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Barriers to the integration of computers in early childhood settings: Teachers' perceptions

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Abstract This study investigated teachers' perceptions of barriers to using - integrating computers in early childhood settings. A 26-item questionnaire was administered to 134 early childhood teachers in Greece. Lack of funding, lack of technical and administrative support, as well as inadequate training opportunities were among the major perceived barriers to the use of computers in early childhood settings. Four barrier-factors were extracted: "lack of support", "lack of confidence", "lack of equipment" and "class conditions". Teachers' confidence with technology had a direct significant effect on the factors "lack of support" and "class conditions" (number of computers and number of children in class). The greater teachers' confidence with technology, the minor teachers' perceived barriers regarding support and class conditions. Teachers' confidence with technology and the existence of a computer resulted in higher probability of computer use in class. Implications of findings for in-service teacher training are discussed.

Keywords Early childhood settings · Barriers · Computer · ICT · Teacher perceptions

1 Introduction

The fierce debate on whether computer use inhibits (Cordes and Miller 2000; Alliance for Childhood 2004) or enhances (Clements and Sarama 2003) young children's learning and development is less polarized now. Research studies on early childhood education and ICT (Haugland and Wright 1997; Stephen and Plowman

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2003a; Lankshear and Knobel 2003; McCarrick and Li 2007; McKenney and Voogt 2010) have indicated that computer can be used as a tool to support learning, and assist communication, collaboration, creativity and language development in young children. Such studies document the potential of ICT to create innovative, engaging and substantive learning opportunities for young children. Recognizing that there is a wide range of technology applications available to young children, the issue is not, whether technology should be considered and used in early childhood education settings, but how and whether it makes a difference in children's learning and development (Parette et al. 2010).

Early childhood education teachers can play an important role in supporting and extending children's experiences with computers (Stephen and Plowman 2008; Siraj-Blatchford and Siraj-Blatchford 2006; Nir-Gal and Klein 2004). Judge et al. (2004) reported that it is increasingly important for early childhood educators to introduce and use computers in their settings, particularly for those children who do not have access in the home. Governments throughout the world recognize that the success of educational systems rises and falls on the backs of teachers (Davis 2002). A review of the literature has suggested that the integration of technology into teaching and learning is typically affected by teachers' technology skills, teachers' technology beliefs and teachers' perceived technology barriers (Hew and Brush 2007). Teachers' beliefs about the role of ICT for learning are important in teachers' pedagogical reasoning (Webb and Cox 2004) and their beliefs often limit their efforts to integrate ICT into classroom practices (Pelgrum 2001). It is obvious that unless teachers perceive as valuable the new technologies, they will be unwilling or unable to use them meaningfully. Although ICT is now an accepted tool in kindergarten class, a tool that has the potential to support children's learning and development, and early childhood teachers have, in general, positive views about computer use in kindergarten class (Ihmeideh 2009; Gialamas and Nikolopoulou 2010), many teachers still struggle to integrate technology in their teaching practice (Ihmeideh 2009). Taken into account that early childhood teachers' views are essential for ICT use-integration in early childhood settings, it is important to investigate their perceptions regarding barriers to the integration of computers in such settings. Many issues may present barriers to the use of technology in kindergartens, including classroom budget limitations, attitudes about technology, and lack of knowledge and/or training (Parette and Blum 2013). The identification of teachers' perceived barriers is important, as some barriers may play a role in excluding technology in early childhood settings.

The aim of this paper was to investigate the barriers to the integration of computers in early childhood settings, from the perspective of Greek early childhood teachers. For the purpose of this paper, we briefly explain specific terms used. Initially, we use the term *computers* as synonymous and as more preferable to the terms *ICT* (Information and Communication Technology) and *technology*.

Apart from computer software, several commercial products that incorporate some aspect of ICT target young children: for example, electronic-musical keyboards, programmable interactive toys and digital cameras. However, practitioners define ICT more narrowly as computers and printers and this view is very influential (Stephen and Plowman 2003b). We also use the term *early childhood settings* as synonymous to the terms *kindergartens* and *pre-schools*.

