



Article

Information and Communication Technologies in Primary Education: Teachers' Perceptions in Greece

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Abstract: Innovative learning methods including the increasing use of Information and Communication Technologies (ICT) applications are transforming the contemporary educational process. Teachers' perceptions of ICT, self-efficacy on computers and demographics are some of the factors that have been found to impact the use of ICT in the educational process. The aim of the present research is to analyze the perceptions of primary school teachers about ICT and how they affect their use in the educational process, through the case of Greece. To do so, primary research was carried out. Data from 285 valid questionnaires were statistically analyzed using descriptive statistics, principal components analysis, correlation and regression analysis. The main results were in accordance with the relevant literature, indicating the impact of teachers' self-efficacy, perceptions and demographics on ICT use in the educational process. These results provide useful insights for the achievement of a successful implementation of ICT in education.

Keywords: teachers' perceptions; teaching skills; ICT in education; primary education



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1. Introduction

Without any doubt, innovative applications transform our societies, improve growth and create solutions to urgent problems [1–3]. This is permanent, because the continuous development of technology contributes to the formation of new methods or the improvement of existing ones.

New learning methods enhance the educational process and become part of so-called educational innovation. Troussas et al. [4] observed that mobile learning and game-based learning promote increases in students' knowledge level. Shulman and Sherin [5] argued that vision, motivation, understanding, practice, reflection and community are essential characteristics for educators who are oriented towards implementing educational innovation.

It is clear that the environment, teachers, parents and education decision-makers can contribute positively to the implementation of educational innovation, but they can also pose potential obstacles. As this research focuses on teachers, who are generally accepted to be the protagonists of education, their critical role in the implementation of ICT should be emphasized. According to Hinostroza et al. [6], teachers should have the ability to develop and apply appropriate problem-solving knowledge and necessary communication skills in order to prepare students for the knowledge and information society.

Teachers' perceptions of ICT are among the most critical factors for their adoption and effective application in education. According to the technology acceptance model developed by Davis in 1989, there are two main factors that influence the acceptance of technology: perceived effectiveness and perceived ease of use. Although this theory has been revised several times, these two factors are still valid for understanding technology use [7]. The intensity of ICT use by teachers is also one of the important factors in ICT integration [8]. Furthermore, another study reveals that there is a positive correlation

between the frequency of ICT use and teachers' computer literacy [9]. Many studies have replicated similar findings related to teachers' perceptions of ICT integration. Despite the variation regarding the relationship between perceptions and teachers' demographic profiles, such as age, gender, teaching experience and ICT training, studies reveal that teachers have relatively positive perceptions of the use of ICT in learning activities [10–13]. There are many factors that influence teachers' perceptions of using ICT in the teaching and learning process, such as professional competence, perceived benefit, and cooperation among teachers [14]. However, several researchers have highlighted self-efficacy as the most important factor influencing both teachers' perceptions of ICT and ICT application in the educational process [15–18].

At the end of the second decade of the 21st century, the COVID-19 pandemic affected almost all countries of the world. The application of ICT was deemed necessary to mitigate the effects of social distancing measures applied in both work and educational environments. However, the forced adoption of ICT did not mean that the educational community was properly prepared for it. Teachers and students had to adapt immediately to the reality of the "virtual" learning environment, which replaced the physical one. Aivazidi and Michalakelis [19] found that during the COVID-19 period in Greece, primary school teachers did not seem to accept the use of ICT tools like e-learning platforms, even though the e-learning process was mandatory. In the framework of the above research, it is supported that even in a period where the use of ICT tools was mandatory, their use could not be efficient without the appropriate motivation, skill acquisition and training. Furthermore, this is a finding reported in other relevant cases as well [20].

Students in primary education have some very specific characteristics; for example, it has been found that they can be easily distracted or bored and not pay attention to their teachers [21]. However, today, students live in a world where ICT is of significant importance for almost all everyday activities. Among others, this is a reason why ICT can trigger students' interest [22,23]. At the same time, it has been found that ICT applications can motivate students to pay more attention to the educational process, support their memory, improve their learning skills and enhance collaboration, problem-solving and the joy of learning [24–27]. Thus, ICT application in primary education can be very important, since it supports several aspects of the educational process and, at the same time, can provide an innovative learning experience with significant added value for students. In addition, in contrast to the other levels of education, the major aim of ICT application in primary education is to support and provide an innovative learning experience, rather than to train students on computer use. The importance of ICT in primary education has become even more important since the COVID-19 pandemic has changed the learning environment by bringing future changes closer [28]. Thus, there was a need for a study to analyze the perceptions of the teachers who are supposed to apply ICT in education, after the new era brought by COVID-19 became evident, and can become even more evident, while taking into account that that curriculum of primary education in Greece is currently being reformed [29].

