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# Examining teachers' beliefs about ICT in education: implications of a teacher preparation programme

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## Abstract

The survey presented in this article examines current teachers' beliefs and attitudes towards information and communication technologies (ICT) in education. A total of 1165 primary and secondary education teachers participated in the study, immediately after following a training programme on basic ICT skills. The authors' results showed that the majority of the teachers in the sample have positive attitudes towards the training programme they attended, the general role that ICT can play in education and the integration of ICT in the educational process. The authors' findings also revealed some parameters that interfere negatively, thus making many teachers cautious of or sceptical about ICT integration in educational practice. Multivariate analysis identified three groups of teachers that exhibited a consistent approach: a group of teachers having positive attitudes towards the items of the research, a second group with negative attitudes and a third one with neutral beliefs about ICT in education. Moreover, the authors' analysis extracted significant information on the profile of the teachers within each of the three groups. They found that personal factors (subject matter, teaching experience and gender) are strongly associated with the beliefs and perceptions teachers hold about ICT in education.

*Keywords: ICT in Education; Teachers' Beliefs; Teachers' Professional Development; Educational Policy*

## Introduction

Educational systems around the world, in both developed and developing countries, are under increasing pressure to use information and communication technologies

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(ICT) in order to teach students the knowledge and skills needed for the future knowledge society. Since the 1990s a large number of educational initiatives and research have been directed towards ICT integration in schools. Various approaches have been tried. Prominent among them have been, firstly, the development of technology infrastructure in schools and, secondly, the production and infusion in schools of sophisticated ICT-based tools for instruction and learning.

According to policy-makers worldwide, ICT in schools should lead to significant educational and pedagogical outcomes, beneficial for both students and teachers (Office for Standards in Education [Ofsted], 2002; European Commission, 2004; Queensland Government, 2004). Nowadays, the actual impact of the integration of ICT into everyday classroom practices constitutes an essential question. A large amount of research has shown that the use of ICT in education can increase students' motivation and deepen understanding, promote active, collaborative and lifelong learning, offer shared working resources and better access to information, and help them to think and communicate creatively (Jonassen, 2000; Webb, 2005). In other words, ICT appears to change the very nature of teaching and learning. With the emerging new technologies the teaching profession could evolve from an emphasis on teacher-centred instruction to student-centred, interactive learning environments.

In practice, however, established curricula and teaching approaches still remain essentially unchanged, while technology is usually underused and poorly integrated into the classroom (Cuban, 2001; Ofsted, 2004). It seems that the outcomes of the relevant initiatives are more evident in pupils' achievement in ICT capability than in applying their skills and knowledge to other subjects across the curriculum (Ofsted, 2004). Although home access to ICT has been growing rapidly both for students and teachers, and ICT infrastructure in the schools (computer labs, educational software disposal, connection to the Internet, etc.) has improved substantially over recent years, teachers do not appear to make effective use of ICT tools in their instruction (Russell *et al.*, 2003; British Educational Communications and Technology Agency [Becta], 2004a; Waite, 2004). It seems that their attitudes and skill level still remain an obstacle for them to adopt and make effective use of ICT (Dexter *et al.*, 1999; Lang, 2000; Pelgrum, 2001; Becta, 2004a).

During recent years a large number of initiatives, coming from both the research community and educational policy authorities, have been directed towards the preparation of teachers in order to enable them to integrate ICT in their everyday educational practice. Various programmes have been established in the European Union (EU) countries (European Commission, 2002, 2004), USA (PT3, 1999), Australia (Queensland Government, 2004), the UK (Ofsted, 2002) and so on, aiming at enhancing teachers' skills in the pedagogical application of ICT in instructional and learning processes. Designing and implementing successful ICT teacher preparation programmes is considered to be the key factor to fundamental, wide-ranging educational reforms (Vosniadou & Kollias, 2001; Watson, 2001; UNESCO, 2002). Until now, most teacher training programmes have been designed to raise teachers' ICT knowledge and skill levels, and foster positive attitudes towards ICT as a teaching and learning tool (Cox *et al.*, 1999; Kumar & Kumar, 2003; Galanouli *et al.*, 2004).

It is widely recognized that teachers' educational beliefs are strong indicators of their planning, instructional decisions and classroom practices (Bandura, 1986; Pajares, 1992). As Van Driel *et al.* (2001) argued, most reform efforts in the past have often been unsuccessful because of their top-down approach, which failed to take teachers' existing knowledge, beliefs and attitudes into account. Therefore, a thorough analysis of teachers' conceptions of ICT in education can provide insights into the prerequisites for their successful preparation. Searching for efficient ways to prepare teachers to adopt ICT as an integral part of their everyday teaching strategies has been a major priority for most countries across the world (Lang, 2000; Knezek & Christensen, 2002; Davis, 2003; Dexter & Riedel, 2003; Niemi, 2003; Pearson, 2003; Becta, 2004b; Hennessy *et al.*, 2005).

This article examines the effect of an ICT training programme, implemented in Greece in the framework of the Information Society initiative (Information Society, 2003), which examined teachers' beliefs and perceptions about ICT in education. Our findings indicate that the teachers in the sample were generally positive and willing to adopt ICT as a teaching and learning tool. We identified three discrete groups of teachers who exhibited a consistent approach across the research items: a group having strongly positive attitudes towards ICT in education, a second group of teachers which are in general negative, and a third one with neutral beliefs. Moreover, multivariate analysis gives significant information related to the profile of the teachers within each group of beliefs. We found that personal factors (namely subject matter, teaching experience, ICT use and experience, and gender) are strongly associated with teachers' beliefs and perceptions about ICT in education. We conclude with some implications concerning teachers' effective preparation in ICT in education.

### Teachers and ICT in education

Teachers' attitudes towards ICT in education have a significant influence on ICT adoption and implementation behaviours in the classroom. Teachers in general agree that computers constitute a valuable tool and they are positive about students' attainment of ICT knowledge and skills. In many cases, they perceive ICT as a new subject matter in education rather than a new way of teaching and interaction between learners and knowledge (Williams *et al.*, 2000). It appears that, even though they recognize the importance of introducing ICT in education, teachers tend to be less positive about its extensive use in the classroom and far less convinced about its potential to improve teaching (Cox *et al.*, 1999; Zhao & Cziko, 2001; Russell *et al.*, 2003).

Although teachers show great interest in and motivation to learn about ICT, their use of ICT tools is limited and focused on a narrow range of applications, mainly for personal purposes. Most of them continue to use computers for low-level supplemental tasks such as word processing (lesson plans, worksheets, assessment tests, registration of grades, etc.) or getting information from the Internet (Becker, 2000; Williams *et al.*, 2000; Russell *et al.*, 2003; Ofsted, 2004; Waite, 2004). Relatively few teachers routinely use ICT for instructional purposes and even fewer are integrating ICT into

subject teaching in a way that motivates pupils, enriches learning and stimulates higher-level thinking and reasoning (Becta, 2004a).