2 Theoretical background

2.1 Barriers to using – integrating computers in education settings

Most of the studies regarding barriers to using-integrating computers in class derive from primary and secondary education settings. Research studies (Jones 2004; Al-Senaidi et al. 2009; Karasavvidis 2009; Agyei and Voogt 2011; Prestridge 2012) have reported a number of barriers/obstacles teachers experience in the integration of ICT in their classrooms such as lack of access to resources, lack of confidence among teachers, lack of time, lack of training opportunities, technical problems, lack of knowledge about ways to integrate ICT in lessons, poor administrative support and poor fit with the curriculum. The identification of barriers (and the ways they affect teachers) may help decide on how to overcome them. In 2004, the British Educational Communications and Technology Agency commissioned two reviews of the research literature at international level to identify some of the factors which either prevent teachers making full use of ICT in their work, or enable and encourage the uptake of ICT by teachers (across different education levels). The published report (Jones 2004) included the following conclusions: (a) levels of access to ICT are significant in determining levels of use of ICT by teachers, (b) teachers are sometimes unable to make full use of the technology because they lack the time needed to prepare materials for lessons, (c) resistance to change is a factor which prevents the integration of ICT in the classroom, (d) technical faults with ICT equipment are likely to lead to lower levels of ICT usage and (e) teachers who have little or no confidence in using computers in their work, will try to avoid them. Wood et al. (2005) showed that comfort/confidence with technology was related to greater computer integration in the classroom. They identified individual characteristics such as experience with computers and confidence with technology as reasons for why teachers do not use-integrate computers (despite increased availability of hardware).

Some barriers are related to the limited resources, lack of time, lack of technical support (the so-called external barriers), while others are related to teachers' negative attitudes and lack of confidence (the so-called internal barriers) (Bingimlas 2009; Al-Senaidi et al. 2009). Researchers also refer to other ways of grouping the barriers: for example, to consider whether the barriers relate to the individual (i.e., teacher level barriers) such as lack of time, lack of effective training and technical problems, or to the institution (i.e., school level barriers) such as lack of time, lack of confidence and resistance to change (Veen 1993). However, there is not a single accepted classification of barriers, as a barrier could fall under either category. For example, lack of time has been identified as a persistent barrier by teachers in terms of planning ways to use computers in the class, in terms of teacher training and development, or in terms of lack of time in schedule for children to use computers.

The literature on barriers to using - integrating technology in early childhood education settings, includes a small number of empirical studies. These studies revealed that several of the above mentioned barriers are similar for early childhood education as well. A recent study (Ihmeideh 2009) which investigated pre-school teachers' and principals' perceived barriers in Jordanian pre-school education settings revealed (a) that most kindergarten teachers were aware of the value of using technology for learning and teaching and (b) as main barriers the lack of software, lack of funding, lack of time

and lack of teachers' technology skills. Teachers' technology skills and confidence with technology are important barriers, as they may have access to computers but feel they are unprepared and lack the necessary experience to successfully integrate technology in their teaching. Chen and Chang (2006) showed that kindergarten teachers feel that they are unprepared, with almost half of them self-identifying as technology novices.

Another study (Turbill 2001) on the use of technology in the Australian kindergarten literacy curriculum, found that kindergarten teachers consider some barriers that inhibit them from integrating technology into their curriculum: lack of time, scarcity of software and lack of understanding of the possible use of technology with young children. Sandberg (2002) investigated Swedish kindergarten teachers' perceptions regarding computer use in their classrooms and found that although the computer was viewed as a potential tool for children's' learning, the lack of time and limited access to resources were viewed as barriers to using computers in the classrooms. Edwards (2005) found that selection of appropriate software is an important factor influencing technology use in early childhood classes. Copley and Ziviani (2004) examined the barriers to the use of assistive technology for children with multiple disabilities and found that the lack of appropriate teacher training, negative staff attitudes, difficulties in managing equipment and time constraints as the main barriers to the use of technology in teaching and learning process.

2.2 Computers/ICT in early childhood education in Greece

The Greek educational system is centrally organized and the main bodies of educational policy and planning are the Ministry of Education (YPEPTH) and the Pedagogical Institute (PI). In early childhood (children's ages 3–6), during the last decade, several kindergartens in both private and public education acquired computers but very few of them participated in small-scale research or pilot projects. Until recently, there was a lack of a central plan for the introduction of ICT. The Pedagogical Institute has lately published a framework for the introduction of ICT in teaching and learning the so-called 'Cross-Thematic Curriculum Framework for ICT. For early childhood education, it sets directions for programmes regarding planning and development of activities in the context of the following subjects: language, mathematics, environmental studies, creation/expression and computer science (YPEPTH - PI 2003). These programmes are not considered as independent subjects, but it is suggested to be taken into account when planning and implementing meaningful and purposeful activities for the children.

In order to successfully implement the curriculum, it is essential that teachers be provided with the appropriate training and early childhood classrooms with the appropriate resources. Regarding resources, many kindergartens have lately acquired computers for use by the children. However, those kindergartens equipped with computers in classrooms have, more or less, similar technology facilities (i.e., predominantly one computer, rarely two computers). There are no computer labs in kindergartens. Recent research (Nikolopoulou 2014) has indicated that the most commonly used programs in kindergarten classes were the MS Paint, commercial and educational CD-ROMs, and the MS Word, while the use of the internet was rare. Regarding teachers, they are responsible for translating into practice the expectations/visions of curricula planners. The 'Teachers' training on ICT in Education' programme (YPEPTH - PI 2009), which is the most widespread in Greece, included the training of early childhood teachers as well. The first phase of the programme (A-level training in ICT use) included training in

technical skills (use of word-processing, spreadsheet, presentation programs and internet) and has been attended by many early childhood teachers. However, the second phase of the programme (B-level training in ICT use), which is dedicated to providing teachers with the pedagogical skills for ICT integration in class, commenced recently and as a result a small number of teachers have attended it (YPEPTH 2012). This current large scale in-service training initiative aims, among others, to familiarize teachers with appropriate educational software and the skills to adopt/integrate ICT in their everyday teaching practices.

