Learning in the Information Age

Visher and Jain (1997) describe a *teacher* as "someone who intervenes in the learning process of others" (p.25). They argue that "the process can be seen as providing prompts for engaging, stimulating, structuring, and encouraging learning in individuals and communities" (p.25). Teachers need to be well prepared to provide meaningful and stimulating learning environments for their students since, as Lytle (2000) states, successful school improvement and change will increasingly be led by teachers. Altun and Satilmis (1996) state that "the teacher is one of the most influential factors in the success or failure of education" (p.569). However, as Schon (1991) argues, teaching occurs in a complicated, fast-moving environment in which teachers must make decisions about ill-defined, fuzzy problems that are not susceptible to simple stimulus-solution matches.

With the ICT innovation, the task of teaching profession has become more complicated for teachers and educators since new approaches to teaching have emerged. When a teacher wants to incorporate ICT successfully into his or her teaching processes, she/he should change the way she/he teaches (Byrom, 1998: Stratford, 2001). Becker and Ravitz (1999) found that technology has been a driver of change in teaching practice among secondary science teachers. Byrom (1998) claims that effective use of ICT and employing new pedagogical practice or teaching style, supported by ICT, lead to improvement in student learning. To fully integrate ICT in the classroom teaching activities, educating teachers about how to use ICT, when, and when not to use ICT is the heart of this long-running change process.

Oliver (1994) points out that;

> "The task of instructing and helping teachers to understand and adopt new approaches must involve large scale changes to the teachers' content and pedagogical knowledge. Adoption of information and communication technology into classroom teaching requires new curriculum approaches and practice" (p.141).

Darling-Hammond (2000) points out that "public dissatisfaction with schools has included dissatisfaction with teacher education" (p.166). Researchers, policy-makers and teacher educators have come up with new approaches to teacher education.

In the next part, these approaches to preservice teacher education will be elaborated regarding ICT as a change agent in the process of teacher education.

### 2.4.1 Educating Student Teachers: Will they teach the way they were taught?

According to Calderhead and Shorrock (1997), during initial training and first few years in the classroom, many teachers experience difficulties in learning to teach. Thus preparing the prospective teachers for the profession is as complex and challenging task as teaching itself. Darling-Hammond (1999) discusses what teachers need to be capable of, putting emphasis on knowledge and capability, which they need to know and be able to do. She classifies these knowledge and abilities as subject matter knowledge, pedagogical content knowledge, knowledge of development, understanding of differences, understanding of motivation, knowledge about learning, knowledge of assessment, teaching strategies, curriculum resources and technologies, collaboration, ability to analyse and reflect on their practice (for further information, Darling-Hammond, 1998:14-17; see also Ben-Peretz, 2001). She also maintains that teachers learn all these just as students do: "by studying, doing, and reflecting; by collaborating with other teachers; by looking closely at students and their work; and by sharing what they see" (p.18). From this point of view, in theory, learning to teach in preservice education requires some certain approaches just like in the other levels of schooling and social life. As Broadfoot (1992) claims, "one of the most widely pursued questions in educational research concerns the attributes of the good teacher" (p.46). However, she points out that there is no single answer to the question of who is the good teacher or what is the way to teach most effectively (see also Skilbeck, 1992).

There are two broad approaches to teacher education, one based on behavioural theories and one based on cognitive/constructivist theories. Both approaches contribute to the development of teacher education programmes. Willis and Mehlinger (1996) point out that at the bottom of the two approaches there is a difference in the way of teaching.

#### 2.4.1.1 Behaviourist Approach to Teacher Education

The behaviourally oriented skill-based programmes, known as *competency-based* teacher education, were popular in the 1970s and 1980s (Willis and Mehlinger, 1996). This model views teaching as "a well defined, structured activity" (Willis and Mehlinger, 1996:987). Skills are learned through organised and repetitive practice of each skill in a systematic and highly prescribed style, and performed largely independent of complex applications in which these skills might play some roles (Pachler, 1999; Becker, 2001).

With Copley's (1992) descriptions:

> "The didactic approach, one of information transmission, views teachers as masters of particular knowledge domains, whose job is to transmit expertise to students primarily by lectures and recitation. In the didactic class, students memorize facts and concepts of the domain, practice skills until they have mastered them, and demonstrate mastery on appropriate tests" (p.617).

As Crawford (2001) claims "teachers attempt to control all aspects of the learning process and expect pupils to overtly demonstrate what they have learnt...Learning is considered to have taken place only if there is an observable change in behaviour" (p.14). As Crawford (1999) states, teaching consists of the transfer of knowledge from teacher to pupil in a classroom, in which the behaviourist approach in action. In teacher education the competency-based approach mirrors the characteristics of behaviourist approach. Briefly stated, in the competency-based approach, teachers become professionals when they display that they can give the correct answers to tests after completing their instruction modules. In this approach teaching is a well-structured task with clear-cut answers or solutions to the problems and issues a teacher must handle in the classroom (Willis and Mehlinger, 1996). Thus the task of teacher is to teach the answers. Competency-based approaches can therefore be justified as giving student teachers clear targets of achievement and explicit evidence of their progress (CNAA, 1992).

In the early days of ICT adoption, ICT was incorporated into teaching and learning activities in classrooms as drill-and-practice, tutorial programmes and simulation/programming (Willis and Mehlinger, 1996; Dalgarno, 2001). Newton and Rogers (2001) argue that in this type of ICT use in education the computer is seen "as the teacher presenting pupils with structured information and questions that invite a response" (p.23). Higgens (2001) claims that these kinds of software, designed in the behaviourist approach to teaching and learning, citing from Black and William (1998), may not help students to improve. On the other hand, Crawford (2000) points out that in a behaviourist designed classroom teachers are regarded as *gods of knowledge*. He adds that due to rapid changes in technology itself and the content domain, teachers cannot be gods of knowledge.

In teacher education, teacher educators, who adopt the behaviourist theory in their teaching activities, "would spend most of their time explaining kinds of software, demonstrating the use of technology in education, and training teachers to work with different types of hardware" (Compley, 1992:617). From this perspective, it is obvious that among the models of ICT integration, discussed in the previous section, the vertical integration model best suits the characteristics of behaviourist approach. Vrasidas and McIsaac (2001) maintain that in teacher education ICT as a separate subject approach is "fundamentally flawed" (p.129). They believe that ICT skills should be taught on the meaningful tasks and in the real life authentic context.

#### 2.4.1.2 Cognitive/Constructivist Approach

In teacher education, the behaviourist programs gave way to programmes based on the cognitive/constructivist model that makes radically different assumptions about how teachers should be prepared for their professional roles. According to Levin (2000), much of recent reforms in education are based on constructivist ideas about learning, and "all versions of constructivism call for students to be engaged more actively in learning" (p.161) (for more information about different versions of constructivism, see Irzik, 2001; Matthews, 2002; Richardson (ed), 1997; Mehan, 1998; Tudge, 1993; Gergen, 1997). He argues that without much more direct learner involvement reform or innovation in education "cannot succeed and should not proceed" (p.155).

Copley's (1992) description of a constructivist approach is that;

> "The constructivist model, one of facilitating learning, views teachers as facilitators whose main function is to help students become active participants in their learning and make meaningful connections between prior knowledge, new knowledge and the processes involved in learning" (p.681).

Larson (1995) maintains that in constructivism, learning is an active process. Constructivist theorists believe that "learning is better or more effective when teachers use constructivist teaching methods, like culturing and keying bacteria as opposed to lecturing about bacteria" (Winitzky and Kauchak, 1997:62). The learner's role is to construct his/her own understandings and skills in experiencing some challenging tasks (Compley, 1992). Students construct their own knowledge from their experiences, mental structures, and beliefs (Larson, 1995; Holt-Reynolds, 2000; Jofili et al., 1999; Naylor and Keogh, 1999; Hodson and Hodson, 1998). Compley (1992) also points out that "the most important component of instruction in the constructivist model is the modelling of the learning process" (p.681).

Richardson (1997) argues two distinct forms of constructivist teacher education being advocated. The first one endeavours to educate STs how to teach in a particular constructivist manner. She claims that this kind of constructivist teacher education is based on Piagetian theory, and the process involves the ways to teach particular subject matters. Thus, this form "often involves considerable direct instruction in theory and practice" (p.10). The second form of constructivist approach includes working with teachers and STs "to help them understand their own tacit understandings on their actions" (p.10). Thus, this form "attempts to model a manner of involving students in investigations of premises and perspectives that is thought may be used by the preservice students when they begin to teach" (p.19). Thus, enough opportunities and experience need to be provided for STs to test, discuss, and compare different perspectives and approaches to teaching (MacKinnon and Scarff-Seatter, 1997).

In teacher education, *School-based (Reflective Practitioner)* approach to initial teacher education mirrors the characteristics of the second form of constructivism, Richardson argues. Bradford and Dana (1998) see the field-based component of preservice teacher education as the most critical milieu. In school-based approaches teachers must construct their own knowledge base, and their own professional skills. Thus professional development occurs most effectively in environments where student teachers can practise and then reflect on their work under the guidance of an instructor who understands the process and is a master practitioner (Willis and Mehlinger, 1996). The classroom is not a well-structured, simple environment where preformed answers are available for every contingency. The goal of teacher education, therefore, is to develop teachers in touch with what is happening in the classroom and who regularly and continuously reflect on their decisions with an eye to improving their professional practice (Willis and Mehlinger, 1996; see also Leitch and Day, 2001). Bryan and Abell (1999) state that experience plays a significant role to develop professional knowledge, and the heart of knowing how to teach cannot be learned from coursework alone. School-based initial teacher training has been to narrow the gap between teacher training theory and classroom reality (Iredale, 1996).

ICT has features to support constructivist teaching and learning since it can be used in authentic, active and co-operative activities (Vrasidas and McIsaac, 2001; Crawford, 2000;). According to OTA's (1995) findings, teachers' constructivist use of ICT provides opportunities for their students to "conduct their own scientific inquiries or projects or engage in collaborative activities, and the teacher assumes the role of facilitator or coach" (p. 49). Loveless et al., (2001) point out that ICT can play a crucial role "in supporting learners in constructing knowledge from a variety of information resources and experiences" (p. 73).

They also maintain that "technology does not change practice; people do – as their knowledge, understanding, skills, beliefs and goals change" (p. 73). ICT will, however, support and help teachers move their pedagogy from teacher-centred to more student-centred, project-based and collaborative methods. Thus, the teacher "must consider the new ways of thinking that technology affords. The way that ICT is used reflects the teacher's beliefs about pedagogy…"(p. 74). As Cloke and Sharif (2001) point out, "teachers' beliefs and theories about teaching are major factors in influencing teachers to use ICT in their teaching" (p. 8). Teachers with the cognitive/constructivist teaching philosophies are stronger users of ICT, and those teachers have increased their use of ICT in their teaching practices (Becker, 2001; Becker and Ravitz, 2001). To make it clear, the differences between behaviourist and cognitive/constructivist approaches are covered in Table 2.4.

| | Behaviourist | Cognitive/Constructivist |
|---|---|---|
| Classroom activity | Teacher-centred, Didactic | Learner-centred, Interactive |
| Role of the teacher | Fact teller, Always expert, Delivers information in a structured coherent order | Collaborator, Sometimes learner, Facilitator |
| Role of the learner | Listener (passive reception of information), Always learner | Collaborator, Sometimes expert |
| Instructional emphasis | Facts, Memorization | Inquiry and invention, Problem solving, Argument, dialog and debate |
| Concepts of knowledge | Accumulation of information in discipline structures | Transformation of facts |
| Assessment process | Norm referenced, Multiple-choice items | Criterion referenced, Portfolios, Exhibitions<br>Performance assessment projects |
| Technology use | Drill and practice, Tool for teacher presentation | Communication, Collaboration, Information access, Measuring, recording, reporting, Tool for student presentation |

Table 2.4 Two distinct pedagogies (the table above is formed from, Ried and Becker (2000); Guile, 1998; and Dwyer, 1996)

To sum up, ICT has the potential to help the educators/teachers to improve the quality of teaching and learning from the traditional behavourist way to the more constructivist way. That does not mean that traditional didactic practice will be left behind completely. As Guile (1998) maintains, with careful thought, the two approaches can be an integral part of a continuum of learning-teaching strategies. In the next part, as integrating ICT in Preservice Science Teacher Education Programmes is the main subject in this thesis, a brief elaboration will be provided whether ICT as an innovation in schools would change the way to teach and learn science.

### 2.4.2 What can ICT Change in Teaching/Learning Science?

ICT has many qualities that make it so important in the learning and teaching process. There is, of course, no single best use of ICT in teaching and learning activities. OTA (1988) points out twelve key capabilities of the technology in education. These most promising uses and demonstrations of technology in education are as in the table following:

*Drill and practice to master basic skills

*Development of writing skills

*Problem solving

*Understanding abstract mathematics and science concepts

*Simulation in science, mathematics and social studies

*Manipulation of data

*Acquisition of computer skills for general purposes, and for business and vocational training

*Access and communication for traditionally unserved populations of students

*Access and communication for teachers and students in remote locations

*Individual learning

*Co-operative learning

*Management of classroom activities and record keeping (p. 12-14).

As discussed earlier in this section, cognitive/constructivist teaching approaches are powerful and beneficial to student learning. Learning is an active process, and students construct their own meaning and understanding of their experiences in this process (Naylor and Keogh, 1999) as "active participants rather than passive receivers" (Newton and Rogers, 2001:38). In science teaching/learning, *practical activities/enquiry-based teaching* (Newton and Rogers, 2001) or the *application of science* (Turner, 2000) are crucial to secure students' benefits regarding their conceptual understanding and procedural understanding of science (Bencze, 2000; Newton and Rogers, 2001). "The primary goal of science education is to contribute to the intellectual development of learners through the acquisition and application of scientific knowledge, skills and understanding" (Newton and Rogers, 2001:139).

ICT can be a valuable tool to help students to construct their own knowledge, and helps teachers to make students active participants in teaching/learning processes since ICT has the potential to support student-centred activities (Newton and Rogers, 2001; Gibson, 2001; Burton, 1997). However, there are some indications that using ICT may cause some side-effects or drawbacks (see Wellington, 1999; Tebbutt, 2000; Newton and Rogers, 2001). For this reason, "...ICT needs to be used selectively" (Newton and Rogers, 2001:35). Science teachers need to be careful to decide and plan when, when not, why and how ICT will be a part of their teaching activities.

There are many studies which illustrate that ICT might contribute to enhancing the quality of science teaching and learning. Wellington (1999) reports on the *Chemistry School* Project, which was a collaborative initiative, jointly funded and organised by the Nuffield Curriculum Projects Centre and New Media Press, aiming to enhance the teaching and learning chemistry at key stage 4, that ICT is seen as a valuable tool by the teachers. In his study, he classifies teachers' perceptions of using ICT in their chemistry teaching. Teachers see the 'added value' of ICT as follows; visualisation, differentiation, variety of approach, effects on attitudes and motivation of pupils and teachers. In the same study, students' perceptions are not much different from their teachers'. Newton and Rogers (2001) describe some clear contributions of different ICT sources to teaching and learning science in their book, *Teaching Science with ICT*, suggesting the way to incorporate them into teaching science in order to secure their benefits (see also OTA, 1988/1995; Ross et al., 2000; Becker and Ravitz, 1999; Barton, 1997; Rogers, 1990; de Jong et al., 1998). McFarlane and Sakellariou (2002) state that ICT can either be used as an integral tool of laboratory-based practical activities to enhance them or as a virtual alternative to real practical work. McFarlane proposes a model of the iterative process of science to structure science teaching/learning environment, providing some examples of current use of ICT alongside this process, as illustrated in Figure 2.5.

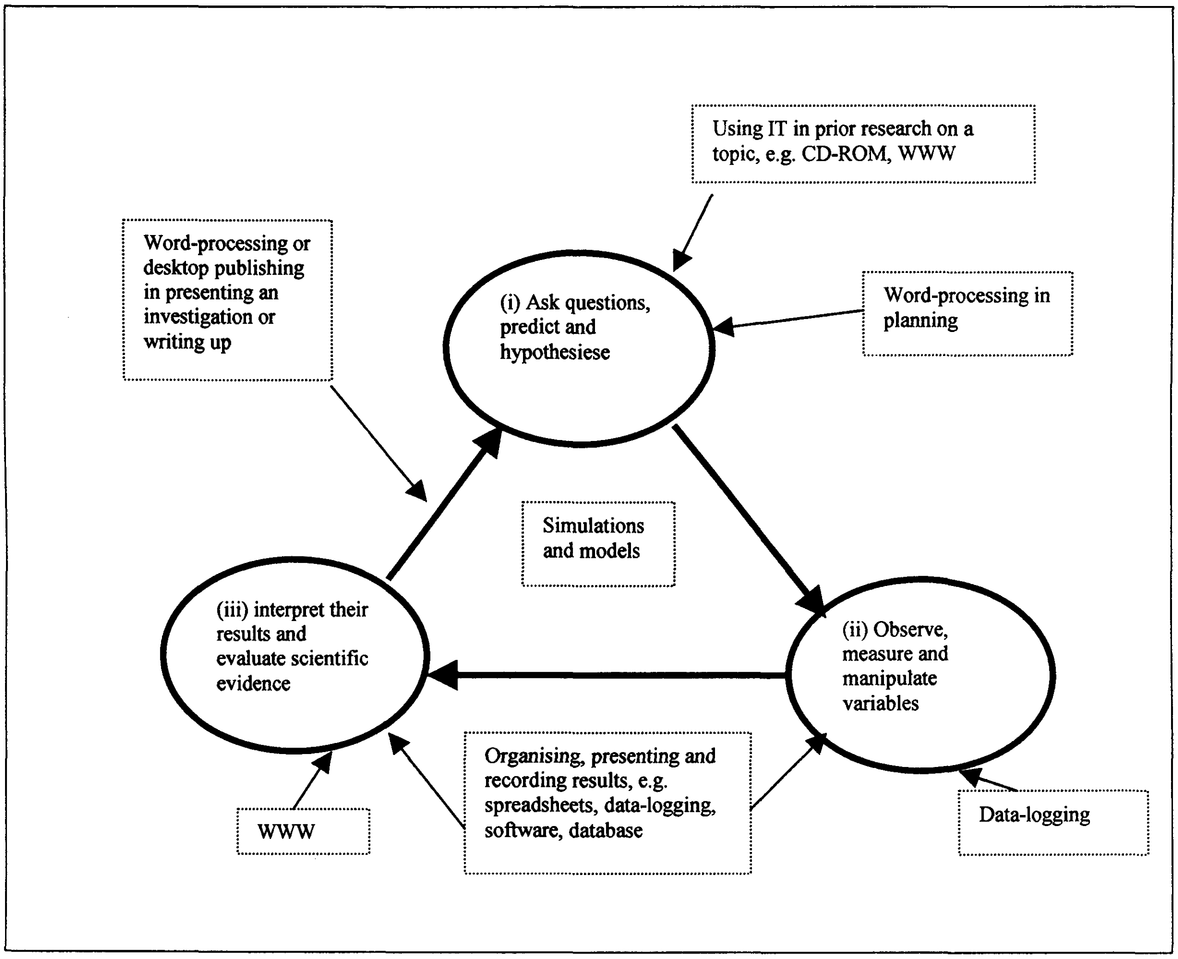



Figure 2.5 A model of the iterative process of science that can be used to structure experience of science at the school level with some examples of current use of ICT (McFarlane, 2000, cited from McFarlane and Sakellariou, 2002:221)

As particularly emphasised in the first section of this literature review, in any kind of innovation in education individuals involvement, ownership and commitment are crucial to secure the potential benefits. To make this happen, there are some certain needs for practitioners to be met. It is evident from the current literature that these needs are similar at all levels of education in respect to integrating ICT into education. Tebbutt (2000) points out that there is a danger of being unsuccessful by expecting too much, too quickly, from teachers, and paying too little attention to the detailed reasons why teachers find difficulty in incorporating ICT into their teaching. In the next part, factors associated with the slow uptake of ICT integration in education will be elaborated.

### 2.4.3 Factors Affecting the Use of ICT in the Classrooms

For at least two decades ICT has been used in education. However, the obvious benefits of using ICT in learning and teaching processes are not fully exposed (Watson and Ross, 1998). Moreover, it is claimed that ICT has intangible benefits in education, and it has very little impression on changing traditional teaching (Olson, 1990; Levin and Riffel, 1997). Having said that, many others claim that ICT can contribute to improve the quality of teaching and learning (Somekh and Davis, 1997; Williams et al. 1998; Moseley et al., 1999, Willis and Mehlinger, 1996; Davis and Tearle, 1999).

In the first section of the literature review of this thesis, some crucial requirements, which provide pressure and support for the implementation of any educational innovation, have been discussed. In schools there have been a number of barriers to make use of ICT more effectively. Here again these barriers, from a wide range of literature, are the same at schools and universities, as will be elaborated next. All barriers are linked to each other in some way, that is, to succeed the ICT integration into teaching and learning process all barriers must be dealt with equally since one may increase or decrease the possible benefits or drawbacks of the other(s).

David (1994) defines some sets of requirements for effective use of technology in education, as illustrated in Figure 2.6.

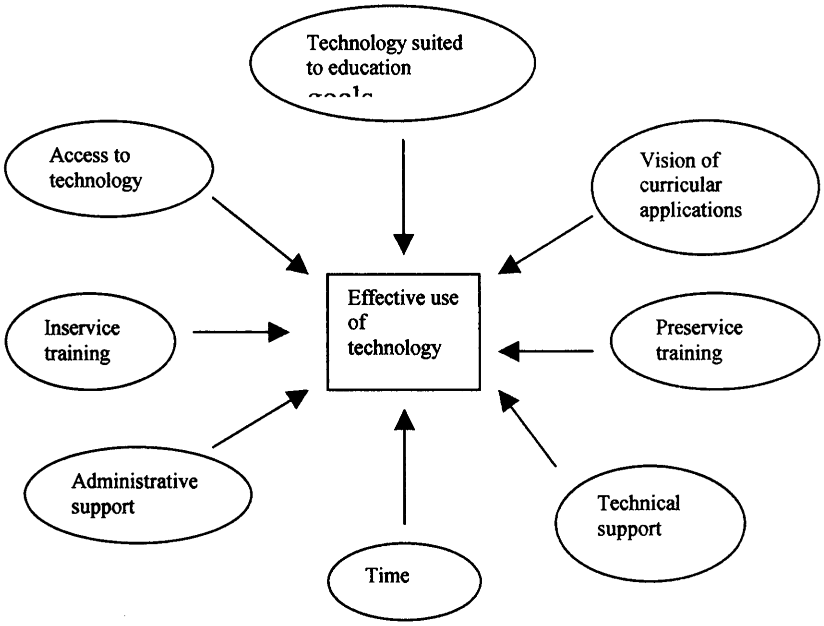



Figure 2.6 Requirements for effective use of technology (quoted from OTA, 1995, p.20)

### 2.4.3.1 A clear shared-vision is needed for the ICT integration

Hord (1995) sees vision as a starting point of a change. People involved in a change process take a stand for a preferred future in the light of their vision. A clear vision of what education is about may help the practitioners to create a vision of ICT integration and ICT's role in education (Budin and Meier, 1998; Lewis, 1999). ICT has been a complicated innovation in education since it may influence all components of education. For this reason, as OTA (1995) reports, teachers have become confused, and managers frustrated, with many educators unclear where they should be headed in directing technology use. In many cases today and especially in early times of ICT adoption, there have been lack of understanding and consensus about the role, value and effectiveness of ICT in education (Roberts and Ferris, 1994; Budin and Meier, 1998; Parmley et al., 1997).

In the NCATE (2001) report, it is pointed out that

> "no vision about the future of teacher education is likely to prove useful if it is not closely tied to a set of assumptions about the future of schooling and the impact of the technology on school instruction. This visionary process is one that must remain fluid and subject to amendment as conditions and opportunities change" (p.8).

As pointed out in the first section, Hargreaves (1997) maintains that vision is best perceived as a *shared journey*, not destination- always open to revision and review. On the other hand, Conlon (2000) states that "...unless teachers, learners and communities can articulate their own visions of educational change, new technology could take them into a future that they would never willingly have chosen" (p.109), discussing two contrasting vision of education, which will not be argued here. Developing a shared vision within a school regarding the integration of ICT in teaching and learning may be a basis for the other emerged issues from ICT innovation to overcome or direct.

Sun et al. (2001) point out that the vision statement should result in a simple, concise paragraph that summurises your answers to the questions "Why is ICT important to the students and teachers in your school?" and "Why do you believe that technology is a necessary tool for teaching and learning?"

It would be better to give a clear example of a vision statement here. The vision statement below is from The University of Connecticut, the USA (for more examples of secondary schools' vision statements, see Sun et al., 2001).

> The University of Connecticut will be a leader in the use and development of Information Technology. The university will be a community for teaching, learning, research, and service in which information technology: is ***integrated*** into daily life, enhances ***productivity***, promotes and creates new opportunities for ***learning***, is actively ***explored***, and is continually ***renewed***.
> (Web-based doc. At: http:\\www.uc2000.uconn.edu/aitrpt12.htm)

To sum up, as Roberts and Ferris (1994) stresses, lack of a clear, shared, vision for the role of ICT in education is one of the reasons for the slow uptake of integrating ICT into education.

#### 2.4.3.2 Creating a plan for ICT integration and providing time for teachers and implementation process

Sun et al. (2001) points out that technology planning is a complex process and takes place over time. It is not simply about providing hardware, software, cables, and connections. It is also about managing people involved in the change process and resources available for achieving the goals have been embarked to do. They claim that there are two main points of technology planning in an institution:

The first one is *time* for people involved in the implementation process and for the implementation process itself. As Budin and Meier (1998) point out, in reality, integrating technology is a process that occurs over time, a process of continual change and growth. For teachers new tasks arise because the work is undertaken with ICT (Dawes, 2001). Thus, teachers need realistic time to practise their new skills, reflect on new knowledge and consider effective ways of integrating ICT to enhance pupil learning (TTA, 1998). Sun et al. (2001) state that when teachers experience a different kind of learning environment, they need time to consider about the new knowledge they are getting. This may help them to question their own attitudes and beliefs about ICT through personal reflection and to begin the process of change. On the other hand, technology itself change rapidly, requiring continual learning. Teachers, administrators and also students need time to gain the ICT capability needed in the implementation process.

Consequently, many studies illustrate that time is an important factor to integrate ICT in education (OTA, 1995; Willis and Mehlinger, 1996; Budin and Meier, 1998; Wellington, 1999; Sun et al. 2001; Callaway et al., 2002), and a strategic plan must include a time schedule for taking certain actions to accomplish the vision of ICT in teaching and learning (Sun et al., 2001).

The second element is strategic action. Sun et al. (2001) state that in practice, planning is a series of linked and interwoven action steps. These actions include planning to plan, gathering information, managing resources, providing ongoing training and support, writing curriculum, and evaluating progress, as well as many others. All those actions are designed to achieve particular goals, and each goal is outlined to support the overall vision of the plan (Sun et al., 2001).

#### 2.4.3.3 Creating an atmosphere for change

Robertson et al. (1996) discuss teachers' resistance to incorporating ICT their teaching process. They argue that following issues are the reasons for teachers' resistance;

*Resistance to organisational change

*Resistance to outside intervention

*Time management problems

*Lack of support from the administration

*Teachers' perception

*Personal and psychological factors.

These factors reveal that teachers understanding of ICT innovation, their commitment and ownership are crucial to secure maximum benefits from ICT in a school. In this sense teachers, obviously, must be an integral part of the change process; indeed, teachers must be in the centre of the change.

McQuenn et al. (2002) state that change is succeeded only when those affected have an opportunity to participate in the change. Understanding the need for change is one of the central problems in educational reform (Cox et al., 1999). In the case of ICT use in education, teachers need to know how ICT can be used or exploited to meet particular objectives within their own subjects of the curriculum to improve students' achievement (Moseley et al., 1999). In many change processes people do not have a clear and coherent sense of the reasons for educational change. Thus, there is superficiality and confusion, resulting in failure of a change implementation, groundless and misdirected resistance

(Fullan, 1991). Many teachers still see ICT as an extra or add-on rather than an integrated resource within teaching (Williams et al., 1998). In this sense leaders' or administrators' roles are crucial to create an environment which helps teachers to incorporate ICT in their teaching practices. From policy-makers to ICT coordinators, all should help, encourage and give their support to teachers. According to Wellington's (1999) study, lack of support or even discouragement e.g. from the ICT coordinator is an impediment to teachers' ICT use in schools. Collaboration and cooperation between teachers and administration and/or ICT coordinators are crucial to create the environment desired.

In conclusion, as Watson (2001) argues;

> "curricular integration is a complex, difficult to learn process; many educators feel isolated and alone; time to experiment, explore and study innovations is essential but rare in schools; resentment and resistance destroys projects; ownership is critical to success; and administrative support is essential" (p. 260).

#### 2.4.3.4 Access

Access is one of the basic prerequisites for effective teacher use of ICT in schools (OTA, 1995; Mumtaz, 2000). In conjunction with this, the quantity of the available ICT resources in schools such as counts of equipment, student-computer ratios is important, but the quality of available access to ICT resources are more important than the number of resources available regarding effective integration of ICT in teaching and learning process.

Williams et al. (2000) points out that "the need for greater access to ICT in the classroom emerged as an important issue although the solutions are not necessarily restricted to a simple increase in numbers of computers" (p.170). They perceive the access issue in two categories: total lack of availability of ICT and lack of ready access when needed.

Taylor (1997) defines three ways of the deployment of ICT in schools and universities: a separated ICT room or laboratory, single computers in each classroom, and cluster of computers in a variety of locations in the building. Apparently, each of these approaches has advantages and disadvantages (see Taylor, 1997:229 - 231). According to Ofsted (2002) findings, teachers' personal access to a computer for the purpose of preparation and planning has a major role for successful teacher training and subsequent classroom use. There is often a difficulty for teachers who have had some training to be able to use ICT in their teaching activities, if there are not sufficient ICT resources and enough time (Cox, et al., 1999).

#### 2.4.3.5 Educating Teachers

As Roberts and Ferris (1994) state teacher education has been a major identified need since computers first appeared in schools. As elaborated in the previous section in detail, teacher education about ICT is the heart of change desired regarding integrating ICT in education. However, the support or training given to teachers, have been based on technical skills, rather than pedagogical practice (Cox, et al. (1999; Jurema et al., 1997; OTA, 1995; OECD, 1992). Training about pedagogical use of ICT must be offered for teachers as well as technical and ongoing support and training. More importantly, Cox et al. (1999) assert that once teachers have finished their initial training they do not expect to need much further training therefore do not take the initiative to better their practice and learn new skills. Thus, by pressure and support, teachers should question their own professional practice.

#### 2.4.3.6 Managing ICT

Somekh et al. (1997) maintain that the management of change across a whole institution is never easy. In the case of ICT integration, they point out that very few institutions in education have so far succeeded the integration of ICT across the whole institution effectively. In a school, the way managing ICT may have its influences on all aspects of ICT related activities; from teachers' use to students' use. Crawford (2001) analyses the models of educational management, identified by Bush (1995), regarding effective ICT management strategies in secondary schools. Here these models of management will not be elaborated in detail, but it is assumed that providing some information might be enough to draw the picture of the case under investigation in this thesis (for more information. see Crawford, 2001).

Crawford (2001) describes the *formal* management structure as the most effective method for implementing ICT, in which the headteacher with ICT expertise leads the implementation process. In this hierarchical model it is evident that implementing ICT effectively is in danger if headteachers or senior managers do not have enough ICT expertise since "managing the delivery of ICT in its entirety requires considerable technical expertise" (Crawford, 2001:22). The second model is the *collegial* approach, which provides opportunities for teachers to cooperate with others for implementing ICT in their school. In this model, power is shared and the actual practice is a result of collective decision, even if there is some doubt about its possibility in practice (Crawford, 2001). The third one is the *political* model, which "ICT coordinators may seek to enhance their legitimate, positional authority and power through the development of their personal charisma, and the possession of superior technical expertise" (Crawford, 2001:23). ICT coordinators have considerable authority over the allocation of ICT resources to other teachers, and the availability of technical support. *Subjective* model, which can provide insights into individuals' perceptions of organisations (Crawford, 2001). Effective implementation of ICT may occur if individuals' understanding, values and standpoints are taken into account. Agreeing with Bush, Crawford (2001) maintains that this is a slow process and may not always be adjusted in the ways planned. *Ambiguity* models of "educational management may provide partial explanations of the difficulties inherent in delivering ICT in schools" (Crawford, 2001:24). Bush (1995) defines the difficulties in ambiguity models as follows;

> "...that there is lack of agreement regarding institutional goals and purposes; that that organisational processes, rules and structures are not entirely explicit or well understood; that organisations are characterised by fragmentation and loose coupling of decentralised subgroups; that individuals' powers and responsibilities are not clearly defined; that participation in decision making is inconsistent; and that the process of identifying problems and their solutions, and implementing, monitoring and evaluating these is not a linear, rational process". (quoted in Crawford, 2001:24)

Finally, *cultural models* of educational management take into account the shared values and meanings of teachers' professional experiences in a school. In this model, as

Crawford (2001) points out, ICT must become part of the dominant school culture to integrate ICT across the whole school. In each model of educational management leadership is the key ingredient regarding any change process, in this case ICT as an innovation, whatever the form it is; a shared one, an ICT coordinator, or senior administrators.

To sum up, as Sun et al. (2001) point out, barriers to successful ICT integration into teaching and learning are the same for all educational institutions at all levels, but some of them have additional issues.

### 2.4.4 Conclusion

As a long running innovation in education, attempts have been made to integrate ICT into teaching and learning. As an obvious result of these attempts, teacher education programmes have been influenced by the ICT initiatives. The teacher is the most influential factor in the success or failure of education. For this reason, their preparation is crucial. Throughout this section, two distinct basic theories of teaching have been elaborated in detail regarding the role and applications of ICT in each approach.

The behaviourist approaches to teaching and learning view teaching as a 'structured activity' (Willis and Mehlinger, 1996), 'knowledge and skills transmission' (Copley, 1992). In conjunction with this, in behaviourist approaches, learning is viewed as 'observable change in behaviour' (Crawford, 2001) or 'mastery on appropriate tests'

(Copley, 1992). In didactic approaches, learners are usually passive listeners. On the other hand, the cognitive/constructivist approaches view learners as 'active participants in their learning', teachers as 'facilitators' (Copley, 1992), and learning and teaching as 'active processes' (Larson, 1995). It is evident that ICT has the potential to be used in the both approaches, behaviourist and cognitive/constructivist. However, integrating ICT into education requires some basic steps which affect the success of the implementation. These factors are the same at all levels of education, pre-school to higher education. Each factor discussed in this section may affect the implementation process equally, and thus deserves the same attention. As stated repeatedly, the individuals' understanding and commitment (i.e. teachers, educators, all staff involved in education and students) become more important to fully exploit the potential of ICT in education. Educating teachers, educators, academic staff and students is central part of the success of the change, so the way to educate them.

As a result of this reasoning, in the first part of this section the two distinct theories of teaching and learning were elaborated, in consideration of teacher education and ICT applications. Learning and teaching will be more effective and powerful if the cognitive/constructivist approaches are used by educators. ICT, in this sense, acts as a facilitator of various practices and has the potential to be used in a constructivist educational environment. In the second part, factors associated with ICT implementation process have been discussed. It is evident that these factors may be increased or decreased in number, depending on different real life contexts. Here, more common factors in the literature have been taken into consideration.

## 2.5 Summary and Conclusion on the review of the literature

Literature reveals that there are many factors may affect the implementation of an innovation in education. There is always the human factor in any change process, which plays the most crucial role. Individual understanding, commitment and ownership of any innovation in education make the implementation process proceed successfully or fail. The transformation of individual understanding of innovation in education is the essence of the process of change. To receive full help and support from the individual practitioners in the light of the requirements of the intended change in education, the implementation process must be facilitated through some crucial strategies, such as Hord (1995) suggests.

ICT, as a long run innovation, has received much more attention than any other innovation in education. Many countries have embarked on a range of development programmes to stimulate the use of ICT in education throughout the last two decades. As revealed in the literature, as technology itself has rapidly changed, the ways to integrate ICT into education and to make use of full potential of ICT in teaching and learning have epistemologically shifted, from horizontal to vertical and/or hybrid model of integration, from technological-centric to a combination of equally technology-pedagogy-practitioner sensitive phase.

However, despite the fact that ICT has had the prominence in the Government's agendas, many reports and studies illustrate that the use of ICT in teaching and learning processes is still insufficient and disappointing in every country. In this sense integrating ICT across the curriculum became a must to exploit the full potential of ICT regarding its pedagogical benefits. In practice a combination of vertical and horizontal integration models (hybrid model) has been adopted in many institutions. However, alongside the teacher's other knowledge such as subject matter and pedagogical content knowledge, teachers' ICT capability, in the case of this thesis in which PSTEP were investigated teacher educators' ICT capability, has become an important essence of successful integration of ICT. Literature indicate that teachers' ICT skills reveal their understanding of the potential of ICT and their determination to incorporate ICT in their teaching. However, integrating ICT requires more than technical skills on ICT, it requires a clear understanding of the value of using ICT in subject teaching and appropriate time and approach to make use of ICT in other subjects. In essence, many studies illustrate that teachers incorporate ICT in their teaching tend to be the ones who use more student-sensitive approaches, as expected from the use of ICT. This student sensitive use of ICT lead to improvement in student learning about ICT and subject matter. As an inevitable result of the Governments' persistence of integrating ICT at all levels of education, teachers should change their teaching formats and styles. This is not just for the sake of technology, but for preparing more effective teaching and learning environments for their students.

As Loveless et al. (2001) put it, *technology does not change practice – people do*. Thus, teachers should be ready for the emerging issues ICT brought up and deal with the issues on behalf of their roles in the implementation process. From this point, the review of the literature reveals that there is not a clear cut solution to overcome the issues emerged, and there is not just one issue either. Teachers go through stages in time as they learn to incorporate technology into teaching and learning. Teachers' ICT capability, understanding, willingness and commitment are essential, but not enough. The literature also shows that there are some crucial factors affecting the use of ICT in the classrooms. More or less the factors are the same at every level of education, from primary to higher education. The teacher is the key to successful integration. ITE becomes at pivotal point to educate teachers of quality regarding ICT capability. However, the literature indicates that teacher educators do not model the use of ICT. Until educators integrate ICT in their own teaching/learning activities, the gap between what have been said about the potential benefits of ICT (the expected) and what really is going on (the reality) in using ICT in current education context will be bigger.