Referring to the context of primary education in Greece, it should be noted that primary schools educate children in the age range of 6–12 years. Thus, primary education is provided for a period of six years and is compulsory for all children, as are the next three years of secondary education [30]. According to the Constitution of Greece, the state is committed to providing free education and promoting the development of a society characterized by social equity and equality. Referring to public schools, it should be noted that most of the teachers are permanently employed; however, there are some teachers who are employed on a short-term basis in order to cover some extraordinary needs [31,32]. However, in private units, labor relations are different.

The aim of the present research is to analyze the perceptions of primary school teachers of ICT use in Greece and how these perceptions can affect ICT application in the educational process. In this way, by exploring teachers' perceptions of ICT use after a period of

mandatory application, we intend to provide evidence supporting an understanding of how ICT in primary education in Greece can be applied in the following years.

Concerning the paper's structure, Section 1 is the introduction. Section 2 refers to the review of the relevant literature and the development of the research hypotheses. Section 3 includes the research methodology. The research results are presented and discussed in Section 4. Last, the paper's conclusions, implications and future research directions are included in Section 5.

2. Literature Review and Research Hypotheses Development

2.1. Self-Efficacy

According to Bandura [33], people express their behaviors based on a system referring to belief in their ability to perform certain behaviors successfully. This self-efficacy theory has been widely used in research related to individual intentions to use ICT. Two major forms and theories of self-efficacy have been identified. The first theory is the theory of self-efficacy which refers to the belief in a person's abilities to successfully perform a certain course of behavior. The second theory is the theory of behavior which refers to a person's power to produce the desired outcomes and to prevent the undesired ones [34].

Both of the above forms of self-efficacy are considered key situational or task-related factors in how people construct and live their lives. A person's perception of their ability to use computers well is defined as computer self-efficacy, which deals with the assessment of what can be done in the future [35], and refers to assessments about the ability to apply skills to wider tasks, such as promoting education. In the case of teachers, research has suggested that a strong sense of computer self-efficacy influences both the frequency and manner in which ICT are used in everyday educational practice [35]. Furthermore, existing literature has demonstrated that teachers' strong sense of self-efficacy affects how often and how ICT are used in their daily teaching and learning practices [36,37].

Thus, the following research hypothesis, H_1 , was developed: "teachers' perceived self-efficacy is positively correlated with ICT use in the educational process".

2.2. Perceived Effectiveness

Different types of perceived effectiveness have been reported as important factors supporting the use of ICT use in primary education in the results of several studies [10,38,39]. Prestridge [40] compared the potential uses of ICT (accessing, presenting, processing, playing with and communicating information) and the levels of learning promoted.

Tondeur et al. [41] conducted a factor analysis on a sample of 352 primary school teachers, aiming to develop a possible typology of uses at this educational level. Their analysis revealed three factors: one referred to the use of ICT as an information tool, another referred to it as a learning tool, and a third focused on the development of basic skills.

In their research, De Aldama and Pozo [42] referred to a typology of uses that focuses on the interactive teacher–student–content triangle, in an attempt to overcome those frameworks that focus only on ICT capabilities and features or on large-scale pedagogies and teaching issues. In particular, they argued that the above interactive triangle between the teaching activity, the learning contents and the students' activity for their acquisition is very relevant. Therefore, they distinguished between the three main components present in any learning/teaching activity: outcomes (what is learned), processes (the cognitive activity through which learning takes place, including the use of ICT) and conditions (the teaching tasks or activities through which learning takes place).

Based on the above analysis, research hypothesis H_2 was developed: "the perceived effectiveness of ICT is positively correlated with its use in the educational process".