3 Methodology

3.1 Objectives of the study

As stated in the first section, the aim of this paper was to investigate the barriers to the use-integration of computers in early childhood settings, as perceived by the kindergarten teachers. The research objectives were:

1. To investigate early childhood teachers' perceptions of barriers to using-integrating computers in early childhood settings;
2. To confirm the factorial structure of the questionnaire and the relationships among factors regarding teachers' perceptions of barriers;
3. To investigate the impact of teachers' individual characteristics (years of teaching experience, A-level training in ICT use, years of computer experience, confidence with technology) on teachers' perceived barriers;
4. To investigate the impact of teachers' individual characteristics (years of teaching experience, A-level training in ICT use, years of computer experience, confidence with technology) and of barriers on "computer use" in class.

3.2 The sample

The sample consisted of 134 early childhood teachers who teach in various kindergartens in/around Athens, in Greece. They were all female, and this high percentage is consistent worldwide with the predominance of females in the population of early childhood teachers (Chen and Chang 2006). Demographic and individual characteristics of the sample (sex, years of teaching experience, years of computer experience, access to computer at home, views on computer appropriateness in kindergarten class, in-service teacher training in ICT), as well as class conditions (number of computers in class, computer use in class) are shown in Table 1. Half of the early childhood settings (50 %, or 67 out of the 134 kindergartens), where teachers work, had only one computer in class (this reflects the typical situation in Greek kindergartens), while around one third of the classes (35.6 %, or 49 out of the 134 kindergartens) had no computer at all. The questionnaire was administered in Easter of the academic year 2011–2012. The responses were anonymous, that is the teachers were assured that there was not right or wrong answer and their responses were not going to be related to any assessment.

Table 1 Demographic, individual characteristics of the sample (134 teachers) and class conditions

Teachers' characteristics	
Years of teaching experience	Years of computer experience
1–5 (16.4 %)	< 1 (11.2 %)
6–10 (25.4 %)	1–2 (12.7 %)
11–15 (11.9 %)	3–5 (21.6 %)
16–20 (14.2 %)	5^{+} (54.5 %)
20^{+} (32.1 %)	
Views on computer appropriateness	Access to computer at home
Positive views (82.8 %)	Yes (93.3 %)
Negative views (1.5 %)	
Not sure (15.7 %)	
Teacher training in ICT - A' level (technical)	Teacher training in ICT - B' level (pedagogical)
Yes (53.7 %)	Yes (14.2 %)
No (46.3 %)	No (85.8 %)
Class conditions	
Number of computers in class	Computer use in class (with children)
None (35.6 %)	Yes (67.2 %)
One (50.0 %) - (one third of them with internet access)	No (32.8 %)
Two (9.7 %)	
Three (3.7 %)	

3.3 The research instrument

Data was collected by the use of a questionnaire, which consisted of two sections. Section A involved statements regarding teachers' demographic and individual characteristics (sex, years of teaching experience, years of experience with computers, teachers' in-service training in ICT, access to computer at home, computer self-efficacy), teachers' views about the appropriateness of computer use in kindergarten class, as well as information about characteristics of the class conditions (number of computers in class, number of computers with internet access, use of computers in class by children). Computer self-efficacy was assessed by using the four items of "confidence with technology" subscale (Pierce et al. 2007) (see Appendix). In assessing teachers' views/perceptions about the appropriateness of computer use in class, teachers were asked to reply to the question "do you believe computer to be an appropriate tool in kindergarten class (in supporting/developing children's learning)?" using a three-point Likert-type scale (yes, no, not sure).