Research also indicates that many teachers have positive attitudes toward technology but they do not consider themselves qualified to effectively integrate ICT into their instruction (Ropp, 1999). Lack of adequate training and experience is considered one of the main reasons why teachers have negative attitudes toward computers and do not use technology in their teaching (Yildirim, 2000). On the other hand, most findings suggest that teachers with ICT knowledge have a more positive attitude toward the potential of computers in education (Cox *et al.*, 1999; Yildirim, 2000). According to a study by Shapka and Ferrari (2003), it appears that teachers training to teach at secondary level had higher self-efficacy than elementary teachers and were less likely to predict that they would give up or avoid a challenging task. The impact of effective teacher training on ICT can be measured in terms of changes in attitudes on the part of teachers (Yildirim, 2000; Kumar & Kumar, 2003; Galanouli *et al.*, 2004) and of students as well (Christensen, 1998).

A series of independent studies indicate that both teachers' personal theories and perceptions about teaching and learning processes and their level of competence with ICT play a major role in how they implement ICT and how they motivate themselves to use ICT tools in the classroom (Gobbo & Girardi, 2001; Niederhauser & Stoddart, 2001; Sime & Priestly, 2005). It seems that teachers' pedagogical cultures shape their representations of ICT use in the classroom (Ruthven *et al.*, 2004), and they are likely to adopt practices with computers that reflect their beliefs about teaching and learning (Drenoyianni & Selwood, 1998). It has been shown that teachers with the most constructivist teaching philosophies regarded the role of computers in their instruction as very important (Ravitz *et al.*, 2000; Becker, 2001). Higgins and Moseley (2001) argued that the most effective teachers not only had a positive attitude towards ICT but had good ICT skills and used computers as a part of a stimulating environment favouring pupils' inquiry and collaboration.

Recent studies (Hu *et al.*, 2003; Ma *et al.*, 2005) have found that teachers' perceptions of ICT usefulness are significant in determining intentions to use ICT in their instruction. A survey in Greek secondary schools (Jimoyiannis & Komis, 2006) outlined five interrelated factors which influence teachers' perceptions about technology and professional development aimed at integrating ICT in their instruction:

- a) continuous ICT support and coordination;
- b) ICT pedagogical development enabling teachers to use technology in everyday classroom practice;
- c) partnership (collaboration with specialist teachers and colleagues in the school);
- d) availability of sophisticated educational software in schools;
- e) ICT infrastructure development in schools.

Various models have been developed aiming at teachers' preparation for ICT integration in their classrooms (for example, Rogers, 1995; Russell, 1995; Zhao *et al.*, 2002; Franklin & Sessoms, 2005; Toledo, 2005). The 'one shot' and the 'one shot plus follow-up' approaches have not been shown to be effective for teachers' develop-

ment in ICT in education (Schrum, 1999; International Society for Technology in Education, 2002) and yet persist. Most of the models above follow the stages approach, proposed by Rogers (1995) to outline the diffusion of innovations, and consider technology separately from the content and the pedagogy.

The model of Technological Pedagogical Content Knowledge defined by Mishra and Koehler (2006) seems to be a promising framework which describes the knowledge required by teachers to effectively integrate ICT in their instruction. The main idea is that true ICT integration in everyday teaching and learning needs to consider technology, content and pedagogy not in isolation, but rather in the complex relationships in the system defined by three key components:

- knowledge of the pedagogy that is applicable to the specific content;
- knowledge of how subject matter is transformed by the application of technology;
- knowledge of how technology can support pedagogical goals.

### **ICT in education: the Greek experience**

Technology integration in the classroom is considered to be a significant national priority for the Greek educational system and is further supported by EU policy. Although computer science has been present in secondary schools as a separate subject (called Informatics) since 1985, the first well-established effort for ICT integration in schools started in 1996, when the Ministry of Education launched an ambitious project named *Odysseia* (*Odysseia*, 2000). This programme, funded by Greek and EU authorities and implemented between 1996 and 2001, aimed at creating a critical mass of teacher communities able to integrate new teaching and learning practices based on ICT. It consisted of three main action lines:

- a) Setting up the necessary infrastructure. By the end of 2004 all secondary schools had at least one fully equipped computer laboratory of 10–12 workstations (there are also some schools having two computer labs) and an Internet connection line through the Greek School Network. By contrast, 37% of primary schools had a computer laboratory and 96% were connected to the Internet. Many secondary schools and an increasing number of primary schools have now developed their own web sites and denote their presence in cyberspace. Every preschool, primary and secondary teacher has his/her own email account free of charge through the Greek School Network.
- b) Developing sophisticated material for learning. During this whole period 50 new educational software titles were developed, covering various subjects in the curriculum. Moreover, 17 well-established titles from international literature have been adapted to the Greek language (i.e. Interactive Physics, Modellus, Cabri, etc.).
- c) Teachers' ICT training and support. A considerable number of ICT training programmes for teachers took place. Most of them were held in schools and were mainly directed towards the application of ICT tools in instructional practice.

This, however, was just the first step towards introducing ICT into schools. In the framework of the Information Society initiative (Information Society, 2003), the Greek Ministry of Education and the European Commission have also funded a large-scale project called Teachers' Training on ICT in Education (TTICTE). This ambitious initiative was focused on teachers acquiring basic ICT knowledge and skills regarding the application of ICT in education. The first phase of this programme, costing €240 million overall, took place during 2002–2003 and approximately 84,000 primary and secondary education teachers participated. In addition, participants were strongly encouraged and financially supported, with a further fund of €50 million, to purchase their own personal home computers.

The project aimed at offering teachers basic ICT knowledge and skills, in order to be able to make effective use of computer applications in their instruction. The whole course lasted 48 hours in total, which were spread over 16 lessons of three hours' duration each, in a two-month period. The curriculum content comprised basic ICT concepts, office applications (e.g. word processing, spreadsheets and presentation software) and the use of the Internet. Furthermore, two lessons (six hours in total) were devoted to the presentation of educational software.

The teacher training courses were administered in ICT training centres specially established for the needs of the project. The ICT training centres were certified by the Greek Ministry of Education. In the case of the prefecture of Ioannina, where the present study took place, the training centres were operated at state secondary schools, at the University of Ioannina and at some vocational training institutes in the area. Every class consisted of 10–12 teachers. The project took place in two periods during the academic year 2002–2003, and 165 classes were held. A total number of 1620 preschool, primary and secondary teachers participated, and 98 trainers, mainly high school computer science teachers, were employed. A local committee carried out the administration of the project in the area (the first author was one of the members of this committee).

Through the initiatives described above it is hoped that many more teachers than before will be willing to explore the possibilities of ICT, and that their confidence in the use of computers and networked resources is enhanced. It is reasonable to expect that entirely new practices will evolve in schools and also that teachers will be working in a more collaborative manner, both with their colleagues and with their students.