# 3. METHODOLOGY

## 3.1 Introduction

In this chapter, firstly, the theoretical underpinnings of the study that is the focus of this research will be discussed in detail. The main aim for doing this is to draw a picture of the study regarding its ontological, epistemological and methodological background assumptions. By doing this, some basic assumptions about the 'being' of reality to be sought will be made. Moreover, the 'nature' of the knowledge that is sought about this reality will be very helpful to define the 'way' (methodology to be used) to reach this knowledge as accurately as possible. Secondly, the research questions and their nature will be classified. This part will reveal what is to be investigated by which method(s), and why these methods are chosen. Thirdly, the data sources, the sample selection procedure, issues such as quality of the study and ethical issues, and the role of the researcher in the study will be examined. Fourthly, the process of data collection will be described. Fifthly, the procedure of data analysis will be explained. Finally, a conclusion will be drawn in the light of the discussions throughout the whole chapter.

## 3.2 Framework of the Study

This study is about the integration of Information and Communications Technology (ICT) into Pre-service Science Teacher Education Programmes (Physics, Chemistry and

Biology) (PSTEP) as a recent and ongoing innovation in education. Thus the main purpose of this study is to *understand* and *explore* the implementation process of ICT in PSTEP, using a case study design.

In conjunction with this main purpose of the study, first of all, it was intended to understand the policy of the Central Government, the Council of Higher Education, and the Faculty of Education under investigation regarding the integration processes of ICT into Pre-service Teacher Education (PTE) in Turkey.

Secondly, at the end of PSTEP (in the final term of four-year training period), student teachers' operational (technical competence on ICT) and application skills (using those operational skills in teaching their special subject: pedagogical use) on ICT, their knowledge and understanding of ICT and their attitudes towards ICT were explored.

Thirdly, how the ICT innovation in the PSTEP has been implemented was intended to be understood by obtaining lecturers' and student teachers' perceptions and observing their actual practices in the classrooms. Meanwhile, factors associated with ICT integration process and lecturers' and student teachers' actual uses of ICT were explored.

Finally, a model to integrate ICT into PTE was proposed for the three teacher education programmes under investigation in the light of participants' suggestions, current literature and the researcher's own experience and understanding of ICT integration.

The role of the individuals involved in the implementation process: their understanding, personal and professional use (i.e. pedagogic use) of ICT and their attitudes towards this innovation, and their perceptions about the integration process were explored. The research is about the process and the individuals' views involved in it, rather than outcomes or just an event. The implementation of ICT in teacher training is a process which include human beings and its own complexity, not an event that could be manipulated or controlled as in experimental and survey studies.

As Creswell (1994) states, one of the fundamental reasons for carrying out a qualitative study is that the study is exploratory. The researcher seeks to understand participants' **points of view** and the research **context** and s/he builds a **holistic picture** based on his/her interpretations and participants' views about the phenomenon. In this respect, it is believed that the **qualitative approach** (i.e. case study) embraces the objectives of this study and finds the answers to the research questions.

### 3.2.1 Research Questions

As Robson (1993) points out, there is no automatic way of generating research questions. In this study, having reviewed a great deal of literature related to the research subject area: using ICT in education, in general, and integrating ICT into teacher education/training in particular, the researcher decided on the main topic to be studied. Research questions were developed through the literature review and ongoing academic dialogue with supervisors and other colleagues. Some questions were rewritten at the end of this process. Finally, the next nine questions were decided to be investigated as sub-research questions which frame the main research question; **"What are the factors affecting the process of integrating ICT innovation into Pre-service Science (Physics, Chemistry and Biology) Teacher Education Programmes?"**.

Blaikie (1993) states that "social research is about exploring, describing, understanding, explaining, predicting, changing or evaluating some aspects of the social world"(p.4). Research questions can be divided into three groups: 'what', 'why' and 'how' questions. 'What' questions are related to exploring and describing, 'why' questions are related to understanding and explaining some characteristic of phenomenon, and 'how' questions are related to practical outcomes (see also Robson, 1993). In this study the research questions are:

1. What is the aim of ICT related training in pre-service science teacher training?
2. What are the student teachers' ICT capabilities, and how confident they feel about using ICT?
3. What are the lecturers' capabilities on using ICT as teaching-learning and professional development tool?
4. What are the student teachers and lecturers' attitudes towards using ICT as teaching tools?
5. What challenges do the student teachers and lecturers face during their use of ICT in schools and at faculty?
6. Why do/ Why do not the lecturers and student teachers use ICT as teaching tools?

7. What are the lecturers' and student teachers' perceptions about the use of ICT in science teaching and learning? How does ICT affect their practices and roles?
8. How ICT is integrated into pre-service teacher training?
9. What are the lecturers and student teachers' views about ways of moving forward in developing student teachers' ICT skills?

Creswell (1994) points out that the design of a study begins with the selection of a topic and a paradigm. He goes on stating that paradigms, which help people to understand phenomena, encompass both theories and methods. In the next part, in order to make theoretical underpinnings of the study clear, basic assumptions in educational and social research in general and in the study in particular will be discussed. The reason for doing this discussion in this chapter is related to two things. The first one is to make the study clearer for the reader. Usher (1996) states that it is the failure to examine these assumptions which leads to research normally being understood as a 'technology', as simply a set of methods, skills and procedures adjusted to a defined research problem.

The second one, more importantly, is that as a Turkish Government sponsored student in the United Kingdom, the researcher has to submit a copy of the finished study to the Turkish Ministry of Education. In the Western world qualitative research in education is widely accepted, and there has been a great deal of research in which qualitative approach is used. On the other hand, in Turkey, qualitative study and its base are still quite controversial in terms of data collection methods, the nature and essence of qualitative study, reliability, validity and generalisability of the results of qualitative studies. It might be reasonable to think that the reason for this debate derives from lack of understanding or *misunderstanding* of theoretical underpinnings of qualitative research. It is assumed and hoped that theoretical discussions about the methodology in the next part will help *some* Turkish readers to understand the theoretical underpinnings of educational research, as well as this study.

### 3.2.2 Theoretical Underpinnings of the Study: the background assumptions and implications for this Study

Each social science researcher has looked at the social world in different ways. Those differences result in applying different logic and techniques to educational research for each researcher. "They have conducted different styles of research and collected different sorts of data and information by means of a quite staggering array of techniques" (Hitchcock and Hughes, 1989:13). These differences are due to different background assumptions. There are three kinds of background assumptions, which ought to be taken into consideration, to investigate any social phenomena.

Ontological assumptions concern the very nature or essence of the social situation being investigated. 'What kinds of things are there that can be known about it in the world?' is a question of ontology. That is to say, what is the form and nature of reality? So ontology refers to issues concerned with 'being' (Hughes, 1990). Cohen and Manion (1994) put emphasis on some questions of ontology; such as: Is social reality external to individuals- imposing itself on their consciousness from without- or is it the product of individual consciousness? Is reality of an objective nature, or the result of individual cognition? Is it a given 'out there' in the world, or is it created by one's own mind? They state that "these questions spring directly from what is known in philosophy as the nominalist-realist debate" (p.6). It is beyond the scope of this study to examine the nominalist-realist debate in detail, but some brief information about nominalism and realism may be helpful in order to have an overall knowledge and understanding about the theoretical underpinnings of this study.

Nominalist ontology presumes that the objects of thought are only words and that there is no independently available thing forming the meaning of a word (Cohen and Manion, 1994). In conjunction with this, nominalists deny that there is any genuine or objective identity in things which are not identical (Armstrong, 1978). That is, multiple realities exist in any social and educational setting since individuals, involved in the setting, construct realities. However, the realist ontology asserts that objects have an independent existence. That is to say, realists hold that the apparent situation is the real situation (Armstrong, 1978). In respect to social or educational research, deciding ontological assumptions makes the phenomenon to be investigated clear and explicit, that is, what kind of thing is there to be searched? Greenwood (1994:85) makes points about physical and social reality as follows:

> Physical and social phenomena ...differ in one essential respect. Chairs may exist independently of our knowing that they do; our knowledge of the existence of chairs is not constitutive of their existence. In contrast, social phenomena do not exist independently of our knowledge of them...Social realities, therefore, are constructed and sustained by the observation of the social rules which obtain in any social situation by all the social interactors involved...Social reality is,

> therefore, a function of shared meanings; it is constructed, sustained and reproduced through social life (Quoted in Crotty, 1998:54).

In this research, the aim of the inquiry was to *understand* the phenomenon, in this case, the process of ICT integration into PSTEP. As stated in the introduction part of this chapter, preservice science teachers' training about ICT is part of teacher training programmes in Turkey. The process of ICT-related training varies in the light of individual application and understanding of the phenomenon. Each lecturer carries out a different practice in her or his classrooms and has different understanding of ICT (i.e. its potential, use, value, and so on). Thus you cannot define an independent reality in the process of ICT integration into teacher training, rather, the meaning of the reality to be searched is depend upon the individuals' words and interpretations in the research setting. Thus the reality to be searched about is *a function of shared meanings- **socially being*** (Usher, 1996; Guba and Lincoln, 1994/98). It may have multiple meanings as many people are involved in the research setting. In this case, each individual lecturer, manager, policy-maker and student teacher may understand it in a different way or give it a different meaning. As a result of this reasoning, it may be said that this study is based on *nominalist ontology* that accepts the existence of multiple realities of any social situation.

The second set of assumptions is epistemological. *Epistemology* refers to the question of knowing and the nature of knowledge. So epistemological assumptions concern the very basis of knowledge, the form it takes, and the way in which knowledge may be communicated to other human beings (Hitchcock and Hughes, 1989; Cohen and Manion, 1994). In this sense, an interaction has to be between the researcher and the researched or individuals to be studied. As a theory of knowledge, epistemology presents a view and a justification for what can be considered as knowledge (Blaikie, 1993; Hofer and Pintrich, 1997; Usher, 1996). In conjunction with this, Hitchcock and Hughes (1989) state that there are two distinct ways of making sense of social reality. These are the positivistic and interpretative models of social and educational research. Each of them has different methodological implications (Walker and Evers, 1994). Paradigms, as basic beliefs systems, are sets of ontological, epistemological assumptions and methodological implications within which research is framed (Guba and Lincoln, 1994/98; Thomas, 1998). Husen (1994) points out that a paradigm arbitrates the criteria according to which one selects and defines problems for research and how one approaches them theoretically and methodologically.

**Positivism** claims that scientific knowledge is the criterion of rationality; that scientific knowledge must be free of metaphysics, that is, the claims of experience as the ultimate foundation of human knowledge must be based on pure observation that excludes the interests, values, purposes and psychological schemata of individuals (Howe, 1988; Hindess, 1977; Usher, 1996). Durkheim (1964) states that "for a positivist, the social scientist must study social phenomena in the same state of mind as the physicist, chemist" (Quoted in May, 1997:10).

Positivists see the social reality as a complex of causal relations between events depicted as an emerging patchwork of relations between variables. The causes of human behaviour are regarded as being external to the individual (Blaikie, 1993). Guba and Lincoln (1998) points out that this realist ontology assumes that the existence of a reality is driven by immutable natural laws and mechanism. Positivist epistemology is dualist and objectivist. They argue that it is assumed that the investigator and the investigated 'object' are independent entities, and the researcher is capable of studying the object without affecting it or being influenced by it. Research is conducted as through a one-way mirror. Values and biases are prevented from influencing outcomes, so long as the set procedures are thoroughly followed (Guba and Lincoln, 1998).

Positivist methodology is experimental and manipulative. Questions and/or hypotheses are established in prepositional form and subjected to empirical test in order to confirm them. Possible confusing states must be carefully controlled and manipulated to prevent outcomes from being unacceptably biased (Guba and Lincoln, 1998). The positivist paradigm relies on a nomothetic methodology, which seeks to establish general law-like findings which can be estimated regardless of a certain time and place (Bryman, 1988; Cohen and Manion, 1994). On the other hand, the origin of interpretivism lies in the intellectual traditions of hermeneutics and phenomenology. Various terms have been used to identify this approach, such as anti-naturalist, anti-positivist or post-positivist. Its central principle is that there is a basic difference between the subject matters of the natural and social sciences (Blaikie, 1993). Interpretivism is the view that;

> "...at least as far as the social sciences are concerned, metaphysics (in the form of human intentions, beliefs, and so forth) cannot be eliminated; observation cannot be pure in the sense of altogether excluding interests, values, purposes and psychological schemata; and that investigation must employ empathic

> understanding (as opposed to the aims of explanation, prediction, and control that characterise the positivistic viewpoint)" (Howe, 1988:13).

Layder (1998) states that the interpretivist vision of social analysis correctly insists that a subjective point of view is of paramount importance in understanding social life.

> Interpretivist persuasions are predicated on the assumption that the empiricist's picture of social reality omits something most important, namely, inter-subjective, common meanings- "ways of experiencing action in society which are expressed in the language and descriptions constitutive of institutions and practices" (Taylor, 1971/1987:75) (quoted in Schwandt, 1998:225).

Interpretivists in general focus on the processes by which these meanings are created, negotiated, sustained, and modified within a specific context of human action. They believe that one must interpret the world in order to understand the meaning of this world. The means or processes by which researcher arrives at this kind of interpretation of human action (as well as the ends or aim of the process) is called Verstehen (understanding) (Schwandt, 1998/1994).

Interpretivism entails an ontology in which social reality is regarded as the product of processes by which social actors together negotiate the meanings for actions and situations; it is a complex of socially constructed meanings (Blaikie, 1993). Human experience is characterised as a process of interpretation rather than sensory, material apprehension of the external physical world, and human behaviour depends on how individuals interpret the conditions in which they find themselves (Usher, 1996). Therefore, social reality is not "thing" that may be interpreted in different ways; it is those interpretations. Hence, in contrast to physical reality, social reality is pre-interpreted (Blaikie, 1993).

In its epistemology, it is assumed that the knowledge comes from everyday concepts and meanings. The social researcher enters the everyday social world in order to understand the socially constructed meanings, and then reconstructs these meanings in social scientific language (Blaikie, 1993). The interpretative paradigm has an **ideographic methodology,** which locates its findings in specific time-periods and locales (Bryman, 1988; Cohen and Manion, 1994). As it can be seen from two paradigms, positivist and interpretivist, elaborated above, they support quantitative and qualitative methodologies in the social sciences respectively (Glesne and Peshkin, 1992).

In order to understand the research setting, interpretations of the subjects (i.e. lecturers and student teachers) and the researcher were needed. It is evident that the successful implementation of an innovation (i.e. ICT) in education is not easy because there are many factors which affect the change process. These must be taken into consideration. In conjunction with this, there are human factors in any change process, which play crucial roles. Individuals' understanding, commitment, and contribution to educational change make the implementation process proceed successfully or fail.

In this study, the lecturers and student teachers were the subjects of the research and in the centre of the ICT integration process. It was assumed that the knowledge related to the research questions comes from the natural context, the researcher's interpretations and the subjects' understanding and interpretations of the setting with their own words, observations and experiences. Thus it was assumed that this study requires a qualitative approach, interpretivist in its epistemology. As discussed earlier in this chapter, each paradigm is characterised by an approach to the studies in social and educational area. In the next part, some brief information about quantitative and qualitative approaches will be provided.

### 3.2.3 Quantitative - Qualitative Distinction

First of all, as stated before, both quantitative and qualitative methodologies represent distinct paradigms based on conflicting philosophical assumptions. Howe (1988) points out that the differentiation between quantitative and qualitative is at three levels of research practice: data, design and analysis, and interpretation of findings. In the measurement sense, data are quantitative if they fit an ordinal, interval, or ratio scale; in the ontological sense, data are quantitative if they exclude values, beliefs, and intentions. At the level of design and analysis, as well as interpretation of results, quantitative ones are mechanistic, non-judgmental or objective. Firestone (1987) points out four differences between quantitative and qualitative research. Both have different assumptions about the world. Whereas quantitative research is supported by a positivist philosophy which assumes that there are social facts with an objective reality apart from the beliefs of individuals, qualitative research is based on an interpretative philosophy which assumes that reality is socially constructed through individual or collective definitions of the situation. The second difference is about purpose. On the one hand, quantitative research seeks to explain the causes of changes in social facts, primarily through objective measurement and quantitative analysis. On the other, qualitative research is more concerned with understanding the social phenomenon from the actors' perspectives through participation in the life of those actors.

Another one is about approach. In order to reduce error, bias, and other noise that keeps one from clearly perceiving social facts, the quantitative researcher typically employs experimental or correlational designs, with Bryman's (1988) words, 'a structured approach'. The prototypical qualitative study is the ethnography which helps the reader understand the definitions of the situation of those studied (Firestone, 1987), with Bryman's (1988) words, 'unstructured approach'.

Finally, the role of the researcher differs in each approach. Ideally the quantitative researcher must try to avoid bias. To do this so, researcher's contact with the people under study is fairly brief or even non-existent (Bryman, 1988). On the other hand, the qualitative researcher entails much more continued contact.

Briefly stated, both quantitative and qualitative approaches take different positions in view of epistemology, and hence divergent paradigms. In applying these underpinning assumptions to this study, knowledge or realities to be sought were assumed and accepted as in ontologically nominalist, epistemologically interpretivist and methodologically ideographic nature. Table 3.1 gives a clear justification of the research questions and their background characteristics.

| The Research Questions | Objective(s) | Knowledge, reality being sought | Method(s) | Comments |
|---|---|---|---|---|
| What is the aim of ICT related training in preservice science teacher training? | To explore and define the vision of ICT related training | Descriptive Exploratory | Document analysis*<br><br>Interview** | *Documents from central government, the council of higher education and faculty of education.<br>**Interview with lecturers who are responsible for ICT course. |
| What are the student teachers' ICT capabilities, and how confident they feel about using ICT? | To explore and describe STs' capabilities and confidence on ICT | Descriptive Exploratory | Questionnaire*<br>Interview**<br>Observation*** | *Questionnaire has been developed for student teachers<br>**Interview with student teachers and lecturers<br>***Observing classroom practices at Faculty of Education |
| What are the lecturers' capabilities on using ICT as teaching-learning and professional development tool? | To explore lecturers' ICT capabilities | Descriptive Exploratory | Interview*<br>Observation** | *Interview with lecturers<br>**Observing their practice in the classrooms |
| What are the student teachers and lecturers' attitudes towards using ICT as teaching tools? | To investigate STs and lecturers' attitudes towards ICT | Descriptive Exploratory | Questionnaire*<br>Interview** | *Questionnaire for student teachers<br>**Interview with both lecturers and student teachers |
| What challenges do the student teachers and lecturers face during their use of ICT in schools and at faculty? | To investigate the barriers to ICT use in teaching and learning | Descriptive, Exploratory | Questionnaire*<br>Interview**<br>Observation*** | *Questionnaire for student teachers<br>**Interview with both groups<br>***Observing classroom practices |
| What are the lecturers' and student teachers' perceptions about the use of ICT in science teaching and learning? How ICT affects their practices and roles? | To explore individual perceptions and the impact of ICT in teaching | Descriptive Exploratory | Questionnaire*<br>Interview**<br>Observation*** | *Questionnaire for student teachers<br>**Interview with both groups<br>***Observing classroom practices |
| Why do/ Why do not the lecturers and student teachers use ICT as teaching tools? | To explore the use of ICT and its effects on practice | Descriptive Exploratory | Questionnaire*<br>Interview**<br>Observation*** | *Questionnaire for student teachers<br>**interview with both groups<br>***Observing classroom practices |
| How ICT is integrated into preservice teacher training? | To explore and describe the ICT integration process to teacher training. | Descriptive Exploratory | Document analysis*<br>Questionnaire**<br>Interview***<br>Observation****** | *Documents from central government, the council of higher education and faculty of education.<br>**Questionnaire for student teachers<br>***Interview with both groups<br>****Observing classroom practices |
| What are the lecturers and student teachers' views about ways of moving forward in developing student teachers' ICT skills? | To obtain STs and lecturers' views about the future of ICT training | Descriptive Exploratory | Questionnaire*<br>Interview** | *Questionnaire for student teachers<br>**Interview with both groups |

Table 3.1 The research questions and their classifications.

It is quite clear that ontological and epistemological issues are connected. "Claims about what exists in the world almost inevitably lead to questions about how what exists is made known" (Hughes, 1990:5). Methodological consideration arises from that kind of reasoning. **Methodology** is the analysis of how research should or does proceed. It covers discussions of how theories are generated and tested- what kind of logic is used, what criteria they have to satisfy, what theories look like and how particular theoretical perspectives can be related to particular research problems (Blaikie, 1993). Briefly stated, the aim of methodology is to help researchers to understand not the products of the research but the process itself (Cohen and Manion, 1994). Thus the methodological question is "how can the researcher go about finding out whatever he or she believes can be known?" (Guba and Lincoln, 1998). **Methods**, on the other hand, of research are the actual techniques used to collect and analyse data related to some research questions or hypothesis. In the social sciences they include interviewing with people, getting people to fill in questionnaires, observing behaviour and examining documents or other records of human activity (Blaikie, 1993).

**Ontological Assumptions** *will give rise to*

↓

**Epistemological Assumptions** *which have*

↓

**Methodological Implications** *for choice of particular*

↓

**Techniques of Data Collection**

Figure 3.1 The relationships between sets of basic assumptions of research (Quoted in Hitchcock and Hughes, 1989:15)

After deciding on the ontological and epistemological assumptions a researcher wants to make about the world, he or she must determine how one can know about such a world. And then the researcher might decide which questions are worth asking about that situation under investigation (Cook, 1983). The relationship between these sets of assumptions can be expressed as in Figure 3.1 in applying the theory to this study.

So far the researcher has tried to argue the philosophical underpinnings of educational research and its relevance to this study. In the next part, he will present the argument for conducting a case study approach based within a qualitative-interpretivist paradigm.

### 3.3 Case study

**Case study** is a strategy in which a researcher investigates a single phenomenon within its *real context*, restrained by *time and activity*, and collects *detailed information* by using *multiple methods* of evidence or data collection in a sustained *period of time* (Yin, 1989; Robson, 1993; Gillham, 2000). Robson (1993:52) emphasises that case study is "a strategy, i.e. a stance or approach, rather than a method, such as observation or interview". The case to be selected can be an individual, or a group, or a setting, or an institution or organisation or just a part of it, or a programme, or an event, or roles and relationships within a process, or whatever it is that a researcher is interested in (Robson, 1993; Wellington, 2000; Stake, 1995; Gillham, 2000). In this study, the focus of the case was to investigate the process of ICT integration in preservice science teacher training programmes. In investigating this process, the participants' perceptions, skills, intentions and values about the phenomenon to be searched and their roles and relationships within the process were explored by using multiple methods in the case selected.

Denscombe (1998) defines particular characteristics of case study research as in Table 3.2

| |
|---|
| <u>Case study research characteristically emphasizes</u> |
| *Depth* of study rather than breadth of study |
| The *particular* rather than the general |
| *Relationships/processes* rather than outcomes or end-products |
| *Holistic* rather than isolated factors |
| *Natural settings* rather than artificial situations |
| *Multiple sources* rather than one research method |

Table 3.2 The main characteristics of case study research (adopted from Denscombe, 1998:32).

In this study, the cases investigated are illustrated in Figure 3.2. As shown in Figure 3.2, this study includes three secondary preservice science teacher education programmes – i.e. Physics, Chemistry and Biology. The student teachers from these three programmes are expected to teach their specialist subject in secondary schools – i.e. 15-17 age group- after their graduation.

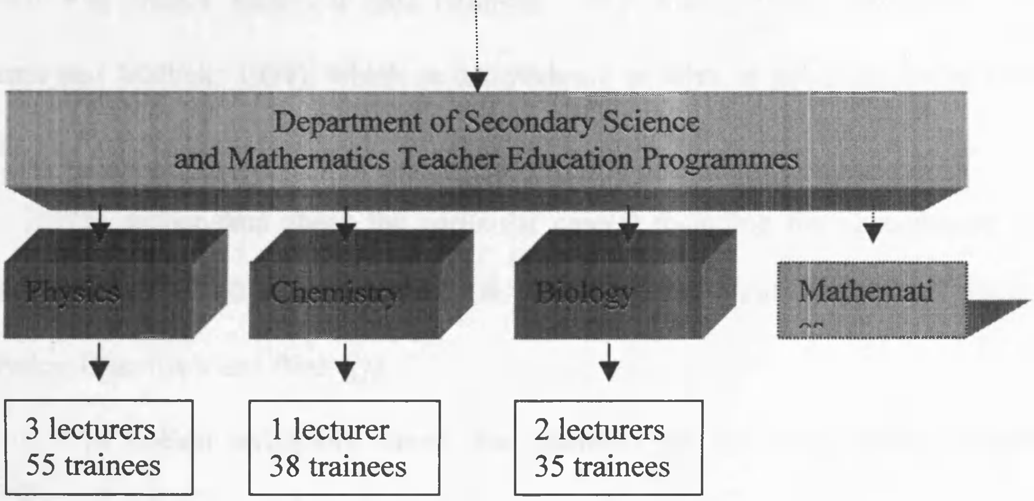



Figure 3.2 The case(s) under investigation; three science departments of Fatih Faculty of Education.

According to Verma and Mallick (1999), it is essential to adopt a case study approach when investigating an educational process. In this study, it was essential to employ a case study strategy in order to understand the cases holistically. That is to say, it was strongly believed that use of case study strategy was most appropriate to obtain rich and valid data about the implementation process of integrating ICT in preservice science teacher education/training programmes in that particular Faculty of Education under investigation.

In conjunction with this, in this study *case study* was adopted since its objectives were:

- to understand and explore holistically "the ICT integration process" into pre-service science teacher education programmes and "the context" within the process takes place (Robson, 1993; Stake, 1995).

- to collect empirical data (Robson, 1993; Stake, 1995; Denscombe, 1998; Verma and Mallick, 1999), which is the evidence of what is going on in the research setting in view of the phenomenon investigated .

- to gather data about the particular case(s) regarding the phenomenon in the setting (Robson, 1993; Denscombe, 1998): PSTEP of Fatih Faculty of Education (Physics, Chemistry and Biology).

- to collect evidences about the phenomenon by using multiple methods (document analysis, questionnaire, semi-structured interview and observation) and data sources (documents, student teachers, lecturers and the setting) (Robson, 1993; Denscombe, 1998).

Why this particular Faculty of Education was chosen for the study will be explained under the section entitled *sample selection.*

In this study, as stated earlier, triangulation was used in each case to increase the validity. In this respect, the next part provides some basic discussion about triangulation and its uses in educational research generally and in this study specifically.

### 3.3.1 Triangulation in Case Study

Social scientists are likely to exhibit greater confidence in their findings when these are derived from more than one method of investigation (Bryman, 1988). Denzin (1994) states that "triangulation" is the application and combination of several research methodologies in the study of the same phenomenon. All data gathering methods have inherent weaknesses (Smith, 1996). And no single research method will ever capture all of the changing features of the social world under study. For these reasons, the most fruitful search for sound interpretations of the real world must rely upon triangulation strategies (Denzin, 1989/1994).

Denzin (1994) defines four possible basic types of triangulation:

a- *data triangulation* involving time, space, and persons;

b- *investigator triangulation* using multiple, rather than single investigator;

c- *theory triangulation* using more than one theoretical scheme in the interpretation of the phenomenon;

d- *methodological triangulation* involves using more than one method that may include within-method and between-method strategies.

There is also multiple triangulation, when the researcher combines in one investigation multiple researchers, theoretical perspectives, sources of data, and methodologies (Denzin, 1994). Denzin (1989) states that *between methods* triangulation is a much more satisfactory form of method triangulation. Its basic feature is the combination of two or more different research techniques in a particular study. In practice, there is also a great deal of research reports that provide both quantitative and qualitative data. Many combinations of quantitative and qualitative research are quite reasonable and selecting that kind of methodology should depend on the purposes and circumstances of the research (Hammersley, 1992).

The notion of combining quantitative and qualitative approaches in a single study owes much to past discussions about "mixing methods, linking paradigms to methods, and combining research designs in all phases of a study" (Creswell, 1994:174).

At issue is the question whether the paradigms must be linked with research methods. The assumptions behind linking paradigms with methods are that such an approach makes researchers confident about selecting between quantitative and qualitative method types, rather than combine them (Creswell, 1994). Several views arise in this discussion. The "purists" mention that paradigms and methods should not be mixed; the "situationalists" say that certain methods are appropriate for particular situations; and the "pragmatists" attempt to integrate methods in a single study. The pragmatists argue that a false dichotomy existed between quantitative and qualitative approaches and that researchers should make the most appropriate use of both paradigms in understanding social phenomena. Creswell (1994) points out three models of combined designs.

* In *two-phase design*, the researcher tries to carry out a qualitative phase of the study and a separate quantitative phase of the study. As Hammersley (1996) points out, this is a *complementarity*, that is, qualitative and quantitative data complement each other. The researcher and reader are confident to justify the assumptions each paradigm entails since in this design the two approaches are secluded clearly, yet the reader might not see the connection between the two phases (Creswell, 1994).

* In *the dominant-less dominant design,* "the researcher presents the study within a single, dominant paradigm with one small part of the general study drawn from the other paradigm" ( Creswell, 1994:177). This approach presents a coherent paradigm picture in the study and still collects narrow information to investigate in detail one feature of the study. In this design, quantitative and qualitative researches facilitate each other (Bryman, 1988; Brannen, 1992), as Cresswell (1994) puts it, less dominant facilitates the dominant paradigm. The principal weakness in this design is misusing the qualitative paradigm, as purists say, because the vital assumptions of the study would not link or match the data collection procedure (Creswell, 1994).

* *Mixed-methodology design* represents the highest degree of mixture of the two paradigms. The researcher would mix aspects of the qualitative and quantitative paradigms at all or many methodological steps in the design. "The paradigm might be mixed in the introduction, in the literature review and theory use, and in the purpose statement and the research questions" (Creswell, 1994:174). This approach adds complexity to a design and uses the advantages of both quantitative and the qualitative paradigms.

Jick (1983) points out some issues with using triangulation. Triangulation should not be used to legitimate a dominant, personally preferred method. Each method should be represented in a significant way. One method may be stronger or more appropriate but this needs to be carefully justified and made explicit (Denzin, 1989; Jick, 1983). Otherwise, the purpose of triangulation is subverted. In the light of the discussion about using triangulation or combining data gathering methods in a single research, it is evident that, in this study, *between method* triangulation was adopted, including both qualitative and quantitative methods (i.e. document analysis, observation and semi-structured interview as qualitative methods and questionnaire as quantitative one). In conjunction with this, according to Creswell (1994) justification, *the dominant-less dominant design* can be a true label for data collection in this study since the study was in a qualitative-dominant nature, yet questionnaire and qualitative data gathering methods were used to explore the research phenomena, and thus multiple data collection sources were used as sources of evidence (i.e. questionnaire, interview, observation and documents).

In the next part, detailed information about the sample and participants being selected in this study will be provided.

### 3.3.2. Sample Selection and the Participants

Robson (1993) states that in case study research it is crucial to make decision about;

- Which persons are observed and/or interviewed? (Who)
- In which settings are data collected? (Where)
- At what times (When), and;
- Which events, activities or process are to be observed? (What)

Relately, Miles and Huberman (1994) point out that sampling involves decisions about which people to observe or interview with, and also about settings, events, and process. Table 3.3 applies these principles in terms of their relevance for this study.

| ***Sampling parameters*** | ***Sample Chosen in the study*** |
|---|---|
| Settings | Faculty of Education, classrooms, laboratories. |
| Actors | Lecturers from three pre-service science teacher education programmes with different characteristics (e.g. experience, academic and administrative responsibility, specialist subject), student teachers from each programmes with different characteristics (e.g. subject area, gender). |
| Events | Actual use of ICT and other technology, teaching, lecturers' and student teachers' roles during teaching/learning activities. |
| Process | Using ICT in practice, teaching style and format, ICT integration process, student teachers training about ICT and improving their ICT technical and pedagogical skills. |

Table 3.3 The description of the sample in the study (adapted from Miles and Huberman, 1994:30).

As stated earlier, the researcher was a member of this Faculty before he came to the UK, and when he gets the degree in the UK, he will go back to the same Faculty. In this respect, it is hoped that this study might contribute to improving the process of integrating ICT into pre-service teacher education programmes under investigation. Hargreaves (1978) discussed the five capacities of qualitative research to make a contribution to policy and practice: 'appreciative, designatory, reflective, immunological, and corrective' (quoted in Hammersley, 2000:392). Educational research in general and qualitative studies in particular have been criticised in terms of not making a difference in policy-making and practice. Hammersley (2000:393) emphasises that "...today there is more need than ever for research serving these functions" of qualitative research in education.

In this case study research, it was believed that understanding practitioners' (i.e. lecturers and student teachers) points of view and practices related to the phenomenon being studied represents *the appreciative capacity* of the study. This holistic investigation mirrors the reality (i.e. what is really going on out there) and highlights issues that need to be tackled, which is described as *the reflective capacity* of qualitative research (Hammersley, 2000). This reflective reality or acquiring knowledge about everyday experience or practice of the participants "can provide knowledge which will indicate what is necessary to make treatment effective" (Hammersley, 2000:397) (*immunological capacity*). Finally, Hammersley (2000) points out that qualitative studies can clarify the meaning and validity of the concepts and assumptions built into theories of practices in education. In this study, rather than broad underlying theory, the approach or model of integrating ICT into PSTEP can be corrected in the light of the knowledge acquired from the setting by this qualitative-based study (*the corrective capacity*). So, by selecting his own prospective institution the researcher, hopefully, will have the opportunity to put findings from the study into practice when time comes. Next, brief information will be provided about how participants were selected.

Below, Table 3.4 gives some information about the distribution of the participants across three pre-service science teacher education programmes, including their roles in the research across methods.

| | | **Physics** | | **Chemistry** | | **Biology** | |
|---|---|---|---|---|---|---|---|
| **Methods** | | Interview *Observation | Questionnaire | Interview *Observation | Questionnaire | Interview *Observation | Questionnaire |
| **Participants** | ***Lecturers*** | *3 M | | *1M | | *2M | |
| | ***Student Teachers*** | 12 (6 Male, 6 Female) | 55 (33 Male, 20 Female, 2 missing) | 8 (5 Male, 3 Female) | 38 (21 Male, 17 Female) | 9 (5 Male, 4 Female) | 35 (20 Male, 14 Female, 1 missing) |

*Lecturers being observed in real classroom context.

Table 3.4 The Research Participants.

As it can be seen from the table 3.4, the participants were in two groups: lecturers and student teachers from each programme. All student teachers from each programme were asked to fill in the questionnaire, so 128 student teachers from three programmes participated in filling the questionnaire. At the end of the questionnaire a statement was added, in which the student teachers were asked whether they wanted to take part in further study, that is, whether they wanted to be interviewed, and to write their name, programme, phone number and e-mail, if they had one. All student teachers, who agreed, were interviewed. Apart from this, three more student teachers were asked to be interviewed after observation, who had not wanted to be participants from the beginning. This was because of their role in the classroom during observation, and the researcher took notice and wanted to acquire their understanding, perceptions, and use of ICT in teaching/learning. So, 29 student teachers, out of 128, from all three programmes participated in interviewing. 6 lecturers, out of 7, were asked to be interviewed and observed in the classroom. All lecturers took part in the study voluntarily. So, 3 lecturers from physics, 1 from chemistry, and 2 from biology programmes were interviewed and observed. All the participating lecturers were observed throughout three lessons, either subject or method courses. The lessons observed were randomly selected.

It is believed that the sample was sufficient for the purpose of the study. In the next part, the three evaluative criteria (i.e. validity, reliability and generalisability) will be discussed.

### 3.4 Quality in the Study

Scott (1996) states that a research paradigm can be identified by its ontological, epistemological and methodological positions, as discussed earlier. He also points out that a research paradigm can be distinguished by some evaluative criteria in view of the quality in research.

In conventional quantitative research the concepts of *validity*, *reliability*, *generalisability* and *objectivity* represent the criteria of the quality in research. However, there is an ongoing debate about whether these criteria are appropriate when carrying out a qualitative research in education and social world. According to Hammersley (1992), there are three options for educational researchers to follow. First, researchers can use the same criteria in social and educational research that has been used in natural science. Second, different criteria should be taken into consideration since the study of the social world is substantively different from the study of natural world, which was accepted in this research. Third, it is not possible to develop criteria, which underpin the study of social world. So, some researchers argue that these criteria accepted for quantitative research (e.g. survey, experimental studies etc.) are inappropriate when dealing with qualitative case study data (Lincoln and Guba, 1985; Robson, 1993). Lincoln and Guba (1985) propose four alternatives – ***credibility***, ***transferability***, ***dependability*** and ***confirmability***. Robson (1993) sees these alternatives more appropriate to reflect more faithfully the assumptions behind qualitative studies even if there are some strong opposition to such views Lincoln and Guba's suggestions, such as Hammersley (1992) and Scott (1996).

Having stated this, what is important here is whether the beginner researcher has enhanced the quality of the study and by which means. Even if the researcher believes that qualitative case study should be treated differently in view of its quality since it has its own ontological, epistemological and methodological uniqueness, here in this research the researcher used both sets of criteria together. This is because of the ongoing debate about the criteria for judging the quality of qualitative case study research. So, the main focus was what he has done to enhance the quality of the study in the light of the debates about the judging the quality of the research. In the following part, these efforts will be explained.

*Credibility (internal validity)*: "Here the goal is to demonstrate that the research was carried out in a way which ensures that the subject of the enquiry was accurately identified and described" (Robson, 1993:403). That is, credibility means the extent to which the design of a study provides a control and therefore confidence in interpreting results, whether the findings are credible to researcher, subjects and readers, and whether findings are the authentic portrait of the studied (Miles and Huberman, 1994).

In this study, the researcher took some precautions to enhance credibility (validity). Firstly, the researcher had been a member of staff before the study for three years, so he had enough experience in the same culture - prolonged involvement (Robson, 1993). Secondly, it was assumed that the use of different methods of gathering data would enhance the credibility - triangulation (Robson, 1993; Cohen and Manion, 1994; Denzin, 1989/1994; Stake 1995; Silverman, 1993; Smith, 1996). Member checks were also used to improve credibility. In this process the participants were requested to examine raw data, and they were asked to review the data for accuracy to improve the credibility – member checks (Robson, 1993) or respondent (member) validation (Silverman, 1993; Smith, 1996).

*Dependability (reliability):* Dependability represents reliability. In qualitative case studies, the underlying issue is whether the process of the study is consistent, reasonably stable over time and across researchers and methods (Miles and Huberman, 1994). Using triangulation of gathering data, as discussed above in connection with credibility, could be a test for dependability, so it was in this study (Robson, 1993). In conjunction with this, it was believed that the research questions were clear and congruent with the features of this case study design (i.e. the process of the research). Robson (1993) states that if the research processes followed are clear, systematic, well documented, providing safeguards against bias, and so on, this constitutes a dependability test. In this sense the procedure of this case study were tried to be made clear and explicit to the reader by providing open definition of the case and context and explicit information about the methodology used. In order to enhance the dependability (reliability), the researcher also have piloted all materials having been used in the data gathering process.