Section B involved 26 statements/items (see Appendix) aiming to investigate teachers' perceived barriers to the integration of computers in kindergarten classes. All statements were taken or slightly adapted from the relevant literature, and in particular, from the studies of Franklin (2007), Al-Senaidi et al. (2009) and Ihmeideh (2009). The 26 statements were separated into six groups, as follows: the first group involved four statements (S1, S2, S3, S4) related to lack of access to resources, the second group involved seven statements (S5, S7, S8, S9, S12, S13, S16) related to

lack of support (financial/technical/pedagogic), the third group involved three items (S6, S10, S24) related to lack of time (e.g., to use computers in class, for in-service training) the fourth group involved three items (S11, S21, S25) regarding disbelief of ICT benefits, the fifth group involved five items (S15, S18, S19, S20, S23) regarding lack of teacher confidence/skills/knowledge, and the sixth group involved four items (S14, S17, S22, S26) regarding class conditions (large number of children in class, lack of space in locating the computer, curriculum demands, class management when computers are used). Teachers were asked to rate their views on a four-point Likert type scale: 1 (not a barrier), 2 (minor barrier), 3 (moderate barrier) and 4 (major barrier). Two major procedures were employed to establish content validity for the instrument. First, a literature review was conducted to ensure that the barriers were based upon established concepts. Second, the instrument was reviewed by a panel of early childhood teachers (who did not participate in the main survey) and ICT in education specialists.

3.4 Data analysis

Structural equations models fitted in this study, were based on the appropriate covariance matrices using maximum likelihood estimation in AMOS 20 (Arbuckle 2007). The statistical software SPSS version 20.0 (2011) was also used in data management and various analyses.

4 Results

4.1 Descriptive measures for barriers and factorial structure of the questionnaire

In order to evaluate the importance of teachers' perceived barriers to the use-integration of computers in kindergarten class, mean values and standard deviation were calculated and are shown in Table 2.

Initially, a PCA (Principal Component Analysis) using 26 items of the barriers' questionnaire was conducted. PCA revealed a four factor structure of the administrated questionnaire based on the screen plot of factor variances (Table 2). Each item had a factor loading over the threshold 0.45 on only one factor. The first factor (F1), labeled "lack of support", was associated with seven items: lack of time for teachers to learn/practice/plan ways to use computers (in the class), lack of administrative support, lack of information about educational software and its appropriateness/quality, lack of support regarding ways to integrate technology into the curriculum, inadequate training opportunities, lack of technical support, lack of time for in-service training. The second factor (F2), labeled "lack of confidence", loaded by eight items: fear of using technology, negative teachers' attitudes, lack of confidence in using computers, managing equipment, lack of teachers' technology skills, lack of interest of the school principal about computer use, uncertainty about usefulness of technology in early years, lack of knowledge of the possible use of computers in class. The third factor (F3), labeled "lack of equipment", loaded by five items: outdated, incompatible or unreliable computers, not enough computers, lack of internet access or internet is not easily accessible, lack of funding, lack of good educational software. The fourth factor (F4), labeled "class

Table 2 Factor loadings, means and standard deviation per item (26 items: S1-S26)

	Factors				Mean	S D
	F1	F2	F3	F4		
S6 Lack of time for teachers to learn/practice/plan ways to use computers (in the class)	.732				3.04	0.95
S7 Lack of administrative support	.689				3.25	0.79
S16 Lack of information about educational software and its appropriateness/quality	.601				3.09	0.92
S8 Lack of support regarding ways to integrate technology into the curriculum	.540				3.04	0.84
S5 Inadequate training opportunities	.537				3.28	0.80
S9 Lack of technical support	.496				3.50	0.73
S24 Lack of time for in-service training	.416				2.81	0.85
S25 Fear of using technology		−.851			2.51	1.10
S19 Negative teachers' attitudes		−.758			2.79	1.11
S23 Lack of confidence in using computers		−.722			2.50	0.98
S20 Managing equipment		−.635			2.52	1.07
S15 Lack of teachers' technology skills		−.551			3.18	0.91
S13 Lack of interest of the school (principal) about computer use		−.550			2.66	1.18
S21 Uncertainty about usefulness of technology in early years		−.531			2.35	1.05
S18 Lack of knowledge of the possible use of computers in class (with the children)		−.493			2.84	0.90
S2 Outdated, incompatible, or unreliable computers			.813		3.31	0.96
S1 Not enough computers			.795		3.04	1.01
S3 Lack of internet access or internet is not easily accessible			.680		3.31	1.02
S12 Lack of funding			.619		3.55	0.81
S4 Lack of good educational software			.461		3.13	0.92
S22 Many demands of the curriculum				.872	2.46	0.98
S10 Lack of time in schedule for children to use computers in class				.752	2.32	1.02
S26 Class management when computers are used				.547	2.43	0.98
S11 Concern about children's access to inappropriate material				.546	2.36	1.09
S14 Large number of children in the class				.538	3.25	0.96
S17 Lack of space in locating the computer(s) and its peripherals				.365	2.75	1.09
Chronbach-a	.78	.86	.79	.75		

All responses ranged from 1 (not a barrier) to 4 (major barrier)

Factor 1 (F1): "lack of support", Factor 2 (F2): "lack of confidence", Factor 3 (F3): "lack of equipment", Factor 4 (F4): "class conditions"

conditions", loaded by six items: many demands of the curriculum, lack of time in schedule for children to use computers in class, class management when computers are used, concern about children's access to inappropriate material, large number of children in the class, lack of space in locating the computer(s) and its peripherals. Two items (S17 and S24) had loadings under the cutoff but were associated with the appropriate factors. The four factors (also called barrier-factors) showed satisfactory internal consistency: Cronbach's α coefficient ranged from .75 to .86 (Table 2). Inter-factor correlations were small to mediocre with a positive sign (Table 3). "Confidence with Technology" scale showed a high Chronbach-a coefficient (a=.89). It is noted that the second barrier-factor (F2), labeled "lack of confidence", is distinct/different from the "confidence with technology" subscale (described in section 3.3).