## **The study**

### *Objectives and research questions*

Working with teachers who were familiarized with ICT as described above, this study was designed to provide information to better understand:

- the impact of the TTICTE project on teachers' perceptions and beliefs about ICT in education;
- the factors that may intervene and influence teachers' beliefs and ideas about ICT in education;

- the differences in teachers' beliefs across their attributes, such as gender, subject specialty, ICT former experience and teaching experience.

There are two main purposes justifying this study:

1. To replicate and extend previous research concerning secondary teachers' attitudes and beliefs about ICT in education and to determine whether some of those prior findings still exist (Jimoyiannis & Komis, 2006). We hypothesized that past research may have become outdated because of teachers' recent exposure to computers and the development of their ICT knowledge and skills.
2. The results presented here are the first large-scale findings concerning Greek primary and secondary teachers' beliefs about ICT in education. We believe that they could be of particular educational value to the Greek educational policy authorities and the educational community in order to: a) evaluate the impact of the project; b) implement the next (second) phase of teachers' professional development in ICT in education; and c) suggest efficient ways of continuous support for teachers, so that they can apply technology effectively in their classroom practice.

### *The sample*

The survey was administered in the Ioannina prefecture, Greece, following the TTICTE training programme as described above. Out of the 1620 participants in the TTICTE training programme, a total of 1165 preschool, primary and secondary education teachers (540 males and 625 females) participated in the survey. Accordingly, the research achieved a 71.9% response rate. The research sample was representative and the subjects corresponded to approximately 60% of the teaching population in the area.

Table 1 shows the composition of the sample according to the teachers' subject specialties and the subjects they taught at that time. As one can see, the teacher sample is spread across curriculum subjects.

Based on their teaching experience, seven different groups of teachers were established as follows: 1–5 years (TE1), 6–10 years (TE2), 11–15 years (TE3), 16–20 years (TE4), 21–25 years (TE5), 26–30 years (TE6) and more than 30 years (TE7). Table 2 shows the classification of the teachers according to their years of teaching experience.

### *The instrument*

The instrument was a Likert-type scale containing items that presented statements of beliefs toward ICT and its application in education. Many of the survey statements were worded positively. However, a small number were worded negatively. We used a five-point scale anchored by 'strongly agree' and 'strongly disagree'.

There were four dimensions represented in the scale, namely:



Table 1. Classification of teachers' subject specialties

Specialty	Frequency	Percentage %
Preschool	79	6.8
Primary	391	33.6
Theology	35	3.0
Philology (Greek language & history)	216	18.5
Mathematics	86	7.4
Science	77	6.6
Foreign languages	76	6.5
Physical education	79	6.8
Economics	16	1.4
Social studies	18	1.5
Technology	53	4.6
Art & music	21	1.8
Various	18	1.5
<b>Total</b>	<b>1165</b>	<b>100.0</b>

- How do teachers evaluate the programme and their training in ICT?
- What are teachers' beliefs and perceptions about ICT as a teaching and learning tool?
- What are their beliefs about ICT integration in educational practice?
- What are their perceptions and beliefs about the impact of ICT on the role of the school, the teacher and educational media?

Demographic information such as gender, age, years of teaching experience, subject specialty, type of former ICT training and so on, was also requested. The instrument also included two questions regarding beliefs about students acquiring basic ICT skills and students using ICT tools for research and learning across the curriculum. The teachers in the sample responded particularly positively to the above two items, at a percentage of 97% and 88% respectively. For this reason, the related data were not included in our multivariate analysis.

Table 2. Teachers' classification according to their teaching experience

Item	Teaching experience (years)	Frequency	Percentage %
TE1	1–5	112	9.6
TE2	6–10	151	13.0
TE3	11–15	195	16.8
TE4	16–20	212	18.2
TE5	21–25	246	21.1
TE6	26–30	199	17.1
TE7	>30	49	4.2
	<b>Total</b>	<b>1165</b>	<b>100.0</b>

*The procedure*

All the teachers who participated in the TTICTE programme were asked to respond to the questionnaire just after the end of the training course. We chose this particular time period in order to minimize the possibility of other factors that might influence the participants' views and perceptions of ICT in education. Teachers were asked to respond as honestly as they could and were assured that there was no right or wrong answer. No other intervention took place before the survey. The researcher's role was restricted to answering teachers' questions in order to clarify the items under research. To ensure that all questions included in the questionnaire were clearly understood, a trial run of the survey was carried out at five ICT training centres. The trial group consisted of 50 teachers.

*The method of analysis*

Our findings have been analysed along the axes represented in the instrument. Data analysis was performed at two distinct levels. The first level was based on the statistical description of the results while the second level consisted of the multivariate analysis of the input data using the method of Multiple Correspondence Analysis (MCA) (Benzécri, 1992; Greenacre, 1993) employed by SPAD version 5.0. The MCA analysis aims at a deeper investigation of teachers' perceptions and beliefs about ICT in educational practice. Using this type of multivariate analysis we can derive a global view of the data and interpret the different approaches teachers exhibited across the questionnaire. Moreover, we can reveal various correlations according to teachers' personal characteristics (e.g. gender, subject specialty, teaching experience, etc.). Specifically, MCA analysis yields a scatter plot (correspondence map) of the results in a two-dimensional space which emerges from the first two factors of the analysis. The correspondence map constitutes a comprehensive graphical display and a classification of the teachers in relation to their attributes and their responses to the various items in the questionnaire. In other words, the correspondence map depicts teacher categories that are associated close together (see Figure 3).

In our analysis we have used as dependent variables the values  $Q_i = j$  of the responses teachers gave to the various items ( $Q_i$  is the questionnaire item and  $j = 1-5$ , where 1 corresponds to 'strongly agree' and 5 corresponds to 'strongly disagree'). Five items have been used as independent variables, namely gender, subject specialty, teaching experience, (former) ICT training and computer ownership.

**Results***The evaluation of the project by the teachers*

The first research axis deals with teachers' views of the TTICTE programme they attended. The majority of the teachers in the sample evaluated positively their training on ICT skills in relation to their teaching work (75.2%) and their subject specialty (82.2%). They were very satisfied with their trainers and the instruction method they

used (94.2%). On the other hand, the teachers considered the total training hours of the course to be insufficient (65.7%), whereas they thought that the content of the lessons was extremely comprehensive (68.1%). Finally, they would prefer an ICT training course organized at novice and experienced levels (97.2%).

#### *The teachers' ICT use profile*

A total of 685 teachers in the sample (58.8%) reported ownership of a personal computer at home, while 377 teachers (32.4%) had an Internet connection and 286 (24.6%) their own personal email account. A percentage of 38.2% of teachers had attended some training concerning computers and general-purpose software before their participation in the TTICTE project.

We have distinguished five different groups of teachers according to their ICT engagement. As shown in Table 3 one in two teachers had no previous computer experience before entering the programme.