*Transferability (generalisability):* Generalisability is the process whereby a particular set of findings can be applied to a much larger set of circumstances or population. In this study, the goal was to understand the setting selected holistically. That is, how ICT innovation implemented and which factors affects this implementation process. So, in this study, law-like findings or positivistic generalisation were not seen as an ultimate goal here. Having said this, quoting Robson (1993), Kennedy argues that "applying the findings about one situation or case to a second one" (p. 405) is the job of the person interested in this study to warrant generalisation. Here, as Robson (1993) and Lincoln and Guba (1985) suggest, the researcher of the first case study must provide the information needed to do this transfer.

For this reason, from the beginning in this chapter the researcher provided a clear and "thick description" (see Lincoln and Guba, 2000) of the research process including underlying theories, research methods and procedures in order to understand findings. It was hoped that this might be helpful for other researchers interested in the study to warrant that case-to-case transfer or generalisation. As Stake (2000) discusses, it is useful to understand a full and through knowledge of the particular, recognising it in new and different settings. He uses the term *naturalistic generalisation* and sees it as intuitive and empirical. Quoting Lincoln and Guba (2000), he thus sees case studies as "they may be epistemologically in harmony with the reader's experience and thus to that person *a natural basis for generalisation*" (p.36).

Stake (1995) argues two ways of generalisation. He points out that the case study researcher may provide assertions to produce the propositional generalisation or provide input into the reader's naturalistic generalisations. He goes on stating narrative descriptions help the reader to form vicarious experience and naturalistic generalisations and assertions help the reader to work with existing propositional knowledge to modify existing generalisations. In case of naturalistic generalisations, opportunity for vicarious experience need to be provided by giving a thick description of methodology used and providing a narrative account, a story, personalistic description, and emphasis on time and locale.

As it can be seen from the discussion about methodology earlier and the purpose of the study, an ideographic methodology, in which time and context are the boundaries of the research, was adopted. Having said this, it is clear that the study was conducted in a certain period of time, context and with a particular group of individuals, which were not the true representatives of the whole population (all pre-service science teacher education programmes in Turkey). Thus naturalistic generalisation might be possible, but as stated earlier it is the job of others to replicate this study and to compare the findings of this study with their own findings and context. Here the researcher's aim is to provide clear and explicit knowledge about the use of methodology and input (i.e. direct quotations from the participants) so that the reader is able to form naturalistic generalisation.

In any kind of research, especially in the qualitative case study, access and ethical issues are crucial. In the next part, information about access and ethical issues in the study will be provided.

### 3.5 Access and Ethical Issue in the Study

In this study, to have an access to the research setting the researcher had written a letter to the Head of Pre-service Science and Mathematics Department in the Fatih Faculty of Education, including the research proposal. Then he had an appointment to discuss the research process and aim of the study in detail with the Head of Department. As procedural necessity and to have full access to the setting, an appointment was arranged to meet the Dean of the Faculty, and again the aim of the study and its process were explained by the researcher to the Dean. Finally, permission was granted for the study. After gaining full access to the setting, the issue of gaining access to the participants was a crucial ethical consideration. This was because of the researcher's primary responsibilities to the participants, especially in qualitative case studies like this. The researcher took a number of ethical precautions as indicated below.

*Consent:* Obtaining the consent of people under investigation is a crucial concern. "The principle of informed consent arises from the subject's right to freedom and self-determination" (Cohen et al.2000:51). With Diener and Crandall's (1978) definition, informed consent is "the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would likely to influence their decisions" (Quoted in Cohen et al.2000: 51). As it can be seen from this definition, the researcher must ensure that subjects have a complete understanding of the procedures to be used in the investigation, any risks involved (Drew et al.1996). In the study, each participant made his/her decision freely and was a volunteer for the study, after being told about the purpose and process of the study. So, the consents of participants were obtained from the beginning.

*Harm:* Harm is the most basic concern in all research, so it was in this study. The researcher has the responsibility to research subjects in order to protect them from any physical and mental danger due to research procedure (Drew et al.1996; Cohen et al. 2000). During obtaining the consent of each participant, the researcher explained clearly that no harm would come to the participants because of the nature and results of the study.

*Privacy:* "The individual or collectivity has the freedom to decide for themselves when and where, in what circumstances and to what extent their personal attitudes, opinions, habits, eccentricities, doubts and fears are to be communicated to or withheld from others" (Social Sciences and Humanities Research Council of Canada, 1981, Quoted in

Cohen et al.2000: 60-61). Privacy is likely to be violated during or after an investigation. The researcher cannot ignore privacy in any study. He/she must take all precautions possible, if a potential for privacy risk exists (Drew, et al. 1996). In this study, participant privacy was guaranteed by the researcher, and her/his privacy would never be revealed in any stage of the research.

*Deception:* "The deception lies in not telling the whole truth" (Cohen et al.2000: 63) about the purpose, nature, or results of a study. Drew et al. (1996) points out that consent is necessary if there is potential risk for subjects in the research process. But it is clear that there is no effective consent in process using deception. They recommend that subjects must at least be given enough information about possible risks. Deception was not an issue in this study, at least the researcher aware of, due to the purpose and nature of the study. The whole truth about the research purpose and process was explained by the researcher.

*Anonymity:* The essence of anonymity is that the information obtained from subjects should in no way reveal their identity (Cohen et al. 2000). In the study, it was guaranteed by the researcher that the participants' identities would not be revealed in any stage of the study.

*Confidentiality:* The shared secret between the researcher and subject must be protected from the public. The meaning and limits of confidentiality in relation to the research project must be explained to subjects openly and clearly (Tuckman, 1994). In this study, the participants were told that the information they gave might be in the final report, but their identities will not be revealed in any stage.

In the next part, the researcher will provide information about his role in the study.

### 3.6 The role of the researcher

Wellington (2000) points out that in social and educational studies the researcher is the key 'instrument'. In this qualitative case study, as Stake (1995) argues, "the researcher as interpreter" (p.97) role was seen as a true label for the researcher. As discussed earlier, this study was rooted in the interpretivist paradigm, which holds that reality is socially constructed through actors' definitions of the phenomenon under investigation. Thus the researcher's main focus was to understand the phenomenon from the participants' viewpoints through using a set of data gathering methods. In this sense, the researcher's role was to interpret those data collected and to help the reader to understand the case under investigation. In conjunction with this interpreter role, Stake (1995) points out that "most case studies are not evaluation studies, but some interpretations made by the researcher will be evaluative in nature, so at least in that sense the case researcher is always an evaluator" (p.96).

During this case study research, firstly, at the questionnaire stage the researcher role was the one who distributes the questionnaires to the participants and collects them after being filled. At the semi-structured interview stage, the researcher's role was to interview the participants to find answers to the pre-arranged questions. During interviewing prompt and probe questions were used. Prompts were used to find about some participant student teachers' and lecturers' activities, which the researcher had observed in the classroom. Probes were used for the purpose of deeper understanding of the topic being talked about.

Having said this, in interviewing, Drever (1995) states that it is better to maintain some 'distance' between the researcher and the interviewee. Here he mean that maintaining distance helps the researcher to make it clear that both side have different and complementary roles in the interview. The researcher's task is to understand the participants' viewpoint, not to evaluate it.

Finally, at the observation stage the researcher role was again the one, who observes the lessons and take notes. In all stages the researcher had tried to stay apart as far as possible, not to affect the natural setting, but tried to understand it thorough participants' point of view by interviewing and questionnaire and his own interpretation of the phenomenon in the natural setting. Denscombe (1998) points out that there is the possibility that the presence of the researcher can lead to the researcher effect since in qualitative case study there is an involvement over a period of time. This involvement might lead the studied to behaving differently from normal.

In the next part, data sources and data gathering procedure will be elaborated in detail.

## 3.7 Data Sources and Data Collection Procedure

In this section, the data gathering sources have been employed in the study are described, including some brief information each method and the elaboration of the research instruments design. In this study, multiple data sources were employed for data collection in order to improve the quality of data and to draw better picture of the setting. The methods used in this study are document analysis, questionnaire, interview and observation. In the following part, each method will be elaborated in detail.

### 3.7.1 Documents as the data resources

Document analysis takes both quantitative and qualitative forms. The aim of document analysis is to understand the context of documents. Erikson et al. (1991:50) state that;

> "Quantitative content analysis seeks to show patterns of regularities in content through repetition and qualitative content analysis emphasies the fluidity of the text and content in the interpretive understanding of culture." (Quoted from May (1997:171).

According to May (1997) "documents, as the sedimentations of social practices, have the potential to inform and structure the decisions which people make on a daily and longer-term basis" (p.157). Sources of documentary research are divided into two groups: primary and secondary sources (Ary et. all, 1972). Primary sources include original documents, relics, remains, or artifacts; and they are eyewitness accounts reported by an observer or participant in an event (Best, 1977). On the other hand, the secondary source is a reproduction of an original document or of the report of an interviewer other than the actual witness (Turney and Robb, 1971). Whether the document is a true one or not is an important consideration; that is, collected information may not be valid if there are any deletions or additions.

In this study, ***document analysis*** provided some necessary and useful background information about the phenomenon for a starting point. As shown in Table 3.5, knowledge to be sought from the documents was about the aim of ICT related training or expectations of authorities from Faculty of Educations to train/educate prospective teachers in relation to the phenomenon.

| **Research Questions** | *Knowledge to be sought from the documents* |
|---|---|
| What is the aim of ICT-related training in pre-service-science-teacher-education programmes? | The aim of ICT training in Turkish education system in general, in pre-service teacher education in particular. |

Table 3.5 The research question in relation to documents analysis

By reviewing the documents available, very limited indeed, the researcher had the opportunity to describe objectives and activities of the ICT-related training in the setting. The documents available were helpful to understand what the expectations were from Pre-service Teacher Education Programmes and Student Teachers regarding ICT training by Government. The researcher had the opportunity to make a comparison between what were expected (i.e. policy, vision, curriculum) and what was going on in the real setting. Documents were collected from the Turkish Ministry of Education, the Council of Higher Education and the lecturers.

### 3.7.2 Questionnaire

*Questionnaire survey* is a popular way of data gathering. In a questionnaire, all respondents are exposed to the same questions. There is no one coming between the respondent and the question. For this reason, questions in a questionnaire must be formulated and piloted very carefully in order to avoid misunderstanding (Munn and Drever, 1990).

On the other hand, validity and reliability are essential considerations. Sampling, piloting and return rate are very crucial in this respect. The information collected by means of questionnaire tends to describe rather than explain why things are the way they are, and the respondents are forced into answering the researcher's formulation of the question, particularly closed questions (Munn and Drever, 1990). In this study a data gathering instrument was developed to measure the beliefs of student teachers' self-confidence in some aspects of their ICT-related training and the setting.

The basic epistemological question here is whether beliefs can be measured. Reynolds (1995) points out that there are two aspects of belief, cognitive and evaluative.

> "The cognitive aspect is belief in the attitude object: the fact that it does or does not exist. The evaluative aspect is the belief about the attitude object: is it good or bad? ... for all beliefs about an attitudinal object carry some implicit or explicit evaluation that can be measured" (p. 218).

In this study, the attitudinal object was the self, specifically, the professional self-confidence and beliefs of student teachers. Student teachers' beliefs were measured through a number of carefully selected items and open-ended questions. As Table 3.6

illustrates, the questionnaire consists of four sections with a cover letter, in which the aim of the study were explained to the participants.

*Section A* covers student teachers' beliefs about the ICT-related training and their use of ICT. In this section most of the questions were open-ended. This gave the researcher the opportunity to acquire information about STs' ICT related training and their use of ICT with their own words.

*Section B* covers student teachers' basic ICT technical skills and their self-confidence on each item. Respondents were asked to indicate how much confident do they feel about those specific items by checking a five-point scale ranging from 'none' to 'very high confidence' scored from 1 to 5. Thus, it is clear that the higher the score, the more confidence the respondents have.

*Section C* covers student teachers' application skills and their self-confidence on each item. They were asked to indicate how much confident do they feel about those specific items by checking a five-point Likert scale ranging 'any confidence at all' to 'very high confidence'.

*Section D* covers student teachers' attitudes towards ICT by checking a five-point Likert scale ranging 'strongly disagree' to 'strongly agree'. The attitude section consists of both positive and negative attitude statements.

| **Research Questions** | **Questionnaire sections and topics covered in each section** |
| --- | --- |
| -What are the student teachers' ICT capabilities, and how confident they feel about using ICT? | **Section A:** Student teachers' beliefs about the ICT-related training and their use of ICT. |
| -What are the student teachers' attitudes towards using ICT as teaching tools? -What are the student teachers' problems and | **Section B:** Student teachers' basic ICT technical skills and self-confidence. |
| challenges they face during their use of ICT in schools and at faculty? -What are the lecturers' and student teachers' perceptions | **Section C:** Student teachers' application skills and self-confidence |
| about the use of ICT in science teaching and learning? How ICT affects their practices and roles? -Why do/ Why do not the lecturers and student teachers use ICT as teaching tools? -How ICT is integrated into preservice teacher training? -What are the student teachers' views about ways of moving forward in developing their own ICT skills? | **Section D:** Student teachers' attitudes towards ICT |

Table 3.6 Research questions and questionnaire

In the study, the aim of using the questionnaire is to draw a general picture or to get a notion about the research setting. By means of questionnaire, the researcher reached the whole student teachers in three science programmes. The questionnaire includes closed and open-ended questions. So a subject's point of view can be captured by using open-ended questions.

As part of the study, the questionnaire items were developed after reviewing a great deal of literature by the researcher. Then the questionnaire items were discussed with the supervisor. In April 2001 the questionnaire was piloted by 15 science student teachers. During piloting the questionnaire, the subjects were asked to criticise any bad wording, misleading, complex, and irritating items. All student teachers attended class day in each pre-service science programmes were asked to complete a questionnaire. Thus number of returns were 128 (all STs). At the end of the questionnaire, all STs were asked whether they want to take part in the study for the interview. So, the sample for interviewing was selected by this way. In the next part as a third data gathering method will be elaborated.

### 3.7.3 Interview

Interviews produce rich insights into people's experiences, opinions, aspirations, attitudes and feelings (May, 1997). In order to get rich insight about the subject or setting the researcher asks questions and interviewee respond to them. Cohen and Manion (1994) point out three ways of using interview. It is used as a deeper information obtaining technique. It also may be used to test hypotheses or to define a new one. Finally, it may be used in combination with other methods to follow up unexpected results, and also to validate other methods. There are three types of interview commonly used in education; *the structured interview, the semi-structured interview, and the unstructured interview.*

In *the semi-structured interview* questions are specified, but the interviewer is more free to probe beyond the answers (May, 1997). Thus qualitative information about the subject can be obtained by using probe and prompt to the answers (May, 1997). Interview schedules can include open-ended and closed questions. Questions about age, sex, occupation, and so on can be asked in a standardised format. Researchers could obtain factual information about the respondent's circumstances, collect statements of their preferences and opinions, and examine in some depth their experiences, motivations and reasoning (Drever, 1995).

By using interviews researchers have the opportunity of asking 'WHY' questions in order to get a deeper insight about things under study. May (1997) also states that the role of the interviewer during the interview may influence the interviewee response, that is, is the researcher or observer a scientist, a friend or only a stranger? It is possible that the interviewee behaves in terms of relationships with the interviewer.

**Semi-structured interview** was chosen as a third data gathering method to understand and explore STs and lecturers' experience, perceptions and background regarding the phenomenon being investigated. In this sense it is important to understand how people make sense of their own world with their own statements. Using semi-structured interview helped the researcher acquire the information or data intended. However, during interviewing prompt and probe questions were used. Prompts were used to develop further understanding about the participants' activities in the classroom that had been noticed during observation. Probes were used for the purpose of deeper understanding of the topic being talked about. Probes and prompt questions will be illustrated in Table 3.7 and 3.8 in italic format.

Interviews with STs were taken place in a pre-arranged room thanks to the Head of Department and in the lecturer's own office with each lecturer. Table 3.7 and 3.8 illustrate how research questions were covered in interviewing with lecturers and student teachers.

| **Research questions** | **Lecturers' Interview Questions** |
|---|---|
| What is the aim of ICT related training in pre-service science teacher training? | What are the objectives of the ICT-related course you teach? *Who defines the objectives?*<br>Do you think the ICT-related course was adequate in preparing student teachers for teaching in their own subject area with ICT? *If yes, can you give (explain) some evidences for that? If not, why?*<br>What are your priorities for developing student teachers' skills, knowledge and attitudes in ICT? *Are you happy with the outcomes?* |
| What are the lecturers' ICT capabilities on using ICT as teaching-learning and professional development tool? | Do you use any ICT resources as a teaching tool? *How often? Why? Can you give an example how you used them?*<br>Do you have any difficulties in understanding the technical aspects of ICT? *If yes, how do you overcome these difficulties? Is there anyone to get help?*<br>What kind of ICT resources and other technologies do you feel most confident with during your practical activities?<br>*Why?*<br>Have you had direct experience of planning and managing lessons with ICT in the classroom? *If yes, can you give an example? Have you had any difficulties or problems during your practical use?*<br>Have you ever received any ICT training? *When? How long? Was it enough or helpful for your current practice?* |
| What are lecturers' attitudes about using ICT as teaching tools? | Are you interested in developing your skills and knowledge in ICT? *Why?*<br>How do you keep up to date with ICT developments?<br>Do you think that the benefits of ICT outweigh the time and energy needed to implement it? *Why?* |
| What are lecturers' challenges they face during their use of ICT in practice? | What extra support would make you use of ICT more effective?<br>What are the management and organisational challenges you face during your use of ICT?<br>Do you feel confident about helping your students work with ICT in classrooms?<br>What do you think about computer terminology?<br>How do you get access to ICT resources in that faculty? |
| Why do/ Why do not the lecturers and student teachers use ICT as teaching tools? | Do you use any ICT resources as a teaching tool? *Which one(s)?*<br>What are the barriers to the use of ICT in teacher training at this faculty in particular, and in science teaching in general? |
| What are the lecturers' perceptions about the use of ICT in science teaching and learning? How ICT affects their practices and roles? | What do you think about the main benefits and drawbacks of ICT use in science teaching and learning?<br>Do you think ICT changes the way to teach and learn science? *How?*<br>In general has ICT had an impact on your teaching ways? *If yes, how?*<br>What do you think about the potential of pre-service teachers as change agents in ICT use in school setting? |
| How ICT is integrated into pre-service teacher training? | Does this faculty have a plan to integrate ICT in teacher training? |
| What are the lecturers' views about ways of moving forward in improving student teachers' ICT capabilities? | What do you think about the need for appropriate teacher training in using ICT in science teaching and learning?<br>If you could improve the integration of ICT into science teacher education, what would you do? |

Table 3.7 Research and interview questions for the lecturers (probes and prompts are written in italic)

| Research questions | Student Teachers' Interview Questions |
|---|---|
| What are the student teachers' ICT capabilities, and how confident they feel about using ICT? | **Do you use any ICT resources as teaching tool? *Which one? How often? Can you give an example?***<br>What kind of ICT resources and other technologies do you use during your teaching or personal use?<br>What kind of ICT resources do you feel most confident with during your practical activities?<br>Do you have any difficulties understanding the technical aspects of ICT? *If yes, what have you done during the time? Can you have any help from someone?*<br>Do you think the ICT-related course was adequate in preparing you as a future practitioner for teaching in your own subject area with ICT? *If yes, what did you learn from this course you think? If not, why?*<br>What was the most useful thing that you learned from the ICT related course you took?<br>What was the least useful thing that you learned? |
| What are the student teachers' attitudes about using ICT as teaching tools? | Are you interested in developing your skills and knowledge in ICT? *Why?* |
| What are the student teachers' challenges they face during their use of ICT in schools and at faculty? | How do you get access to ICT resources in that faculty? *Do you get any support when an unexpected thing happen during your use of ICT? From whom?*<br>What extra support would make you use of ICT more effective?<br>What do you think about ICT terminology? |
| Why do/ Why do not student teachers use ICT as teaching tools? | What are the challenges you face during your use of ICT? *What do you do when you have some problems with the use of ICT? Do you think you have enough support during your use of ICT? Why? By whom? How?* |
| What are the student teachers' perceptions about the use of ICT in science teaching and learning? How ICT affects their practices and roles? | What do you think about the main benefits and drawbacks of ICT use in science education?<br>Do you think ICT changes the way to teach and learn science? *How?*<br>Do you think that the benefits of ICT outweigh the time and energy needed to implement it?<br>What contribution does ICT make to learning and teaching science? |
| How ICT is integrated into preservice teacher training? | Have you had direct experience of planning and managing lessons with ICT in the classroom? *If yes, can you give an example?*<br>Do you have any support and encouragement from your tutors during your practice or course? *If yes, how?* |
| What are the student teachers' views about ways of moving forward in improving student teachers' ICT capabilities? | If you could improve the integration of ICT into science teacher education, what would you do?<br>What are the needs of appropriate teacher training in using ICT in science teaching and learning? |

Table 3.8 Research Questions and Interview Questions for the Student Teachers (probes and prompts are written in italic)

The last data collection method was observation. In the next part the use of observation method in the study will be elaborated.

### 3.7.4 Observation

Observation is the most basic and most direct method of obtaining behavioural data which exist (Burroughs, 1975). Researchers have an opportunity to engage in an educational setting to experience it and try to understand and explain the culture and processes of the groups or individuals under study (May, 1997; Denscombe, 1998). Robson (1993) points out that observers' interpretations are the primary data, and an observer needs a great sensitivity and personal skills for worthwhile data. Gold (1958) outlined four types of participant observation, through which observers gain data (Cited from Adler and Adler, 1994; Robson, 1993; May, 1997), *the complete participant* (i.e.the observers seek to engage fully in the activities of the group under study), *the participant as observer* (i.e. the observers choose an overt role and make their presence and intentions known to the group, and it is crucial to get the trust of key members of the group, and thus the observers try to have close relationships with members of the group), *the marginal participant* (i.e. the researchers have a passive role and do not have any responsibility in the group under investigation), *the observer as participant* (i.e. the researchers take no part in the activity to be observed, May (1997) states that this would not be regarded as participant observation).

The marginal participant observation was adopted in this study. The basic aim of the use of observation was to understand and find evidence about what was happening in the classrooms, the style and format the lecturers used during their lecturing, their use of ICT in the classroom, their practice of classroom organisation and to get information about physical environment. The observations took place in subject and method courses rather than specific ICT courses in order to explore using ICT across curriculum and the way ICT has been used in the classrooms (see an example of the observed lessons in Appendix A).

During observation, the researcher took his place at the back of some classrooms, at the corner of others, but had the opportunity to observe all people in the setting although the lecturers' roles were under focus. The researcher took notes (narrative accounts) about the topics under investigation rather than using a "coded schedule" (Robson, 1993). The observation schedule was divided in five parts. These were content/subject being lectured, context, pedagogy (teaching style, teaching format and use of ICT), classroom organisation and other issues (see in Appendix A).

### 3.8 Data Analysis Procedure

Miles and Huberman (1994) point out that "the strengths of qualitative data rest very carefully on the competence with which their analysis is carried out" (p. 10). In this study both qualitative and quantitative data were collected through different data gathering methods, as elaborated in the previous part. During data collection the researcher used the instruments (e.g. questionnaire, semi-structured interview schedules and semi-structured observation schedule) and used himself as instrument (e.g. through informal observations to accumulate information about the case: available technology resources, access and physical environment, and through formal observations as interpreter). Just after each observation raw notes of gathered data was converted into *write-ups* in order to avoid any possible danger to the data and not to forget any incidences recorded during observation since raw notes contained some abbreviations, and were illegible and sketchy because of hand-writing (see Robson, 1993).

It can be very crucial to point out here that all data, including preliminary write-ups of observations, were transcribed in Turkish since the study was carried out in Turkey and the researcher's mother tongue is Turkish. Having finished data collection, the tape-recorded interviews were transcribed manually. Transcripts were written in the original language (Turkish) since the researcher felt that, by doing so, any slip and semantic change or restriction in meaning of the data might be avoided at the beginning of analysis process. However, there was always a possibility of misinterpretation and difficulty of translating some expressions due to the two different cultural contexts (Altun, 2002) and the researcher's competence with the second language, i.e. English. In this sense, through supervisors' and proof-reader's comments in the analysing process and final report, this concern was minimised. Official documents, the transcripts of interviews and responses to open-ended questions in the questionnaire were dealt with likewise. The quantitative data from questionnaire, on the other hand, were entered into SPSS for further statistical analysis. Alongside the descriptive statistics, t-test and the analysis of variance (ANOVA) test were used.

After completion of documentation of thick qualitative data, beginning with the official documents, all data were read. At the same time, data were collated, coded and sorted out into themes, clusters and categories by using checklist matrices and highlighting and/or underlining themes in the thick data. In this phase of analysis, called data reduction (Miles and Huberman, 1994) the categories, themes and codes were derived from the data through an inductive approach or posteriori (Wellington, 2000), not pre-established. Actual translation to English began at this stage in order to conceptualise the data in this thesis original language. The data reduction process led to second phase of analysing, data display (Miles and Huberman, 1994), in which the data were organised and assembled, then displayed in diagrammatic and narrative form. As Miles and Huberman (1994) define, the final stage of analysis was conclusion drawing phase, involving interpreting and giving meaning to the data. Basically, in this stage data were read again and again to split and/or combine and/or add new categories, by going through the transcripts, documents available, questionnaires and observation data with special attention to the highlighted/underlined substantive statements in the early stages of analysis. The data were transferred, through coding or writing actual statements, into A3 size analysis sheets. In the writing up process, the research findings were presented thorough narrative writing, using also some tables, grids and graphs. Discussions about the findings were provided concurrently.

In each stage of data analysis research questions were used as *rationales of control and/or focus of the study*, by going back to research questions. As Stake (1995) puts it, to provide vicarious experiences for the reader, while the findings were presented, direct quotations were provided as much as possible, including a description of the physical environment of the case. The Figure 3.3 illustrates the process of data analysis.

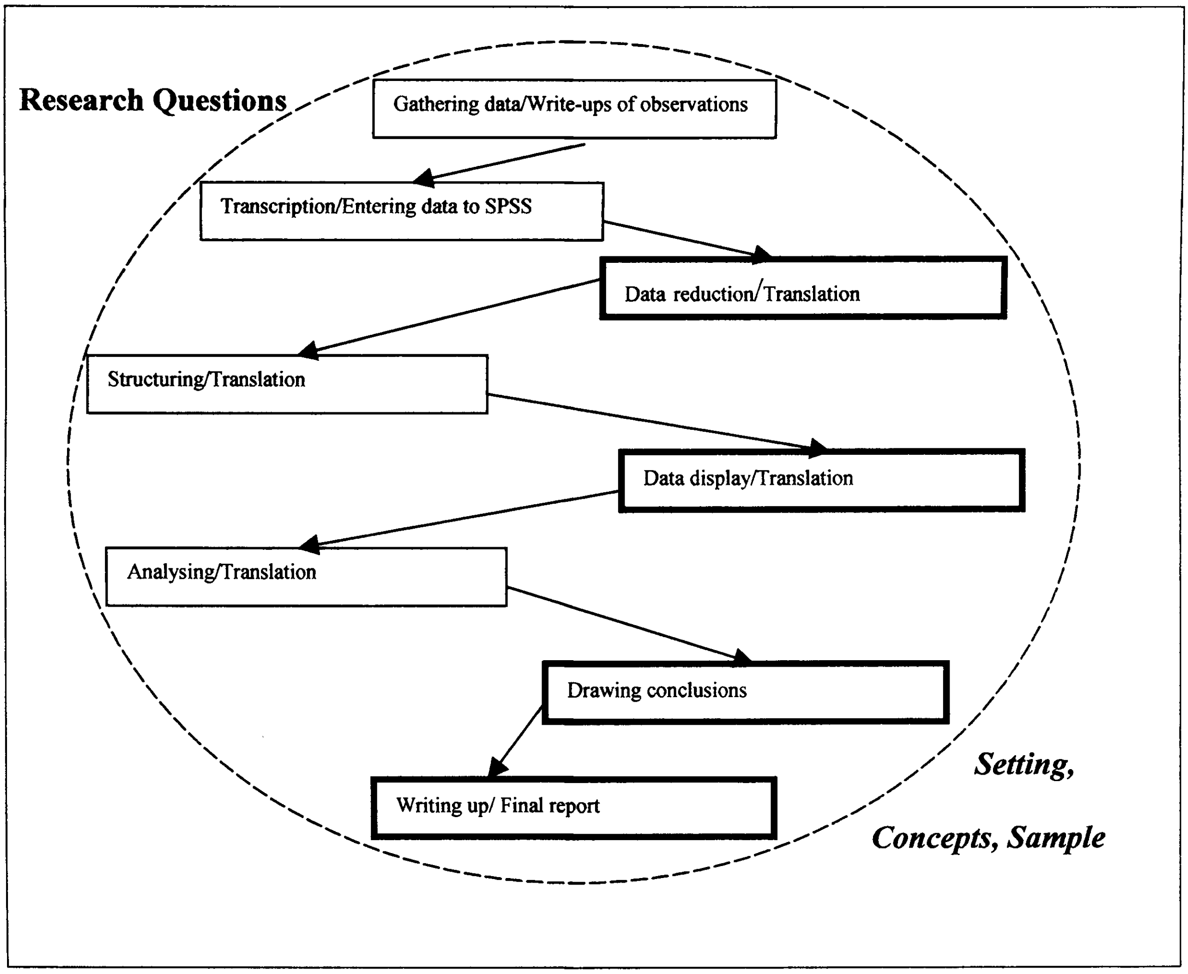



Figure 3.3 The Data Analysis Procedure

### 3.9 Summary of the Methodology

In this chapter the researcher has tried to provide a clear definition of the research procedure from the underpinning theories to practice of the study. Figure 3.4 illustrates the methodological framework of the study.

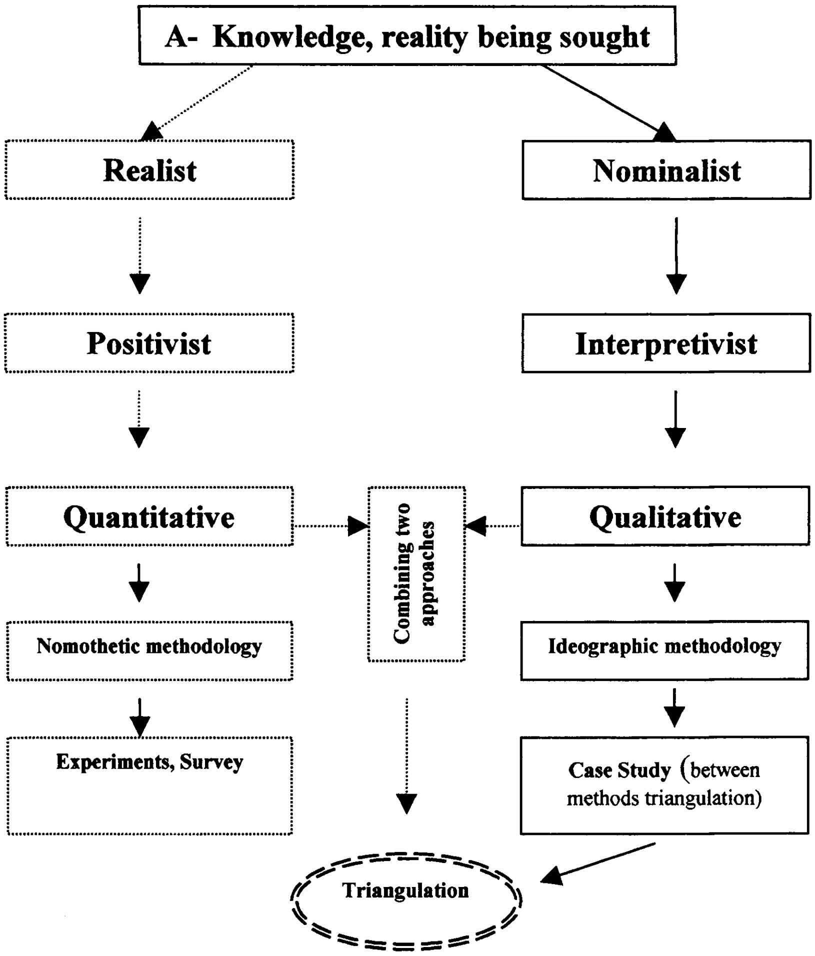



Figure 3.4 Methodological framework of the study.

First of all, the theory of doing educational research and its relevance to this research were discussed. By doing so the researcher has tried to draw a clear picture of the study in relation to its ontological, epistemological and methodological assumptions. The main aim of this study was to understand and explore the integration process of ICT in preservice science teacher education programmes through qualitative case study research, which was adopted to this study.

In the second part the researcher demonstrated that case study embraced the aim of this study. He tried to explain why case study approach was chosen. The aim of this research was not to seek to establish general law-like findings. In contrast, it was to understand, and possibly to reconstruct the knowledge about the phenomenon through the subjects' point of view, written documents and the researcher's interpretations. This was an attempt to try to understand the social world from the point of view of the people who were the subjects of research at any one point in a specific time-period and locale.

In the third part, issues in the practice of the study were carefully addressed. This part included issues such as sample selection, validity, reliability, generalisability, access and ethical issues, and the role of the researcher.

In the fourth part, data collection procedure in this study was explained including the data gathering methods of the study (documents, questionnaire, semi-structured interview and observation).

In the final part, data analysis procedure was explained.

# 4. ANALYSIS AND DISCUSSION

## 4.1 Introduction

As illustrated in Table 3.2, in this study the process of integrating ICT into Preservice Science Teacher Education Programmes (PSTEP) is investigated through a case study approach. In order to address the research questions, two types of data were required. The first kind of data is *factual*, covering the basic characteristics and background of the case chosen and the participants, the availability of ICT resources and access to the resources and support available for lecturers and STs. The second type of data is *perceptual*, covering the participants' perceptions, beliefs and interpretations and researcher's interpretations of the phenomenon being investigated. Thus, this chapter includes the analysis and discussions of the following:

1. Background information about the case and participants
2. The participants' ICT capabilities, their understanding of ICT and their attitudes towards ICT and their recommendations for moving forward
3. The process of ICT integration in the case. The participants' actual use of ICT and state of concern and changes in their teaching styles and formats. The participants' perceptions and interpretations about the process of educating trainees in using ICT as teaching and learning tool in science education
4. Factors affecting the participants' actual use of ICT and the process of integration

## 4.2. Background Information about the Case and Participants

The researcher believes that providing some basic information about the case under investigation and the participants helps the reader to understand the context of the study better. He also believes that, as many researchers and reports indicate (Fullan, 1991; OTA, 1988/1995; Sevik, 2001; Altun, 2002), individuals' backgrounds affect their perceptions, beliefs they hold and their practice. Therefore, firstly, some background information about the case and participants will be provided next in this section.

### 4.2.1 Physical Environment and Infrastructure in the Case

As explained in the previous chapter, *Methodology Chapter*, the study was carried out in Secondary Science Initial Teacher Education Programmes of Fatih Faculty of Education. The Faculty consists of six buildings, including a library, sport areas, restaurants and canteens. As illustrated in the *Methodology Chapter* (see Table 3.2), Physics, Chemistry and Biology Initial Teacher Education (ITE) programmes under Secondary Science and Mathematics Teacher Education Department were the settings of the study. The department administration includes a head of the department and two deputy heads, and each programme has a head and deputy head. The building includes various types of classroom and three ICT laboratories, clustered within three different blocks and a technology-enriched classroom. The Faculty also has some other technology sources such as televisions, videos, OHPs, slide-machines, data-show. When the study was carried out the Internet access was not available within these three computer laboratories. More importantly, due to the lack of available infrastructure of the Faculty regarding telecommunication services, as two lecturers reported, L1 and L4 who had administrative roles, the Internet access was only available for the administrative staff and the lecturers who have some urgent needs. For the student teachers, the Internet service was not accessible within the Faculty.

### 4.2.2 Backgrounds of the Participants

The participants of the study were chosen among the lecturers and student teachers. As illustrated in Table 4.1, the lecturers took part into the study were all male and their ages were between 32 and 42, which might be perceived as they were in their early years of teaching. Four of them had some teaching experiences in secondary level as science teachers, and in higher education as teacher educators. Their experiences in both levels might be valuable in view of acquiring valid information about what has been happening in both levels, regarding the use of ICT (or other technologies) to teach and learn science and to improve teachers' ICT capability.

| Participants | | Gender | Age | Teaching experience | Administrative Responsibility | Graduated | Training about ICT |
|---|---|---|---|---|---|---|---|
| Lecturers | L1* | M | 42 | 10 (Secondary-Higher) | Yes | EdD | No |
| | L2* | M | 42 | 10 (Secondary-Higher) | Yes | EdD | Yes |
| | L3* | M | 32 | 8 (Primary-Secondary-Higher) | No | PhD in Education | Yes |
| | L4* | M | 42 | 10 (Secondary-Higher) | Yes | EdD | No |
| | L5* | M | 38 | 10 (Higher) | Yes | PhD in special subject | No |
| | L6 | M | 41 | 15 (Higher) | Yes | PhD in special subject | No |

Table 4.1 Backgrounds of the lecturers
* Lecturers who had the responsibility of delivering ICT related courses

Four of the lecturers had not taken any training, in-service or pre-service, about ICT. One of the lecturers, L3, had ICT training courses at undergraduate level, in which the course covered some basic technological skills and programming language (e.g. BASIC), and at post-graduate level, in which the course covered mostly the use of ICT in science education. During interview, L3 pointed out that

> "I took a course at undergraduate level, which basically covered the basic skills of computer usage or computer literacy. However, I do not think that I gained enough knowledge and skills of using computers effectively". (L3, Int.)

He also mentioned that not having enough prior knowledge and technological skills about computers and prior knowledge about the educational use of technology in physics teaching-learning led to the ineffectiveness of the courses he took at the postgraduate level. Having held this belief, he stressed on the necessities of these courses at both levels in order to meet the requirements of professional development.