4.2 Impact of individual characteristics on barriers

In order to explore the impact of four specific individual characteristics ("years of teaching experience", "years of computer experience", "A level training", "confidence with technology") on the barrier-factors extracted above (F1, F2, F3 and F4), an initial estimation of correlation coefficients was conducted (Table 4). The "lack of support" factor was significantly correlated with "years of teaching experience" (r=.29, p<.01), "confidence with technology" (r=−.37, p<.01) and "years of computer experience" (r=−.22, p<.01). The "class conditions" factor was significantly correlated to "confidence with technology" scale (r=−.23, p<.01).

For further investigation of direct and possibly indirect effects of the three individual characteristics ("years of teaching experience", "years of computer experience" and "A level training") on the "lack of support" factor, a MIMIC model (multiple indicator multiple cause structural equations model) fitted (model 1). This model illustrated (i) effects of "years of teaching experience", "years of computer experience" and "A level training" on "confidence with technology" scale and "lack of support" factor, and (ii) the direct effect of "confidence with technology" on the "lack of support". In this model, "lack of support" was measured by six indicators. All path coefficients were statistically significant except three coefficients linking individual characteristics with "lack of support". Afterwards, by eliminating the three above mentioned paths, a second pruned MIMIC model (model 2) was fitted/created (Fig. 1). Table 5 presents path coefficients of model 2. The goodness-of-fit indices, demonstrated acceptable fit: NFI, TLI, CFI >0.95 (Hu and Bentler 1999), χ^2/df<3 (Carmines and McIver 1981) and RMSEA<0.08 (Browne and Cudek 1993). This

Table 3 Factor intercorrelations, factor means and standard deviations, and reliability indices

Component	(F1)	(F2)	(F3)	Mean	Std. Deviation	Cronbach-a
lack_of_support (F1)				3.15	.56	.78
lack_of_confidence (F2)	.159			2.67	.74	.86
lack_of_equipment (F3)	.210	.168		3.27	.70	.79
class_conditions (F4)	.351	.280	.203	2.59	.68	.75

Table 4 Correlations among factors and other individual characteristics

	A level training	Years of teaching experience	Confidence with technology	Years of computer experience
lack_of_support (F1)	.066	.292[a]	−.365[a]	−.222[b]
lack_of_confidence (F2)	.031	.116	−.107	−.072
lack_of_equipment (F3)	.027	−.101	.086	.076
class_conditions (F4)	−.010	.112	−.234[a]	−.170

[a] Correlation is significant at the 0.01 level (2-tailed)

[b] Correlation is significant at the 0.05 level (2-tailed)

model reveals that the effects of individual characteristics on "lack of support" are only indirect, being mediated by "confidence with technology".

4.3 Identification of variables predicting computer use

The impact of specific individual characteristics and of barrier-factors on "computer use (yes/no)" was investigated by logistic regression analysis (Table 6). The independent