Although the teachers studied showed great interest and motivation to develop their ICT skills, we discovered that the most active users (9.4%) were restricted to a narrow range of supplemental tasks, either for personal purposes or supporting their traditional instruction. They were usually preparing their lessons and/or getting information from the Internet, reiterating thus the results of previous studies (Russell *et al.*, 2003; Waite, 2004). Only a small percentage of the teachers in the sample (1.7%) used ICT as a teaching and learning tool incorporated as short episodes into the existing curricula and their conventional instruction methods. Figure 1 shows the distribution of the teachers related to their ICT profile.

Approximately six out of ten teachers have a PC at home, while one in three has an Internet connection and one in four a personal email account. Despite that, only a small percentage of the teachers use ICT in their instruction and even fewer use ICT as a learning tool. There are also significant differences in the ways men and women use ICT. The gender factor still remains critical as far as the teachers' ICT profile is concerned. As a general comment, it appears that access to ICT in their school or home environment is not a particular barrier to the teachers. But the availability of ICT tools does not seem to be a factor favouring or promoting by itself the teachers' use of ICT for educational purposes.

Table 3. Teachers' classification according to their ICT experience

Computer experience	Frequency	Percentage %
No experience at all	571	49.0
Use computers rarely	326	28.0
Use computers frequently	138	11.9
Use computers to support traditional instruction	110	9.4
Use computers as a teaching and learning tool	20	1.7
<b>Total</b>	<b>1165</b>	<b>100.0</b>

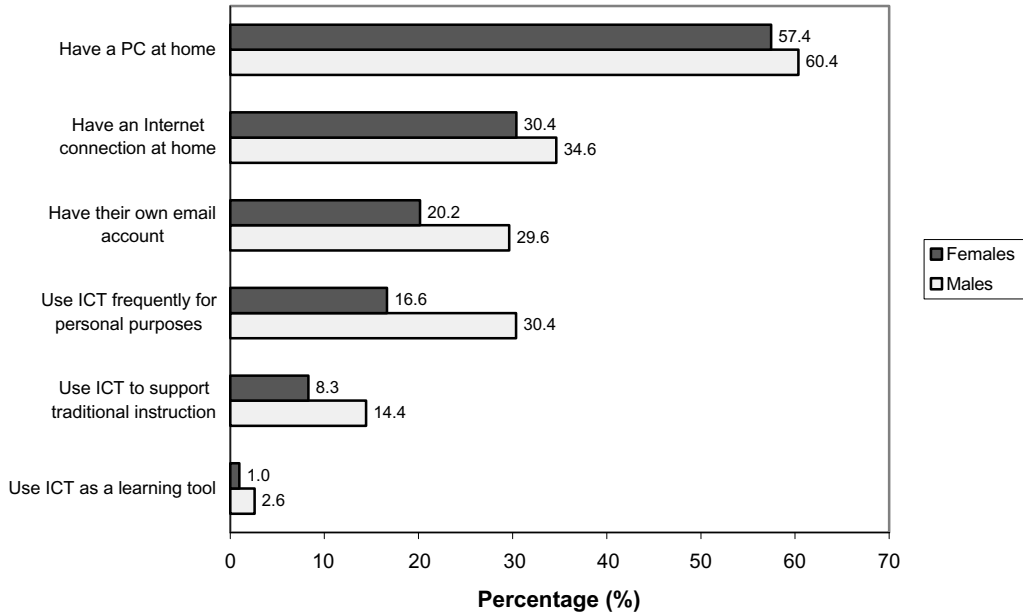


Figure 1. Sample teachers' ICT profile

Figure 2 shows the distribution of the teachers who use ICT frequently to support their conventional instruction. We have found that the core subject teachers in the curriculum (preschool, primary, literature/history and mathematics teachers), with the notable exception of science teachers, do not use computers that often. On the other hand, business and technology teachers reported that ICT use occurred frequently during their preparation and their instruction. Our results confirm previous findings that teachers' ICT usage for educational purposes varies between different subject areas (Becker, 2001).

The teachers were also asked to mention ICT applications that they could use in their instruction. The great majority (74.8%) were not ready to give at least one example, while the rest were restricted to presentation software (3.4%) or the Internet (4.8%) to support their traditional instruction process. Finally, 3.3% of the teachers referred only to basic ICT applications for administration and teacher preparation purposes (word processing, spreadsheets, etc.).

On the other hand, approximately one in ten teachers reported educational software relevant to their subject matter instruction. Those teachers referred to the educational software they were familiarized with during the lessons in the programme (3.3%), and to various commercial multimedia titles or electronic encyclopaedias (4.2%). Moreover, most of the science teachers mentioned well-known simulation software such as Interactive Physics, Modellus, Tina, WorkBench, etc. Simulations provide a wide range of affordances by supporting learning in science, enabling students to perform at higher cognitive levels (Webb & Cox, 2004) and promoting conceptual change (Jimoyiannis & Komis, 2001). It seems that simulations have also

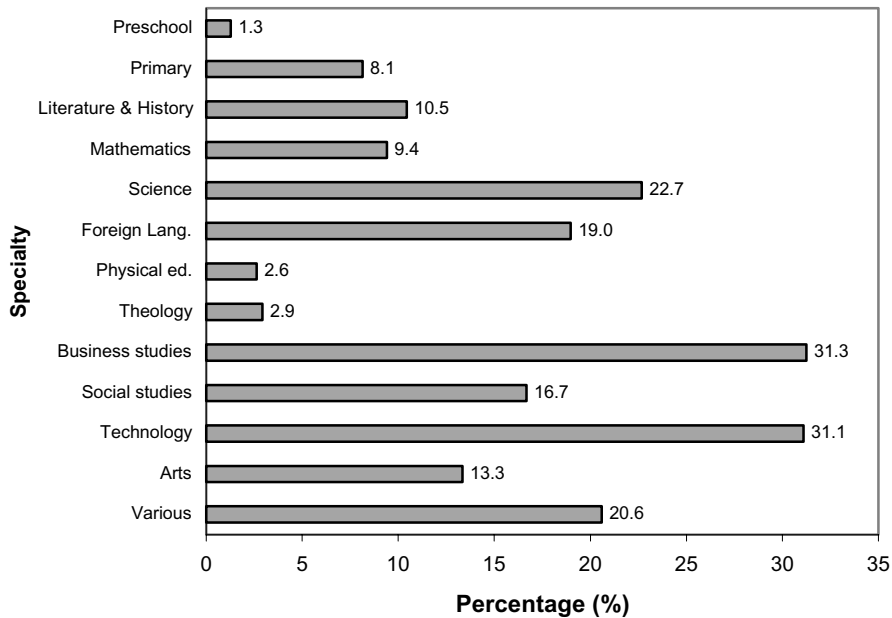


Figure 2. Teachers using ICT for instruction purposes

been recognized by the science teachers in the sample as effective learning tools, supporting thus the argument that ‘the affordances offered by simulations can be incorporated into the existing curriculum with very little change in teachers’ pedagogical practices’ (Webb & Cox, 2004, p. 258).

It appears that the result of the TTICTE programme on teachers’ awareness of effective ICT applications for their subject instruction was not satisfactory. The great majority of the teachers were not able to gain a wider view of ICT in education beyond its technological dimension.