L2 also had an ICT-related course during his MSc programme about computer assisted science education. He pointed out that 'we only examined a couple of package programmes throughout this course'. He also added that

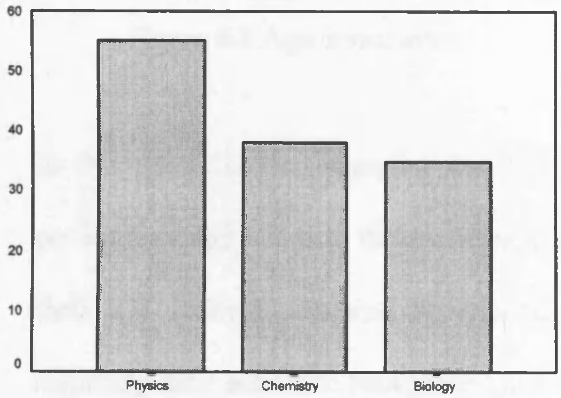
> "I believe that I should have taken some more courses to improve my knowledge and skills on information technology in order to catch up with recent developments in the area. Apart from the course I took in my MSc programme, I have tried to improve my skills on ICT by closely observing and examining my teachers' [lecturers] and colleagues' practical uses of ICT. Furthermore, if I needed some help, for instance, how to use some presentation tools such as power-point or software to draw graph or something, I asked for help from my colleagues. By doing so I improved my presentation skills and knowledge of the use of ICT". (L3, Int.)

However, none of them, the lecturers, are completely ICT-illiterate. All of them see ICT as a part of their professional development, and they have improved their ICT skills, which will be elaborated in detail later in this chapter, through their personal efforts and practices. Five of the lecturers have had the responsibility of teaching the course, called 'Computer Assisted Science Teaching', within last 5 years.

| | **Physics** | | **Chemistry** | | **Biology** | |
|---|---|---|---|---|---|---|
| ***Student Teachers*** | questionnaire | Interview | questionnaire | interview | Questionnaire | interview |
| | 55 (33 Male, 20 Female, 2 missing) | 12 (6 Male, 6 Female) | 38 (21 Male, 17 Female) | 8 (5 Male, 3 Female) | 35 (20 Male, 14 Female, 1 missing) | 9 (5 Male, 4 Female) |

Table 4.2 Participating Student Teachers

As illustrated in Table 4.2, student teachers from three science programmes took part in the study. 128 STs in total (51 female, 74 male, 3 missing) participated in filling the questionnaire, as illustrated in Figure 4.1 and Figure 4.2.



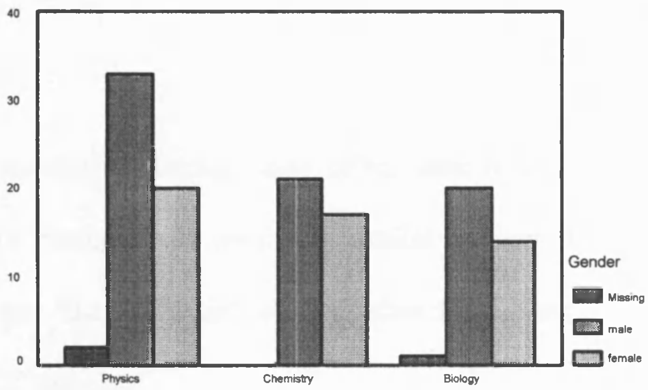




Figure 4.1 Participants from three programmes. Figure 4.2 Gender distribution.

As explained in the previous chapter, 29 STs (16 male and 13 female) were interviewed. All STs had already taken the ICT related courses. 127 STs has already finished or pursued their teaching practice in schools. In fact, this study has been carried out in the final academic-term of their ITE under the assumption that it would be possible to obtain the participants' perceptions about their whole initial education regarding the phenomenon in schools during their teaching practice and in the faculty throughout their training period. As many studies illustrated, age is a crucial variable for the use of ICT. However, STs' ages vary between 19 and 27, as illustrated in *Figure 4.3*, and thus age is not assumed as an important variable in this case because of the fact that they were all at the same age group.

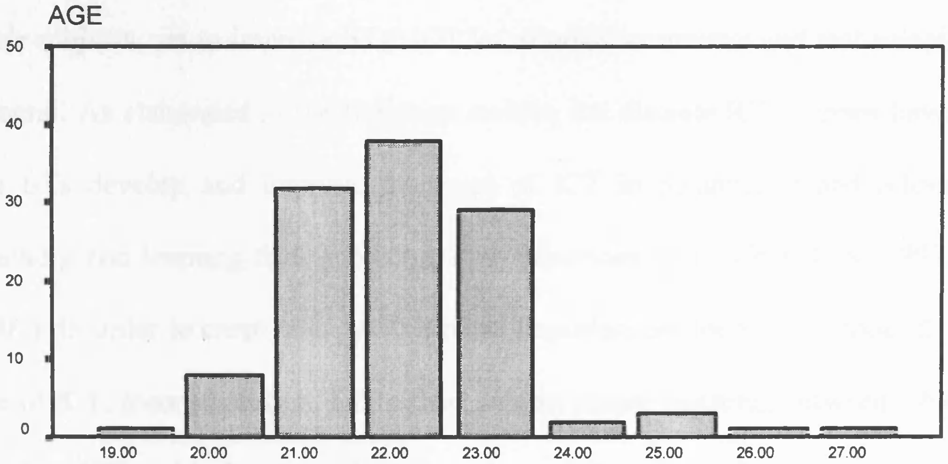


Figure 4.3 Age distribution

In this study, having accepted that the participants' backgrounds affect their beliefs, perceptions and practice, the participant STs' backgrounds were very similar in view of their ICT training, teaching experience, age. The lecturers', on the other hand, vary regarding their academic background and ICT training.

### 4.2.3 Curriculum

In the Fatih Faculty of Education computer-related courses, called Introduction to Computer Science I-II, have been provided since late 80s. They cover some basic skills (e.g. operating computers, using MS-DOS, formatting diskettes and developing STs' knowledge on hardware) and programming languages (e.g. BASIC). This course has been given throughout the first and second terms in the second-academic year of ITE. The main aim of these courses was not to educate trainees to use ICT in teaching and learning their subjects, yet to improve STs' ICT knowledge, awareness and technological skills in general. As elaborated in the literature review, the discrete ICT courses have not helped the STs develop and improve their use of ICT in meaningful and relevant context, teaching and learning their subject matter (Yeomans et al, 1995; Cox, 1997; Crawford, 2001). In order to create and provide more opportunities for STs to model their expected use of ICT, incorporating ICT into their subject matter teaching, between 1996 and 2000, another ICT related course had been provided, called 'Computer Assisted Science Teaching'. Providing this course was the idea of the lecturers of the Science and Mathematics departments, three of them had taken part in this study, L1, L2 and L4.

With the latest re-structuring of ITE in Turkey, this course has been provided as a selective course in the three ITE programmes, replacing another course in the core curriculum, called 'Instructional Technology and Material Development'. The report about the re-structuring of ITE indicates that ICT ('modern instructional technology' is used in the original document) is seen and understood as an important essence of teachers' and STs' professional development.

> "Because of the fact that being able to know about modern instructional technologies and to use them in teaching process would help the teachers improve their quality, this area [training about ICT] will be covered in the new teacher training programmes. Especially, computer literacy, reaching and spreading the information by computer (through the Internet) and developing and producing teaching materials are viewed as basic objectives in pre-service teacher education". (Document 2, p. 31).

In Turkey, even though there has been a lot of talking about the integrating ICT into the school curriculum, vertically and/or horizontally, through different governments since early 1980s, it seems that there has not been much done to put the 'talking' into practice. When the researcher had sought for documents about the ICT curriculum or cross curricular ICT, he could not find much for document analysis. The only available document was produced by Higher Education Authority (HEA) and sent to the ITE programmes briefly indicates that student teachers should be trained about;

> "Various instructional technology, their places and applications in teaching process, developing teaching materials through using instructional technology (e.g. work sheets, transparencies, slides, video, computer-related teaching materials, and so forth) and evaluating various materials". (Document 1, p.166).

In the same document it is indicated that

> "For the course, 'Instructional Technologies and Material Developments', having basic computer skills (for STs) is a must. For the STs who does not meet this condition, another basic computer course which might be an undergraduate or postgraduate one is provided beforehand". (Document 1, p.165).

What these basic skills are is not clarified in that document. Apparently, it is up to the ITE programmes to decide how they evaluate the STs' ICT capability. In this sense discrete ICT model has been adopted in all ITE programmes in Turkey, including the programmes under investigation. As stated before, another ICT-related course, which is a selective one, is provided within these three science teacher education programmes. In this course STs would have the opportunities to develop and improve their ICT capability if they select the course. The third document which was produced by these programmes, including the topics of the selective courses, indicates that STs should be informed and educated about

> "Principles of teaching with computers, the importance of computers in teaching process, the ways to use computers in teaching physics [chemistry and biology] (e.g. teaching the subject, keeping record, simulations, labs works, drill-and-practice, and so forth), choosing good software, using package programmes, planning the teaching process and preparing working sheets". (Document 3, p. 1.3.5).

Computer Assisted Science Education course was first developed in 1996 and given by some participating lecturers in this study since then. In the development process, the lecturers, who did their EdD/PhD abroad, identified certain contents for the course, as described in the quotation above. Apart from L6, all participating lecturers had had the responsibility of teaching these courses across the three science subjects. The course had been taught in the first academic term in the third academic year of each science programme (i.e. three hours in a week throughout fourteen weeks). Even though the core curriculum was decided by the lecturers in these courses at the beginning, in time the course had turned into a course which was dependent upon the ICT capability and understanding of the lecturers who were responsible for the courses.

How successful they have been and what they have done will be elaborated later in this chapter. First the participants' ICT capabilities, understanding and attitudes will be identified and discussed next.

### 4.3 The Participants' ICT Capabilities, Understanding and Attitudes

It is evident that the participants' ICT capabilities, their understanding of innovation, ICT, and their attitudes towards ICT are pivotal to make use of ICT in teaching/learning and personal needs (Fullan, 1991; Roberts and Ferris, 1994; Budin and Meier; 1998; Lawson and Comber, 1999). In this analysis and discussion chapter, the researcher believes that identifying and revealing the participants' capabilities and understanding of ICT and their attitudes towards ICT would be very helpful for the reader to understand characteristics of people who have the responsibilities and/or are expected to integrate ICT in the ITE programmes under investigation.

As Crawford (2001) puts it, over the last 20 years the definition of ICT capability has changed due to the fact that technology itself has changed rapidly and alongside with this change understanding of ICT and its use in education has changed as well. In this study the participants' ICT capability was perceived as two components: technological and application capabilities. To understand or examine and analyse the participants' current ICT capabilities, the researcher used three different sources: interviews, questionnaires and observations.

### 4.3.1 The Participating Lecturers' ICT Capabilities

As Williams et al (1998) argue, in this study by technical skills or competence "handling hardware and software" (p.8) and other related instructional technology was meant. As illustrated in Table 4.3, the lecturers' technical skills were identified in three groups; basic, moderate, advanced skills. These technical skills were identified through analysing the transcripts and narrative observation notes. The grouping of the technical skills derived from the literature review (Russell et al, 2000; Denning and Selinger, 1999; Fisher, 2000) and the researcher's own understanding and interpretation.

| Level of difficulty | Technical skills | Lecturers |
|---|---|---|
| Basic ICT skills | Turning on/off computers, OHP, TV, Video | All |
| | Keyboarding | All |
| | Creating/opening/saving/deleting files from hard disk and diskette | All |
| | Using printer | All |
| Moderate ICT skills | Word-processing | All |
| | Using CD-ROM | L1, L2, L3, L4 |
| | Using data-show | L1, L2, L3 |
| | E-mailing | L1, L2, L3, L4, L6 |
| Advanced ICT skills | Using the Internet | L1, L2, L3, L4, L6 |
| | Creating graph/charts | L1, L2, L3, L4 |
| | Using spreadsheets | L1, L2, L3, L4 |
| | Using data-bases | L1, L2, L3, L4, L6 |
| | Using educational software packages | L1, L2, L3, L4 |
| | Programming language (LOGO) | L3 |

Table 4.3. The lecturers' technical skills

The data indicate that all lecturers possessed the basic ICT technical skills, as seen in Table 4.3. L1, L2, L3 and L4 possessed most of the moderate and advanced ICT technical skills. L5, on the other hand, did not have any moderate and advanced technical skills, but he can use more conventional tools such as OHP, slide-machine and video.

However, all lecturers have mentioned some sort of difficulties and problems during their use of ICT resources, rather than using available more conventional instructional technology such as OHP, slide-machine, TV and video. During interviews when asked which ICT tools and other technology they are capable of using, they all pointed out that they use computers in word-processing, writing up their research reports and producing other materials they need for personal and professional purposes. This is the case for many other study results, indicating that the lecturers' preference of making use of ICT has been at relatively low level tasks such as word-processing (Altun, 1996; Simpson et al, 1999; McCoy, 1999; Pederson and Yerrick, 2000). Other than this conventional use of computers, the data show some other capabilities of the lecturers, as quoted below.

> "... I also use some package programmes such as Holomda together with presentation tools such as data-show... I use the available technological tools here such as video, TV and OHP... and also to analyse quantitative research data I use the SPSS software." (L1, Int.)

> "I use the Internet to search for information about my research projects and for communication... I generally make use of OHP and data-show as presentation tools... and computers to draw table/charts." (L2, int.)

> "... searching for the latest studies related to my subject area, physics education, over the Internet and e-mailing... In teaching activities I use OHP, and during delivering ICT related course I used computers, data-show and available package programmes. I should say that I could use all the available technology in that faculty... I can use computers, OHP and data-show at the level of incorporating them into a lesson." (L3, int.)

> "Mostly I use the Internet... for preparing my lessons, searching for information related to my own research area and e-mailing... I also use OHP as presentation tool. To prepare hand-outs for students and transparencies for OHP, I use Word-processing." (L4, int.)

> "In teaching activities I can use OHP, slide machine and video." (L5, int.)

> "... and to search for the articles, research reports and other information, related to my studies, I use the Internet, including communication via e-mail... I also use slide machine very often and OHP occasionally. Besides, I use TV, microscope and camera all together by connecting them. When I found some micro-organisms or bacteria on the microscope, I put a camera over the microscope and link it to the TV, so all students can see it from the big TV screen." (L6, int.)

As seen from the Table 4.3 and the quotations above, majority of the lecturers possess the technical skills over various ICT tools and other technologies. Apart from L5, who only used word-processing, the data reveal that they were capable of making use of ICT in both personal and professional uses in advanced level. Having said this the lecturers use computers and the Internet in their academic studies as productivity tools, writing up their academic reports and printing them out, searching and downloading information from the WWW, communicating via e-mail. In their teaching activities even if they possessed the technical skills, they did not use ICT regularly, which will be elaborated in detail later in this chapter. Next how the lecturers apply their technical skills to practise will be discussed.

As Williams et al (1998) put it, application skills are the capability in handling and making use of ICT for specific purposes; personal and professional applications. In Table 4.4, the lecturers' application skills are presented, analysing the interview transcripts and narrative notes during observations. The lecturers' application skills were identified through examining the responses to the questions; which ICT resources they make use of, and for what purpose they use them, providing some actual illustrations of their uses of ICT. During observations, on the other hand, the ways to use ICT tools and other technological resources also were taken into account in order to understand their application skills.

| *Resources* | *Lecturers* | *The purpose and way of the use* |
|---|---|---|
| OHP | All | Presentation*, modelling technology use for students |
| TV, Video | L1, L5, L6 | Demonstration, modelling the use of technology |
| PCs | All | Personal needs, word-processing, printing out hand-outs for STs and acetates for OHP, keeping STs' records, training STs |
| The Internet | L1, L2, L3, L4, L6 | Searching for information (academic purpose), searching for information to prepare lesson plan, communicating via e-mail |
| Educational software packages | L1, L2, L3, L4 | Demonstration, educating STs and developing their capabilities by examining and evaluating appropriateness of software packages |
| Data-show | L1, L2, L3 | Presentation |
| Data-loggers | L1 | Training STs |
| Slide-machine | L5, L6 | Presentation, demonstration |
| Combining various tools | L6 | Demonstration* |

Table 4.4 The Lecturers' application skills. *Observed lecturers' use

As illustrated in Table 4.4 and the quotations above, all lecturers had the capability to make use of some sort of technology and/or ICT tools. However, they use OHP very often as presentation tool, but mostly use computers for their personal and academic needs.

Once again it should be mentioned here that even though the lecturers have acquired technical skills (e.g. L1, L2, L3 and L4) and knew how to apply them, the actual practices, examined through observations and the lecturers' responses to the related interview questions in this study, revealed that the integration of ICT in teaching and learning processes, including discrete ICT courses, has not been fully successful. All the lecturers taking part in this study accepted this as a fact. As illustrated in Table 4.4 and the direct quotation above they mostly make use of ICT and other available technologies when they plan their lessons, using word-processing and the Internet. In the classroom they have the capability and knowledge of managing and organising ICT, as they model the use of technology as presentation and demonstration tools occasionally (e.g. L1, L2, L3, L4, L6 through their actual use, L1, L2, L3, L4, L5 through trainees' actual use). The findings also show that they do not use ICT in their teaching processes regularly, even though they make use of ICT in their own personal and academic needs. This supports Simpson et al (1999), OTA (1995), Oliver (1994) and McCoy's (1999) findings, indicating that the lecturers do not model the use of ICT in their own teaching practice even if they had the ICT capability. What reason(s) could hinder incorporating ICT into teaching and learning is the pivotal question here. L4, for instance, made his potential technical and application skills very explicit when asked whether he had any previous experience of using ICT in his teaching.

> "In our faculty there is only one classroom which has some ICT resources available. I once had an experience when I was abroad. ICT resources were located in the classroom. I gave a seminar to my colleagues, using OHP, computer, TV and video". (L4, int.)

Thus, practitioners' ICT capability itself might be no use if there are some other issues which should be taken into account seriously. This other issues associated with the actual use of ICT within classroom in the case will be elaborated in detail later in this chapter, but here it is crucial to point out that the majority of the lecturers have ICT capability to some degree. Having said this, all of them agreed that their capabilities were not enough and should be improved and developed regarding the latest developments and changes in the phenomenon. This supports Pedersen and Yerrick's (2000) findings in their study, suggesting that science teacher educators need to gain more practical knowledge. Next, the participating STs' ICT capabilities will be elaborated.

### 4.3.2 The Participating Student Teachers' ICT Capabilities

As illustrated in Table 4.5, STs' technical skills were identified in threefold: basic, moderate and advanced technical skills. Interview data reveal that STs had acquired mostly basic skills of ICT and other conventional technology.

| Level of difficulty | Technical skills | Student Teachers |
|---|---|---|
| Basic ICT skills | Turning on/off computers, OHP, TV, Video | 24 (12PT, 7CT, 5BT) |
| | Keyboarding | 22 (12PT, 5CT, 5BT) |
| | Creating/opening/saving/deleting files from hard disk and diskette | 17 (10PT, 3CT, 4BT) |
| | Using slide-machine | 2 (2BT) |
| | Using printer | 12 (6PT, 3CT, 3BT) |
| Moderate ICT skills | Word-processing | 22 (12PT, 5CT, 5BT) |
| | Using data-show | 1 (1PT) |
| | E-mailing | 7 (3PT, 2CT, 2BT) |
| Advanced ICT skills | Programming language (LOGO) | 12 (12PT) |
| | Using spreadsheets | 3 (2PT, 1CT) |
| | Using educational software packages | 7 (4PT, 1CT, 2BT) |
| | Using the Internet | 14 (7PT, 4CT, 3BT) |

Table 4.5 The Participating Student Teachers' Technical Skills
PT for Physics trainee; CT for Chemistry trainee; BT for Biology trainee

Word processing is the most significant use among STs. Most of the STs commented that they were encouraged and also forced to write their assignments and/or other works by using computers. PT2, for instance, commented that

> "Our lecturers want us to write our assignments on the computer and print them out, so in a way we have to use computers... By doing so I must admit that I personally have learned a lot and improved my keyboard skills, and now I can use Word without asking any help". (PT2, Int.)

The majority of the STs in the interview sample mentioned that they were capable of operating some basic skills, such as turning on/off PC, OHP, TV and video, keyboarding skills and managing files from hard disk and diskette, 24, 22 and 17 respectively, out of 29 STs. Only 14 STs mentioned that they use the Internet, but the majority of this group (12 STs) do not feel confident, and they have had some challenges to access the Internet as well. Only 7 STs mentioned that they use the Internet for communication purpose via e-mail. Nevertheless, there are some STs taking part in the study, who are capable of using the ICT resources very often and in advanced level. PT11, for instance, commented that

> "I use the Internet very often to search and download information I need, to download new programmes or renew the current one on my PC, to play games, to chat and to communicate with my friends via e-mail which is secure and fast... I also know how to write programmes in different programming languages. I use LOGO, BASIC and Q-BASIC, nowadays I am trying to learn C+. I, for instance, produced a simulation by using LOGO programming language last term, which was about alternative current, as an assignment for the course, 'Computer assisted physics teaching', and presented it in the classroom, which was a quite good experience for me". (PT11, Int.)

On the other hand, the majority of STs emphasised that they have not used ICT and other technology sources very often, especially for teaching and learning their subject. However, as illustrated in Table 4.5, they have acquired some various technical skills, through their training and/or their own individual efforts.

> "I used LOGO programming language to produce a simulation of friction, doing the assignment for the ICT related course last term and a simulation of water wave for another course this year and made classroom presentations [in the Faculty]. Other than these, I only use computer when I need to write my assignments". (PT1, Int.)

> "Even though I have taken two ICT related courses and passed successfully, I cannot use a computer now… Only once I used OHP for a presentation". (CT2, Int.)

> "I must admit that I do not feel so confident using these technological devices, but when I need to use them, for presentations, research and so forth, I can manage… Like we did last week, we, as a group of 8 STs, used computer, OHP, digital camera and video-TV set to present our study about light and noise pollution". (BT7, Int.)

Data derived from interviews also show that more STs from the physics ITE programme had technical skills of technology than STs from other two ITE programmes, Chemistry and Biology. Another significant finding was that all STs from physics programme can use LOGO programming language. This is because they were taught about LOGO in the ICT-related course. Only 7 STs reported that they ran through the available educational package programmes to examine them and learn themselves; only one of them actually used them in the classroom during his teaching practice.

The findings, from the student teacher questionnaires, presented in Table 4.6 support the findings from the interview and observation, indicating that on most of the moderate and advanced ICT skills STs do not feel so confident. As explained in the previous chapter, the Methodology Chapter, the findings derive from the whole STs from three different programmes under investigation. STs were asked how confident they feel on the items of the questionnaire, using 5-point Likert scales, from none to very high confident. The total alpha reliability was found to be high for each section of the questionnaire; technical skills, application skills and attitude-scales, with values of .94, .92 and .83 respectively. The level of significance chosen for this study was .05. Independent sample t-test was used to examine and compare means of items of questionnaire regarding the independent variable, gender. To examine and compare means of items regarding the independent variable, STs' subject areas, one-way analysis of variance (ANOVA) was used. Scheffe's

multiple post hoc comparisons were also conducted for the independent variable, subject area.

| **Level of difficulty** | **Items** | **Mean** | **t** | **F** |
|---|---|---|---|---|
| **Basic ICT Skills** | Turning on the computer and loading a diskette. | **3.72** | **3.00*** | **4.02**** |
| | Formatting a new diskette. | **2.68** | **3.70*** | **12.18**** |
| | Saving and opening files from hard disk | **3.13** | **4.58*** | **4.98**** |
| | Saving and opening files from a diskette. | **3.35** | **3.14*** | **10.34**** |
| | Using a computer keyboard. | **3.13** | **1.85** | **2.13** |
| **Moderate ICT Skills** | Using a word processor to create a variety of documents | **2.14** | **3.33*** | **4.42**** |
| | Selecting and setting a printer option | **2.53** | **3.73*** | **5.84**** |
| | Running through a simulation or computer game | **3.21** | **4.59*** | **.33** |
| | Using e-mail. | **2.34** | **5.94*** | **1.47** |
| **Advanced ICT Skills** | Creating graphs or charts with a computer. | **2.49** | **2.20*** | **3.79**** |
| | Knowing how to search for information from the internet. | **2.76** | **5.41*** | **1.17** |
| | Using spreadsheets. | **1.90** | **2.76*** | **4.83**** |
| | Using educational software packages | **2.07** | **4.58*** | **.82** |
| | Using CD-ROM information sources | **2.22** | **5.00*** | **.34** |
| | Using On-line information sources | **2.47** | **5.36*** | **.51** |
| | Using computer programming language. | **1.96** | **.93** | **45.11**** |
| | Using databases | **1.68** | **4.06*** | **1.29** |

Table 4.6 STs' Technical Skills: questionnaire results
*Statistically significant difference was found between male and female STs (t-test, P < .05)
**Statistically significant difference was found between three different ITE programmes (Anova, P < .05)

As seen in Table 4.6, the findings suggest that STs were more confident on basic ICT skills than on moderate and advanced skills. Even though majority of STs reported that they use computers for word-processing as Cuckle et al (2000) and Simpson et al (1999) also found, the mean rating of their self-rated confidence level on the related-item was just over *low confident* (M = 2.14). Their confidence levels on some advanced ICT skills such as 'knowing how to search from the Internet', 'using on-line information sources', 'using CD-ROM information sources' (M=2.76, M=2.47, M=2.22 respectively) were higher than their confidence level on word-processing. The highest mean rating given to an individual item was 3.72, which is just under *high confident*, 'turning on the computer and loading a diskette'. The lowest mean rating, on the other hand, given to an individual item was 1.68, which is under *low confident*, 'using databases'. The latter may be related to unavailability of such programmes, as Altun (1996) found in his study in which the subjects were lecturers.

The questionnaire data also show that male STs feel more confident than female STs on all items as Denning and Selinger (1999) found. The independent t-test results indicate that, apart from two items, 'using a computer keyboard' and 'using computer programming language', statistically significant difference was found on each item between male and female student teachers (see t-values for each item in Table 4.6, $p < .05$).

On the other hand, as illustrated in Table 4.6, statistically significant differences were found between those three science teacher education programmes regarding STs' confidence levels on majority of the basic ICT skills, two moderate and three advanced ICT skills (see F values for each item in Table 4.6, $p < .05$). On the majority of the items, regarding moderate and advanced ICT skills, statistically significant differences were not found. On items such as 'using a word processor to create a variety of documents', 'using spreadsheets' and 'using computer programming language' there were statistically significant differences among those three programmes.

To understand which programme(s) actually cause the differentiation, the multiple comparisons-Scheffe test was run. According to the results from the multiple comparison

Sceheffe-test, on all of the items STs of physics programme reported relatively more confidence than other two programmes, chemistry and biology, as Cuckle et al (2000) found. STs of Biology programme had considerably lower scores overall among three ITE programmes. On the item, 'using computer programming language', for instance, the biggest significant difference was found between physics and other two programmes, chemistry and biology, the mean differences were 1.30 and 1.54 respectively. Overall, even though STs of Chemistry programme reported more confidence than STs of Biology on the majority of the items, it is not statistically significant. Thus, STs of Physics programme created the differences regarding ANOVA test results among those three programmes, which is also revealed in the interview results.

The second essence of STs' ICT capability, application skills, was defined and explored through interview, observation and questionnaire. The results from interview sample are illustrated in Table 4.7. STs' application skills varied over some sources of ICT and other technology. During classroom observations STs' uses of ICT and other technologies were also taken into account. Having defined STs' application skills, their actual uses of ICT during their teaching practice in schools and their training in the Faculty were elaborated through their responses to the interview questions and their elaboration about why and how they make use of ICT and manage the situation. STs were asked to talk about their uses of technology in practice, teaching and learning activities, in order to find out how they apply their ICT technical capabilities to teaching and learning activities.

| *Resources* | *STs* | *The purpose and way of the use* |
|---|---|---|
| OHP | 8PT, 4CT, 6BT | Presentation* |
| TV, Video | 2BT | Demonstration* |
| Computer | 10PT, 2CT, 5BT | Personal needs, word-processing*, printing out hand-outs and acetates for OHP*, presentation*, power-point presentation |
| The Internet | 7PT, 4CT, 3BT | Searching for information, searching for information to prepare lesson plan*, communicating via e-mail |
| Educational software packages | 4PT, 1CT, 2BT | Demonstration, developing their capabilities by examining and evaluating appropriateness of software packages |
| Digital camera | 2BT | Recording*, presentation* |
| Data-show | 1PT | Presentation* |
| Slide-machine | 2BT | Presentation, demonstration |

Table 4.7 The STs' application skills. *Observed STs' application skills

As seen in Table 4.7, STs make mostly use of ICT in order to present their research and/or assignments to the classroom. The STs who took part in an activity including ICT resources commented that they did it as a part of ICT-related course and/or other courses. All STs of Physics programme, for instance, had to make a presentation in the ICT related course to model the use of ICT in teaching physics. Their most common experience of ICT in the physics programme was to use LOGO to produce a simulation or model of an event or concept in physics. Then they prepare a lesson plan and make a classroom presentation using ICT, including a final report for the lecturer of the course in Word version as part of assessment. On the other hand, STs of Chemistry and Biology programmes use conventional technologies more such as OHP, slide-machines and TV-Video set. Cuckle et al (2000) also found that STs' subject area was one of the main factors affecting their classroom use of ICT. STs' of Physics programme had used ICT in practice more than STs of Chemistry and Biology, according to the findings of their study.

Only one ST in the interview sample, BT1, reported that he actually used ICT during his teaching practice in his practising school.

> "I have not used any kind of technology here in the Faculty, but I used an educational software package and computer in my practising school... I first arranged the computer lab and chose one of the available educational software, which you could not find that much here in the Faculty. Then I took students to the computer lab. First I explained the topic, which was about cells, and then run the simulations, using a big white screen... You should have seen them, the students, they were so focused, unbelievable". (BT1, Int.)

Some STs point out that even though they wanted to use ICT resources during their teaching practice, their mentors did not allow them to do this, claiming some excuses such as class-size, organisation and worthlessness. In some other schools, on the other hand, some STs reported that there were not any ICT resources available. In the observed lessons, it was found that STs have made use of ICT in performing practical activities as part of the training courses in the Faculty. They mostly use technology as presentation and/or demonstration tools: OHP, Data-show and slide machine. During the observations, they also illustrated that they would exploit the full potential of ICT if the sources were there ready to access.

A group of eight STs of the Biology programme, for instance, showed what they were capable of using ICT resources in planning lesson plans, working collaboratively and presenting the subject matter in the classroom, including showing their other application skills such as class management and organisation as well. During their delivery of the subject matter, which was voice and light pollution, they searched information and downloaded some pictures from WWW (the Internet access was not available in the Faculty) and they recorded real environment pictures to demonstrate the environment they have lived in by using digital camera. Three of them who were in the interview sample pointed out that during the planning and preparation process of the lessons (2-hours) they made a good team work.

> "Some of us searched the information and pictures we needed from the Internet and downloaded them into diskettes, and others used digital camera to bring our very own environment into classroom. Some prepared the presentation documents and transparencies for OHP using Word… We asked for help from outsiders if we got stuck... and we came together and decided what we would do in the presentation... I think we learned a lot about the process of using technology in subject teaching and tested ourselves, I believe. I think we did great as a group, and I believe we would do much better than this if we had a well organised classroom in which the Internet and more computers were available". (BT6, Int.)

STs reported some constraining factors, which prevented them from using ICT in their practice in the schools and Faculty. These factors will be elaborated in more detail later in this chapter. Table 4.8 shows STs' level of confidence on application skills, derived from questionnaire results.

| **Items** | **Mean** | **t-value** | **F-value** |
|---|---|---|---|
| Preparing lesson plans which include ICT | 2.94 | 2.01* | 1.161 |
| Knowing how to select ICT resources as teaching tool. | 3.03 | 1.75 | .970 |
| Knowing how to evaluate ICT resources in teaching process | 3.31 | 1.83 | .282 |
| Using ICT to present subject. | 3.12 | 2.64* | .303 |
| Using ICT to facilitate teaching strategies. | 3.01 | 2.55* | .052 |
| Having the knowledge of organisational and management strategies related to ICT in education. | 2.59 | 3.40* | .011 |
| Demonstrating organisational and management skills in the classroom. | 2.70 | 3.09* | .034 |
| Monitoring students' progress by the use of ICT. | 2.73 | 2.69* | .278 |

Table 4.8 STs' level of confidence on ICT application skills: questionnaire results

The questionnaire data illustrates that STs' mean rating of confidence level was around 3, corresponding to feeling 'confident'. The highest mean rating given to an individual item was 'knowing how to evaluate ICT resources in teaching process' (M=3.31). The lowest one, on the other hand, was 'having the knowledge of organisational and management strategies related to ICT in education' (M=2.59). STs' questionnaire results suggest that even though they reported relatively high self-confidence on the related items of application skills, their self-rated application skills were not only proper reflections or feedback of their practice. Only 33.6% of STs reported that they had an actual experience with ICT in their teaching and learning activities during their training and/or school experience period. Rather, it appears that their confidence derived from their general knowledge and/or beliefs about ICT and its use in teaching science.

As illustrated in Table 4.8, statistically significant differences were found between male and female STs regarding their self-rated confidence levels on six items, out of eight (see the t-value for each item in Table 4.8, $p < .05$). On only two items, 'knowing how to select ICT resources as teaching tool', 'knowing how to evaluate ICT resources in teaching process', there were not significant differences between male and female STs. Having said this, the data show that male STs feel more confident than female STs on all items. On the other hand, as far as ANOVA test results concerned, statistically significant differences were not found between three science programmes (see the F-values for each item in Table 4.8, $p > .05$) even though STs of Physics programme reported relatively higher level of confidence on all items covering application skills.

### 4.3.3 Summary and Discussion on the Participants' ICT Capability

The findings from the interview and observation show that five of the participating lecturers have had certain ICT skills at all three levels, as shown in Table 4.4. Parallel to many other studies, this study also shows that the lecturers' use of ICT and other technology seems to be at a low level, such as word-processing and using various technologies as presentation tools. Although they possess relatively higher ICT capability, they do not use ICT in their teaching as much as they make use of ICT in their own personal and academic needs. They make use of computers as productivity tools, producing lesson plans, keeping records and producing acetates for OHP. Apart from L5, they have the capability and knowledge of using available ICT and other technology resources, yet they all reported some challenges to incorporate ICT into teaching activities. For their own learning and needs they reported that they had used the Internet for accessing variety of information and communicating via e-mail, and they examined or used educational package programmes to train STs. The participating lecturers have acquired and improved their current ICT capability through their own efforts and home use rather than taking special ICT training.

The results of this study support Odabasi (2000) and Altun's (1996) studies, carried out in Turkey, which also showed that lecturers use conventional technology more than ICT. Their findings also illustrated that the most common ICT use is word-processing, and it was recommended that lecturers should be offered effective training in order to develop and improve their knowledge and understanding of the teaching potential of ICT. The findings of this study about the lecturers' ICT capability also show similarity with international literature such as Cuckle and Clarke (2002), OTA (1995), Simpson et al (1999) and Murphy and Greenwood (1998).

As Levin (2000) puts it, reform in education

> "cannot succeed and should not proceed without much more direct involvement of students in all aspects... Indeed, greater student involvement would constitute an important reform in its own right" (p. 155).

Thus, student teachers' ICT capability is accepted as crucial as the lecturers' in order to integrate ICT into ITE fully. As it is the case in many other countries, ITE programmes in Turkey have attempted to develop and improve STs' ICT capabilities. Taylor (2003) points out that developing personal ICT skills is crucial since "the skills are needed for wider professional duties such as managing assessment data, producing teaching materials and updating subject knowledge" (p.129). STs' ICT capabilities were examined through questionnaire, interviews and observations in this study. As illustrated in Table 4.5, the majority of the STs have acquired basic ICT skills such as turning on/off computers, keyboard skills, managing files from hard disk and diskette. Similar to lecturers, word-processing is the most common use of ICT among STs. Many international studies have come up with similar results (see Murphy and Greenwood, 1998; Mellar and Jackson, 1992; Simpson et al, 1998; Cuckle and Clarke, 2002; Cuckle et al, 2000; Taylor, 2003). Especially STs of the Physics programme reported that their use of word-processing has been improved since the lecturers encouraged or forced them to use computers to write up their assignments. All Physics STs also had to use LOGO programming language during taking the ICT related course and present their works in the classroom. STs' technical skills of using spreadsheets, educational software and the Internet were very low and infrequent. Only half of the STs reported that they had used the Internet, yet very *rarely*. Only two mentioned that they have used the Internet *very often*. Apart from these, the other Internet users also added that they do not feel confident. From the STs' questionnaires, it is clear that male STs feel more confident on both technical and application ICT skills. On most of the items, statistically significant differences were found between male and female STs (see Table 4.6 and 4.8). Interestingly enough, overall, STs reported higher confidence on application skills than technical skills. It is believed that this was perhaps because their rating of application skills was not a proper reflection of their practice in teaching. Rather, their popular knowledge and understanding of ICT affected their responses, since only 33.6 % of all STs reported that they had actual experiences with ICT in their teaching and learning activities during their training in the Faculty and school experience period.

According to ANOVA test results, whilst statistically significant differences were found between the three ITE programmes over several technical skills (see Table 4.6), there was no significant difference between programmes over application skills (see Table 4.8). The results of Sceheffe-test suggested that STs of Physics had more confidence on the items related to technical skills than STs of Chemistry and Biology.

In conclusion, both groups of participants have acquired various ICT skills, but they do not feel confident to use ICT resources in teaching. Thus, the lecturers will need more support or training to improve and develop their ICT capability. The majority of the STs will need to take in-service courses as practising teachers since their initial training about ICT was not enough to integrate ICT into their teaching and learning activities. The participants' understanding and attitudes towards the innovation, ICT, is as crucial as their ICT capability for *appropriate* integration, which will be elaborated next.

## 4.4 The Participants' Understanding of ICT

In this section the participants' understandings of the innovation, ICT, are analysed and discussed regarding its role in the new teaching-learning environment, its value and potential. The lecturers' perceptions of ICT are derived from interviews, and actual illustrations of their perceptions were sought from the field notes during observations. The STs' perceptions, on the other hand, are revealed through questionnaire (i.e. through open-ended questions), interviews and observations during lectures. Fullan (1991) and Goodson (2001) argue that individual understanding of any change and innovation is the critical point in the change process. However, as Fullan (1991) argues, at the individual level, people involved in educational change process may see and understand the reality of innovation in different ways.