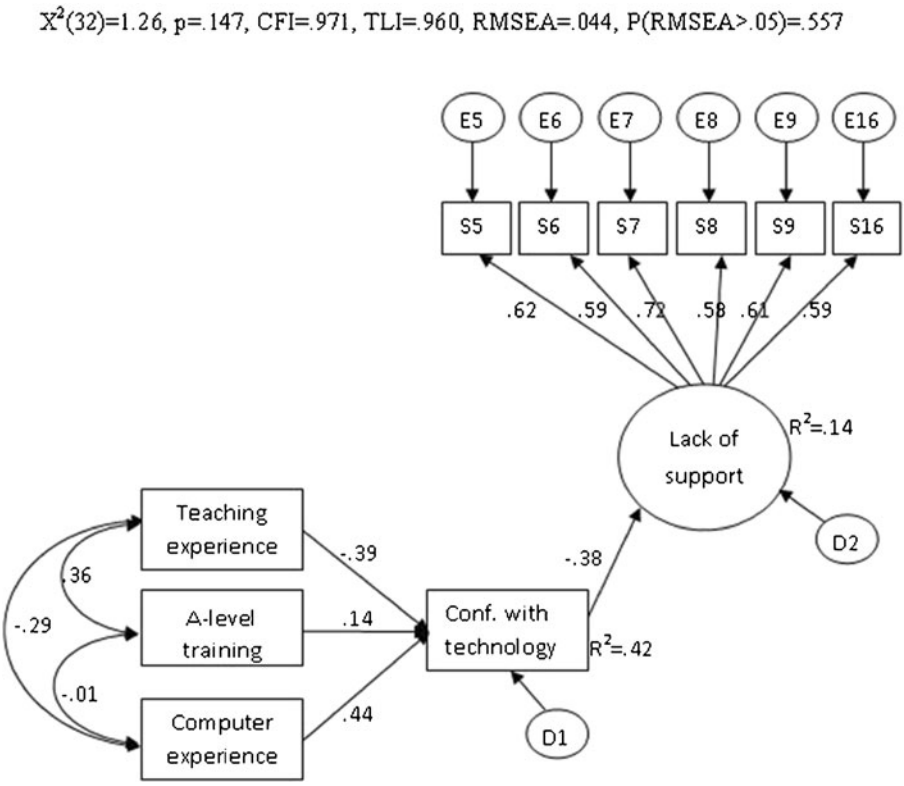

Fig. 1 Lack of support path model

Table 5 Regression weights: (Group number 1 - Default model)

Dependent – Independent pair:		Regression, (Standardized) weight	
Confidence_with_technology	<—	A level training	.20 (.14)[a]
Confidence_with_technology	<—	Years of computer experience	1.30 (.44)[a]
Confidence_with_technology	<—	Years of teaching	−.18 (−.39)[a]
Lack of support	<—	Condidence_with_technology	−.26 (−.38)[a]
Indicator- Latent pair			
S5	<—	Lack of support	1.00 (.62)[a]
S6	<—	Lack of support	1.13 (.59)[a]
S7	<—	Lack of support	1.14 (.72)[a]
S8	<—	Lack of support	.98 (.58)[a]
S9	<—	Lack of support	.91 (.61)[a]
S16	<—	Lack of support	1.04 (.56)[a]

[a] significant at .05 level

variables entered in the logistic regression model were the four barrier-factors F1-F4 (i.e., “lack of support”, “lack of confidence”, “lack of equipment” and “class conditions”), “confidence with technology”,“A level training”, “years of computer experience” and “computer in class (yes/no)”. The barrier-factors had no significant effect on “computer use”. “Confidence with technology” scale showed a significant positive effect (B=1.12, Wald=4.66, p=.031). The higher/greater the teachers’ confidence, the higher was the probability of “computer use” in class. The existence of a computer in class played an important role on “computer use” (B=2.09, Wald=27.16, p<.001). “A level training” had a significant positive effect on “computer use” (B=1.64, Wald=8.82, p=.003). There was a higher probability of computer use in kindergarten class among trained teachers in comparison with untrained teachers.

Table 6 Logistic regression of “computer use” on barrier-factors and individual characteristics

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	lack_of_support	.501	.621	.650	1	.420	1.650
	lack_of_confidence	−.516	.437	1.392	1	.238	.597
	lack_of_equipment	−.717	.435	2.719	1	.099	.488
	class_conditions	.293	.464	.397	1	.528	1.340
	confidence_with_technology	1.124	.521	4.655	1	.031	3.077
	comp (1)	2.904	.557	27.162	1	.000	18.240
	years of computer experience	−.068	.303	.050	1	.823	.934
	A level training (1)	1.643	.553	8.823	1	.003	5.171
	years of teaching experience	−.007	.195	.001	1	.973	.993
	Constant	−2.976	2.557	1.355	1	.244	.051

Variable(s) entered on step 1: lack_of_support, lack_of_confidence, lack_of_equipment, class_conditions, confidence_with_technology

comp(1): existence of computer(s), A level training (1): attendance of A-level training

5 Discussion and conclusions

This study investigated the main barriers to using-integrating computers in early childhood settings, as perceived by Greek early childhood teachers. Although there is a body of evidence regarding teachers' perceived barriers to the use–integration of computers in class, this evidence is predominantly based on elementary and secondary education settings and there is limited evidence regarding kindergartens. Thus, the findings of this study contribute to the existing body of the literature by adding evidence of the current status of early childhood teachers' perceived technology barriers.