#### *The teachers’ beliefs about ICT as a teaching and learning tool*

The second research axis concerns the investigation of teachers’ beliefs about ICT as a teaching and learning tool. There were six items in the questionnaire representing this axis (Table 4).

The majority of the teachers are in general positive about ICT since they perceive it as a tool for instruction and learning for every subject in the curriculum and also as a tool that can help students’ critical thinking. It is interesting, on the other hand, that only four out of ten teachers are convinced about the usefulness and the effectiveness of ICT in the instructional process.

The first two factors of MCA analysis give 21.67% of the total information produced. They have  $\lambda_1 = 0.5024$ ,  $\tau_1 = 13.11\%$  and  $\lambda_2 = 0.3283$ ,  $\tau_2 = 8.57\%$  respectively. The first MCA dimension (axis) differentiates between the strongly positive teachers and those who are neutral about the items concerning ICT as a teaching and

Table 4. Teachers' beliefs about ICT as a teaching and learning tool

	Item	SA 1	A 2	U 3	D 4	SD 5
Q31	ICT can be a tool for instruction and learning for every subject matter in the curriculum	38.9	41.1	12.0	6.4	1.6
Q33	I believe that ICT is useful only for administration and teachers' work preparation (leaflets, exams, tests, etc.)	16.2	18.9	6.2	27.3	31.4
Q34	ICT is impressive but cannot contribute substantially to teaching and learning	5.9	23.1	10.9	34.9	25.2
Q35	I believe that ICT cannot contribute to learning because it do not activate students	3.1	13.1	10.2	41.4	32.2
Q36	I believe that ICT can help students' critical thinking	23.1	40.3	16.4	15.3	4.9
Q44	I need more reasons to be convinced about ICT usefulness in the educational process	17.1	29.4	14.3	19.7	19.5

Key: SA = strongly agree; A = agree; U = unsure; D = disagree; SD = strongly disagree.

learning tool. The second axis juxtaposes teachers with neutral beliefs with those who are negative towards the items above.

Figure 3 shows the correspondence map in the space defined by the first two dimensions (variance axes). We can distinguish three discernible groups of teachers defined by the values projected on the variance plane:

The first group (G1) is determined by the values corresponding to the teachers that have strongly positive beliefs about ICT as a teaching and learning tool (values Q31 = 1, Q33 = 5, Q34 = 5, Q35 = 5, Q36 = 1, Q44 = 5). It appears that this group is internally cohesive, since the teachers are strongly positive towards the items in this research axis. Near G1 are placed mainly the male teachers, primary and preschool teachers, the economics, technology, science and foreign language teachers and physical educators. Also placed are teachers having their own PC, teachers with low (TE1, TE2) and high (TE7) teaching experience and those that attended some training in ICT before the TTICTE programme.

The second group is determined by the values corresponding to the teachers with positive and neutral beliefs about ICT as a teaching and learning tool (values Q31 = 2, 3, Q33 = 3, 4, Q34 = 3, 4, Q35 = 4, Q36 = 2, 3, Q44 = 3). Also located are teachers who have not been convinced about ICT usefulness in the instructional process (value Q44 = 2). Near G2 are placed mainly the female teachers, teachers that do not have their own PC, Greek language and history teachers, theology, art/music and various specialty teachers and teachers in the middle of service experience (TE4).

The third group comprises teachers with negative beliefs about ICT as a teaching and learning tool (values Q31 = 4, Q33 = 1, 2, Q34 = 1, 2, Q35 = 1, 2, 3, Q36 = 2, 3, Q44 = 1). Near G3 are placed mathematics and social studies teachers, teachers who have attended no training in ICT and teachers with 11–15 and 21–30 years of teaching experience (TE3, TE5, TE6).

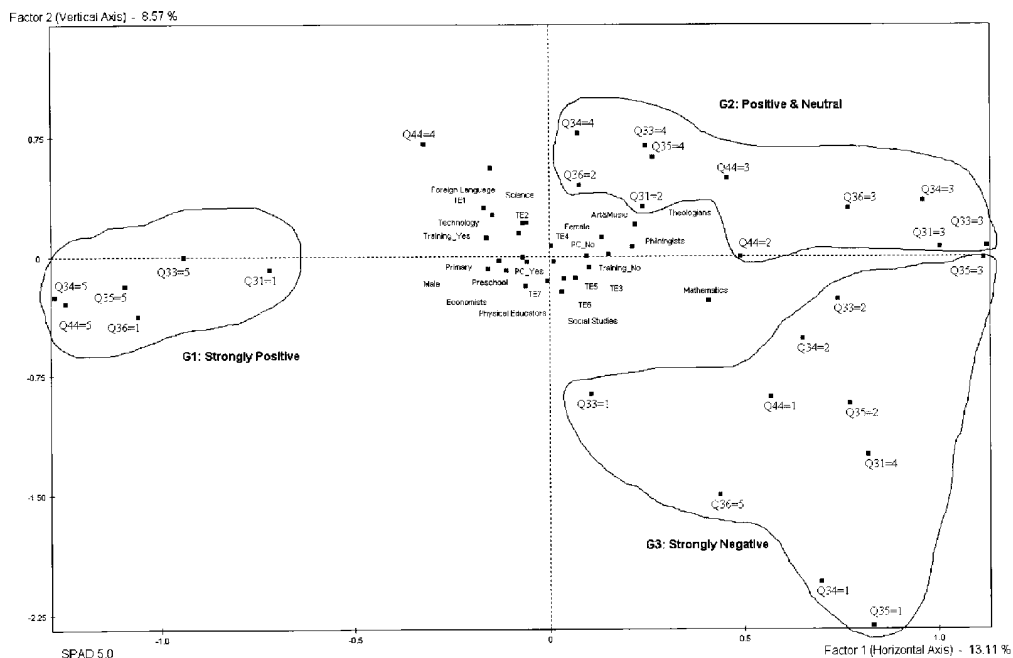


Figure 3. Teachers' beliefs about ICT as a teaching and learning tool

The main conclusion extracted from the correspondence map (Figure 3) is that there is a strong correlation between the values of the variables determining the three groups of teachers. This indicates that the network of teachers' beliefs is strongly cohesive within every group (the Gouttman effect). This means that the teachers' beliefs are consistently similar along the six items of this axis, that is, the teachers responded more or less in the same way (positively, negatively or neutrally) to the items given in Table 4.

#### *The teachers' beliefs about ICT integration in education*

The third research axis consisted of six items and concerns teachers' beliefs about ICT integration in education. As one can see in Table 5, the great majority of the teachers (up to 91.6%) perceive ICT as a necessity in our modern society. It seems that the ICT pedagogical aspect is not clear or prevalent in teachers' views, although six out of ten recognize the importance of knowing how to organize their instruction and the students' tasks using ICT tools.