The findings of data analysis revealed that the participating lecturers' perceptions of ICT vary, as can be seen from Table 4.9. The data suggest that they see and understand ICT as; information sources, presentation tools, a facilitator, medium to change current style of teaching and learning. These themes emerged from their personal and academic uses, reported or observed, and their beliefs.

| Lecturers | ICT as information sources | ICT as presentation tools | ICT as a facilitator | ICT as a medium to change current style of teaching and learning | Constraints |
|---|---|---|---|---|---|
| L1 | Variety of information, Easy to reach | Easy and effective presentation | Abstract concepts to concrete, motivation, drill-and-practice, help with learning diffic. | Constructive learning environment | Clear targets needed, distraction after a while, costs, pre-planning needed and time consuming for teachers |
| L2 | A new way of reaching knowledge | Effective presentation* | Visual, constructing and testing your own concepts, students own ways of reaching knowledge | Student-led activities*, collaboration* | Wrong or misleading models or simulations, ready knowledge may lead students to being reluctant |
| L3 | Accessing a vast amount of knowledge | Effective presentation* | Abstract concepts to concrete!, safety, motivation, drill-and-practice, helps for slow learners | Student knows the ways to reach information, and construct his/her own knowledge | Skepticism about package programmes, modelling and simulation |
| L4 | Accessing and storing variety of information | Effective presentation* | Storing, abstract concepts to concrete, safety, motivation | Student-led activities*, student-centred*, collaboration* | Skepticism about package programmes, modelling and simulation, lack of lab. skills, skepticism about www information |
| L5 | Easy access to vast amount of information | Effective presentation* | Abstract concepts to concrete, visual | Student-led activities and presentation*, collaboration* | Cost, loss of motivation after a while |
| L6 | Up-to-date information, variety of information | Effective presentation and demonstration * | Support with different sources of information | Developing higher order thinking | Getting bored if used always |

Table 4.9 The participating lecturers' perceptions of ICT. *Observed

| ICT as | facilitators | Information sources | Presentation tools | Medium to change current style of teaching and learning | Constraints |
|---|---|---|---|---|---|
| The Participating Student Teachers | Visual*<br><br>Abstract concepts to concrete*<br><br>Motivation*<br><br>Saving time*<br><br>Drill-and-practice | Variety of information sources*<br><br>Saving and constructing your own information source,<br><br>Accessing a vast amount of knowledge by means of the Internet* | Effective presentation*<br><br>Time savers<br><br>Whole class presentation by means of OHP and data-show, using big white screens*<br><br>Motivation* | Active learning<br><br>Individualised-learning<br><br>Providing constructivist teaching and learning environments<br><br>Flexibility<br><br>Collaboration and cooperation* | Time-consuming in preparation stage*<br><br>Lack of students' experience of ICT<br><br>Selecting the right source for the right task is crucial<br><br>Teachers' competence on using and managing ICT in teaching is a must<br><br>Cost<br><br>Skepticism about class management*<br><br>Distraction<br><br>Lack of social interaction<br><br>Lack of enough educational materials over the Internet in Turkish |

Table 4.10 The participating student teachers' perceptions of ICT. *Observed

In both groups of the participants, even though they had never used ICT in their teaching and learning activities, some individual perceptions and understanding of ICT reflected popular knowledge rather than reflection upon their actual practice, among STs in particular. Next, each emerging themes derived from the data will be elaborated in more detail to understand how the participants appraise and perceive the use of ICT in science teaching and learning.

### 4.4.1 ICT as Information Sources

Although all participating lecturers perceive ICT as information sources, their perceptions of the ways to benefit from these sources vary. L1, L5 and L6 tend to perceive ICT as an ever accessible library in which one can reach the information whenever they need by means of the Internet, data-bases, CD-ROM, and so forth, and use it in order to explain the topics to students in the classroom. L1 and L6 also use the Internet for their own academic studies, reaching up-to-date information related to their subject area. L6, for instance, reported that

> "Producing original information should be the most crucial part of the academic researchers' duties… duplication is for nothing. Knowledge has been produced so fast that only the titles of produced studies within 15 days might be listed in a 100-page leaflet. Thus, using ICT is the easiest and fastest way to realise what happens around the world and follow the agenda… I sometimes use the information I got from the net in my lessons, making it easier to understand, so that the students could understand easily, and present it to my students". (L6, Int.)

L2, L3 and L4, on the other hand, mentioned that ICT, especially the Internet, can be used in an individualised-knowledge construction way in which individuals, students or lecturers, can set their own tasks to search for, organise and analyse information with their own pace. In this vein, L3 mentioned that

> "I personally think that we, as lecturers, should direct or guide students through a new approach in which they can themselves discover the ways to reach the information they need and construct their own learning environments and knowledge…Technology can serve this purpose very efficiently". (L3, Int.)

L4, on the other hand, raised an emerging issue about the reliability of information available over the Internet.

> "I have used the Internet to reach up-to-date information related to my academic studies, and also sometimes to prepare lesson plans and produce hand-outs for students... Even though there are a great deal of information over the Internet, that does not mean that all the information presented is valid and reliable. Thus, this must be taken into consideration seriously by the users, I do not know, by simply checking who put the information over the Internet or looking at the references..." (L4, Int.)

As the participating lecturers differ from each other in making use of ICT as information sources, STs' perceptions of benefiting from ICT as information sources were also twofold. Firstly, the data revealed that the STs perceive ICT as information sources, providing accessible vast amount of information available anytime and anywhere, in which mostly the teacher directs and sets the rules. However, four STs made complaints about lack of available educational materials over the Internet written in Turkish language.

> "You can reach varieties of information through the Internet, yet from my own experience I must say that there is very little information about different aspects of education written in Turkish language. When I was writing an assignment for the course, Special Teaching Methods, I attempted to search for information about the topic I selected but, as I said, I could not find that much useful information over the Internet. Having said this, I believe that teachers can use these tools in order to gather information to prepare his/her lesson plans... I know there are lots of educational sites over the Internet in English or other languages, which I do not understand..." (PT9, Int.)

> "Once one of our lecturers told us that when he needed some academic articles or research reports he had to travel to Ankara [capital city] to use libraries of other universities such as ODTU [Middle East Technical University], but now he said that he could reach any kinds of information over the Internet... Teachers can use ICT to reach up-to-date information about the subject s/he teaches by using these information sources... You do not have to go to another country to learn about their culture. The Internet brings this culture to you. There is lots of information available for everyone if there are a computer and phone line in place". (CT4, Int.)

Secondly, they also perceive ICT as information sources which the users set their own targets to search for, organise and analyse the information through independent uses. One illustration of this sort of understanding and use of ICT was observed in the Biology programme. A group of eight STs had planned and presented a two-hour presentation, and three of them were interviewed afterwards. In these two lessons, their use of ICT as information sources is worth mentioning here. They first selected a topic to do a research, discussing it with the lecturer, L5. Then they came together and decided about individual roles in the process. The STs used the Internet in order to gather some theoretical information about sound and light pollution and downloaded the information on a diskette. Then they transformed the theoretical information into presentable format using acetates for OHP. They also downloaded some pictures from the Internet to illustrate light pollution in daily life. For illustrating sound pollution, some others used a digital camera which could be linked with a TV or computer, they took some examples from different parts of the city of Trabzon and measured the level of sound, including a drama-play by themselves. During presentation they compared the theoretical information gathered from the Internet and other sources such as books, journals, newspapers, and so forth, with the data gathered from the real life. By doing all these they incorporated ICT into their planning, preparing and presentation processes. They in a way constructed their own data base as well as used ICT, particularly the Internet, as information sources. One of the STs from the group, BT4, expressed himself after the presentation as follows:

> "It was excellent... First of all, what we have done was a research-based work. We searched for information about voice and light pollution in and abroad mainly by means of the Internet. Then we tried to discuss the health and environmental problems they might cause and compared the theoretical values with the values we measured in the daily life... To be honest I could not imagine this kind of lesson throughout my school life. I personally have learnt a lot about the topics

> we focused on and the use of technology to deliver the lesson... After the lesson we have got lots of positive feedback from our friends about the presentation". (BT4, Int.)

As Grabe and Grabe (1998) discuss the active role of the student in the learning process, the information was not "presented to the students in some kind of final, distilled form" (p. 7). They argue that students have to "dig for" the information and they have to "pull together bits and pieces of information from several sources, generate personal summaries, and make decisions" (p. 7). In the lesson mentioned above, as Grabe and Grabe (1998) describe, active involvement of the student teachers was not just physical but mental as well, throughout the processes of information gathering, planning and presentation. Selinger (2001a:88) argues the potential of ICT in an authentic learning environment that

> "the idea that teachers are fountains of knowledge and that children are empty vessels waiting to be filled with the knowledge and wisdom of their teacher is untenable in the information age. The amount of available knowledge and the breadth and depth of it are far beyond the realms of most teachers as is their control of learners' access to it... teachers need to encourage skills in which learners seek new information and consider alternative viewpoints, question their sources, and make judgements about the validity and reliability of evidence and information presented to them from a range of sources".

She redefines the role of the teachers as facilitators in the information age rather that just as knowledge transmitters. The data revealed that majority of the participants were aware of that they need to change the traditional role of the teacher to exploit the full potential of ICT, from knowledge transmitters to facilitators/guides.

### 4.4.2 ICT as Presentation Tools

All the participating lecturers use ICT and other technology to present information in the classroom. This was the most common use of ICT among the lecturers during their teaching activities, as far as interview results concerned. For this purpose, they mostly use OHPs, data-show and for demonstration video-TV set and slide-machines. During observations, it was observed that the technology users, L3 and L6 made use of ICT not only to present pieces of information, but also to discuss the topics presented and/or demonstrated. By doing so, they attempted to get students' attention through whole class discussion, and interaction among STs, the lecturer and the ICT source was created. Likewise, STs' most common use of ICT and other conventional technology has been as presentation tools as well. As discussed earlier in this chapter, the lectures mostly used OHPs during presentation, and to produce acetates they use computers, the Internet and printers. L1 reported that

> "We used OHPs and data-show to make presentations more effective. We, as lecturers, make use of presentation tools such as OHP and data-show. One of the main reasons is to model how presentation could be carried out, using technology, for the student teachers. And we encourage and force student teachers to use them as well by giving them group tasks related to the use of technology in their subject teaching. I can say that they are enthusiastic about using new technology". (L1, Int.)

STs' questionnaire results showed that one third of STs reported that they had made use of technology in teaching and learning activities. All of them, the technology users, had used them as presentation and demonstration tools, such as OHP, slide-machine, data-show, TV-video set and computers. All STs of Physics programme interviewed with mentioned that they presented their assignments to the classroom at the University, related to the ICT-training course, using computers and data-show. Some of them also made used of ICT as presentation tools in other courses, yet this time their most commonly used technology was OHP. Half of the STs of Chemistry mentioned that they only used OHPs as presentation tools. STs of Biology Programme, on the other hand, have made used of different tools to make their presentations such as slide-machine, OHPs, TV-video set and computers.

> "I used OHP twice for presenting my assignments to the classroom. I preferred OHP since it is easy to use and due to the big white screen efficient to whole class presentation, every student can see what you are talking about... In this sense, technology is a new colour in teaching profession". (PT2, Int.)

> "I only used OHP since here there are not much of other technologies provided for us". (PT4, Ques.)

> "I used OHP to present my research report for the course, Field Study... Easy to use and saves time". (CT5, Int.)

> "You saw yesterday, as a group, we used OHP, TV and computer to present our assignment to the classroom... These tools make presentation interesting for students and motivate them... The preparation of these two lessons which you observed had taken four days, but it was great at the end". (BT6, Int.)

One of the most disappointing findings from the data is that even though the majority of the participating STs have made use of ICT or other technology in teaching and learning, only one ST mentioned that he actually used ICT in his teaching placement school.

As stated earlier, the lecturers usually use OHP as a presentation tool. L3, for instance, reported that

> "In my teaching activities, on the other hand, I use OHP very often and data-show in the computer-assisted science teaching course, as presentation tools, which make the presentation more effective and easy. At the same time I know that my use of technology may help the students to understand its potential as presentation tools". (L3, Int.)

L5 and L6 make use of different technological sources as presentation and demonstration tools. They very often use slide-machine, OHP, TV-video-set to present pieces of information or demonstrate the events or samples from natural life, such as a micro-organism, cells of different plants and demonstration of natural habitat of the livings. In this sense, as L5 and L6 are from Biology programme, the kind of ICT sources having been used by lecturers varies regarding their subject areas. In conclusion, the lecturers perceive ICT and other technology resources as effective tools for presentation and demonstration, and so they incorporate them into their daily teaching activities for this purpose through their own uses and/or the STs' uses. They also reported that the use of technology as presentation tools saves more time even though they had to spend more time in the planning and preparation of the presentation materials.

### 4.4.3 ICT as a facilitator of teaching and learning

As discussed in the previous chapter, the Literature Review, the use of ICT in teaching other subjects can improve students' learning and enhance the quality of teaching, facilitating the processes of teaching and learning (Grabe and Grabe, 1998; Loveless, 1995; Newton and Rogers, 2001). In this study, the participants reported some added values of ICT as facilitators of teaching and learning. All participating lecturers and STs believe that visual aids of ICT can help students to improve their learning of concepts and events in science through simulations and modelling. They all also emphasised that there are many concepts and events in science, which might not be understood, or misunderstood by students by using the old traditional ways of teaching. They all believe that ICT has the potential to facilitate the teaching and learning process of these subjects. The following quotations from the interviews exemplify their perceptions of ICT as facilitators:

> "In fact, there are high expectations from ICT, which I believe some of them can be met. First of all students can reach the information very easily and fast. They can watch some *abstract concepts and events* in a more *concrete* way on a screen... If you *direct and guide* students, they can *design experiments* in Physics, *see* them on a screen and *share and discuss* them with others. ICT can help *students with learning difficulties* through the use of *drill-and-practice*. It may also *motivate* students... In this processes the role of the teacher is very crucial. Students must be *directed and guided* very well". (L1, Int.)

> "In Physics there are lots of *concepts and events which are not simply observed in real life and are dangerous* to do experiments in laboratories. I believe that students learn best by doing actual experiments in the Physics laboratories, but if it is not possible to carry out the experiment, what should we do? It seems that in that case the best way is to make use of ICT by using *simulations and models* to improve students' learning... Having said this, *the quality* of software or educational package programmes must be taken into account carefully... Simply saying, ICT can *stimulate* students and help them to *construct* the new concepts in their minds. In this sense, ICT has the potential to provide more *real-like experiences* for students through *visualisation and sound effects*". (L2, Int.)

STs used various terms in order to define the added values of ICT in science teaching and learning activities. The most commonly stated value of ICT was its *visual effect*. Most of the STs believe that the more students use their sense organs, the more effective teaching and learning will be. Their comments on the values of ICT as facilitators were very similar to each other. As far as the interview and questionnaire results, they see ICT as making *abstract concepts and events visual*, devices *stimulating and motivating* students, *time saver*, tools to increase *productivity*, *drill-and-practice* tools for *slow learner* and *students with learning difficulties*, devices supporting *active learning*. Following excerpts exemplify the STs' perceptions of ICT as facilitators of learning and teaching:

> "We know lots of thing about Physics since we generally memorise the subjects we have been taught through traditional teaching approaches, but we cannot

understand or interpret what happens in reality for most of the subjects. With its *visual and sound* effects technology can help students understand the events or concepts better... Through students's active involvement ICT can also help them develop their higher order thinking by questioning and discussing what they observed or generated from ICT sources... In this context the teacher's role also should be a guide rather than knowledge transmitter. The students' role, on the other hand, should be knowledge seeker or researcher". (PT5, Int.)

"The concepts or events we learn in schools are abstract things. Take a chemical reaction, for instance, it is hard to understand what really is happening during reaction. The use of software can improve learning. This also motivates students". (CT1, Int.)

"During taking the course [Computer Assisted Chemistry Teaching] last year we used a software, enabling us to do experiments on a computer screen regardless of any danger. You can try and learn everything about the event you have chosen. You can control the variables or change them and their amounts. In a way you have a direct interaction with the event and computers... You can see the reactions visually, which is very important for deeper understanding". (CT3, Int.)

"To change the traditional teaching styles which are inefficient and should be buried in the history of teaching and learning, teachers should use technology... Students must be guided to search for information and construct their own knowledge, as we did yesterday". (BT6, Int.)

During observations, the lecturers and student teachers' uses of ICT and other technology were about facilitating the teaching and learning processes. Four class-hours of observations, out of 18, were student-sensitive and research-based in all these lessons. STs who had responsibilities during these observations used different sources of technology to share their own knowledge and research results with their friends through classroom presentations. During these observations the lecturers' roles were as guides or facilitators.

Even though most of participants perceive or make use of ICT as facilitators of teaching and learning processes and learning itself, very few of them had some doubts about the value of the use of ICT regarding learning. L3, for instance, was skeptical about the benefits of using simulations, models and drill-and-practice. He reported that

> "By means of technology you can make the concepts, which are mostly *abstract* and hard to comprehend, more *graspable*. I do not give any response to the question 'how much'. However, in my point of view it is still more effective than traditional approaches". (L3, Int.)

L4 also made some comments on models and simulations in Chemistry teaching and learning, mentioning that the teacher has an important role to play during the use of these kinds of software. S/he must warn students that the observed reality on a screen is not the real reality but just a model or simulation to understand the things better. L5 and L6 have made use of ICT and other technology for the purpose of demonstrations. L5 reported during interview that he has used especially slide-machine to demonstrate the pictures of plants and other organisms. He also emphasised that "*visualisation* is very crucial in teaching and learning Biology. In this sense ICT can be a great help for teacher to explain the subject and for students to improve their learning". Likewise, L6 also mostly have used slide-machines and OHPs for the same purpose. He also set up a new system in Biology laboratory, in which it enables him to *demonstrate* "micro-organisms, bacteria and ferments under microscope, using a camera and TV" to whole class. The students' involvement in these lessons was mental rather than physical, through the discussions led by the lecturer. Apart from L1 and L6, during observations there were some lessons in which the STs fully participated in through activity-based and research-based works and discussions. Grabe and Grabe (1998:27) points out that "the emphasis in the activity-based learning shifts from the transmission of information to an emphasis on asking critical questions, finding goal-relevant information, evaluating and integrating information to create personal knowledge, and communicating effectively". The data suggest that the lecturers and STs participated in the study have made use of ICT as facilitators even if it has not been so regular, in which the use of technology facilitates the processes of teaching and learning, through visualisation, sound-effects, collaboration and cooperation, enhancing productivity, saving time, information sources, flexibility and individualised-learning opportunities.

### 4.4.4 ICT as a medium to change current teaching styles

As Underwood and Underwood (1990), Newton and Rogers (2001), Grabe and Grabe (1998), Loveless et al. (2001) and many others argue that ICT has the potential to change classroom practices from traditional teacher-centred to student-centred. Loveless et al. (2001:73) emphasise the roles of the people during the change, pointing out that "*technology does not change the practice, people do*". The data revealed that all the participating lecturers believe that ICT can be very valuable to provide student-sensitive learning environments even though their points of view and uses vary in formats of delivery. Here the participants' perceptions of ICT as a change agent are to be discussed, the impact of ICT in their teaching practice will be analysed and discussed in detail later in this section. The following quotations exemplify their perceptions of ICT as a medium to change the nature of teaching practice.

> "If you use these technological sources through teacher-centred ways like a demonstration or presentation tool, you can not benefit from the potential of ICT much. I believe that students should use these sources and do activities in and out of school. Teachers should create *constructivist learning environments* for students, and ICT can be very helpful for doing this. For this to happen the first thing to be done is to educate the user about how they can benefit from these

> sources... That is, basic objective is to give students *responsibilities*, put them at *the centre of activities*". (L1, Int.)

> "We must use ICT for *student-led activities*... Teachers do not provide all the knowledge in the classroom. ICT has created a new opportunity for all, which is to search for more information about the subject you were taught... To be honest, this is the most crucial point of which I like technology. As *a group or individually*, students have the opportunity to search for information and share with their friends and teachers". (L2, Int.)

The lecturers used the terms 'constructivist learning environment', 'student-led activities', 'new way to reach information', 'knowledge construction', 'collaboration', 'higher order thinking', 'individualised learning' in order to describe the potential impacts of ICT in teaching and learning science. These concepts have been used and defined within the constructivist pedagogies. Having said this, the data also revealed that all lecturers believe that ICT can at least enhance the quality of traditional teaching approaches during whole class presentation and demonstration even when teachers' teaching approaches do not change.

Contrary to the lecturers the majority of the STs tended towards more teacher-guided-student-use of technology within classrooms even when their comments were within constructivist approaches. That is, for deeper and longer lasting learning, for instance, educational programmes should be used by students rather than whole class demonstrations with the help and directions from the teacher. They raised the notions that, by doing so, students' involvement would be accomplished, participating actively into activities. However, three of them also mentioned ICT can be used in a context in which students can take full responsibility of their learning activities by means of various information sources, particularly the Internet.

> "By using technology in student-centred ways, it would be possible to have students who are able to question the information, thinking in a various ways and construct their own knowledge". (PT1, Int.)

> "ICT can change the ways to teach and learn. Throughout our school life [primary and secondary] we have been contented with what our teachers have provided for us. With the introduction of ICT into education now we can learn about whatever we want, in many cases we even do not need our teachers' help". (PT2, Int.)

> "In this new learning environment the student is active which is a plus for long lasting and deeper learning". (CT7, Int.)

> "Last year I examined a CD [educational package programme]. It provides the necessary information first, including some games enables you to repeat the subject, and then provides some questions to assess your progress. You as a student has the control and power over your learning". (BT1, Int.)

It is crucial to mention here that even though the student teachers believe that ICT can create new learning environments for students through student-centred uses of technology, they also see the teacher as a main instrument who still provides the basic information of the subject, on one hand, and creates new opportunities for students for active participation, on the other. CT6, for instance, points out that

> "I believe that ICT has the potential to change this rotten traditional teaching and learning. Having said this, sometimes we also need this approach [traditional teacher-centred]. Teachers should explain the subject as well". (CT6, Int.)

During observations (i.e. the observed lessons of L4 and L5) there was some evidence which illustrated that the use of technology and the participants' underpinning pedagogies were in a constructivist framework. However, the traditional teacher-centred approaches were dominant. As stated earlier, the current ways of incorporating ICT and change in teaching styles will be elaborated later in this chapter.

### 4.4.5 Summary and Discussion on the Participants' Perceptions and Understanding of the Innovation, ICT

As Atkin (2000) argues, the main purpose of educational change is to make an impact on the practitioners' beliefs, skills and perspectives. However, the practitioners' understanding of the intended change or an innovation differs from each other (i.e. through different subjective realities). Fullan (1991) argues that in the initial phase of the change or innovation utility, practitioners' understanding and potential benefits of the innovation must be clear for people involved in the process. In other words, individuals and institutions ought to know where they are heading (Hargreaves, 1997). The participants' perception of the innovation, ICT, have been analysed and discussed in this section.

The data suggest two aspects of the participants' understanding and perceptions of ICT. The first one is that ICT can enhance the ways the practitioners have done things. That is, ICT have the potential to make the ways of teachers' current teaching and learning activities easier, quicker and more efficient. The second one, on the other hand, was that ICT has the potential to change things around; the ways to teach and learn, creating new learning environments and providing new pedagogical approaches to teaching and learning. The latter would change the roles of the teacher and learner and the traditional practices of teaching and learning. Indeed, the introduction of ICT into education will be a success if the latter is successful. However, in both applications the added values of ICT cannot be ignored. The participants' perceptions of ICT mainly featured four roles for ICT; as facilitators, information sources, presentation tools and as a medium to change the nature of teaching and learning. This is summarised in Table 4.11 across different sources of data. The most commonly stated "added values" of ICT in science education are presented in Table 4.11. Even though they were not many, some participants made their comments on the other beneficial uses of ICT in educational settings such as tools for professional development, communication tools and administrative tools.

| Summary across the data sources | Interview | Observation | Questionnaire |
|---|---|---|---|
| ICT provides a new way of reaching vast amounts of information | * | * | * |
| ICT provides a variety of information sources and promotes knowledge-construction, searching for information, questioning, analysing, summarising and sharing it with others | * | * | * |
| Presentations are more effective by means of ICT methods | * | * | * |
| ICT provides visual experiences for the learners; abstract to concrete | * | | * |
| By means of simulations and related software it is possible to do experiments which are dangerous, too slow or fast | * | | * |
| ICT motivates the learners | * | * | * |
| ICT helps the students with learning difficulties and slow learners, and promotes individualised-learning | * | | * |
| ICT saves teachers' and students' time and increases productivity | * | | * |
| ICT provides constructivist learning environments | * | * | * |
| ICT promotes student-centred/led activities | * | * | * |
| ICT promotes collaborative and cooperative learning | * | * | * |
| ICT develops higher order thinking skills | * | * | * |
| ICT promotes active learning | * | * | * |

4.11 The Participants' understanding and perceptions of ICT across data sources

As can be seen from the Table 4.11, the participants' understanding of ICT as an innovation in education and particularly in science teaching and learning were twofold. In the table the asterix "*" is used to illustrate that the groups of participants agreed with the idea presented in general. In some cases, however, the researcher presented some statements which were perceived as crucial even if few participants raised the issue in the data. ICT enhances the current teaching and learning, and ICT has the potential to change the current teaching and learning practices. Most of the summarised items in the table illustrate that the participants' understanding of using ICT in science education were in a nature of cognitive-constructivist theory of teaching and learning. This supports the findings of many research reports (Dwyer et al. 1991; OTA, 1988/1995; Crawford, 2001; Ofsted, 2002; Altun, 2002; Acun, 2003; Lunenberg and Korthagen, 2003; Jakobsdottir, 2001; Schulz-Zander et al., 2002; Reid et al., 2003) and theoretical literature (Gros, 2002; Somekh, 2000; Gibson, 2001; Leach and Moon, 2000; Grabe and Grabe, 1998; Newton and Rogers, 2001; Pachler, 2001; Selinger, 2001a) about the value of ICT in education. However, as Fullan (1991:107) argues, "educational change depends on what teachers think and do". As illustrated in Table 4.11, the data revealed that the participants' beliefs about ICT were very positive, yet their actual uses of ICT in a format they perceived the appropriate use of ICT were very limited. That is, their beliefs and understanding of the potential use of ICT and their practices did not correlate with each other very much. In the following part the participants' attitudes towards ICT will be elaborated.

### 4.5. The Participants' Attitudes towards ICT

As Koohang (1989) argues user acceptance of computers in the classroom is one of the factors associated with successful implementation, adding that negative attitudes towards computers could be an impediment to using computers as teaching and learning tools. Levine and Donitsa-Schmidt (1998) state that attitudes and beliefs are predictors of behaviour and behavioural intentions. They argue Fishbein and Ajzen's (1975) theory of reasoned action which postulates that

> "beliefs about an object lead to attitudes toward it and that, in turn, attitudes lead to behavioural intentions regarding the object. Intentions, for their part, affect actual behaviours toward the object. Finally, there is a feedback loop in which bahavioural experience serves to modify beliefs about the object... attitudes toward computers use affect users' behavioural intentions (future desire), which in turn affect actual computer usage (experience)" (Levine and Donitsa-Schmidt, 1998:128).

In this study, the STs' questionnaire had a section in which STs' attitudes towards ICT were measured. This section consists of 26 items, divided into two groups: positive attitude statements and negative attitude statements. The section of the questionnaire related to attitudes towards ICT was based on several existing questionnaires and ideas after a careful literature review (Mikropoulos et al., 1998; Levine and Donitsa-Schmidt, 1998; Woodrow, 1991; Hunt and Bohlin, 1993; Askar et al., 1992). The instrument was a Likert-type instrument. For each item, the response was recorded in SPSS as strongly disagree = 1, disagree = 2, don't know = 3, agree = 4 and strongly agree = 5. A higher score on positive statements corresponds to a more positive attitude towards ICT. In contrast, a higher score on negative statements corresponds to a more negative attitude towards ICT. The coefficient alpha reliability score for attitude scales was .83.

Another source of data for deeper understanding of STs' attitudes towards ICT was the semi-structured interview. During interviews STs' own experiences, beliefs and desires were sought in order to reveal their attitudes towards ICT within their own conceptual frameworks and assist and validate the findings from other data sources. The participating lecturers' attitudes towards ICT, on the other hand, were elaborated by semi-structured interview and observation. For both groups of participants, it is important to note that their negative attitudes arise from other emerging barriers or frustrations from the setting throughout the ICT integration processes, such as lack of training, lack of sources, time, and so forth.

The data revealed that the participants' attitudes were threefold: anxiety, appreciation and interest, and usefulness. That is, there were patterns that they felt uneasy about using computers, and in some cases this uneasiness turned into fear, especially among student teachers. Having said this, all participants had appreciation and substantial interest in ICT and other technology. Also they all perceived and some of them actually used ICT as valuable sources in order to enhance current teaching and learning practice and change the traditional teaching/learning environments and understandings towards more cognitive/constractivist ways of instruction. Next each theme will be elaborated in detail.

### 4.5.1 Attitudes towards Perceived Values of ICT in Education

It is very encouraging that all the participants in the study had and exhibited very positive attitudes towards ICT. All participants have stressed that ICT can make things easier and enhance ongoing practices or create new learning environments for the learner. The participants' attitudes towards the usefulness of ICT in education in general and in science education in particular are presented.

| Usefulness of ICT | Lecturers | Student teachers |
|---|---|---|
| ICT improves students' learning | * | * |
| ICT improves and enhances the quality of teaching and learning processes | * | * |
| ICT creates new and favorable opportunities for individual learners | * | * |
| I have doubts about benefits of some educational software regarding learning outcomes | * | |
| ICT can be very useful for administrative purposes | * | * |
| ICT can increase productiveness | * | * |
| ICT changes the way to teach and learn | * | * |
| ICT saves time during classroom applications | * | * |

Table 4.12 The participants' attitudes towards the usefulness of ICT in education

Between two groups of participants, the lecturers and STs, there was not much difference regarding their attitudes towards ICT as useful tools. In this part, only two lecturers, L2 and L3, mentioned that they were skeptical about the benefits of some educational package programmes or software. All lecturers participating in this study emphasised that the ways to use ICT in teaching and learning activities matter. L4 also raised a question of reliability of the Internet-based information. STs, on the other hand, mentioned that these software or package programmes could help the learner understand the topic much easier than traditional approaches. Both the STs and lecturers also reported that ICT could be more useful or beneficial if it is used in an appropriate time and for appropriate subject. The teacher has the responsibility when and which resources would be used to gain more positive outcomes. Another stressed utility of ICT was using ICT as tools for administrative purpose and increasing productivity. There has been a detailed analysis and discussion about the participants' beliefs and perceptions of ICT under the section 4.4, entitled the participants' understanding of ICT. As discussed there, the participants' beliefs and perceptions of ICT were very positive and promising regarding their attitudes developed thorough either their actual experience or popular culture. As discussed earlier in this section, ICT related courses were first provided by the participating lecturers, L1, L2 and L4, when nobody asked them to do so. Unlike many changes in the Turkish educational system, this was a bottom-up change rather than a top-down one. They believed that prospective teachers need to be educated about the use of ICT in science education, and perceived ICT as a necessity for teaching profession. As a result of their personal efforts these courses have been taught since 1996 in three science programmes and Mathematics programme.

| **Items** | **mean** | **t-value** | **F-value** |
|---|---|---|---|
| *I find using ICT time consuming.* | 1.94 | 1.43 | .07 |
| The computer is like a private tutor. | 3.51 | .11 | 1.17 |
| The computer is an educational tool. | 4.21 | .62 | .28 |
| The computer is an effective learning tool. | 4.28 | .76 | .28 |
| *Systems are slow, I would be quicker using a book* | 2.00 | .60 | .00 |
| *Computers are a luxury for schools at any level.* | 2.48 | .17 | .06 |
| Using ICT, educators improve teaching quality. | 4.33 | 1.0 | .28 |

Table 4.13 Student Teachers Attitudes towards the usefulness of ICT: questionnaire results (*negative attitude statements in italic*)
* t-test: between gender for $p < .05$ ** ANOVA: between programmes for $p < .05$

As can be seen from Table 4.13, STs had very positive attitudes towards ICT regarding its usefulness in education, according to questionnaire results. The highest average score was 4.33, corresponding to over *agree* with the statement, "using ICT, educators improve teaching quality". The lowest average score, on the other hand, on positive attitude statements was 3.51, corresponding to nearer to *agree* with the statement, "the computer is like a private tutor". This was simply because of STs' perceptions of ICT as facilitators rather than devices which take over the teacher's role in the classroom. During interview, the majority of STs mentioned that, just like ICT, the teacher's role should be a facilitator as well. As can be seen from the Table 4.13, average scores on negative attitude statements were low, around 2 corresponding to *disagree*. This also illustrated that STs were positive about the use of ICT in education. In order to look at possible differences between male and female STs' attitudes, t-test was run. Even though male STs scored relatively higher than female STs, the differences were not statistically significant. According to ANOVA-test results there were not statistically significant differences between three science programmes, Physics, Chemistry and Biology, regarding STs' attitudes towards ICT on the items illustrated in Table 4.13. As was the case in STs' ICT capabilities, analysed and discussed earlier, under the title 4.3.3, STs of the Physics programme showed highest positive attitudes towards ICT, according to results of multiple-comparison Scheffe-test. This suggested that there was a slight correlation between STs' ICT confidence and their attitudes towards ICT; that is, the more confident they feel using ICT, the more positive attitudes they have towards ICT. Their high level of confidence and positive attitudes towards ICT also increased their actual use of ICT in their personal and professional needs. The crucial barrier to their use of ICT during observation was the availability of resources and access. During interviews the lecturers and majority of the STs stated that access to ICT resources had been an impediment.

It is obvious that the STs developed attitudes towards ICT through their training processes. Their statements during interviews showed some similar patterns about the usefulness and advantages of ICT in science education. Their actual uses of ICT also showed similarities as well. When questions were asked about their ICT training in both interview and questionnaire, their responses to the questions were very similar. They mostly mentioned that they used technology to present their subjects, to produce documents using word-processor and printer, to search for information from the Internet, to facilitate learning processes, and to communicate with others (i.e. for personal needs rather than professional needs). Some of the STs, PT7, PT9, PT11, CT7, for instance, had developed very positive attitudes towards ICT after taking ICT training courses and observing actual uses of ICT and other technology in their classrooms by their peers, lecturers or themselves. The majority of the STs reported that they had known nothing about computers and their uses in teaching and learning until they took the course, computer assisted science teaching, which was provided in the third academic year. Some of them mentioned that they should have been taught about pedagogical uses of ICT from the beginning of their training. Their positive attitudes towards ICT have also affected their behaviour and behavioural intentions in a very positive way. PT11, for instance, stated that

> "ICT creates a new way of teaching and learning... shifting from traditional ways of instruction to more student-cetred... Until I first took this course [computer assisted science teaching], I did not know much about computers. Our lecturer asked us to write a small programme about a topic, using LOGO. My topic was related to alternative current circuits. At the beginning stage it was really hard for me, but when I realised that what I was doing was working, I was so happy and relieved. After that, computer has become my best friend. Now I can use all technological devices available". (PT11, Int.)

All STs, whether they had the capability or not, reported that they wanted to use ICT in their prospective teaching profession since they believed that ICT was useful in teaching and learning processes. PT7 mentioned that

> "I want to develop my skills and want to be able to use more complex technologies since I believe that a good teacher ought to know about and use these sources to teach their subject... Why do not I provide more beneficial

> opportunities for my students to learn about Physics in more effective ways?". (PT7, Int.)

Among STs, overall, STs of Physics were more enthusiastic towards using ICT in teaching and learning their subject matter. The data suggested that this was because they had more direct experiences related to using ICT in teaching and learning processes in the Faculty than their peers from the other two programmes, including programming in LOGO.

In conclusion, all participants, lecturers and STs, had very positive attitudes towards ICT as useful tools, either they actually used them or not. They clearly appreciated value and potential of ICT. Very few of them have reported some possible negative features of ICT. However, they were cautious rather than being negative. They believed that ICT could be very useful in all segments of educational processes, from administrative purposes to teaching and learning. Their emphatic beliefs towards the usefulness of ICT in educational processes in general and in science teaching and learning in particular led to positive attitudes towards ICT. In turn, their attitudes led to increasing actual uses of ICT regarding personal and/or professional needs. This result was very explicit for the STs of the Physics programme since they reported relatively higher involvement in using various ICT sources. They also reported that they were willing to use ICT and develop their capabilities for future applications and keep up with future developments. Having said this, the impediments arising from current state of the settings, the Faculty or schools, affected their eagerness to use ICT appropriately.

### 4.5.2 The Participants' ICT Anxiety

By ICT anxiety, *psychological discomfort* (Speier et al., 2003), which might come from using new tools, concern over making mistakes and concern over possible technical and management problems, was meant. Brosnan (1998:225) argues that computer anxiety is likely to affect performance "when something unknown, or unpredicted, occurs during the interaction... Anxious individuals may therefore be able to perform a limited number of familiar tasks, but eager to end the interaction as soon as possible (or avoid it all together where possible)".

| ICT anxiety | Lecturers | Student teachers |
|---|---|---|
| Class management could be a problem during ICT use | * | * |
| Teachers and students' competent of using ICT in teaching and learning is crucial | * | * |
| I get nervous if some technical problems appear | * | * |
| I cannot cope with technical problems | * | * |

Table 4.14 The participants' attitudes towards ICT: anxiety

The data from interviews revealed that majority of the participants were anxious about using ICT in teaching and learning activities in respect to two crucial points. One was, as can be seen from Table 4.14, the concern or panic over any possible technical problems during using ICT resources. The other one was the concern related to class management. STs were more anxious about possible technical problems, so the majority of them, the ICT users, preferred to use simple resources such as OHP, slide machines, TV-video set for their presentations and demonstrations during presenting their assignments in the classroom. Out of 29, only four STs, three STs from Physics and one ST from Chemistry programmes, did not mention any kind of anxiety about technical problems. The participating lecturers, who used ICT and were willing to use in the future in their personal and professional needs, on the other hand, seemed less anxious since some of them, L1, L2, L4 and L5, reported that they might get help from their colleagues if needed. Direct quotations from interviews are presented next in order to exemplify the participants' ICT anxiety.

> "I cannot say that the capability I had is enough on this field. Our post-graduates or research assistants know much more about ICT than us in some applications. When we get stuck we might get help from them... I prefer to use OHP in the classroom since it is easier to use". (L2, Int.)

> "I can use computers, OHP and data-show at the level of incorporating them into a lesson, yet when some technical problems occur, I am not that competent to overcome them. However, I have not needed any help so far in this aspect. This does not mean that I will not need tomorrow. Using computers in the classroom is very hard because it is too crowded. When you take all students to the computer labs, there is limited number of computers, 4 or more students for one computer. Normal classrooms, on the other hand, do not have the infrastructure required". (L3, Int.)

> "When I need to draw a graph or chart [for personal needs] I just get stuck and need some help from someone else... It is not a shame to accept that I have not got the capability that I could use computers in the classroom. Indeed, I really want to develop my skills. Majority of my students know much about computers than I do". (L5, Int.)

Besides concern over possible technical problems both groups of participants stressed that they did not have appropriate training about technical and application skills of ICT. So, it is believed that lack of enough knowledge and/or skills or confidence was the driving factor of anxiety, as Divine et al (1995) argue.