With regard to the first objective, to investigate early childhood teachers' perceptions of barriers to using-integrating computers in early childhood settings, teachers' perceived major barriers were: lack of funding (item S12, *M*=3.55), lack of technical support (item S9, *M*=3.50), outdated/incompatible/unreliable computers (item S2, *M*=3.31), lack of internet access (item S3, *M*=3.31), inadequate training opportunities (item S5, *M*=3.28), large number of children in the class (item S14, *M*=3.25) and lack of administrative support (item S7, *M*=3.25) (see Table 2). In Greek state kindergartens there is insufficient funding (for both hardware and software) and insufficient support for teachers, thus the lack of technical, financial and administrative support together with the lack of funding were perceived by teachers to inhibit their use of technology. Our results are in some agreement with earlier research in kindergartens (Ihmeideh 2009) which reported lack of funding and lack of teachers' technology skills among teachers' perceived ICT barriers. Greek teachers also perceived as a major barrier the lack of appropriate/good educational software (item S4, *M*=3.13), a barrier linked to lack of funding and also perceived as inhibitor by early childhood teachers in Jordan (Ihmeideh 2009) and Australia (Turbill 2001). An interesting finding was that the large number of children in kindergarten class was viewed as a barrier by Greek teachers (*M*=3.25), but it was not reported as a barrier in earlier research. We believe this is linked to the specific class conditions in different countries. For example, in Greece, the number of children in a class may range from 12 to 23. Moreover, when the large number of children in a class is seen together with the small number of computers in class, the ration 'children per computer' can be identified (e.g., instances of having one computer per 23 children). In turn, this may also affect the way computer use is managed in class. Despite the high prevalence of technology in primary and secondary education, the computer equipment issues are still relevant in Greek kindergartens, and this is reflected in teachers' perceived barriers. Our findings are also in some agreement with earlier studies in primary and secondary education (e.g., Jones 2004; Agyei and Voogt 2011), which reported among teachers' perceived barriers lack of access to resources, lack of confidence and lack of training opportunities. Thus, there seems to be a similarity across different education levels.

With regard to the second objective (to confirm the factorial structure of the questionnaire and the relationships among factors regarding teachers' perceptions of barriers), the analysis demonstrated that there were four factors in the 26-item questionnaire: "lack of support" (F1), "lack of confidence" (F2), "lack of equipment" (F3) and "class conditions" (F4) (see Table 2). This indicates that literature-originated constructs of barriers shown in other education levels (primary, secondary and higher education) are existent in early childhood education as well. In particular, there is an

agreement with the study of Al-Senaidi et al. (2009), as three of the factors extracted in our study, "lack of support", "lack of confidence" and "lack of equipment", were similar to the factors extracted in their study (conducted in higher education sector). Another interesting similarity between the two studies was that the barrier-factors had small intercorrelations (as shown in Table 3), which suggests that they were perceived as distinct by the teachers.

With regard to the third objective, to investigate the impact of teachers' individual characteristics (years of teaching experience, A-level training, years of computer experience and confidence with technology) on teachers' perceived barriers, we found that: (a) three of the above mentioned individual characteristics, "years of teaching experience", "years of computer experience" and "confidence with technology" had a statistically significant effect on the factor "lack of support", and (b) the individual characteristic "confidence with technology" had a direct statistically significant effect on the factor "class conditions" (see Table 4). The first finding means that the less the years of teaching experience (a characteristic which is typically linked to younger teachers), the more the years of computer experience and the more the confidence with technology, result in teachers' perceiving the "lack of support" as a minor barrier. Interestingly, the characteristic "A-level training" (technical training) was not significantly linked to any barrier-factor (Table 4). A-level training was not linked to teachers' perceptions of barriers and it had a minor impact on teachers' confidence with technology. It seems that A-level training did not enhance teachers' confidence with technology. We expect the second phase or B-level teacher training (i.e., providing them with the pedagogical skills to integrate ICT) to have a positive impact on teachers' confidence with technology. Further analysis of the data has revealed that the characteristics "years of teaching experience" and "years of computer experience" had an indirect significant effect on the factor "lack of support" via the characteristic "confidence with technology" (Fig. 1 and Table 5). This finding in combination with the above mentioned finding (b), indicate that the "confidence with technology" had a direct significant effect on the factors "lack of support" and "class conditions". This means that those teachers who are more confident with technology perceive as minor barriers the lack of financial/technical support and the class conditions (class management when computers are used, large number of children in the class etc.). This has implications for in-service teacher training and is discussed later in the section.

The fourth objective aimed to investigate the impact of teachers' individual characteristics (years of teaching experience, A-level training, years of computer experience and confidence with technology) and of barriers on "computer use" in class. As shown in Table 1, 67.2 % of the sample (90 teachers out of the total 134) reported that they make computer use in class with the children, while 32.8 % (44 teachers) make no computer use. The predominant reason for those teachers not using a computer in class was the lack of a computer (49 out of the 134 kindergartens had no computer). We found that two individual characteristics (confidence with technology and A-level training) and one barrier-factor (lack of equipment) had a significant effect on "computer use" in kindergarten class (see Table 6). This finding means that the higher/greater teachers' confidence with technology and the existence of a computer result in higher probability of computer use in class. There is agreement with earlier research (Pelgrum 2001; Hew and Brush 2007; Ihmeideh 2009) which has shown that teachers' perceived technology barriers (lack of equipment, confidence with technology, inadequate training etc.)

greatly affects computer use-integration into teaching and learning. The study of Wood et al. (2005) showed that primary and secondary teachers' comfort with technology was the only significant predictor of technology use-integration in the classroom. Additionally, this study's finding supported our recent research finding (Gialamas and Nikolopoulou 2010): the higher teachers' confidence with technology, the higher was their intention to use a computer in kindergarten class. Although the samples of early childhood teachers were different, a link was found between teachers' confidence with technology, their intention to use a computer in class and their classroom practices.