The first two factors of the multivariate analysis give 18.80% of the total information produced by MCA. They have  $\lambda_1 = 0.4147$ ,  $\tau_1 = 10.82\%$  and  $\lambda_2 = 0.3061$ ,  $\tau_2 = 7.99\%$  respectively. The first variance factor corresponds to the positive–negative beliefs axis. This axis shows the contradiction between strongly positive and negative teachers as far as the items concerning ICT integration in education

Table 5. Teachers' beliefs about ICT integration in education

	Item	SA 1	A 2	U 3	D 4	SD 5
Q30	I believe that I will not be able to use effectively ICT in my job	6.1	24.3	12.6	29.4	27.2
Q37	We have to introduce ICT in schools because it will prevail in the future society	57.2	34.4	4.2	3.3	0.9
Q38	I am cautious about ICT use in education, because ICT restricts social interaction and isolates people	11.9	37.1	9.4	29.3	12.3
Q39	I believe that I will not be able to use ICT in my instruction, because I feel insecure about its application in education	5.5	24.6	17.2	30.5	22.2
Q40	I should use ICT in my instruction but I do not know how to organize and manage students' learning tasks	26.7	35.7	13.2	14.9	9.5
Q41	I want to use computers in the instruction of my subject matter, but it frightens me that students are more skilled in ICT	9.1	16.8	7.5	25.9	40.7

Key: SA = strongly agree; A = agree; U = unsure; D = disagree; SD = strongly disagree.

are concerned. The second factor is characterized as the neutral–negative beliefs axis, since it juxtaposes teachers with neutral attitudes with those who responded negatively.

The correspondence map in Figure 4 shows that the teachers in the sample are explicitly grouped around three poles according to their responses:

The first group (G1) comprises the teachers who have positive beliefs about the integration of ICT in education (values Q30 = 5, Q38 = 4, 5, Q39 = 4, 5, Q40 = 4, 5, Q41 = 5). Near G1 are placed mainly the male teachers, and economics, technology, science, primary and art/music teachers. Also placed are teachers having their own PC and those who attended ICT training before the TTICTE programme. In general, teachers having 1–15 years of service experience (TE1, TE2, TE3) are positive about ICT integration in education.

The second group (G2) is determined by teachers who are neutral about the items concerning ICT integration in the educational process (values Q30 = 3, 4, Q37 = 2, 3, Q38 = 3, Q39 = 3, Q40 = 2, 3, Q41 = 3, 4). Near this group are placed mainly foreign language and preschool teachers.

Finally, the third group (G3) comprises the teachers who are negative about ICT integration in education, since they correspond to the values Q30 = 1, 2, Q38 = 1, 2, Q39 = 1, 2, Q40 = 1, Q41 = 1, 2. The mathematics, Greek language and history, theology and various specialty teachers are negative about ICT integration in education. Also located there are the teachers who do not have their own PC at home, those who have not attended any training about ICT and the teachers having 21–30 years of service experience (TE5, TE6).



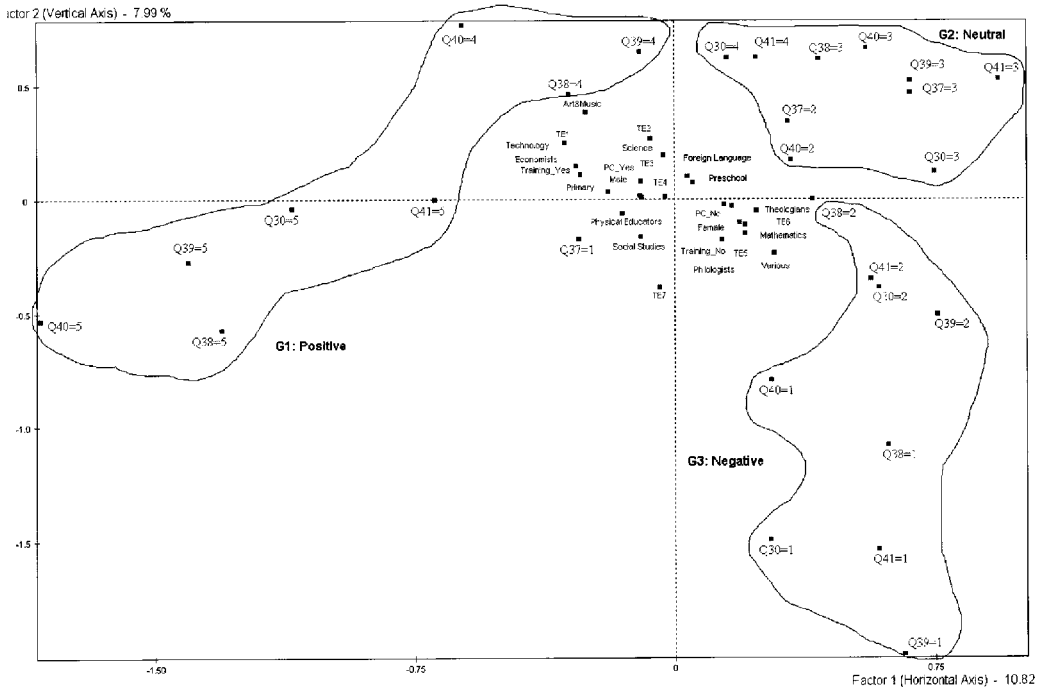


Figure 4. Teachers' beliefs about ICT integration in education

*The teachers' beliefs about ICT and the role of school, teachers and textbooks*

The fourth research axis concerns teachers' beliefs about the changes that ICT could induce, as far as the role of the school, the teacher and the educational media is concerned. Our results along the items of this axis are presented in Table 6. The great majority of the teachers (ranging from 51% up to 74%) believe that ICT will cause substantial changes in the educational process (concerning the role of the school, the role of the teacher and new ICT-based media replacing textbooks). The majority of the teachers in the sample (68.7%) believe that ICT will upgrade the role of the teacher.

The first two MCA factors represent the most significant factors and give 22.66% of the total information derived. They have  $\lambda_1 = 0.4917$ ,  $\tau_1 = 12.29\%$  and  $\lambda_2 = 0.4146$ ,  $\tau_2 = 10.36\%$  respectively. The first axis is the neutral–strongly positive beliefs axis. It shows the opposition between neutral or positive teachers and the teachers who are strongly positive about the items concerning the changes in education because of ICT. The second axis (factor) is characterized as the positive–strongly negative beliefs axis. This axis juxtaposes teachers with positive or neutral attitudes with the teachers who are strongly negative about the items above.

The values of the variables projected on the variance plane are explicitly grouped around three poles (Figure 5):

The first pole (G1) is defined by those teachers who have positive–neutral attitudes towards the role of ICT in education (values  $Q43 = 3$ ,  $Q45 = 2, 3$ ,  $Q46 = 2, 3$ ,

Table 6. Teachers' beliefs about ICT in the educational process

Item	SA 1	A 2	U 3	D 4	SD 5
Q42 I am afraid that ICT will reduce the teacher's role, and this will be negative for children's education	8.4	19.8	8.9	32.6	30.3
Q43 ICT will upgrade teacher's role making it more substantial	29.9	38.8	13.7	13.2	4.4
Q45 I believe that the role of the school will be radically changed in future years because of ICT	34.4	39.6	10.7	11.4	3.9
Q46 I believe that the teacher's role will be radically changed in future years because of ICT	27.1	41.5	9.9	15.8	5.7
Q47 I believe that textbooks' preferential role in education will be replaced by new media based on ICT	15.0	36.0	12.7	25.1	11.2

Key: SA = strongly agree; A = agree; U = unsure; D = disagree; SD = strongly disagree.