> "I do not know much about computers. I believe that there are many good things about computers which we might benefit from, but I cannot experience them. I cannot write fast and find what I want from the Internet. I try to draw a table, I just cannot do it, then I leave it there. To be honest with you, I gained antipathy against computers even if I believe that computers are helpful in teaching and learning Physics". (PT3, Int.)

> "Since we did not get an appropriate training about computers, I stay away from computers due to anxiety, whether I could do it, or not. During group works, like some friends of mine, we stayed close to friends who were more familiar with computers". (PT6, Int.)

> "I do not know how to use these devices... and not knowing how to use them makes me depressed and discouraged. I get dispirited. I just draw pictures by hand at that time". (CT2, Int.)

> "When I used TV-video set and OHP, I tested the materials beforehand repeatedly so that I would not face any embarrassing situations. Thanks God, nothing happened during my presentation". (CT6, Int.)

> "I do not know much about computers, they seem very complex to me". (BT4, Int.)

As noted earlier, five of the participating lecturers (except L6) had the responsibility to teach ICT-related course before, yet they all reported that they were not so competent that they could overcome any technical problems or mistakes during using ICT. They (L1, L2, L3 and L4, for instance) separated STs into two or three groups to overcome some possible management problems in order to provide more practice for STs with a relatively small number of class-size. It is important to note here that the lecturers have not used computers in the classroom in their teaching, apart from ICT-related courses. Having said this, as it will be elaborated in detail later in this chapter, their understanding and strategy of integrating ICT across curriculum were more student-centric. During observations, the lecturers' use of ICT and other technology were very limited and traditional, yet they let STs use ICT during their planning and presentation.

In Table 4.15, the data from STs questionnaire are presented. Simply looking at the overall means on each item, it can be seen that STs were relatively anxious over the item, "*I get anxious each time I need to learn something new about ICT*", with 3.40 mean. The t-test results revealed that overall gender was not an important variable in respect to ICT anxiety. Only on one item, "*The use of ICT in the educational process generates technical problems*", statistically significant difference was found between male and female students ($t = 3.01$, $p < .05$), indicating that male STs were more anxious about possible technical problems.

| **Items** | **mean** | **t-value** | **F-value** |
|---|---|---|---|
| I find using the computer easy. | 3.26 | 1.80 | 4.04** |
| *It would be hard for me to learn to use ICT.* | 2.24 | .70 | .007 |
| *I cannot cope with all the ICT jargon.* | 2.75 | .66 | .14 |
| *I feel uneasy when people talk about ICT.* | 2.07 | .22 | 6.99** |
| I feel comfortable working with ICT. | 3.46 | 1.42 | .78 |
| *I get anxious each time I need to learn something new about ICT.* | 3.40 | .78 | .51 |
| *The use of ICT in the educational process generates technical problems.* | 2.90 | 3.01* | .95 |
| *I feel uncomfortable thinking of me using computers in the classroom.* | 1.68 | .71 | 1.88 |
| *I feel lost in the information age.* | 2.62 | .58 | .07 |

Table 4.15 Student teachers' ICT anxiety: questionnaire results (*negative attitude statements in italic*)
* t-test: between gender for $p < .05$ ** ANOVA: between programmes for $p < .05$

According to ANOVA test results, only on two items, "I find using the computer easy" and "*I feel uneasy when people talk about ICT*", there were statistically significant differences between three science programmes, ($F = 4.04$, $F = 6.99$, respectively, $p < .05$). Multiple-comparison Scheffe-test showed that on both items STs of Physics department were the least anxious group. Overall, on all items, STs of Physics showed a low level of anxiety among the three programmes.

### 4.5.3 The Participants' Appreciation of and Interest in ICT

Overall, the participants reported a positive appreciation of using ICT and other technology in their personal and professional needs. Thus, some of them have already developed an interest in using ICT in teaching and learning. Among those, L3, PT7, PT9, PT11 and CT7 were more enthusiastic in their own ways. They all stressed that they believe in the potential of ICT in the processes of teaching and learning, and they all reported that they would carry on developing their ICT capability and catch up with the developments in their careers. In conjunction with this, all other participants also reported positive thoughts and attitudes towards using ICT in teaching and learning, yet their tendency was more *platonic* rather than making some efforts to learn more about ICT and its use in teaching and learning. In practice, however, all lecturers had developed their required ICT skills and used ICT resources in their personal and academic needs, whilst they were reluctant to use them in their teaching activities. Of course, this did not mean that their reluctance or avoidance were due to their dissatisfaction or antipathy towards using ICT in teaching and learning, but mostly due to other factors influencing the process of ICT integration, which will be elaborated later.

| ICT appreciation and interest | Lecturers | Student teachers |
|---|---|---|
| I believe the use of ICT is advantageous in every aspect | * | * |
| I want to benefit from ICT to teach science [Physics, Chemistry, Biology] | * | * |
| ICT is a necessity in the information age for all | * | * |
| I want to have ICT training for personal and professional needs | * | * |
| I want to learn more about ICT and its appropriate uses in science education | * | * |

Table 4.16 The participants' attitudes towards ICT: appreciation and interest

As illustrated in Table 4.16, data from the interviews revealed that the participants' intentions were in favour of learning and using ICT in their future practices. They reported that they perceived ICT as a part of their profession in the information age. Their willingness to learn more about ICT and its uses in teaching and learning were the predictor of their appreciation and interests. The following quotations exemplify their appreciation and interest in learning about ICT and its use in education.

> "I believe that using these tools in teaching and learning should be a routine for teachers and students like a piece of chalk. First of all, I should say that all lecturers here, who make use of them or not, believe that using these new tools is very useful… I personally would like to develop my ICT skills and to do research about appropriate integration of ICT in Science teaching and learning". (L1, Int.)

> "In-service training about the use of ICT should be provided for all lecturers. I would love to take part in a course which provides more practical uses of ICT in teaching and learning rather than theoretical knowledge". (L2, Int.)

> "I would like to learn more about ICT for two main purposes: to benefit from them as much as possible for my own academic studies, and to provide more quality teaching for our students". (L6, Int.)

As can be seen from the quotations, the lecturers were not happy with their past experiences, and they would like to learn more about ICT.

> "These tools improve the quality of teaching and learning. Teachers' tasks would be easier, and students understand the subject much better… I want to develop myself in using technology to teach Physics. First thing I will do is to buy a computer when I graduate". (PT5, Int.)

> "We are living in the Information age, we cannot do anything without technology. I am feeling sorry for myself for not being capable to use ICT at the level I desire. To be a good teacher, I will definitely develop myself in this area". (CT4, Int.)

Data from the STs' questionnaire are presented in Table 4.17. As can be seen, STs had positive attitudes towards ICT. The highest mean score was on the item, "*I would like to know more about ICT*", with 4.49. Overall, the data revealed that STs appreciated ICT. T-test results showed that there is no statistically significant difference between male and female STs. Only on one item, "*I wish computers had never been invented*", significant difference was found between male and female STs ($t = 1.41$, $p < .05$), indicating that male STs appreciated the invention of computers less than female STs. Having said this, both groups' means were less than 2 corresponding *disagree*.

| **Items** | **mean** | **t-value** | **F-value** |
|---|---|---|---|
| *People managed before without computers, so computers are not necessary now.* | 1.56 | .445 | 6.02** |
| I would like to know more about ICT. | 4.49 | 1.65 | .11 |
| I think I would enjoy using a computer. | 4.36 | 1.02 | .33 |
| *The world would be better off without computers.* | 1.42 | 1.08 | .92 |
| ICT training is a priority for me | 3.62 | 1.24 | .15 |
| *I don't see the need to learn about ICT* | 1.80 | .90 | 3.14** |
| Computers are fascinating. | 3.56 | .63 | 1.16 |
| Using ICT broadens your horizons. | 4.17 | .61 | .73 |
| I would be glad seeing my students using ICT. | 4.20 | 1.3 | .53 |
| *I wish computers had never been invented* | 1.41 | 2.0* | 1.05 |

Table 4.17 Student teachers' appreciation of and interests in ICT: questionnaire results (*negative attitude statements in italic*)
* t-test: between gender for $p < .05$ ** ANOVA: between programmes for $p < .05$

ANOVA test results also showed that there was not much difference between three science programmes regarding the STs' appreciation and interest of ICT. Only on two items, "*People managed before without computers, so computers are not necessary now" and* "*I don't see the need to learn about ICT*", statistically significant differences were found between STs of three programmes, ($F = 6.02$, $F = 3.14$ respectively, $p < .05$). Multiple-comparison Scheffe-test showed that on both items STs of Physics department had a better appreciation of and developed more interest in ICT and its use in teaching and learning. Overall, on the majority of the items, STs of Physics showed higher level of appreciation and interest. The data suggested that there was a positive correlation between STs' previous experience with ICT or use of ICT and their level of appreciation of and interest in ICT.

**4.5.4 Summary and Discussions on the Participants' Attitudes towards ICT**

Previous research shows that practitioners' attitudes towards ICT are crucial in successful integration of ICT in teaching and learning (Koohang, 1989; Woodrow, 1991; OTA, 1995; Lawson and Comber, 1999; Simpson et al., 1998; Simpson et al., 1999; Brosnan, 1998; Hunt and Bohlin, 1993). In this study, the data suggested that the participants had positive attitudes towards ICT and its uses in teaching and learning their subjects. Their attitudes derived from their beliefs and perceptions and from their relatively limited experiences of ICT. The participating lecturers' negative attitudes towards ICT were the skepticism about the quality of software to be used (i.e. misleading simulations or models of science concepts or events) and its impact on learning, and about the creditability of information presented on-line. Both STs and lecturers also pointed out that class management would be a problem during the use of ICT. They stressed that high number of class-size, lack of enough sources and teachers' strategies of using ICT in subject teaching might be main impediments of successful class management.

The participants' attitudes towards ICT were categorised as threefold. First of all, all participants had a good appreciation of the positive potential of ICT in all aspects of education from administrative uses to teaching and learning special subjects. This supports the findings of Simpson et al. (1999), Simpson et al. (1998), Woodrow (1991), Altun (1996), Altun (2002) and Acun (2003). Second, even though the participants had mentioned positive attitudes towards the usefulness of ICT in education, majority of them also possessed ICT anxiety. They indicated that possible technical and management problems were the barriers hindering their use of ICT even in the course related to ICT training and might be barriers for their future uses in their prospective subject teaching. It is believed that this anxiety towards ICT was one of the barriers and made especially STs use more conventional technologies such as OHP and slide-machine during their presentations rather than using computers, data-show, presentation software, the Internet, and so on. The data also revealed that available support for the user was very crucial to reduce the level of anxiety and increase the use of ICT for personal and professional applications. As Granger et al. (2002)' study suggests appropriate full-time technical support is necessary to integrate ICT into teaching and learning activities. They also found informal and just-in-time learning as most useful for teachers. Third, the data revealed that the participants appreciated the introduction of ICT into education and some (e.g. L3, PT7, PT9, PT11 and CT7) developed interest in learning more about ICT and its use in teaching and learning. Regardless of what their ICT capability is, all mentioned that they would like to learn more about the use of ICT, and if the conditions were satisfactory, they would incorporate ICT in their teaching processes consistently. However, the majority of the participants have not made a great deal of efforts to learn more about ICT, other than they were given.

As to the gender issue, on all three themes -usefulness, anxiety and interest- there were no statistically significant differences between male and female students, except for on a few single items, even though on the majority of items male students showed slightly positive attitudes towards ICT and its use in teaching and learning and were less anxious about using ICT in teaching and learning their subjects. These findings support Nash and Moroz (1997), Koohang (1989) and Askar et al. (1992)'s studies, and contradict Marshall (1997)'s study. Similarly, as to the subject issue, although STs of Physics had slightly higher positive attitudes towards ICT and its use in teaching and learning, overall this was not found statistically significant according to ANOVA test results, except for a few single items. As many other studies such as Koohang (1989, Altun (1996), Altun (2002), Levine and Donitsa-Schmidt (1998) have already suggested, previous ICT experience usually lead to positive attitudes towards ICT and its pedagogical uses, in turn, positive attitudes towards ICT might not necessarily lead to increasing the use of ICT in teaching and learning. As Divine et al. (1995) put it, no matter how useful computers are perceived, the practitioners would be reluctant to use them if they lack confidence in their ability to use them appropriately. However, Granger (2002) found that ICT skills alone are not enough for successful implementation, factors such as attitudes, personal philosophy and access to skills training are also contributing to the process of appropriate and successful implementation.

### 4.6 The Integration Process of ICT within the Case

As presented earlier in this chapter, technology related training goes back to late 1980s in the case under investigation. International literature reveals that the efforts to introduce computers to teachers and students to integrate technology into curriculum have been made since early 1980s in developed countries (Downes et, al., 1995; Hjarnaa and Bollerslev, 1995; Sakamoto and Gardner, 1995; Gorny, 1995; Owston, 1995; Grandbastien, 1995; Davis, 1992; Alev, 1997). From the beginning efforts, it is obvious that each country had had a similar experience in which students were taught about computers through separate courses related to new technology. In this study, the data revealed that in the Fatih Faculty of Education secondary science programmes and mathematics programme also introduced computer training as discrete courses, Introduction to Computer Science I-II, since late 1980s. Especially having observed and experienced ICT related developments throughout their postgraduate studies in western countries such as Canada, USA and UK, the three participating lecturers from Science programmes, L1, L2 and L4, and another one from Mathematics programme introduced another discrete course, in which the intention was to educate STs how to incorporate ICT in teaching and learning Science and Mathematics. As to the educational change issue here, the lecturers' attempt to provide a new course with a new understanding was a bottom-up change in nature. This supports the lecturers' positive beliefs of and attitudes towards ICT, analysed and discussed earlier.

When asked in the interview what were their intentions to provide these courses in four programmes (Mathematics, Physics, Chemistry and Biology), L2 said:

> "Throughout our Doctorate programmes we understood that with the traditional didactic approaches only, success is limited in education. And, we believed that computers can be used very effectively in physics education. Of course that does not mean that they exploit the full potential of technology there, but by time passing they have tried to improve the use of technology in education. At that time in our country computers only could be used in certain centres as typewriters. We believed that we could improve the use of technology within our own faculty regarding of what has been happening in the western world in this

> area... We opened the course, 'computer assisted physics education'. We were not professionals in this area. Maybe within early years we could only provide very limited activities, but I can proudly say that it has been improving since then". (L2, Int.)

He also defined their first intentions or aims of establishing these discrete ICT courses as follows;

> "Firstly, our basic aim was to improve physics education, making use of the computers or new technology in teaching and learning. Secondly, to improve the standards in education, Ministry of National Education had established 'Curriculum Laboratory Schools' and alongside these schools many others have computer labs and related technologies. However, maybe 95% or 99% of the practising teachers did not know how to turn on/off a computer... By providing these courses in pre-service programmes we intended to educate our prospective teachers of the quality, being able to make use of these technologies. What we have achieved might be controversial and might not have been that effective, but we have tried to get some attention that there are some other ways of teaching and learning and must be improved". (L2, Int.)

As elaborated earlier in the background information, with the latest re-structuring of ITE in Turkey, another course, called 'Instructional Technology and Material Development', was proposed by Higher Education Authority (HEA) and thus has been provided since 2001 in the three science programmes. Having set some main targets for the course (YOK, 1998), HEA let the lecturers decide the new targets or standards. For this purpose, during interview L3 reported that

> "The course, previously known as Computer Assisted Physics Teaching, became an elective course, in the new curriculum, for which the responsible lecturers set the targets. We also have another compulsory course, named Instructional Technology and Material Development, which must be provided in all Faculties of Education. Lecturers from different universities gathered together in Ankara, including one from our Faculty. They decided about the content of the course, in which mainly they chose the sub-tittles of a book. Even if it was not an official document [one page], it follows the sub-tittles of the book, indicating what should be done week by week". (L3, Int.)

As data has indicated, there are three different discrete ICT-related training courses in order to educate STs, including an elective one. This shows that, with Yeomans et al (1995)'s words, a vertical ICT integration model has been in place from the beginning of the introduction of ICT. The placement of ICT resources also is of an add-on in nature, clustering in three separate computer laboratories, and one classroom with presentation tools such as OHP and data-show. The literature describes this vertical ICT integration as an *addition* (Cornu, 1995) rather than an appropriate integration in which the expectations from ICT would be met. Norton (1994) points out that discrete ICT courses hold little assurance in regard to change expected from ICT.

However, even though there was not any written cross curricular ICT provision, the lecturers have tried to incorporate ICT in their teaching process and encourage the others to make use of ICT in delivering across curricular activities. It is clear that if people involved in the process of integration of ICT do not hold the notion that ICT is useful, and so learning about ICT is useful, resistance to change can be expected (Fullan, 1991; Wooley and Booker, 2001). The participating lecturers clearly stressed that they supported the change in the phenomenon; actually they were the ones who initiated the change process in the Faculty. They understand and view ICT as useful tools to improve teaching and learning science and to better educating prospective teachers. Thus, three science ITE programmes themselves have attempted to adopt a hybrid model of ICT integration, through three discrete courses (a compulsory one in the first stage of teacher education and a selective and a compulsory one in the second stage of teacher education for all STs) and through the lecturers' own efforts and willingness of gaining the benefits of ICT across other courses. The lecturers reported that lack of lecturers trained about ICT and its appropriate uses in science teaching and learning has been a crucial barrier to succeed the intentions and targets set in the beginning. As L1 put it:

> "We have attempted to create more chances for student teachers to practise with technology, directing and encouraging them towards using instructional technology in their teaching and learning activities... What we should do to make use of technology in educating STs has been decided beforehand for each academic year in our annual meetings... I must admit we have had some crucial constraining factors, which have made our plans difficult to achieve, such as lack of enough and appropriate infrastructure, trained staff, class-size, and so forth". (L1, Int.)

How successful they have been and what they have done to integrate ICT into their teaching practices will be elaborated next.

### 4.6.1 The Impacts of ICT in Teacher Education: The Question of Change in Pedagogy

Muddux (1998:132-133) states that

> "The lack of information technology integration in teacher education is more critical than lack of integration in schools, and this problem must be solved before integration in public/state schools can be accomplished... It is a truism that if there is a difference between what we [teacher educators] tell students to do and what they see us do, they are much more likely imitate what they have seen. If they experience the power of technology during training, the chances are good that they will desire to make use of that power in their own classrooms".

In this study, one of the aims was to investigate the lecturers' use of ICT in respect to improving their own teaching and educating prospective science teachers in incorporating ICT in their teaching and learning processes, that is, to what extent they model the use of

ICT in the Faculty. Watson (2001:251) points out that "ICT is often perceived as catalyst for change, change in teaching style, change in learning approaches, and change in access to information".

#### 4.6.1.1 The Impact of ICT in Teaching Styles

The data, from interview and observation, revealed that, although ICT has not been used regularly, the impacts of ICT in the participating lecturers' teaching strategies were twofold;

- improving the quality of the traditional instruction which is teacher, content and school-centred (i.e. all lecturers) and;
- changing the traditional instruction to constructivist ways of instruction which were described as student-centred, less context and content-bounded (i.e. L1, L2, L3, L4, L5).

As shown in Table 4.18, apart from L6, the lecturers had performed both types of applications in their teaching. That is, the data suggested that the use of technology did not exclude one or the other in practice. Both impacts have been experienced or observed concurrently in each lecturer's teaching, even sometimes within one lesson. The table below represents the lecturers' uses of ICT and changes, which were mentioned by the lecturers and observed by the researcher. Their general beliefs about teaching and learning were not taken into consideration particularly. Rather, they were asked about; whether ICT could change the ways to teach and learn Science; and how ICT has affected, if ever, their teaching processes in practice. It is worth noting here that especially during observations the lecturers' teaching strategies varied in accordance with the subject being taught. In all subject courses (i.e. related to physics, chemistry and biology) the lecturers preferred the teacher-centred instruction, whilst in methodology courses they mostly preferred student-centred or constructivist approaches, whether having used ICT and other technology, or not.

| Participants | Change due to ICT use (Y/N) | Role of the teacher | Role of the learner | Technology use | Indicators for changes in teaching strategies |
|---|---|---|---|---|---|
| L1 | Y | Transmitter, guide | Researcher, sometimes expert, knowledge transmitter, collaborator | Student presentation, information source, collaboration (group studies) productivity and administrative purposes | Student-led activities and presentations, collaborative learning, learning by programming, research (group studies) |
| L2 | Y | Guide*, information transmitter (presenter) | Researcher*, sometimes expert, transmitter*, collaborator*, active listener (mental involvement)* | Teacher presentation, student presentation*, productivity and administrative purpose, collaboration*, communication | Student-led activities and presentations*, collaboration*, learning by programming, teacher exposition*, research (group studies)*, preparing lesson plans |
| L3 | Y | Guide*, transmitter (presenter)*, collaborator | Researcher, knowledge transmitter, collaborator | Teacher presentation*, student presentation, productivity and administrative*, group studies, information sources*, collaboration, communication | Student-led activities, student presentations, collaboration, learning by programming, research (group studies), teacher presentation*, preparing lesson plans |
| L4 | Y | Guide*, transmitter (presenter), collaborator | Researcher*, sometimes expert, knowledge transmitter*, collaborator*, active listener (mental involvement)* | Teacher presentation, student presentation*, productivity and administrative, group studies*, information sources, communication | Student-led activities and presentations*, collaboration*, research (group studies)*, preparing lesson plans |
| L5 | Y | Learner*, listener*, transmitter | Researcher*, knowledge transmitter*, collaborator* | Student presentation*, teacher presentation, collaboration*, cooperation* | Student presentations*, collaboration*, cooperation*, research (group studies)* |
| L6 | N | Transmitter* | Listener* | Preparing lesson plans, information sources, teacher presentation* | Teacher presentation or demonstration* |

Table 4.18 Change in teaching strategies *Observed

As to the lecturers' use of ICT issue, however, the data revealed that they mostly made use of advanced ICT sources such as the Internet (i.e. for reaching information to prepare lesson materials or to search for academic studies and for personal communication), software (i.e. SPSS, Excel for their academic studies), and word-processing at home or in their offices, which supports Pedersen and Yerrick (2000)' findings. Thus, it was evident that the lecturers made a substantial progress to incorporate various ICT sources and uses into their personal lives, either for personal needs or for academic needs.

They mostly used ICT and other technology as presentation tools, information sources, administrative, communication and productivity tools. In the applications of teaching, which were teacher-centred, all participating lecturers made use of ICT and other technology sources as presentation or demonstration tools. In these applications, their roles could be described as knowledge transmitters or presenters, whilst students' roles were active (through discussions) or passive listener and learner. These types of ICT use enhanced the quality of their current teaching strategies, making things easier and more effective, saving time, producing hand-outs for students, and so forth. Similar results were found in previous research (Altun, 1996; OTA, 1988/1995; Ringstaff et al., 1996; Simpson et al., 1999). However, it is evident that the intended change, integrating ICT into teaching and learning, will not be secured with this limited function of ICT in teaching and learning processes. Levin (2000) describes successful learning environments, referring OECD (1996)' report, "as being meaningful and motivating for learners; taking into account what learners bring; interweaving knowledge, problem solving and application; fostering active learner involvement, and allowing learners to control their own performance" (p.161). This definition falls under the constructivist perspectives of teaching and learning. As previous literature stresses, ICT has the potential to support constructivist ways of teaching and learning, in which the intended change would be successful (Newton and Rogers, 2001; Loveless et al., 2001; Becker, 2001; Gibson, 2001; Naylor and Keogh, 1999; Vrasidas and McIsaac, 2001). White (1995) asserts that educating prospective teachers for a constructivist environment requires active student involvement, reflection, modelling and creating a learning community. Integrating ICT into teaching and learning processes in ITE might provide opportunities for those to happen. In conjunction with this notion, there was evidence that the lecturers made substantial attempts to create constructivist environments for STs, which include the use of ICT during the processes in or out of the Faculty.

The data revealed that, as five of the participating lecturers reported during interviews and put into action during observations, they encouraged and allowed or forced STs to use ICT across the other courses through group works, research and student presentations, guiding them about when and how to make use of ICT in order to gain better benefits. The following quotations illustrate the changes observed and mentioned by the lecturers in their teaching styles.

> "Technology affected my teaching as a contributory factor rather than causing a complete change. Using presentation tools made my presentations easier and effective… I usually prepare worksheets on a computer for my students. Knowing that students could have *access to the information* sources such as the Internet, I have given more homework or assignment to students. They *search for information* and create reports, *using word-processing*, and *present* their works to the class, usually using technology as presentation tools… I can say that the majority of students are very enthusiastic about using technology throughout their group studies". (L1, Int.)

> "As far as I am concerned, using technology as only *presentation tools* such as data-show and OHP, we generally use here, is the same with the traditional *plain-explanation* method... We, in some courses such as *special teaching methods,* give assignments to students as *group studies*, they generally make use of ICT to complete their reports, using the Internet as an *information source* and *writing their reports* on computers, and then they *present their studies* in the classroom. ICT creates new opportunities in this sense, accessing to information in a new way, constructing your own knowledge, learning how much you want. Teachers are not the only information source in this age". (L2, Int.)

L3 and L4 mentioned similar uses of technology and experiences in their classrooms, either by themselves or student teachers. L5, on the other hand, having only used conventional presentation tools such as a slide-machine and OHP in his teaching, mentioned that he asked student teachers to use ICT more during their activities. However, during observations in L5's classroom the highest level of ICT use by a group of STs was observed throughout two lessons. In these lessons, which were based upon presenting their research-based study (group study), STs exemplified a good model of using ICT in ways that support and facilitate the process of learning the subject. The process embraced certain characteristics of constructivist approach:

- authentic learning: student teachers, as group, chose the subject to be investigated, set their aims and timetable, decided about the ways to reach their target, and more importantly lived the process on purpose (i.e. to learn more from the experience);
- cooperative learning: they formed subgroups and decided about each one's responsibility (i.e. to search for theoretical information (verbal or visual) from the Internet and library about sound and light pollution, to collect experimental data (measuring the level of sound in different parts of the city of Trabzon and houses and recording the scenes by using a digital camera), to illustrate one's daily life by playing drama and recording the play by camera)

- collaborative learning: some of the students had more than one responsibility in different subgroups and each member of the group helped and shared his/her thoughts and findings with each other and they structured their final report in a presentation format (i.e. transparencies for OHP, video-tape and a diskette which included pictures downloaded from the Internet) and finally they presented their work in the classroom;
- active/inquiry-based learning: STs were mentally and physically involved in the learning process, which included collecting theoretical information/data and field data, analysing and comparing the data sets, and sharing and discussing the results with others.

It is evident that all those experiences were valuable for learning, and in each phase the role of the technology was crucial. However, these types of ICT use were uncommon for all lecturers. In these types of applications, STs mostly made use of the Internet to search for information, word-processing to write their report, sometimes software to analyse the data they had collected and data-show or OHP to present their work. Out of a total of 18-hours observation, only in five lessons ICT or other presentation tools were incorporated into teaching and learning processes. In the applications, which could be described as student-centred, the lecturers' roles were guide, facilitator, sometimes collaborator and learner, whilst the STs' roles were researcher, active learner, sometimes expert, collaborator, knowledge transmitter.

It is believed that the lecturers' background was an influencing factor in the processes and strategies of integrating ICT into their teaching. First, all five lecturers have had the responsibilities to teach ICT-related courses, which might have affected their understanding and attitudes, and so their practice. Second, those were the lecturers (i.e. L1, L2 and L3) who opened ICT-related courses at the first place in 1996 in this Faculty, and they were well aware of the potential of ICT, which would make substantial positive changes in teaching and learning Science as well as in developing STs' ICT capabilities using ICT in a constructivist framework.

As elaborated earlier in this chapter, the lecturers' perceptions of ICT were very positive regarding its potential to change current teaching and learning practices. Apart from L6, the lecturers stressed that the nature of teaching and learning would change from traditional teacher-centred to constructivist ways of instruction if the new teaching and learning environments were arranged for both teachers and students with respect to the conditions required for successful integration. L6, on the other hand, made his remarks on potential benefits of ICT that ICT could improve the quality of traditional teaching and learning within classrooms, providing up-to-date information, easing presentation or demonstration, easing the teacher's workload during preparation and planning of lessons. In his teaching, he usually made use of conventional technology such as TV, slide-machine, OHP to present the subject.

In conclusion, having looked at the lecturers' ICT capabilities, understanding and attitudes, which were very promising in order to exploit the full potential of ICT in teaching and learning processes, it is evident that the lecturers seemed to be reluctant to integrate ICT into their own practices on a regular basis. However, their reluctance was not the only reason for limited use of ICT.

**4.6.1.2 The Participating Lecturers' Stages of Adoption and Concern**

Fullan (1991) points out that teachers play the most important role in any educational change. The participating lecturers were the ones who have attempted to integrate ICT into teacher training programmes under investigation, and they will continue to do so. As the ACOT project and many other studies illustrated, the practitioners go through stages with time as they develop their understandings and attitudes and learn to incorporate technology into their teaching and learning processes (Dwyer et al, 1990; Comber et al., 1998). Having examined the participating lecturers' ICT capabilities (see Table 4.3; 4.4), perceptions of ICT (see Table 4.9), attitudes towards ICT (see Table 4.12; 4.14; 4.16) and actual use of ICT in their teaching (see Table 4.18), their profiles were compiled as seen in Table 4.19.

As to the lecturers' stages of concern issue, Persihitte and Bauer (1996) point out that it is more likely that an individual would have various levels of concern, as it was the crucial part for the researcher to determine at which stage an individual lecturer would be in this study. For each individual, their most mentioned concerns about ICT and its pedagogical use were specified and then grouped in view of the seven stages defined by the current literature (Persihitte and Bauer, 1996). Then for each individual, in consideration with the most influential one, likely to prevent him from integrating ICT into classroom activities, individual profiles were compiled.

| Stages of Concern | | | | | | |
|---|---|---|---|---|---|---|
| | Refocusing | | | | | |
| | Collaboration | | | | | |
| | Consequence | | | | L1, L3, L4 | |
| | Management | | L6 | | L2 | |
| | Personal | | | | | |
| | Informational | L5 | | | | |
| | Awareness | | | | | |
| | | Entry | Adoption | Adaptation | Appropriation | Invention |
| Stages of Adoption | | | | | | |

Table 4.19 Relationships between stages of concern and adoption of ICT

Similarly, the participating lecturers' profiles related to stages of adoption were determined from the data, based upon the interviews and observations; that is, their ICT capabilities, understandings, attitudes and actual use of ICT (i.e. resources they used and the ways to incorporate them into their teaching) were taken into consideration to determine their adoption levels. After deciding about the most possible level they would occupy, the researcher combined both tables, as illustrated in Table 4.19, to seek whether there were a relationship between their stages of concern and stages of adoption. As seen in Table 4.19, the relationship between two sets was that as the lecturers' levels of concern moved from the 'self-concerns' to 'task and impact-concerns', their adoption levels also moved from entry to appropriation. That is, the level of technology use heightened as the lecturers overcame their self-concerns, especially related to ICT capabilities. This supports studies of Benzie (1999), Persichitte and Bauer (1996), Comber et al. (1998) and Snider et al. (2002), indicating that practitioners' level of concerns have an impact on integrating ICT into teaching and learning.

It is worth noting here that the results do not represent the developments in the lecturers' concern and adoption stages through a time period or training, yet the results show their profiles at the time this study was carried out. As Comber et al. (1998) assert, knowing about the participant' current stages of concern and adoption of the innovation, ICT, may be a better guide to the current policy or practice to move forward. Thus, each lecturer's profile was compiled through the following reasoning.

First of all, the lecturers did not integrate ICT into their teaching in a regular base. That is, the use of ICT in the Faculty was still limited. Thus, in determining the lecturers' profiles, their mentioned or observed ICT uses were taken into consideration. It is worth noting here that all lecturers reported that the Faculty did not have adequate ICT sources and infrastructure. Thus, what they have done in order to incorporate and integrate ICT in their teaching severely depended on what they could do with limited sources available in the Faculty. It is believed that determining their individual profiles would be helpful to take action and move forward.

The data revealed that the participating lecturers, apart from L5, had certain characteristics in respect to integrating ICT into their academic works and personal life. They made use of ICT as information sources (i.e. the Internet, data-bases and CD-

ROMs), as administrative and productivity tools (i.e. keeping records, word-processing, producing presentation materials, and so forth), for personal and academic needs (i.e. e-mail, doing statistical analysis with the help of software such as SPSS, writing their research reports and drawing graphs/charts). L5, on the other hand, only used computers as word-processing tool and producing presentation materials for OHP. In their teaching, they mostly made use of ICT and other conventional technological devices as presentation or demonstration tools (i.e. data-show, OHPs, slide-machine, TV-Video set, digital camera). All lecturers usually used OHPs as presentation tools. L1, L2 and L3 sometimes used data-show as presentation tools. Having said this, it was not the only type of the use of ICT in the classrooms. Some lecturers have made substantial attempts to integrate ICT into student-centric activities. Those were the decisive factors to determine the lecturers' profiles of integrating ICT regarding stages of adoption.

Determining the lecturers' stages of concern was really hard since all of them mentioned some certain concerns that each one might be critical with respect to its impact on integrating ICT into their teaching. However, the researcher sought the most influential one, which might hindered the use of the innovation. Next, each lecturer's profile will be elaborated in a more detailed way.

**L1** (*consequence-appropriation*) was capable of using various ICT and other technological tools confidently. In addition to his using of ICT as presentation tools in his teaching, more importantly during interview he mentioned that he created opportunities for student teachers and encouraged them to make use of ICT through group studies, research, student-led presentation, programming, and so forth. He believes that ICT sources would be more useful for teaching and learning if they are used across curriculum in a way that students are active participants of teaching and learning processes and the teacher is a guide or facilitator. Although he mentioned that managing ICT in the overcrowded classrooms was very difficult and insufficient, he usually, cooperating with other lecturers (i.e. L2 and L3), divided STs in two or three groups to create opportunities for STs to present their research. Thus, his main concern was about the impact of ICT on students' learning about the subject and pedagogical use of ICT, thus he was found at the *consequence* stage. He also mentioned that these individual or group activities, mostly included the ICT resources in preparation and presentation stages, increased STs' enthusiasm to use and learn more about technology. Consequently, he was found at the *appropriation* stage.

**L2** (*management-appropriation*) was also capable of using various types of ICT and other technology even if he mentioned that he was not so confident on using advanced technology. Like all the others he used ICT and other available technologies as presentation tools such as OHPs and sometimes data-show. In this sense, he used presentation tools to enhance his traditional classroom practice. Like L1 he also made substantial attempts to create more opportunities for student-centric classroom activities, giving assignments to students (either research-based or literature-based), encouraging them to make use of ICT in all steps of their works, from preparation to presentation. Although there were many impediments mentioned by the lecturer to integrate ICT into classroom activities in a way that each student teacher gets equal opportunity to practise, these student-sensitive activities were the indicators of his profile as *appropriator*. He had positive attitudes towards ICT, and believed that ICT could be very beneficial as both teaching and learning tools, yet he was skeptical about the benefits and quality of educational software available and the credibility of information presented over the Internet. Having said this, he mentioned during interview that he integrated ICT into constructing his own knowledge, using ICT tools such as the Internet and educational software in the past. He made strong emphasis on classroom organisation, management and lack of time and enough resources to support more student-centric applications. For this reason, he was placed at the *management* stage of concern.

**L3** (*consequence-appropriation*) was one of those who had considerable enthusiasm towards using technology in teaching and learning science. In the teacher education programmes, his main emphasis was on student-centred use of ICT, which, he believed, provided opportunities for student teachers to be active participants of the learning processes, seeking knowledge, analysing information, drawing conclusion, and so constructing their own knowledge. One of his strategies to do so was to let student teachers struggle to learn the subject, experience the learning and teaching processes themselves and produce something new, and teach others to learn and master new skills. During these processes his role was as a guide and sometimes collaborator. However, he also made use of traditional teaching styles and integrated ICT in his teaching as presentation tools and productivity tools (i.e. preparing the content, producing presentation materials, word-processing). As some STs of the Physics programme mentioned, he encouraged and forced them to integrate ICT in their group or individual studies, research and presentation. He also was one of those who integrated ICT into his personal and professional life in a way that, with his words, "makes lots of things easier for me". The lecturer believed that if the conditions were complete; that is, if enough ICT resources were in place in the classrooms and for STs easy and equal access to the resources were available, he could have integrated ICT in his teaching processes in a regular base. As a result of this reasoning above, he was placed at the *appropriation* stage. L3 reported some hindrances to integrate ICT into his teaching appropriately, yet he managed to overcome some of them, through putting some cooperative actions into practice with L1 and L2 such as dividing class-size in some courses. With close relationship and interaction, he preferred to use active and collaborative learning strategy in and out of classroom, through student-led activities, group studies, research and presentation. ICT was a constant value of these processes, basically searching for information, programming, writing research reports or assignments, printing out, presenting their works. His main goal was to enhance the students' learning and teaching experiences, exploiting the potential of ICT and other technology, and thus to help students develop their own understandings and ways to teach and learn. For this reason, he was found at the *consequence* stage.

**L4** (*consequence-appropriation*) had a very positive attitude towards ICT and believed that ICT could make difference in students' learning. He was also capable of using various ICT sources and integrated them into his personal and professional activities. During interview he mentioned that he could use any new technological tools if there was a leaflet explaining how to operate it. He also reported some his concern about the reliability of the information over the Internet. He reported that he used ICT as information sources (i.e. for his academic studies) and communication tools for his personal needs. In his teaching, on the other hand, he incorporated ICT in both types of teaching style: lecturer-centric and student-centric. In lecturer-centric applications, he used ICT and other technology as information source to prepare the content (i.e. basically with the help of the Internet), produce teaching materials such as hand-outs, charts/graphs and presentation materials, and as presentation tools such as OHP. He also encouraged student teachers to make use of ICT and construct and develop their own knowledge and understandings of pedagogical use of ICT through project or research-based activities and group studies. In these applications, his role was as a guide and facilitator. He, like L1 and L3, was found at the *appropriation* stage. During his teaching his main concern focused on creating more student-centric environments to let student teachers do more practice and learn through active involvement and collaborative group studies/research. As he mentioned and the researcher observed in one of his lesson, student teachers made substantial attempts to benefit from ICT during their project/research-based studies and presentations. Thus, since his main concern was about the learning processes and the impact of technology on them, he was found at the *consequence* stage.

**L5** (*informational-entry*) was the one who did not know much about ICT and its pedagogical use and potential. For his personal and academic needs he only used word-processing to write his academic papers. He reported during interview that the majority of student teachers knew much about ICT than he knew. In his teaching, he made use of conventional presentation tools such as slide-machine and OHP. However, he encouraged

STs to make use of ICT during their preparation and presentation of project/research-based studies. His involvement to this process was just as a listener or sometimes a learner. He also mentioned that only in one course he managed to provide student-centric applications. Having said this, he had a positive attitude towards ICT even though his appreciation of ICT was not the reflection of his practice. Since he was not capable of using ICT resources, apart from word-processing, but had a general notion about the innovation, he was found at the *informational* stage. Similarly, with respect to the use of ICT in his personal and professional life, he was found at the *entry* stage.