Our findings have implications for in-service teacher training. Teachers' confidence with technology can be increased via attending appropriate in-service teacher training. In-service teacher training programmes should be carefully designed as these are expected to help teachers, for example, to manage the integration of only one computer in a class of over twenty children and to provide them with skills to evaluate and integrate the appropriate educational software. A number of early childhood teachers in Greece are now attending the B-level training in ICT and this is expected to help them, among others, develop their confidence with technology. Taken into account the low budgets of kindergartens, we suggest all Greek state kindergartens to be equipped with at least one computer with internet access. All educational sectors need to be aware of the possibilities and importance of technology in developing children's learning in order to overcome the barriers which prevent technology use in early childhood settings, so that children can benefit effectively from computer use. In parallel with in-service teacher training, technical, financial and administrative support is needed for kindergarten classes. Within the broader area of ICT, there is a widespread recognition of the need for ongoing professional development and support to integrate technologies effectively (Pelgrum 2001; Van Melle et al. 2003).

Limitations of this study include the size of the sample and the use of a quantitative inquiry only. Teachers' perceived barriers can be further explored with larger and more diverse samples. Additionally, this study could be enriched by using a mixed method (e.g., quantitative and qualitative approaches) in order to obtain a better understanding of the situation. When teachers respond to closed survey items, only the issues questioned can be identified. While open-ended questions may reveal, for example, how some previously reported barriers have changed and may help understand the importance of barriers when it comes to integrating technology in the classroom.

Identifying early childhood teachers' perceptions of barriers to the integration of computers in class is not an end by itself. Future research is needed on how these barriers are overcome to support effective integration of technology in early childhood settings. The rapid advances in computer technology and the changes within schools regarding the presence of technology (class conditions etc.) make it challenging to evaluate the impact of potential barriers over time (Wood et al. 2005). Future research is suggested to investigate (i) how early childhood teachers' perceptions of technology barriers change over time and (ii) the link between teachers' perceptions and their classroom practices. The questionnaire was a reliable and valid instrument to use with in-service kindergarten teachers. In the future, it could be used with other target populations in order to identify possible similarities and differences.

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Appendix

"Confidence with technology" subscale (Pierce et al. 2007)

1. I am good at using computers
[strongly agree] [agree] [disagree] [strongly disagree]
2. I can fix a lot of computer problems
[strongly agree] [agree] [disagree] [strongly disagree]
3. I am quick to learn new computer software needed for school
[strongly agree] [agree] [disagree] [strongly disagree]
4. I am good at using things like VCRs, DVDs, MP3s and mobile phones
[strongly agree] [agree] [disagree] [strongly disagree]

The 26 items of the questionnaire

		Not a barrier	Minor barrier	Moderate barrier	Major barrier
S1	Not enough computers	1	2	3	4
S2	Outdated, incompatible, or unreliable computers	1	2	3	4
S3	Lack of internet access, or internet is not easily accessible	1	2	3	4
S4	Lack of good educational software	1	2	3	4
S5	Inadequate training opportunities	1	2	3	4
S6	Lack of time for teachers to learn/practice/plan ways to use computers (in the class)	1	2	3	4
S7	Lack of administrative support	1	2	3	4
S8	Lack of support regarding ways to integrate technology into the curriculum	1	2	3	4
S9	Lack of technical support	1	2	3	4
S10	Lack of time in schedule for children to use computers in class	1	2	3	4
S11	Concern about children's access to inappropriate material	1	2	3	4
S12	Lack of funding	1	2	3	4
S13	Lack of interest of the school (principal) about computer use	1	2	3	4
S14	Large number of children in the class	1	2	3	4
S15	Lack of teachers' technology skills	1	2	3	4
S16	Lack of information about educational software and its appropriateness/quality	1	2	3	4
S17	Lack of space in locating the computer(s) and its peripherals	1	2	3	4
S18	Lack of knowledge of the possible use of computers in class (with the children)	1	2	3	4
S19	Negative teachers' attitudes	1	2	3	4
S20	Managing equipment	1	2	3	4
S21	Uncertainty about usefulness of technology in early years	1	2	3	4
S22	Many demands of the curriculum	1	2	3	4
S23	Lack of confidence in using computers	1	2	3	4
S24	Lack of time for in-service training	1	2	3	4

S25	Fear of using technology	1	2	3	4
S26	Class management when computers are used	1	2	3	4

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