Q47 = 2, 3). Near this group are placed mainly the female teachers, Greek language and history teachers, and theology, foreign language and art/music teachers. Also grouped there are the teachers with no previous ICT training and the teachers with teaching experience of between 6–10 years (TE2).

The second group (G2) consists of the strongly positive teachers (values Q42 = 5, Q43 = 1, Q45 = 1, Q46 = 1, Q47 = 1). Near G2 are placed mainly the primary teachers and economics, technology, social studies and preschool teachers. Also located there are the teachers with their own PC and those having 26–35 years of service experience (TE6, TE7).

The third pole (G3) is determined by those teachers who are strongly negative (values Q43 = 5, Q45 = 4, 5, Q46 = 4, 5, Q47 = 5) about the changes caused by ICT in education. Near this group are placed the teachers who responded negatively to some of the questions of this axis (values Q42 = 1, Q43 = 4 and Q47 = 4). Also located there are the male teachers, teachers who do not have their own PC, mathematics and science teachers, physical educators and teachers at the beginning (TE1) and in the middle of their careers (TE3, TE4, TE5).

The correspondence map in Figure 5 shows that there is a strong correlation between the values of the variables determining these three groups of teachers. This indicates that teachers' beliefs and perceptions are strongly cohesive along this research axis also.

It appears that the high school teachers teaching the traditional core curriculum subjects (e.g. mathematics and science) are more reserved as far as the possible changes in education caused by ICT are concerned. The same approach has also been exhibited by the teachers who are in the middle of their teaching career. Those teachers are negative about the changes in the teachers' role (that of knowledge transfer, teacher-centred instruction which is prevalent in most Greek schools),

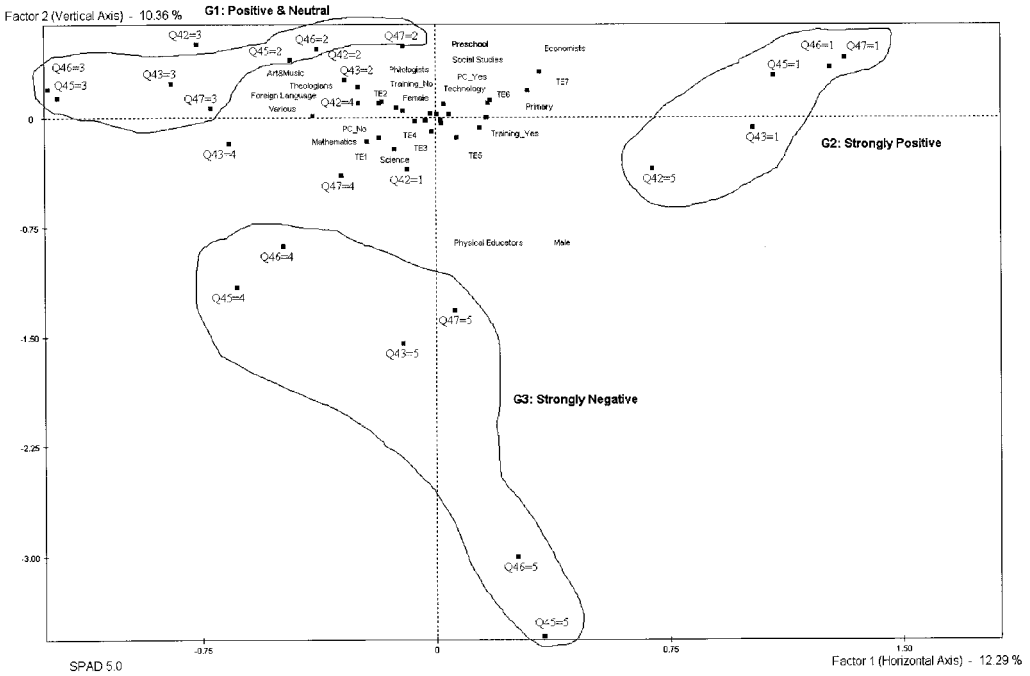


Figure 5. Teachers' beliefs about the role that ICT can play in education

changes in the school and/or class operation and also changes in the educational media used.

This finding needs further investigation in order to determine the role of other parameters that influence teachers' views of the changes in education caused by ICT. A hypothesis is that experienced secondary teachers have adapted themselves to the general school culture, are familiar with the curriculum and have also developed efficient class management techniques. Studies on experienced science teachers have shown that they have developed a *school culture* that could be described as a conceptual framework of knowledge and beliefs about their subject matter, teaching, learning and their students, integrated in a coherent manner (Tobin & McRobbie, 1996; Munby *et al.*, 2000). Moreover, their teaching behaviour usually seems consistent with this framework, and it is very hard for them to transform it or even to try a new, innovative teaching approach.

**Summary and discussion**

This study has examined teachers' concerns and beliefs about the role of ICT in education and the integration of ICT into classroom practice. Our findings indicate that, because of their recent exposure to ICT and development of ICT skills, teachers exhibited increased motivation and willingness to adopt ICT as a teaching and learning tool. The analysis presented hereby reiterates that teachers' ICT skills and beliefs

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about ICT are of great importance to their intentions to use ICT in everyday classroom practices (Kumar & Kumar, 2003; Becta, 2004a). It seems that providing opportunities to teachers to acquire ICT skills is critical in order to strengthen their beliefs about the value of ICT in teaching and learning.

The great majority of the teachers in the sample recognize the radical changes in education brought about by ICT, as far as the role of the school, the role of the teacher and the educational media are concerned. We have also identified three main issues that interfere, making the majority of the teachers sceptical or cautious about ICT integration in educational practice:

- Teachers need more convincing reasons about the usefulness and the effectiveness of ICT in the instructional process. It is striking that 92% of the teachers in the sample consider ICT as a necessity in our modern society, exhibiting a consumer-like approach to ICT in education.
- Teachers are aware of and sceptical about ICT pedagogical perspectives and the difficulties they will face in classroom practice (e.g. to organize and manage students' learning activities based on ICT).
- Teachers are cautious about using ICT in education because they believe that ICT restricts social interaction and isolates people.

One of the most important findings the multivariate analysis has derived is that the teachers have exhibited a consistent network of beliefs about and perceptions of ICT in education throughout the questionnaire. We have thus identified three cohesive groups of teachers according to their views and beliefs: a group of positive teachers, a second one of negative teachers and a third one of neutral teachers. Although the categories above seem, at first glance, quite reasonable our analysis adds considerably to the knowledge of the intervening parameters that shape teachers' categories. The MCA analysis has revealed that personal attributes of the teachers such as gender, subject specialty and teaching experience may play a significant role, influencing their beliefs about ICT in education.