**L6** (*management-adoption*) was the most traditionalist one. He was capable of using ICT resources and other conventional presentation/demonstration tools. Especially he integrated ICT into his personal life in an effective way. That is, during interview he mentioned that he used the Internet to search for information related to his academic subject, to communicate with his peers from different universities for personal or academic purposes. He used ICT as personal productivity tools such as word-processing, printing out, producing the content he taught. In his teaching, on the other hand, he preferred to integrate ICT and mainly conventional technologies into traditional classroom activities. That is, he made use of ICT and other technologies as presentation/demonstration tools. Even though he reported very positive attitudes towards ICT, especially found the Internet the most useful tool and used it frequently for his personal needs, he had made no attempts for student-centric activities which included any type of technology. Thus, he was found at the *adoption* stage. As to the stage of concern issue, he was found at the *management* stage because his main concern was lack of time and resources in place and well arranged classrooms.

In conclusion, it is believed that the participating lecturers' background might be an influential factor on the ways that ICT was integrated into across curriculum activities. Four lecturers, L1, L2, L3 and L4, had backgrounds as educators; both teachers in secondary education and teacher educators in the Faculty. L5 and L6, on the other hand, were subject-specialists. Apart from their teacher educator roles in the Faculty, mainly they have taught special subject courses and got their academic degrees in special subject area. Their main focus was on developing STs' subject matter knowledge rather than developing their capabilities how to teach the subject. As seen in Table 4.19, their profiles were compiled at lower stages of adoption and at more self-concerns stages, when others' profiles were found at the further adoption stages and at more impact-concerns stages. The former group also seemed more cautious about STs' learning in ways that they could construct their own knowledge and understandings, thorough actively participating in the process in which ICT had a substantial role.

### 4.6.2 Developing and Improving Student Teachers' ICT Capabilities

The literature reveals that vertical integration of ICT alone is flawed. As Oliver (1995:142) points out "the skills and knowledge are gained through the applications of computers in meaningful contexts that enable the learner to realise and appreciate the tools that are being used". As analysed and discussed in the previous section, student teachers have been educated about ICT and its pedagogical uses in science education since 1996 in the three Science Programmes under investigation. These programmes have provided ICT related courses, and made substantial attempts to integrate ICT into teacher education and encouraged the use of ICT across methods courses. However, the findings of this study indicated that the attempts to integrate ICT across curriculum activities were not a complete success apart from some individual cases which were very promising in view of changing the nature of teaching and learning from behaviourist approaches to constructivist approaches, as analysed and discussed earlier. The stand-alone ICT courses are still in place in ITE across the world to develop or improve prospective teachers' capabilities, and there is plenty of literature which indicates that through these courses prospective teachers gain skills and understandings. The participants' perceptions of training student teachers through ICT-related courses were thought to be crucial to move forward, and thus will be analysed and discussed next.

#### 4.6.2.1 The Participants' Perceptions and Appraisals of the Stand-alone ICT Courses

Most of the STs, from the three Science programmes, indicated that they were ICT-illiterates when they embarked on the courses related to the ICT. Learning to teach in the Information Age requires new skills, understandings and attitudes to ICT. The Science programmes under investigation have offered educational ICT courses. In this study, the participants' perceptions about training STs to develop their skills through these courses were very disappointing. STs questionnaire results indicated that 74% of STs did not think that the ICT-related courses were appropriate to train prospective teachers in using ICT in science teaching and learning. The STs reported that especially the first courses related to ICT training, Introduction to Computer Education I-II, were completely disappointing and discouraging, which was very unfortunate. Most of them did not even touch a computer, but all passed the courses with success. CT8, for instance, mentioned that

> "We took a course related to computers. Now I do not know anything about it. I passed the course with AA-grade in the first term and BA-grade in the second term. Our main task was to memorise the notes we took during lectures, and there was no application at all".

BT1, on the other hand, indicated that

> "There was a course. Our lecturer told us lots of stories about computers, we took notes, but if you do not practise, you have no chance to learn about technology".

Actually, as the STs above stated, since this two term-course was a complete failure the lecturers provided a second course, *computer assisted science teaching*. The main intention was to educate prospective teachers with competence of being able to use different ICT sources and apply them to their teaching and learning. However, before taking this course, STs' technical skills were very limited or not exist at all. L3 stressed that

> "Students [STs] should have had technical skills before taking the new course. They usually do not know anything about computers, so I had to teach them basic skills instead of teaching them how to integrate ICT into their own teaching and learning Science".

L5, on the other hand, having taught the course for several years, reported that

> "Maybe I have not been successful in teaching students how to use a computer. As a matter of fact, it is not the lecturer's aim in this course. I believe that students who take this course should have acquired the knowledge and technical

> skills required beforehand… In any case, I failed… I cannot assert that they are able to do much about using computer even though they appreciate its value in Biology education".

The data also revealed that the new course also was not planned and was not implemented very well even if the intention was good. The lecturers' overall view on this was that they themselves were not so confident ICT users regarding various ICT applications, and therefore this course has not been as successful as they expected. Their lacking confidence was basically connected with not knowing or not previously having experienced the applications of ICT both in training others and teaching others with the help of ICT. However, as L2 asserted, there has been substantial improvement in its content and delivery. It seemed that, as L3 indicated during interview, they perceived ICT as useful in teaching and learning Science, and hence they initiated it regardless of carefully thinking of what should be taught and by whom. In other words, they managed with what they had got. L1, for instance, having stressed some crucial barriers to appropriate ICT training, reported that

> "Our first aim was to develop teacher candidates' understandings and confidence of using computers or technology in teaching and learning Physics… to develop their skills with regard to their future self-directed applications".

As discussed in the section related to integration, the lecturers, apart from L6, had attempted to integrate ICT into their teaching in a way that student teachers were actively involved in the activities. Similarly, in this course L3 adapted similar activities in the Physics programme. He first explained the theoretical information about ICT and its potential pedagogical uses and benefits in teaching and learning Science. Then he put STs in the centre of the course and let them struggle to find a way out. He mentioned that, by doing so, his main focus was on STs' learning about ICT and its pedagogical uses through their own experiences, and hence they would get the chance to construct their own knowledge and develop their own understandings. According to Lang (2000:47), in these types of applications,

> "learning is considered as a process that depends on teachers' participatory activity as facilitator or coach and the students' self-guided learning… calls for collaboration, team learning, self-assessment and project-based activities, fuelled by substantial support".

It is evident that, however, in this study the STs' very basic ICT skills were a strong barrier to move forward. As the lecturers who had the responsibilities to teach the course in the three programmes, apart from L5, they had to teach some basic ICT skills to the STs rather than focusing on developing or improving their application skills, which include ICT applications in meaningful context. McNair and Galanouli (2002) warn teacher educators that, in discrete ICT courses in which student teachers were taught ICT skills, one of the issues is that student teachers might perceive ICT as tools with very limited applications such as clearer presentation, faster access to information, and so on. This study, nevertheless, illustrated that the STs perceived ICT as a medium which challenged the traditional teaching and learning approaches. The majority of the lecturers arranged opportunities for the STs to experience learning processes that included student-guided learning. In the Faculty, those who had experiences with ICT in a way that showed signs of constructivist approaches, as the reader may recall from the discussion in section 4.6.1.1, particularly valued those experiences during the course or in the other courses. Taylor (2003:133) points out that this might be because these activities "provided a real context and extrinsic motivation for practising".

Student teachers, on the other hand, mentioned considerable appreciation of the value of the course even though they also reported some serious issues. The STs' responses to the questions about the discrete course in the questionnaires and during interviews showed that this course raised their awareness of technology in education. They had positive attitudes towards technology and its usefulness in teaching and learning Science. However, the majority had mentioned crucial concerns on their informational and personal capability of ICT before and after the course, as opposed to the results of many studies especially from developed countries (Ofsted, 2002; McNair and Galanouli, 2002; Lang, 2000; Taylor, 2003; Selinger, 2001b; Simpson et al., 1998).

| | Most mentioned themes among STs |
|---|---|
| Positive views about the course | We learned how to use computers |
| | This course directed us to search for knowledge |
| | It helped to develop our knowledge and some basic skills of ICT |
| | The course stimulate us to learn more about ICT |
| | We observed different uses of technology in teaching and learning |
| | I learned how to prepare teaching materials for students |
| | We gained a general computer culture |
| Negative views about the course | I did not learn much useful things throughout the course |
| | I did not recall much about the course |
| | It will not help because I do not think that we would see these resources in schools |
| | Much was expected from us with very limited skills |
| | The lecturer was not a qualified one to give this course |
| | Practice time was very limited |

Table 4.20 STs' self-evaluation of ICT-related courses

The STs' perceptions or self-evaluation of these courses across the three Science programmes are summarised in Table 4.20. The majority of STs mentioned that they first interacted with ICT resources in these courses, and learnt what they knew about ICT through these courses. The data revealed that STs of all three programmes developed an awareness about the power of ICT in teaching and learning the subject(s) such as multimedia applications, visual experiments, access to the information, presentation tools, word-processing and programming. The following quotations might help to understand the STs' views about the course.

> "The most useful thing that I learned from this course was that I can use a computer. We learned an alternative way to teach and learn Physics even if it was not in a functional way… I do not remember any unnecessary activities during the course, yet there were some weaknesses such as lack of more individual practice". (PT1, Int.)

> "Doing experiments on the computer without any risk of danger was very useful, using some software such as Chem-Lab". (CT3, Int.)

> "Unfortunately, I learned nothing about computers. The content of the course was not related to computers… For this course the teacher [the lecturer] must have been knowledgeable". (BT5, Int.)

For the majority, the course was a chance to develop basic skills as well.

> "We took a course about computer before, but we had not had any experience with computers in that course. Then suddenly we found ourselves into more advanced applications such as programming in LOGO, planning activities which included technological tools. We struggled very much, I believe, however, some of us learned many new things". (PT2, Int.)

> "I found this course very important. As a single term-course with limited resources, it did not help much to learn about ICT and its applications. The lecturers provided chances for us to practise during other academic-terms but with limited knowledge and skills we struggled very much". (PT4, Questionnaire)

> "Taking this course, I developed my basic computer skills and observed and used some educational software… We should have done more practice about the use of technology in Chemistry education". (CT4, Int.)

> "The course was a rite of passage, there was nothing useful about it". (BT5, Questionnaire)

> "Apart from computers, we learned how to use other technologies [OHP, slide-machine and TV]". (BT6, Ouestionnaire)

It is evident that previous ICT experience helped the STs improve their skills and look for educational use of ICT, and hence those who had basic ICT skills requested more meaningful practices during their training about ICT. Those who had not acquired basic

ICT skills reported a strong dissatisfaction with their training, and hence this dissatisfaction led to ICT anxiety. CT2, for instance, who was one of those who took all the courses related to ICT and passed them successfully, was a representative of the latter group. Despite all the courses she had taken, she could not do anything with a computer and in the ICT laboratories she mentioned that she let the other group members do things with computers. She mentioned that "not knowing anything about computers makes me worried".

A crucial point was that the contents of the courses in the three programmes were not consistent; rather, it depended upon the lecturers' decision. In the Physics programme, for instance, the lecturers' main focus was to teach about programming LOGO and preparing lesson plans and student presentations. The Chemistry programme preferred to teach about educational software and presentation tools, including conventional technology. In the Biology programme, the situation was the most dramatic. STs of the Biology programme reported that they went to ICT laboratory once during the course. The delivery of the course was mainly plain explanation of theoretical information about ICT and its potential benefits to teach and learn the subject. With the re-structuring of ITE, a new course was proposed by YOK, but the new course was not offered for the STs who participated in the study. In the three programmes, this new course was first required for new coming STs in 2002-2003 academic year. In this new course, the content is more consistent in all Faculties of Education in Turkey, and STs are guaranteed to be taught about the same topics.

#### 4.6.2.2 Integrating ICT into Teaching Practice: potential to turn things around

As stated in the previous section, the STs, who reported certain ICT skills, asked for more practical experiences in which they could be able to use ICT in meaningful contexts. The literature suggests that the teaching experience in schools is a good opportunity to practise, observe and test the uses of ICT in teaching and learning, and to reflect on their experiences.

However, the data revealed that the STs, apart from BT1, did not use ICT during their teaching practices in schools. BT1 reported that once he used educational software to teach about cells to students in a secondary school during his teaching practice. Very few STs also reported that they made use of conventional technology as presentation tools such as OHPs. Table 4.21 illustrates the reasons, reported by the STs in the questionnaires, for not having used ICT in their teaching.

| Reason | Physics (f) | Chemistry (f) | Biology (f) |
|---|---|---|---|
| Lack of training | 17 | 18 | 24 |
| Shortage of teaching time | 24 | 16 | 13 |
| Preference for other teaching methods | 16 | 14 | 18 |
| Lack of access | 48 | 22 | 17 |
| Lack of appropriate software | 10 | 5 | 13 |
| Concerns over organisational issues | 17 | 5 | 7 |
| Concerns over possible technical problems | 10 | 6 | 9 |

Table 4.21 The STs' reasons not having used ICT in their teaching activities

As can be seen from Table 4.21, the STs of all three programmes reported that lack of access to ICT resources was the most influential factor for not having used ICT in their teaching practices. The majority of the STs, 87 out of 128, reported that the schools they went for their teaching practice did not have an ICT laboratory. Unlike many developed countries, proper access to the ICT sources is a crucial barrier to integrate ICT into formal education in Turkey. There have been some special project schools such as Curriculum Laboratory Schools in which enriched technology laboratories were provided. As Altun (2002) states, one of the goals of these schools or the project was to facilitate the teaching and learning processes, providing technological tools. Apart from these schools and private schools, the majority of the state schools do not have ICT laboratories. However, the number of school in which ICT laboratories were established has increased, and it seems that it will continue to increase. The second most reported reason was lack of training, 59 out of 128. As seen in Table 4.21, the majority of the STs of Biology and almost half of the STs of Chemistry reported their dissatisfaction with their training, and emphasised on their training as an impediment that was prevented them from using ICT in their teaching practices. Nearly half of the STs also reported teaching time and preference for other teaching methods as crucial barriers to incorporate ICT into their teaching, 53 and 48 respectively. Items such as lack of appropriate software, concerns over organisational and possible technical problems were not that frequent. Hence, it is evident that the STs' self-concerns were the more crucial determining factors. Cuckle and Clarke (2002) in their recent study found that although student teachers had received training and developed their knowledge and skills, they however did not use their potential in ICT during their teaching practice.

Although it was beyond the scope of this study to investigate what the real barriers were in the school placements regarding the STs' use of ICT in their practice, the STs mentioned some serious issues that would continue to be crucial impediments to integrate ICT into preservice teacher training in both Faculty and Schools. In this case study, the STs were not required to demonstrate their uses of ICT in their teaching practice to be a practising teachers, as opposed to the case in UK and many other developed countries. In this sense there was not an external pressure. Analysing interviews and questionnaires, it was evident that the STs finished teaching practices in a way that any possible trouble or burden would not emerge. The majority also reported that the teaching practice was just a formality, being there was the only requirement. One of the STs mentioned that

> "I did not use technological tools since I did not want to contradict the teacher's way of teaching. However, in the future if I become a teacher, I will make use of these technological tool as mush as possible". (Physics ST, Questionnaire)

Another crucial issue during teaching practices was that there was nobody to support or help them to use ICT in their teaching basically because of lack of interest.

> "Nobody explained the infrastructure and ICT resources of the school. And you have to do what they say and act how they want. Maybe they [teachers] do not even know about the school's ICT facilities". (Physics ST, Questionnaire)

> "Teachers prefer to use traditional teaching methods, and hence I did the same". (Chemistry ST, Questionnaire)

> "Here in the Faculty our teachers have been doing their best to support or encourage us to use technological tools, we are well aware of that. I did not receive any help or encouragement from my mentor teacher in the school... What I noticed in the schools was that teachers do not use technology... Once I went to a middle school for my research project, the manager [head-teacher] told me that he made the teachers write their lesson and annual plans using computers to force them to make use of computers". (PT2, Int.)

> "I had to teach the way the mentor teacher want me to teach". (Biology ST, Questionnaire)

The majority of the STs mentioned that they did not receive any help from either their tutors or mentors during their teaching practice to incorporate technology into their teaching. However, in the Faculty they also mentioned that the lecturers encouraged, supported and sometimes forced them to use ICT and other technological resources. It is evident that the lecturers could not do much to support the STs in their teaching placements like they did in the Faculty. The collaboration or cooperation between the Faculty and Schools was very limited or did not exist at all, apart from some in-service training programmes. During interview L2 mentioned his experience in an in-service training programme.

> "I cannot say that they [the STs] have the potential to turn things around in schools, integrating ICT into their teaching, since their training here was not so professional. 20 days ago in an in-service training programme I witnessed that the newly qualified teachers [their students from previous years] or practising teachers had not utilised the computer laboratory in the school. As part of the programme we went to computer laboratory, we realised that the majority of the teachers had not been there before. At the beginning they mentioned that they do not have any educational software related to Science in the school, but we saw that their sources were much better than ours in the Faculty... Unfortunately, they did not know how to use these CDs, including previously ours student teachers. They [newly qualified teachers] did not want to change the status quo. That is, if plain explanation was in place, they carried on doing the same. Since they did not want to use their potential, which might be perceived as show-off, they carried on using traditional teaching and were drowned in it. I personally witnessed it in practice".

Like L2, the other participating lecturers did not think that the STs might use their potential to integrate ICT into their teaching even though, as all lecturers mentioned, they had very positive attitudes towards ICT and seemed enthusiastic about ICT and its uses in Science teaching and learning.

### 4.6.3 Summary and Discussion on Integrating ICT into Teacher Training

The data revealed that integrating ICT into teacher education in the case was a vertical policy, in which three discrete ICT courses (one selective, two compulsory) were provided for the student teachers. As many previous studies and reports indicate, this kind of integration alone is not effective and flawed. Nevertheless, the data revealed that the participating lecturers made some attempts to incorporate ICT into their teaching. The most common use was as presentation tools. Apart from L6, all lectures also integrated ICT into their classroom activities in a way that student teachers were given the chances to use various ICT sources in and out of classroom to prepare, plan, produce and present their individual or group studies, research or assignments. It is evident from the data that both the lecturers and student teachers valued these applications as crucial regarding learning the subject and learning to teach the subject with the help of ICT and other technology.

The data also revealed that the impacts of ICT on the lecturers' teaching style were twofold. They used ICT as tools which improve the quality of their traditional teaching (i.e. a teacher, content and school-centred). It is evident that the ICT and other technology were used in a way in which the STs were active participant through individual or group studies, research or assignments. In those activities the STs integrated ICT into their studies from preparation to classroom presentation. Only one lecturer, L6, did not mention the latter type of ICT use. The shift from teacher, content and context-centred activities or teaching processes to student, less content and context-centred activities has led to the change in the lecturers' and student teachers' roles as well. Those lecturers who provided student sensitive teaching and learning environments were facilitators, guides and sometimes collaborators. In these applications the roles of the STs were active learner, researcher, collaborator and information presenter.

Another crucial finding in the study was that the stage of integrating ICT into teaching and learning activities heightened from entry to appropriation as the lecturers' stage of concerns moved from self-concern stages to task and impact-concern stages, from informational to consequence.

From the data it is evident that both the lecturers and STs were not happy with the outcomes of the stand-alone ICT courses. 74% of the STs reported that ICT-related courses were not appropriate and effective to be able to use ICT in teaching and learning Science. It is worth noting here that both groups of participants reported that the basic aim of the course, computer assisted Science teaching, should be to develop new skills to apply the technical ICT skills, which they thought must be taught or learned beforehand, to the teaching and learning processes. Due to lack of previously developed basic ICT skills, in this course the lecturers had to teach the basic ICT skills rather than focusing on application skills. Hence, the STs' technical ICT skills were the barrier to accomplish what the lecturers intended at the beginning.

As to the integrating ICT into teaching practice in schools issue, it is evident that the STs did not make use of ICT. From the questionnaire results, the majority of the STs reported that lack of access to ICT resources in the schools was the most crucial barrier which prevented them from using ICT in their teaching. The STs' reasons for not having used ICT in their teaching overall depended on their personal and informational concerns such as lack of appropriate training and preference for other teaching methods. In conjunction with this they also mentioned that during their teaching practice they did not receive any help from their tutors or mentor teachers. As a result, the STs did not integrate ICT into their teaching practices, apart from one ST.

**4.7 Factors Affecting the Process of Integrating ICT into Pre-service Teacher Education**

As has been analysed and discussed earlier in the sections 4.3, 4.4 and 4.5, the participants' ICT capability, their beliefs and their attitudes towards ICT were crucial factors which might influence the integration processes. These factors have been analysed and discussed earlier since determining the individuals' ICT capability, understandings of ICT and their attitudes towards ICT was thought to be useful to understand and justify the integration process in the case. It was not that the researcher perceived these three factors as more important than those will be elaborated next. However, those are the basic factors, which might influence the success of the implementation in any educational change. Without overcoming those self-related issues, the change is not possible.

Fullan (1991:91) argues four main insights of any change process: "active initiation and participation, pressure and support, changes in behaviours and beliefs, and the overriding problem of ownership". As mentioned earlier in this chapter, the lecturers were proactive participants in the initiation and integration processes of ICT. Supporting Fullan's argument, the data revealed that a few people (i.e. the lecturers, L1, L2 and L4) initiated ICT-related activities through either discrete courses or cross-curriculum activities in the case. This built momentum, and this momentum, even if it was small, led to spreading the innovation across the other programmes in the Faculty. Having said this, there were some crucial factors affecting the ICT integration process in the case, either mentioned by the participants or observed by the researcher. In addition to the factors discussed earlier in this chapter such as ICT capability, understandings and attitudes, the other factors emerged from the case were compiled as follows;

a- Clarity and vision of the change

b- A set of factors: Lack of trained educators and support, class-size and access

c- Management and leadership

#### 4.7.1 Clarity and Vision of Change

It is evident that pre-service teacher education programmes should have a clear vision and a clear and manageable plan to reach the target or to overcome the possible challenges faced in the integration process. During the visits to the Faculty under investigation it was obvious that there were some concerns about educating student teachers with the required ICT capability to prepare them for their prospective job. For this purpose, new cluster-ICT laboratories were established, and a new technology-enriched classroom was prepared. Having said this, as all participating lecturers and student teachers reported, these new facilities were not enough to meet the requirements.

The data revealed that the Faculty did not have a written plan or a vision that would provide a basis for planning and implementing the change. There were substantial differences in the definition of the change in peoples' minds. That is, the individuals were left alone to determine what the innovation was all about. Their individual understandings of the change and its implementation in the case were generated from their own knowledge-construction or skills rather than an explicit common policy. As L1 mentioned during interview, just before each academic year they discussed and decided what to do in each course, but it was evident that the talking stayed there for some of the lecturers.

The data revealed that some (i.e. L5 and L6) understood the change and implemented it in a way that was very simple. They were the ones who mostly made use of ICT and other technology to improve the quality of their traditional teaching, and for them the discrete ICT courses were considered as the only path to develop the STs' ICT skills. They did not have enough knowledge and skills to integrate ICT into their teaching in a way that could change their teaching styles. This was a crucial part of the intended change, integrating technology into teaching and learning processes in which new ways of teaching and learning could be emerged. Fullan (1991:71) points out that "simple changes may be easier to carry out, but they may not make much of a difference". However, the initiators (i.e. L1, L2 and L4) and L3 made use of ICT to improve or facilitate their current teaching with the help of ICT, but also made substantial attempts to change the way they have taught. In this sense, from the evidence of the study, the intended change was accomplished through their individual activities, leading to active-learning, project/research-based learning, collaborative learning and authentic learning, in which ICT had a substantial role. It seemed that as the initiators they had a clear shared-vision in their minds, and knew where they were going and it was revised throughout the implementation in accordance with the new ICT resources and cultivated understandings. As the literature indicates, there has been a lack of understanding and consensus about the role, value and effectiveness of ICT in education (Roberts and Ferris, 1994; Budin and Meier, 1998; Parmley et al., 1997), as it was the case in this study.

All lecturers mentioned that there was not any written plan for integrating ICT into teacher education in the case, and reported that there must be a clear plan to set the standards in the Faculty. Sun et al. (2001) state that in practice, planning is a series of linked and complicated action steps. These actions include planning to plan, gathering information, managing resources, providing ongoing training and support, writing curriculum, and evaluating progress, as well as many others. They carry on stating that all those actions are designed to accomplish particular goals, and each goal is delineated to support the overall vision of the plan (Sun et al., 2001).

In consequence, in this case study it is evident that the vision, which should have supported by a strategic written plan, was not institutionalised or explicit to the others involved in the change process. Having a written plan and an overall vision might create the pressure for the practitioners and make things (i.e. the actions they would take, the ways to integrate ICT, the types of resources available, access to the resources, assessing the process, and so forth) clearer for them.

### 4.7.2 Set of Factors: Lack of trained educators and support, class-size and access

The data revealed that the lecturers have faced some common barriers during their actual practices. These were determined under three themes: lack of trained teacher educators and ongoing support, crowded classrooms and proper access. These barriers were linked to each other as well as linked with other factors affecting the process of the ICT integration. In conjunction with this, each of them had serious and equal impact in the process. That is, analysing these three key factors under a single title does not mean that the researcher pays less attention to those than the other determining factors. The reason for discussing those factors under a single title was because these were the factors all participating lecturers mentioned and faced during their practices, revealed as a set of barriers or reasons for not having used ICT in the case. Table 4.22 illustrates the lecturers' views about the factors preventing them from using ICT in their teaching.

| Themes related to training needs | The lecturers |
|---|---|
| Developing technical skills through in-service training | L2, L5 |
| Developing new skills through research/project-based activities | L1 |
| Developing application skills, getting support from someone who is knowledgeable and skilled | L1, L2, L3, L4, L6 |
| Lack of trained lecturers in teaching ICT | L1, L2, L3, L4, L5 |
| I have many responsibilities due to lack of enough number of lecturer in the Faculty | All |
| More time needed to prepare lessons with ICT | L1, L2, L3, L4, L6 |
| Classrooms are too crowded for individual uses | L1, L2, L3, L4 |
| We do not have someone to support us whenever needed | L1, L2, L3, L4, L5 |
| Appropriate access to the ICT sources in the classrooms is impossible | All |
| More technology-enriched classrooms needed | L1, L2, L3, L4 |
| Access to WWW is very limited for us in the Faculty | L1, L2, L3, L4, L6 |

Table 4.22 Factors affecting the integration process

#### 4.7.2.1 Training and Ongoing Support

As mentioned in the section about the lecturers' background, only two of the lecturers, L2 and L3, had training courses in using ICT to teach and learn science during their Master or PhD programmes. All lecturers mentioned that they developed or improved their knowledge and skills themselves, including those who had ICT training courses previously. All lecturers mentioned that they needed to learn more knowledge and skills of ICT and its practical applications, as illustrated in Table 4.22. L2, for instance, mentioned that

> "In-service training about the use of ICT should be provided for all lecturers. I would love to take part in a course which provides more practical uses of ICT in teaching and learning rather than theoretical knowledge". (L2, Int.)

> "I personally would like to develop my ICT skills and to do research about appropriate integration of ICT in Science teaching and learning. It would be more helpful to support our research projects related to the integration of ICT in teaching and learning Science rather than to provide in-service courses about ICT. I believe that we could learn more throughout these projects". (L1, Int.)

The lecturers mentioned that they would like to learn about more practical knowledge and skills regarding the pedagogical uses of ICT. In order to teach ICT skills to the STs, all lecturers who had taught the courses reported that additional skilled and knowledgeable lecturers were needed to make the courses more effective. They added that those trained lecturers would also help them to develop their skills and facilitate the process of change in the Faculty. It is worth noting here that the Faculty did not have ICT experts or coordinators to train and support the staff when needed. OTA (1995:139) reports that

> "Typically, formal training sessions in the uses and mechanics of educational technologies provide only the basic knowledge that gives teachers an impetus to further experiment. Beyond this, teachers consistently report that having a person at the school site who can help them makes all the difference in the likelihood of their going further with technology someone who is knowledgeable about technology and can help them with questions or problems".

The participating lecturers mentioned that when they got stuck during an application involving ICT they asked help from their peers who were more capable or knew about this particular application. This form of support was a limited collaboration among staff rather than a professional support always there. During observation and interviews, the data revealed that the lecturers' own uses of ICT and other technology were very limited and simple in their teaching. They mostly used simple technology as presentation tools such as OHPs, slide-machine, TV-video set. As L2 reported, they preferred these simple types of technology because they are easy to use. Although they mentioned, apart from L5, certain level of ICT skills, they did not use more advanced presentation tools such as Data-show and Power Point. During observations and interviews with both groups of participants, the lecturers and STs, it is evident that some of the STs used these sources during their presentations in the Faculty. It is believed that training and ongoing support, whatever the form is, would be efficient to integrate ICT into their own teaching activities.

**1.7.2.2 Class-size**

One of the determining factors affecting the use of ICT was overcrowded classrooms. L3, for instance, mentioned that

> "Using computers in the classroom is very hard because it is too crowded. When you take all students to the computer labs, there is limited number of computers, 4 or more students for one computer. Normal classrooms, on the other hand, do not have the infrastructure required. The smaller number of students a lecturer has in his classroom, the more quality of teaching would take place". (L3, Int.)

For some courses, L1, L2 and L3 solved this problem, separating the classroom into two or three groups. By doing so, they offered more chances for the STs to practise. This arrangement also created a new challenge for the lecturers: time. The data revealed that the majority of the lecturers had various responsibilities such as teaching different subject and method courses, administrative roles, doing research and tutoring the STs and supervising postgraduates. It is obvious that all these tasks need substantial time. As Dawes (2001) points out, new tasks would arise if the teacher uses ICT in his/her teaching. Class-size was also found as a crucial challenge for the lecturers in the courses related to ICT. They mentioned that each ST did not have the chance to use a computer during these courses. Some of them preferred watching the others using computers.

**1.7.2.3 Access**

The data revealed that the Faculty had improved its ICT facilities since the beginning of the introduction of ICT to preservice teacher education in the case. Within the last five years two more clustered-ICT laboratories and a technology-enriched classroom had established in order to educate the STs in using ICT in science teaching and learning to develop or improve their technical and application skills. However, these three computer laboratories and a single classroom with some presentation tools, as reported by both groups of participants, were not enough and sufficient. As to integrating ICT into teaching and learning issue, the picture did not look promising. This was because the ICT resources were clustered in different locations in the case as additions rather than integrated into the classrooms in which the actual teaching and learning activities carried out, as Cornu (1995) argues.

For the student teachers, proper access to the resources was not always possible, unless they were taken to the ICT laboratories. These ICT laboratories mostly were used for the ICT-related training courses. The technology-enriched classroom was a place for the lecturers and STs to practise with ICT, basically using a data-show or OHP as presentation tools. L4 reported that

> "I think that there should be some special classrooms for this purpose. With the current economical conditions we cannot integrate these technologies into all classrooms. However, one or two classrooms, in which a Data-show, OHP and TV-video set are located, within each building may solve the problem". (L4, Int.)

L3, on the other hand, raised a serious issue, claiming that

> "Unfortunately, we do not have enough technological tools here. However, we do not make use of the existing tools effectively either". (L3, Int.)

As Mumtaz (2000) discusses, the literature, which illustrated successful implementation of ICT, indicates that the institutions were provided with excellent resources, technical support and financial resources. Nevertheless, she points out that "actual take-up depends largely on teachers' personal feelings, skills and attitudes to IT in general" (p. 337). In this sense, one might argue that some lecturers in this case study would continue to claim or find some excuses as main barriers, preventing them from integrating ICT into their teaching, rather than questioning or reflecting on their self-concerns.

In normal classrooms, on the other hand, as L6 reported, the lecturers had to carry the tools they needed for their teaching such as OHPs, slide-machines and TV-video set. During observing L5's lessons the STs who presented their research-based study had to bring a computer, which was the personal property of a member of the group, to the classroom. Lack of classroom access to the ICT resources therefore was thought to be an impediment preventing the lecturers and student teachers from integrating ICT into their teaching and learning processes. As Mumtaz (2000) points out, this could seriously hinder what they were able to do with ICT.

One of worrying results was that the Faculty staff and STs did not have access to the Internet at the time this study was carried out. Only the administrators and lecturers in an urgent situation could have access to the Internet in the Faculty. Some participants used the facilities of the University main campus, which is nearly ten miles away from the Faculty of Education, or Internet Cafés in the city centre which especially some female

STs found inconvenient. In the Faculty the STs had access to the ICT laboratories as long as they got permission from the Head or a lecturer and there was no lecture in there. The majority of the STs found this very discouraging. The lecturers, on the other hand, had computers at their office or in the department whenever they needed. According to Ofsted (2002) findings, teachers' personal access to a computer for the purpose of preparation and planning has a major role for successful teacher training and subsequent classroom use.

### 4.7.3 Managing the Change

In an institution it is expected that there always should be some certain individual(s) with the capability of facilitating and managing the change process. As part of the latest restructuring of ITE in Turkey, Faculties of Education had bought new ICT resources, and new ICT laboratories were established. The YOK (1998) report about the re-structuring of ITE indicates that training prospective teachers about ICT and its applications in education is perceived as a crucial task of Faculties of Education.

> "...this area [training student teachers about ICT] will be covered in the new teacher training programmes. Especially, computer literacy, reaching and spreading the information by computer (through the Internet) and developing and producing teaching materials are viewed as basic objectives in pre-service teacher education". (Document 2, p. 31).

This material was printed out and sent to the Faculties. This created a subtle motivating pressure for the lecturers. Especially it is worth noting here that since five of the participating lecturers had particular administrative roles in the Faculty they were expected to implement the new changes including the integration of ICT. However, it is evident that there was not anybody among the administrators or other staff who had or was given the responsibility to manage the change related to ICT integration. Thus, each lecturer, either felt a responsibility or had an interest in ICT, have made some efforts to implement the change. In this sense, the model in place regarding ICT integration could be described as the *ambiguity* model, as Crawford (2001) argues. The goals and processes of the change were not explicit to the people involved in the change processes, and the individuals' responsibilities were not clearly defined. There was not a rational process to identify and overcome the problems regarding the ICT integration.

### 4.7.4 Summary and Discussions on the Factors Affecting the Change

The participants' *ICT capabilities*, *understandings* and *attitudes* were elaborated earlier as crucial factors affected the integration of ICT into teaching and learning activities in the case. Both groups of participants had developed or improved their ICT skills, they however did not make use of ICT in teaching and learning activities regularly. Thus, the lecturers will need more support or training to improve and develop their ICT capability. The situation of the STs, on the other hand, was more worrying. The majority of the STs will need to take in-service courses as practising teachers since their initial training about ICT was not enough to integrate ICT into their teaching and learning activities. One of the promising findings in the case was that both groups of participants made very positive comments on the role and value of ICT in teaching and learning Science. Basically, the data revealed that they perceived ICT as facilitators, information sources, presentation tools and as a medium to change the nature of teaching and learning. In practice there were some illustrations which represented these categories, although they were relatively infrequent. In conjunction with this, the participants also had very positive attitudes towards ICT. In this sense, the participants' understandings of and attitudes towards the change promoted the implementation of ICT in the case rather than being a barrier to integration. L1, L2, L3 and L4, and in only one course L5 used this promising factor very productively, providing opportunities for the STs to practise with ICT in teaching and learning different subjects through project/research-based group or individual studies.

As to the specialist subject issue, overall, the data revealed that the STs of Physics were the most confident group on the technical ICT skills (i.e. according to both qualitative and quantitative analysis) among the three specialist subject programmes. It was also evident that there was no significant difference among the STs of the three programmes regarding their ICT application skills and attitudes.

There were other determining factors which were revealed and thought to be crucial impediments to integrate ICT into teaching and learning activities in the case. The first one was lack of *a clear vision and plan* which would help the participants to know where they were heading. In a sense, the goals of the change were not explicit to the majority of the practitioners. That is, the Faculty or the programmes under investigation did not have a clear strategic plan to integrate ICT into ITE. It is believed that a plan in action would have created pressure for the practitioners.

Secondly, it was evident that there was not anybody among the staff who had or was given the responsibility to *manage the change*. The goals and processes of the change were not explicit to the people involved in the change processes, and the individuals' responsibilities were not clearly defined. There was not a rational process to identify and overcome the problems regarding the ICT integration. In this sense, the model in place regarding ICT integration could be described as the *ambiguity* model, as Crawford (2001) argues. As a result of this uncertainty, the change had depended on some practitioners' self-controlled or pursued efforts. They themselves created pressure and looked for support. It is believed that this led to the lecturers' reluctance to the change.

Finally, almost all participants mentioned some reasons preventing them from integrating ICT into their teaching; *lack of trained teacher educators and support*, *crowded classrooms* and *lack of proper access*. The researcher has analysed and discussed these common factors as a set of factors associated with the integration of ICT since all participants made similar comments on these factors. The data revealed that the lecturers did not receive any ICT-related in-service training, and the majority of the lecturers would like to learn more about the pedagogical uses of ICT. They developed their ICT capabilities themselves, and integrated it into their personal lives effectively. However, in their teaching their uses of ICT were very limited or simple. It is evident that they needed to learn more about new technology and its appropriate pedagogical uses. In addition to this, there were not any technical and pedagogical supports for the lecturers available. This also was a crucial impediment to integrate ICT into more meaningful activities. The lecturers received some technical supports from their own peers who were not ICT experts.

The lecturers and STs reported that their classrooms were too crowded, and individual practices were impossible. The lecturers usually did not take the STs to the ICT laboratories because of this impediment, including ICT-related training courses. Some lecturers (i.e. L1, L2 and L3) made some attempts to solve the problem, separating the classroom into groups, but this created another impediment; time. The lecturers reported that there was shortage of teacher educator in the Faculty, thus separating classrooms limited the lecturers' time. However, by doing so each STs had valuable experiences regarding teaching and learning activities across curriculum, whether including ICT or not.

The data also revealed that infrastructure and proper access to ICT were a crucial barrier to ICT integration. It was worrying that the participants did not have access to the Internet in the Faculty at the time this study was carried out. L4 reported that there was an ongoing dialogue between the Faculty and the company to reach a solution on this issue. It was an issue related to general infrastructure of the area, in which the Faculty was located. Another issue related to access was availability of ICT resources when needed. There were clustered ICT laboratories and a single technology-enriched classroom, which were not satisfactory, as far as the participants concerned. It is believed that the integration of ICT into teaching and learning activities could be accomplished if the classrooms had the ICT facilities.