There are close similarities between this study and the survey reported by Goodwyn *et al.* (1997) on English teachers' beliefs and rationales about ICT and the English curriculum. They also divided the teachers who participated into three categories according to the comments they wrote or made in interviews: a) the *fearful* group, consisting of teachers which considered ICT as a threat and a product of personal doubt allied to critical exclusion of ICT from their subject. They were also very assertive to preserve book-based culture against ICT; b) the *unresolved* group, which exhibited some strongly mixed views, that is, those teachers were anxious to preserve the values through which their subject had gained status but were aware too that cultural shifts and changing textual practices are bound to influence the ways in which their students learn; c) the *optimists*, who believed that ICT can significantly enhance English teaching, since it could offer many new ways of reading, writing and communicating with others all over the world. Greek language teachers' concerns recorded in our study are quite similar to those identified by Goodwyn *et al.* (1997).

In the literature review carried out, no evidence was found that points to the correlation between gender and teachers' perception of ICT in education. Earlier studies reported that female teachers had a greater degree of anxiety (Bradley & Russell, 1997) and were less confident computer users (Lee, 1997) than males. A recent report (European Commission, 2003) noted that gender is an issue which determines the use of ICT by teachers and the gap between males and females is even wider as far as the use of the Internet is concerned. We have found that, in general, the male teachers are positive about ICT in education while the female teachers are neutral or negative. Our findings indicate that the gender factor still seems to be critical in fostering positive beliefs about ICT in education in teachers despite the fact that its importance appears to be falling relative to a previous study in the area (Jimoyiannis & Komis, 2006).

Also recorded were significant differences in teachers' beliefs and ICT skills according to their teaching experience. The less experienced (those having 1–10 years of teaching experience) and the veteran teachers (those having more than 30 years of teaching experience) are positive in general. On the other hand, highly experienced teachers (especially those having 20–30 years of teaching experience) are placed mainly into the negative beliefs group. Presumably, teachers of a younger age have been more exposed to technology than their predecessors. This could result in higher confidence levels and more positive views of ICT in education but it does not guarantee by itself higher levels of ICT use in the classroom.

Although a fair amount of literature on teachers' attitudes to ICT in education is available, there is little evidence of the barriers which exist in specific subject areas (Becta, 2004a). To our knowledge, this study is the first one revealing a close relationship between subject matter and teachers' attitudes towards ICT in education. Generally, economics, technology and science teachers were placed into the group of positive teachers. We have also found that primary teachers constitute a particularly positive community about ICT in education. This contradicts the findings reported by Shapka and Ferrari (2003). On the other hand, mathematics, Greek language and history, social studies and theology teachers are negative about ICT in education. Overall, our research confirms previous findings in the USA that the functionality of computers in the classroom is quite different for teachers of different subjects (Becker, 2001). It has been found in this study that business education and elementary teachers reported that computer use occurred frequently during their classes, while mathematics and arts teachers did not use computers that often.

Computers are traditionally perceived as a domain closely related to mathematics and science. Surprisingly, we found that mathematics teachers are negative about ICT and constitute one of the most conservative subject specialties regarding the possible changes in the school mathematics culture brought about by ICT. High school mathematics is evolving, with and through ICT, from an elegant, pure science grounded in theoretical proofs to a powerful problem-solving tool, not always grounded in accurate solutions. However, the following argument, written by a mathematics teacher in the sample, is very striking and could support the idea that ICT-related threats are present in mathematics teachers' concerns and perceptions:

I do not believe that computers can improve learning. I am totally convinced that calculators have restricted students' achievement in numeracy. In the following years, we will see the same thing happening, e.g. a whole generation of students with low achievement in mathematics. Computers will prevent their development in mathematical thinking.

It appears that teachers of the traditional secondary subject specialties, with the striking exception of science teachers, are more reserved and cautious about ICT tools in their instruction when compared to primary and other secondary teachers (technology, economics, art and foreign language teachers). From our point of view, there is another intervening factor in Greek schools which strongly influences teachers' attitudes towards ICT in education. The pressure from the national university entrance exams and the need to cover the set content of the core subjects (language and literature, history, mathematics, physics, chemistry, biology) prevail in the teachers' instruction culture as well as in the students' learning culture.

Our findings resemble, to some extent, those of Hennessy *et al.* (2005, p. 184), who found three different approaches in secondary teachers who had begun to integrate ICT into classroom practice:

- Science teachers were most positive about the educational benefits of ICT.
- Mathematics teachers exhibited the strongest evidence of collective policy-making feelings of pressure to use ICT.
- English teachers showed less integrated use of ICT and more anxiety and feelings of reluctance to adopt ICT as a learning tool.

There are still a lot of parameters to be identified concerning the way teachers perceive ICT in education and the practices followed when they do use computers in their classrooms. Research studies which increase the depth and breadth of information about teachers' attitudes towards ICT as a teaching and learning tool across the curriculum are considered of value. Future research should be addressed at investigating how and why subject cultures differentially affect:

- teachers' views and perceptions of ICT in instructional practice;
- students' perceptions and use of ICT as a learning tool.

There is no doubt that ICT integration in classroom practice is a complex and multi-faceted issue. Teachers should be able not only to use ICT in order to support their traditional instruction but also to reorganize their instruction using ICT. Effective programmes aiming at teachers' ICT preparation and support should be flexible, continuous and subject focused rather than uniform or identical for all. They should clearly articulate specific types of effective instructional models and representative ICT paradigms for every subject in the curriculum. Appropriate support and guidance should take account of teachers' different levels of ICT skills, their subject (curriculum and educational resources) and also their professional development targets.

Professional and pre-service development programmes should also focus on coupling changes in teachers' pedagogical cultures and philosophies for teaching and learning with their training on how to use appropriate ICT tools with their students. Teachers' ICT integration culture and capability is built up over time

from experience, reflection and review. To increase the likelihood of computers being used effectively in school practice, teachers need to be encouraged and helped to acquire convincing experiences about the effectiveness of ICT in teaching and learning. This must be organized in a framework of broader instructional reforms aiming at the subject curricula, the educational media and, principally, at the pedagogical practices used.

Top-down imposed policy decisions and technocentric models for ICT adoption appear to be unresponsive to teachers' perspectives, priorities and classroom or general professional needs. It is imperative to conceive ICT use in education not in terms of a special event or an extra tool supplementary to traditional instruction but in terms of specific pedagogical dimensions. Further research is necessary to address the issues above in order to redirect current policies and strategies employed for ICT integration in classroom practice. Policies concerning ICT in education should principally be addressed at two main points:

- To help teachers adopt ICT not as a trend in our modern technological society but as an efficient teaching and learning tool.
- To encourage teachers to develop a new educational culture by integrating self-development in ICT in education into their professional development planning.

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