In conclusion, the institutional impediments such as lack of support, shortage of educators, lack of access to ICT, overcrowded classrooms, and so on, were more influential factors that had affected the change process. The personal factors such as ICT capability, understanding of the change, attitudes towards the innovation, commitment and so on, on the other hand, were very promising to integrate ICT into teaching and learning activities.

# 5. CONCLUSION

## 5.1 Introduction

The main purpose of this study was to *understand* and *explore* the integration process of ICT into PSTEP, using a case study design. The main research question was "What are the factors affecting the process of integrating ICT innovation into Pre-service Science (Physics, Chemistry and Biology) Teacher Education Programmes?" To find answers to this main question sub-questions were developed, as detailed in Chapter 1.

In this chapter, first of all, the limitations of the study, including methodological critique, are provided.

Secondly, main findings of the study and their implications for practice and policy are elaborated.

Finally, recommendations for improving current state of ICT integration in the case in particular and in initial teacher education in general are made, and for further research some suggestions are made.

## 5.2 Limitations of the Study

It is worth noting here that case study methodology was adopted for this study. It was considered that the case study approach embraced the objectives of this research. This study was about the process of ICT integration in a Turkish Faculty of Education and the individuals' perceptions and interpretations of the process, in which they have been involved for a period of time. In other words, the researcher sought to understand the participants' points of view and the research setting to build a holistic picture. It is evident that the process of ICT integration took various forms, depending upon individual application and understanding. Each lecturer carries out a different practice in her or his classrooms and has different understanding of ICT (i.e. its potential, use, value, and so on). Thus you cannot define an independent reality, rather, the meaning of the reality to be searched is dependent upon the individuals' words and interpretations in the research setting. Thus, as Usher (1996) and Guba and Lincoln (1994/98) argue, the reality to be searched about is *a function of shared meanings-* ***socially being***.

As a result of this reasoning, this study required a qualitative approach to understand the phenomenon holistically. In the data collection process, multiple methods and sources were used: questionnaire for the STs (i.e. consisted of both open and close-ended questions), semi-structured interview, observation and document analysis. Using questionnaire in this study might be viewed as controversial because from the beginning it was assumed that the underlying assumptions about educational research ought to be cohesive. Especially, from the purist perspective, using methods from divergent paradigms contaminates the data, thus should not be used. In this study however the researcher chose a pragmatic way to collect data that represent the case under investigation. So questionnaire was used to collect data from all STs of the three Science programmes and to select the sample (interviewees) for further data collection process.

Spending a limited time for the data collection process in a study like this might be criticised since the objective was to explore the process of integration. However, it is believed that the use of multiple methods and informants to collect data related to the ICT integration process and the participants' experiences, provided reliable and valid data. The ACOT project, for instance, was a methodologically sound study in order to investigate the process of ICT integration and its impacts on practice and practitioners' personal and professional life. To understand the participants' experiences and perceptions related to phenomenon, having collected official or personal documents, the researcher observed the lecturers' lessons and interviewed with them. By doing so, the researcher was provided with the data about what they thought and said about the phenomenon and what they actually did in their classrooms.

As to generalisation issue, an ideographic methodology (Cohen et al. 2000) was adopted for this research, which was time and context-bounded. It is also evident that the sample of this study was a group of individuals who were not the true representatives of the whole universe (ITE in Turkey). Thus naturalistic generalisation (Stake, 2000) might be possible, it is however the job of others to replicate this study or compare the findings of this study with other contexts. To make it easier for the reader, the researcher provided clear and explicit information about the methodology and input so that the reader would be able to make naturalistic generalisation.

## 5.3 Review of the Main Findings and Implications for ITE, Policy and Practice

The research showed that the vertical model of ICT integration was in place as a written policy in the case. That is, the student teachers were trained through different ICT-related discrete courses as add-ons to the general curriculum of ITE. However, from the evidence of this study, the participants' views about the courses regarding their sufficiency and effectiveness were worrying because overall the discrete ICT-related courses did not serve the STs to develop their technical ICT skills at an advanced level and application skills in particular. Having said this, the courses raised an awareness of ICT and limited information and skills of the uses of ICT and other conventional technology in teaching and learning Science. As some of the STs mentioned, they learned from these courses even if what they knew was disappointing. It is clear that this is not enough to secure the potential of ICT in teaching and learning Science, and the STs need to acquire new skills to integrate ICT into their learning and prospective teaching activities. The stand-alone ICT courses are still in place in ITE across the world to develop or improve prospective teachers' capabilities, and there is plenty of literature which indicates that through these courses prospective teachers gain skills and understandings. As many previous studies and reports indicate, this kind of integration alone is not effective, and is flawed.

From the evidence of this study, some of the lecturers made substantial attempts to integrate ICT into their teaching and encouraged the use of ICT across methods courses. However, the findings of this study indicated that the attempts to integrate ICT across curriculum activities were not a complete success apart from some individual cases which were very promising in respect of changing the nature of teaching and learning from behaviourist approaches to constructivist approaches. The data revealed that the participating lecturers made some attempts to incorporate ICT and other technology into their teaching, commonly as presentation tools. The research also showed substantial evidence that the majority integrated ICT into their classroom activities in a way that student teachers were given the chances to use various ICT sources in and out of classroom to prepare, plan, produce and present their individual or group studies, research or assignments. It is evident from the data that both the lecturers and student teachers valued these applications as crucial regarding learning the subject and learning to teach the subject with the help of ICT and other technology. These types of experiences and applications of ICT have implications, as the literature suggests, that would make the difference to accomplish the intended change in using ICT in education in general and in ITE in particular.

As to the integrating ICT into teaching practice in schools issue, the research showed that the STs did not make use of ICT during their teaching practice in schools. They reported some reasons that prevented them from using ICT in their teaching practice. The most commonly mentioned barriers were; lack of access to ICT resources in the schools, lack of appropriate training, preference for other teaching methods, help or support from their tutors or mentor teachers and possible technical and organisational problems. Thus, the research had some implications for the process of teaching practice. As a teacher and later as a research assistant in the city of Trabzon between 1993-1999, the researcher knew that the majority of high-schools which the STs were sent for their practice had at least an IT laboratory with considerable resources. However, as it was the case in the Faculty, access to these ICT sources in the normal classrooms was not possible. The STs, on the other hand, needed support and encouragement from the tutors and practising teachers who should be knowledgeable, have clear understanding of the value of ICT and have positive attitudes towards the use of ICT in teaching and learning Science. Apparently, this requires a close relationship and collaboration between the Faculty and Schools, putting emphasis on the STs' use of ICT besides other requirements. ICT should be integrated into teaching practice as part of the STs' education in order to apply and test their ICT skills and reflect on their practices.

Overall, this study showed that prospective teachers should be educated in a way that provides technical and pedagogical ICT skills, allows them to rehearse and test their ICT skills and reflect on their practices, teaching their specialist subjects. For the ITE in Turkey, this study has a clear implication that a new curriculum, which includes what should be taught in training prospective teachers about ICT and its uses in teaching and learning the subjects, needs to be developed. The current ITE curriculum, as analysed in chapter 4, provides general guidelines, it however does not outline explicit targets which define the requirements for student teachers; required knowledge, understanding, technical and pedagogical skills of ICT. In England and Wales, Initial Teacher Training

National Curriculum for the Use of Information and Communications Technology in Subject Teaching (DfEE, 1998b), and in USA, Standards for Technology and Teacher Education (NCATE, 1995), for instance, national standards were set for ITE.

*Assertion 1: Kick-start discrete ICT course(s) will help student teachers develop basic ICT skills. However, integrating ICT effectively into ITE will be accomplished if student teachers are put in the centre of the integration process and provided with meaningful applications that include ICT in the Faculty and Schools.*

As the ACOT project and many other studies illustrated, the practitioners go through stages with time as they develop their understandings and attitudes and learn to incorporate technology into their teaching and learning processes (Dwyer et al, 1990; Comber et al., 1998). In this study, the researcher sought to understand if there was a relationship between the lecturers' stages of concerns and adoption. The results of this exploration do not represent the developments in the lecturers' concern and adoption stages through a time period or training, yet the results show their profiles at the time this study was carried out. The data revealed that the relationship between the two sets of issues was that as the lecturers' levels of concern moved from the 'self-concerns' to 'task and impact-concerns', their adoption levels also moved from entry to appropriation. That is, the level of technology use heightened as the lecturers overcame their self-concerns, especially related to ICT capabilities. This has an implication for monitoring the implementation process, as Comber et al. (1998) assert that knowing about the participant' current stages of concern and adoption of ICT may help to revise and improve the current policy or practice to move forward.

*Assertion 2: There is a relationship between the practitioners' stages of concern and stages of adoption. This relationship is that as the personal level of concern moves from the 'self-concerns' to 'task and impact-concerns', the personal adoption level is also likely to move from entry to invention. That is, as the practitioners overcome their self-concerns and move to task and impact concerns related to the innovation, they are more likely to integrate it into their teaching and learning activities.*

There is plenty of research and theoretical literature indicating that ICT has an impact on changing the nature of teaching and learning, affecting the teacher's and learner's roles, the ways to teach the subject, the ways to access to the information and learning environments. In this study, the research showed that the impacts of ICT on the lecturers' teaching style were twofold. The first emerging use of ICT was that the lecturers made use of ICT to support or improve their traditional teaching styles (i.e. teacher, content and school-centred). In these applications, ICT or other technological tools were time and energy-savers (i.e. making presentations clearer and easier) for the lecturers or productivity tools (i.e. producing hand-outs for the STs). The second one, on the other hand, was that the ICT and other technology were used in a way in which the STs were active participants through individual or group studies, research or assignments (i.e. student, less content and context-centred). In those activities the STs integrated ICT into their studies from preparation to classroom presentation. These types of applications have led to the change in the lecturers' and student teachers' roles as well. The lecturers who provided student sensitive teaching and learning environments were facilitators, guides and sometimes collaborators, whilst the roles of the STs were active learner, researcher, collaborator and information presenter. This has a clear implication for practice, as the literature also suggests, that the introduction of ICT to education has the potential and therefore an impact to change the traditional roles of teachers and learners and the traditional teaching and learning approaches, simply from teacher-centred knowledge transmission to student-centred knowledge construction. Through collaborative group studies/research/assignments the STs illustrated valuable examples of effective learning in this study. These types of activities resulted in various positive outcomes as the lecturers and STs reported. That is to say, as the reader may recall from Chapter 4, the STs learned the subject through knowledge construction, experienced the learning processes through active involvement, mastered and tested their skills including ICT skills, and learned by teaching through presentations and sharing their constructed knowledge with others. The role of ICT in these processes was crucial (i.e. searching for, organising, analysing and reporting information, and finally presenting the constructed knowledge by means of ICT). It is suggested that the student teachers should be given more opportunities to learn the subject in a constructivist learning environment as well as to improve their ICT skills through meaningful applications. It is hoped that they will teach the way they were taught.

*Assertion 3: ICT has the potential to change the way to teach and learn. That is, ICT provides learner-centred learning environments, promoting active, collaborative, authentic and individualised learning.*

As discussed in Chapter 2, although there has been a great interest and investment in ICT in schools, many studies show that the change is yet to be accomplished. That is, the use of ICT in teaching and learning activities in today schools is improving, yet still disappointing. From the evidence of this study, there were several factors affecting the integration of ICT into ITE programmes. These factors could be characterised as personal and institutional. The research showed that the personal factors were the practitioners' ICT capability, understanding of ICT and attitudes towards ICT. As revealed in analysing the relationship between the lecturers' stages of concerns and stages of adoption, it is clear that without overcoming self-concerns the lecturers do not incorporate ICT into their teaching. Therefore it is not realistic to expect from the lecturers who have some self-concerns to integrate ICT into their teaching and learning activities. As to the lecturers' personal factors issue, it was revealed that the majority of lecturers had the capability to make use of various types of ICT available in the Faculty, especially for their personal and academic needs. The STs' ICT capability was somewhat worrying since the majority reported limited ICT skills. However, both groups of participants need to develop and improve their ICT skills; technical and application skills.

The second personal factor affecting the implementation was the participants' understanding of the change. It was revealed that the participants perceived ICT as facilitators, information sources, presentation tools and a medium to change the nature of teaching and learning. It is evident that the introduction of ICT led to raising the participants' awareness of ICT and its potential in teaching and learning and increasing their knowledge and skills. All the promising things mentioned by the participants about ICT and its value in education were very positive regarding the destiny of the change, yet their perceptions of appropriate use and actual uses of ICT were very limited and infrequent.

The third personal factor influencing the integration process was the participants' attitudes towards the innovation. The participants also had very positive attitudes towards ICT. First of all, all participants had a good appreciation of the positive potential of ICT in all aspects of education from administrative uses to the uses of ICT in teaching and learning special subjects. Second, even though the participants had mentioned positive attitudes towards the usefulness of ICT in education, in particular the majority of the STs mentioned certain ICT anxieties such as possible technical and management problems. One of the illustrations of the participants' anxiety was their preference to use less problematic conventional presentation tools such as OHPs, slide-machines and TV-video set during their presentations rather than using a computer, data-show, presentation software, and so on. Third, it is evident that the participants appreciated the introduction of ICT into education and some (e.g. L3, PT7, PT9, PT11 and CT7) developed an interest in learning more about ICT and its use in teaching and learning. Regardless of what their ICT capability is, all mentioned that they would like to learn more about the use of ICT, and if the conditions were satisfactory, they would incorporate ICT in their teaching processes consistently. Overall, the participants had positive attitudes towards ICT and its usefulness in education in general and in science teaching in particular.

In conclusion, although the participants reported some concerns about their technical and pedagogical ICT skills, the participants' understandings of and attitudes towards the change were in favour of the implementation of ICT in the case rather than being barriers to the integration. One of the general strategies of educating prospective teachers in the Faculty was that the majority of the lecturers preferred using student-centric teaching styles in some method courses. These lecturers who adopted student-centric teaching styles were the ones encouraged and forced the STs to make use of ICT and other technologies, at least as presentation tools. These applications were clear indicators of their recognition of the usefulness of ICT and positive attitudes towards ICT. In return, it was revealed that the STs valued these activities and enjoyed what they were doing, and therefore they had meaningful experiences and improved and tested their ICT skills, developed positive attitudes towards technology and its use in education.

*Assertion 4: The practitioners' capabilities, understandings and attitudes can be the promoters of the change rather than the impediments to the change. Moreover, meaningful and beneficial experience also helps the practitioners to develop or improve their capabilities, understandings and attitudes in return.*

The institutional factors, which were reported by the participants or observed by the researcher, on the other hand, were *lack of a strategic plan or an explicit vision, lack of* *trained teacher educators and support*, *time*, *crowded classrooms* and *lack of proper access, management.* First of all, it is expected that the implementation of any innovation is carried out with a strategic plan supported by a clear vision, which shows what to do, when to do, how to do, why to do and where to go. The research showed that the Faculty did not have a plan for integrating ICT. It can be argued that lack of a strategic plan created a complex situation and gave rise to other factors such as training, support, access to resources, management and class size. A strategic plan therefore would be helpful to find solution to overcome each of these impediments. As analysed and discussed in chapter 4, the lecturers were proactive participants in the initiation and integration processes of ICT. The research revealed that very few people (i.e. the lecturers, L1, L2 and L4) initiated ICT-related activities through either discrete courses or cross-curriculum activities in the case. This built momentum, and this momentum led to spreading the innovation across the other programmes in the Faculty. In this vein, the change was in a bottom-up nature unlike many other changes in Turkish Educational System. The research has an implication for the change process in terms of its *technical quality* (Fullan, 1991). That is, a bottom-up approach alone has shortcomings as well as top-down approach. According to Fullan (1991:18),

> "far too many innovations, even those with laudable (valued) goals, have been rushed into practice without any clear notion and corresponding resources related to how they could be used in practice (or, more charitably, the technical requirements or means of implementation have been underestimated)".

It was revealed that all participants, the lecturers and STs, reported some crucial impediments preventing them from integrating ICT into their teaching and learning. Lack of trained teacher educators affected the integration process including ICT-related discrete courses. Discrete ICT courses had been taught by the lecturers who had not received any in-service ICT training. Professional support for the lecturers and STs were not available in the Faculty. The lecturers reported a necessity for technical and pedagogical supports, and they were willing to learn more about ICT and its pedagogical uses in education. It is believed that training and ongoing support for the participants, whatever the form is, would be efficient to integrate ICT into their own teaching activities. Factors such as overcrowded classrooms, lack of time, limited ICT resources and lack of proper access to these sources mentioned were the barriers to ICT integration.

It was evident that the Faculty had improved its ICT facilities within the last five years. Two more clustered-ICT laboratories and a technology-enriched classroom had established in order to educate the STs in using ICT in science teaching and learning to develop or improve their technical and application skills. However, these three computer laboratories and a single classroom with some presentation tools, as reported by both groups of participants, were not enough. As to integrating ICT into teaching and learning, the picture did not look promising because the ICT resources were clustered in different locations in the case as additions rather than integrated into the classrooms in which the actual teaching and learning activities carried out, as Cornu (1995) argues. Lack of classroom access to the ICT resources therefore was thought to be an impediment preventing the lecturers and student teachers from integrating ICT into their teaching and learning processes. One might argue that these institutional factors would be an excuse for the practitioners unless they are solved.

*Assertion 5: The institutional factors were more influential barriers that affected the change process within the case. On the other hand, the personal factors such as ICT capability, understanding of the change, attitudes towards the innovation, commitment and so on were very promising to integrate ICT into teaching and learning activities.*

## 5.4 An Action Plan to Move Forward

As made clear in this thesis, integrating ICT into an institution requires a strategic plan for taking action to move forward. One of the reasons for selecting this particular case, Fatih Faculty of Education, was that the researcher will be a member of the faculty. For the Faculty and his prospective studies in particular and for other ITE providers in general, a model for integrating ICT into ITE is recommended, as illustrated in Figure 5.1. This plan is based on the ideas from the literature, the lessons learned from the study and the researcher's own understanding of the integration.

**Term I**

A kick-start ICT course

Observing lecturers'

→

**Term II**

Applying the acquired ICT skills to other subject courses in the Faculty

Observing lecturers'

→

**Term III**

Actual classroom experiences in Schools

Observing lecturers'

Supported by:
A clear vision;
ICT-enriched environments in Faculty and Schools;
ICT user lecturers;
Technical and pedagogical support
Ongoing assessment

Figure 5.1 A Constructive Model for ICT Integration

With the latest reform, Secondary Science Teacher Education programmes consist of two phases, which represent consecutive model of ITE, as discussed in the Introduction. The second phase lasts three academic terms (1.5-year). The proposed model is designed in accordance with these terms. In this model there are three key components of the integration process. It is evident that ICT requires new knowledge, understanding and skills. Unlike many developed countries, student teachers come to ITE programmes as ICT illiterate or with very limited knowledge and skills in Turkey, as was revealed in this research. Thus, firstly, it is believed that a kick-start course during first academic term is a necessity. In this kick-start course, student teachers should be taught basic ICT knowledge and skills. Unlike the current situation in these study programmes, these courses must be delivered by ICT specialists or well-trained lecturers.

Secondly, as the literature and this study suggest, the lecturers should model the use of ICT in teaching other subjects so that student teachers are able to experience the ways in which ICT can be effectively incorporated into teaching and learning. They also should create opportunities for student teachers to practise, test their skills, and reflect on their practices in the Faculty. This type of modelling should be carried out throughout three terms. For student teachers, the course, "Instructional Technology and Material Development", would be a place to rehearse, as well as in the other courses through project/research-based studies or assignments. Since the lecturers' use of ICT needs to be promoted, it is recommended that this can be achieved by professional support. Matthew et al. (2002) examined an action in practice from Louisiana Tech University, one-on-one coaching. They found that one-on-one coaching approach is effective to increase teacher educators' technology competency. It is evident that currently the Faculty does not have well-trained staff who may support the lecturers to integrate ICT into their teaching. As discussed in the Introduction Chapter, with the latest reform in ITE Instructional Technologies and Computer Education (ITCE) programmes were created in each Faculty of Education to educate prospective ICT coordinators for primary and secondary schools. These students, as Altun (2002) points out, are trained as technology experts with limited understanding of pedagogy. However, as it was the case at Louisiana Tech, the student teachers of ITCE can be the coaches. As Matthew et al. (2002) found in their studies, the student teachers (coaches) "contributed their technological skills and the teacher educators contributed their pedagogical and content knowledge as they planned together and developed ways to incorporate technology into the classroom" (p.59). Having made contribution to the ICT integration process, one-on-one coaching like this helps the student teachers "develop a sense of themselves as teachers" (p.60).

Thirdly, the model requires meaningful experiences in placement schools. As Barton (1996) argues, student teachers should be given enough time to observe teachers who incorporate ICT into their classrooms and to teach in technology-enriched environments. These experiences will help them develop their ICT skills in meaningful environments, including ICT classroom management skills. However, in this phase student teachers need to be supported by the tutor(s) and mentor(s). It is crucial that both technical and pedagogical supports are provided during teaching practice. It is evident that the use of ICT in schools is still disappointing or at very simple level in Turkish classrooms (Alev, 1997; Altun, 2002), as also was revealed in this study. For this reason, mentor teachers should be preferably ICT users, or willing to use, but certainly have some technical ICT skills and pedagogical understanding. It is also recommended that, as the latest reform in the Turkish ITE suggests, the Faculty, placement schools and LEA need to work together to arrange better environments for student teachers to practise, including providing in-service training courses for mentor teachers.

To sum up, it is believed that this proposal may contribute to the process of ICT integration into ITE. It provides kick-start courses to develop student teachers ICT skills, creates opportunities for student teachers to observe actual practices of others and to practise and test their skills, and to reflect on their practice. To accomplish this, there are some crucial components of the process. It is recommended that a clear vision as a starting point would help the people know where they are heading. Infrastructure, trained tutors and mentors and ongoing support are crucial to the process. An ongoing assessment strategy also will help to evaluate the situation at any point of the process and to determine the problems that may hinder the integration process and to find solutions. For all these above, the Faculty must form a team to track the process and manage the change.

## 5.5 The Scope of the Study

In this research, there were some areas that should be taken into consideration by researchers, policy-makers and institutions. First of all, the research revealed that there was a significant difference between male and female student teachers, based on technical ICT skills. Male student teachers scored significantly higher on the items related to technical ICT skills. This result supports previous research (Kay, 1989; Russell and Bradley, 1997; Selwyn, 1998). As Koohang (1989) puts it, certain differences in cultural, environmental, or early childhood programming do exist between male and female. Based on the findings of the study, it is recommended that further research is needed to find out why female student teachers feel less confident on using ICT than female ones. It is also recommended that female students should have more opportunities to practise their ICT skills in the Faculty and home since the data indicated that male STs had had more practice and previous experience and had easy access to computers in and out of the Faculty, particularly out of the Faculty.

As to the subject issue, overall the STs of Physics were found more confident on using ICT among the three Science programmes under investigation. This may be partly explained by the fact that STs of Physics had substantial experience during taking the ICT course. Nevertheless, Newton and Rogers (2001) point out physics students feel more confident, based on the assumption that they had more experiences with electrical and electronic devices during their laboratory works than those from Chemistry and Biology programmes. Again based on the findings of the study, it is recommended that further research is needed to find out what causes the differences among the three Science areas on using ICT confidently in teaching and learning activities. It is also recommended that equal access and opportunity for each group of STs from the three science programmes should be provided.

Secondly, as discussed in the Introduction Chapter, with the latest change in ITE in Turkey, the Faculty, LEA and Schools need to work together to develop student teachers. However, the findings of the study showed that the relationship among those parts is still disappointing and not organised carefully, especially for the purpose of developing STs' ICT capability. As recommended earlier, a strong collaboration and cooperation need to be established to create opportunities for prospective teachers to practise their ICT skills during their teaching practice. It is crucial to appoint mentor(s) and tutor(s) for each ST, who have considerable ICT capability, both technical and pedagogical, to integrate ICT into teaching practice. Additionally, it is recommended that inservice training courses need to be arranged for both mentors and tutors to determine what should be done for STs to develop their ICT capability. This requires a strong and close partnership among those parts pointed out earlier. It is also recommended that more qualitative research is needed to investigate the partnership model in practice and to understand the contexts holistically.

Finally, many countries around the world have had substantial initiatives to educate their prospective teachers in integrating ICT into teaching and learning. In 1998, for instance, the UK Government revealed, as part of its 'National Grid for learning' (NGfL) strategy, a curriculum for training prospective teachers in using ICT across curriculum, called the Initial Teacher Training (ITT) National Curriculum for the Use of Information and Communications Technology in Subject Teaching (DfEE, 1998b). For each ST, ICT training has become a requirement to be a Newly Qualified Teacher (NQT). Shortly following this, the Government initiated a new inservice ICT training programme,to improve schools and teaching with ICT, the lottery-funded New Opportunities Fund (NOF) for practising teachers and school librarians (TTA, 2002; Ofsted, 2001). "By the end of the programme in December 2003 all teachers are expected to have ICT knowledge and competence at the level of a newly qualified teacher (NQT)" (TTA, 2002:1). Thus some crucial attempts to integrate ICT into education were initiated such as Integrating Learning Systems (Underwood et al., 1996) and Impact2 (DfES, 2001). In the USA, on the other hand, National Standards were set in developing prospective teachers with ICT capability, called Current Standards for Technology and Teacher Education (NCATE, 1995). These initiatives resulted in some very positive and promising outcomes, increasing use of ICT in schools by teachers, providing more hardware, software and Internet access (Ofsted, 2001; TTA, 2002). However, as explained in the literature review chapter, the use of ICT in classrooms is yet to be accomplished. In the TTA's (2002) report, it is recommended that NQTs need to develop and practise their pedagogical and management skills of ICT in schools and classrooms rather than working like an ICT coordinator or technician. Teachers' commitment is also an important factor for the slow uptake. Ongoing support or face-to-face training sessions are needed to develop and increase the use of ICT in classrooms (TTA, 2002). Turkey has not any curriculum or standards for the use of ICT in teaching and learning and for training prospective teachers with ICT capability. Thus, for the policy-makers in Turkey, it is recommended that, as is the case in many developed countries such as UK and USA, Turkey need to develop a similar curriculum which indicates the standards for ITE in using ICT across curriculum, taking into account the developments around the world in the area. It is crucial that the Government and policy-makers need to pay more attention to the developments around the world in the area and support the developments, embarking new initiatives as many developed countries have done. It is evident that Turkey as a developing country has a lot to do in this area. Current ITE for the use of ICT across curriculum is dependent upon individual attempts and efforts of the ITE Faculties in Turkey. Thus, more qualitative study is needed to investigate and understand current states of integration of ICT into ITE institutions such as this study. More qualitative study in the area may help policy-makers, ITE institutions, schools and the practitioners understand where they are heading.

## 5.6 Suggestion for Further Research

Educational research in general, and qualitative educational research in particular, has a short history in Turkey. For this reason, as opposed to the situation in the developed world, research-based knowledge about ICT is very limited in Turkey. Thus, any well designed-research about the phenomenon would be useful and contributes to creating a knowledge base. It is worth noting here that more research about "ICT and pedagogy" should be carried out to illustrate how ICT can improve learning and what ICT provides. Educators are still not convinced to incorporate ICT into their classrooms. Furthermore, the researcher suggests that answers to the following questions should be sought. How can discrete ICT courses be improved to contribute to developing student teachers' technical and pedagogical ICT skills? How can teacher educators' uses of ICT be increased? How mentor teachers integrate ICT into their teaching? What can be done to improve student teachers' use of ICT in teaching placement schools? How can student teachers make use of ICT in Faculty and Schools? What are their reflections on observing and using ICT during teaching practice? What are the minimal requirements of successful ICT integration? Are the novice teachers using ICT in their teaching when they are appointed as practising teachers? Obviously, there are many more questions to add this list awaiting responses.

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APPENDICES

## Appendix A: Interviews, Questionnaire and Observation Schedules

### STUDENT TEACHERS' INTERVIEW QUESTIONS

Name:

Department: Physics ☐ Chemistry ☐ Biology ☐

Gender: Male ☐ Female ☐

Age:

Date and Time of Interview:

1. Do you use any ICT resources as teaching tool? If yes, Which ones? And Why? And How often? If not, Why not?

2. What kind of ICT resources and other technologies do you use during your teaching or personal use?

3. What do you think about the main benefits and drawbacks of ICT use in science education?

4. What are the problems and challenges you face during your use of ICT?

5. Have you had direct experience of planning and managing lessons with ICT in the classroom?

6. What kind of ICT resources do you feel most confident with during your practical activities?

7. Are you interested in developing your skills and knowledge in ICT?

8. How do you get access to ICT resources in that faculty?

9. What extra support would make you use of ICT more effective?

10. Do you have any difficulties understanding the technical aspects of ICT?

11. What do you think about ICT terminology?

12. What was the most useful thing that you learned from the ICT related course you took?

13. What was the least useful thing that you learned?

14. Do you have any support and encouragement from your tutors during your practice or course?

15. Do you think ICT changes the way to teach and learn science?

16. Do you think the ICT-related course was adequate in preparing you as a future practitioner for teaching in your own subject area with ICT?

17. Do you think that the benefits of ICT outweigh the time and energy needed to implement it?

18. What contribution does ICT make to learning and teaching science?

19. If you could improve the integration of ICT into science teacher education, what would you do?

20. What are the needs of appropriate teacher training in using ICT in science?

**LECTURERS' INTEVIEW QUESTIONS**

Name:

Department: Physics □ Chemistry □ Biology □

Gender: Male □ Female □

Age:

Lessons s/he teaches and the period:

Date and Time of Interview:

1. Have you ever received any ICT training? If yes, can you give details of this training? Anything that was useful or not useful about it. If no, how did you acquire the skills and knowledge of ICT?

2. Do you use any ICT resources as a teaching tool? If yes, Which ones? And Why? How often? If not, Why not?

3. What do you think about the main benefits and drawbacks of ICT use in science teaching and learning?

4. What kind of ICT resources and other technologies do you feel most confident with during your practical activities?

5. Do you have any difficulties in understanding the technical aspects of ICT?

6. What extra support would make you use of ICT more effective?

7. Have you had direct experience of planning and managing lessons with ICT in the classroom? Do you feel confident about helping your students work with ICT in classrooms?

8. What are the management and organisational challenges you face during your use of ICT?

9. How do you keep up to date with ICT developments?

10. Are you interested in developing your skills and knowledge in ICT?

11. What do you think about computer terminology?

12. How do you get access to ICT resources in that faculty?

13. What are the objectives of the ICT-related course you teach?

14. Do you think the ICT-related course was adequate in preparing student teachers for teaching in their own subject area with ICT?

15. What are your priorities for developing student teachers' skills, knowledge and attitudes in ICT?

16. Do you think that the benefits of ICT outweigh the time and energy needed to implement it?

17. Do you think ICT changes the way to teach and learn science?

18. In general has ICT had an impact on your teaching?

19. Does this faculty have a plan to integrate ICT in teacher training?

20. What are the barriers to the use of ICT in teacher training at this faculty in particular, and in science teaching in general?

21. What do you think about the potential of pre-service teacher education as change agent in ICT use in school setting?

22. What do you think about the need for appropriate teacher training in using ICT in science?

23. If you could improve the integration of ICT into science teacher education, what would you do?

**QUESTIONNAIRE FOR SCIENCE STUDENT TEACHERS**

Department: Physics □ Chemistry □ Biology □

Gender: Male □ Female □

Age:

Dear Colleague;

As you know, there have been some fundamental changes in pre-service teacher education programmes in Turkey. One of the changes is to train student teachers in using ICT in their future subject teaching as teaching tool. The basic aim of this questionnaire is to get some information about your view of Information and Communications Technologies (ICT) in Pre-service Teacher Training. There will be four sections in this questionnaire, and all instructions have been written in italics to help you distinguish them from the questions.

It is anticipated that the results of this study may influence and future content of teacher education about using ICT in science education. From this point of view your support in this study is very important and appreciated. All responses will be treated in confidence and no individuals will be named in the report of results.

**A- Student teachers' perceptions about the ICT-related course and the use of ICT.**

***In this section, please write your answer in the space provided for each open questions and put a tick in the box corresponding to your answer for close questions.***

1- Overall, do you think that the ICT-related course was appropriate to train teachers in using ICT in science as teaching tool? Yes □ ***go to q2***

No □ ***go to q3***

2- Which aspects were the ICT-related course appropriate?

3- Why do you think so?

4- What could be done to improve this ICT-related course?

5- Why would this improvement matter?

6- What did you like best about the ICT-related course?

7- How would you rate this course?

Excellent □ Good □ Average □ Poor □ Very-poor □

8- How do you get access for ICT sources at this faculty. And how often?

9- Did you go to schools for your apprenticeship?

Yes □ No □

10- Did you use any kind of ICT resources as teaching tool during your training and practice?

Yes □ ***go to q11***

No □ ***go to q12***

11- Which ICT resources did you use? And why?

12- What are your reasons for not having used ICT during your practice?

Lack of training ☐

Shortage of teaching time ☐

Preference for other method ☐

Lack of access ☐

Lack of appropriate software ☐

Concerns over organisational issues ☐

Concerns over possible technical problems ☐

Other *please write in..........................*

**B- Student teachers' basic ICT technical skills and self-confidence.**

***Please put a tick in the box corresponding to your answer. If you do have no idea about one item, please put a tick in the box labeled 'no idea' for that item.***

**Level of confidence**

| No | Items | None | Low | Confident | High | Very high |
|---|---|---|---|---|---|---|
| 1 | Turning on the computer and loading a diskette. | | | | | |
| 2 | Formatting a new diskette. | | | | | |
| 3 | Saving and opening files from hard disk | | | | | |
| 4 | Saving and opening files from a diskette. | | | | | |
| 5 | Using a word processor to create a variety of documents | | | | | |
| 6 | Running through a simulation or computer game | | | | | |
| 7 | Creating graphs or charts with a computer. | | | | | |
| 8 | Knowing how to search for information from the internet. | | | | | |
| 9 | Using e-mail. | | | | | |
| 10 | Using a computer keyboard. | | | | | |
| 11 | Using spreadsheets. | | | | | |
| 12 | Using educational software packages | | | | | |
| 13 | Using CD-ROM information sources | | | | | |
| 14 | Using On-line information sources | | | | | |
| 15 | Using computer programming language. | | | | | |
| 16 | Selecting and setting a printer option | | | | | |
| 17 | Using databases | | | | | |

## C- Student Teachers' Application Skills and Self Confidence

***Please put a tick in the box corresponding to your answer.***

**Level of confidence**

| No | Items | None | Low | Confident | High | Very high |
|---|---|---|---|---|---|---|
| 1 | Preparing lesson plans which include ICT | | | | | |
| 2 | Knowing how to select ICT resources as teaching tool. | | | | | |
| 3 | Knowing how to evaluate ICT resources in teaching process | | | | | |
| 4 | Using ICT to present subject. | | | | | |
| 5 | Using ICT to facilitate teaching strategies. | | | | | |
| 6 | Having the knowledge of organisational and management strategies related to ICT in education. | | | | | |
| 7 | Demonstrating organisational and management skills in the classroom. | | | | | |
| 8 | Monitoring students' progress by the use of ICT. | | | | | |

## D- Student Teachers' Attitudes to ICT

***Please put a tick in the box corresponding to your answer.***

| No | Items | Strongly disagree | Disagree | Don't know | Agree | Strongly agree |
|---|---|---|---|---|---|---|
| 1 | People managed before without computers, so computers are not necessary now. | | | | | |
| 2 | I find using the computer easy. | | | | | |
| 3 | I would like to know more about ICT. | | | | | |
| 4 | I think I would enjoy using a computer. | | | | | |
| 5 | The world would be better off without computers. | | | | | |
| 6 | I find using ICT time consuming. | | | | | |
| 7 | ICT training is a priority for me | | | | | |
| 8 | I don't see the need to learn about ICT | | | | | |
| 9 | It would be hard for me to learn to use ICT. | | | | | |
| 10 | The computer is like a private tutor. | | | | | |
| 11 | Computers are fascinating. | | | | | |
| 12 | The computer is an educational tool. | | | | | |
| 13 | I cannot cope with all the ICT jargon. | | | | | |
| 14 | The computer is an effective learning tool. | | | | | |
| 15 | I feel uneasy when people talk about ICT. | | | | | |
| 16 | I feel comfortable working with ICT. | | | | | |
| 17 | Using ICT broadens your horizons. | | | | | |
| 18 | I get anxious each time I need to learn something new about ICT. | | | | | |
| 19 | Systems are slow, I would be quicker using a book | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 | Computers are a luxury for schools at any level. | | | | | |
| 21 | I would be glad seeing my students using ICT. | | | | | |
| 22 | Using ICT, educators improve teaching quality. | | | | | |
| 23 | The use of ICT in the educational process generates technical problems. | | | | | |
| 24 | I feel uncomfortable thinking of me using computers in the classroom. | | | | | |
| 25 | I feel lost in the information age. | | | | | |
| 26 | I wish computers had never been invented | | | | | |

I will be following up this questionnaire with interviews looking further at student teachers' experience of ICT as teaching-learning tool and their perceptions about using ICT in science as teaching tool. Would you like to take part in these interviews? If so, please tick the box below, providing your name, department, telephone number and e-mail address.

☐ I am interested in taking part in the interviews.

Name:

Department:

Telephone number:

E-mail:

Thank you very much for your assistance.

## OBSERVATION SCHEDULE

* A3-size was used during observations

| Aspects | Content/ Subjects | Context | Pedagogy | | | Classroom Management/ Organization | Other |
|---|---|---|---|---|---|---|---|
| | | | Style | Format | ICT | | |
| Lesson..... | | | | | | | |
| Comments | | | | | | | |

An example of the observed lessons

| L5 | Context | Pedagogy | | | Management | Comments |
|---|---|---|---|---|---|---|
| | | Teaching Style | Teaching Format | Use of ICT | | |
| Lesson 1 | Lecturer's office | Student - sensitive | Group studies, small presentations to lecturer. | None | | Non ICT user in his teaching, but let STs use ICT(Computer, Video, OHP, video-camera: for their presentations Facilitator Encouragement for max. student involvement by group investigations, research and presentations. |
| Lesson 2 | Traditional class design | Student-sensitive | Students' presentation, Whole class discussion, Knowledge transmission (by STs), group studies. | Computer, Video, OHP, video-camera | STs led the class, Lecturer as facilitator | |
| Lesson 3 | Traditional class design | Student - sensitive | Students' presentation, Whole class discussion, Knowledge transmission (by STs), group studies. | Computer, Video, OHP, video-camera | STs led the class, Lecturer as facilitator | |