2.3. Teachers' Perceptions

If the use of ICT is seen as a workplace innovation, then the diffusion of innovation framework appears to be important in explaining the process that makes teachers accept and use ICT in their classrooms to support their classroom teaching [36]. According to

Ertmer [43], once the external barriers (technological infrastructure, technical support, etc.) are overcome, teachers' perceptions are the key factor for integrating ICT in the classroom.

In the case of teachers, a positive teacher perception can facilitate more varied uses of ICT so that learning activities can become more interesting and enjoyable. On the contrary, teachers who have a negative perception will not integrate ICT into their learning activities [7].

More specifically, the research on teachers' use of ICT in education has revealed that perceptions have either a direct or an indirect effect on the use of technology in classrooms. The direct influence of perceptions can be categorized into two groups: perceptions of technology [44] and perceptions of the use of ICT in education. An example is perceptions as a factor that will promote the innovative use of ICT [45]. Positive perceptions of ICT and their use in education are often suggested as factors of satisfaction, and negative perceptions as factors of deactivation [46]. However, positive perceptions of the use of ICT can be more or less specific to ICT in school, ranging from a general positive perception of ICT in education to more specific perceptions of the uses of ICT in everyday work with students in classrooms [35]. Perceptions also have a strong influence on how people interact as members of organizations and groups.

In fact, several studies report a positive relationship between perceptions and active use of technology [43]. Cox and Webb [47] analyzed teachers' perceptions of ICT during the teaching process, based on the educational model, and concluded that the interactive process of development and learning through the active synthetic ability of student positions favored the use of ICT in the classroom. Furthermore, Sang et al. [48] concluded that teachers who had strong positive pedagogical beliefs about students' active synthetic ability were also more receptive to the integration of ICT in the classroom.

As far as the above analysis is concerned, research hypothesis H₃ was developed: "teachers' perceptions of ICT are positively correlated with the degree of its use in the educational process".

2.4. Teachers' Demographics

Teachers' beliefs and the way they use ICT are found to be dependent on a number of variables. Several studies argue that these variables allow the prediction of teachers' different approaches to ICT [49]. Gender, for example, is one of the most frequently studied variables [50]. Vekiri and Chronaki [51] found that computer-mediated school activities were used more frequently by male teachers than female ones. Similarly, men had significantly more positive perceptions of self-efficacy. Last, it was found that women typically used ICT in more sophisticated ways than men.

Age is another factor that is frequently analyzed [45]. Inan and Lowther [52] found that teachers' age was negatively correlated with computer literacy, making it difficult for them to integrate ICT into the classroom and possibly reflecting the fact that the digital divide is also a generational divide.

Another study that aimed to investigate the characteristics, benefits, disadvantages and factors affecting e-learning use showed that some of teachers' demographic characteristics, such as cultural background, affected significantly the adoption of ICT methods in education [53].

Thus, research hypothesis H₄ was developed: "teachers' demographics influence the degree of ICT use in the educational process".

3. Materials and Methods

In order to achieve the aim of the present research, an empirical study was carried out between 15 June 2022 and 31 August 2022. This period was chosen since, in that period, the educational units do not fully operate, due to the summer season. Thus, the teachers had fewer obligations and consequently more time to participate in the study. However, a pilot study was carried out between 10 and 25 April 2022.

Concerning the research design, it should be noted that the research is based on teachers' perceptions, as in all the similar cases reported in the relevant literature.

In order to collect the data for the research, a 7-point Likert scale questionnaire was developed. The questionnaire's development was based on the evidence provided in the relevant literature [7,35,54–56] that fit well with the aim and the research hypotheses of the present study. The questionnaire's sections are provided in Table 1, below.

Table 1. Questionnaire's structure.

Questions	Description
1–5	Emotions from using ICT
6–14	Perceived impact of ICT on society
15–21	Perceived contribution of ICT to productivity
22–34	Perceived effectiveness of ICT in education
35–44	Perceived impact of ICT on students
45	ICT use in educational practice
46	Perceived self-efficacy
47–51	Demographics

The sampling method used was that of simple random sampling, since in this way the equally probable participation of teachers in the sample could make possible the generalization of the research results [57,58]. Since the teachers who took part in the survey were asked to report to the educational unit they work for, it became feasible to monitor the geographical distribution and representativeness of the sample for the schools of the whole country. The research questionnaire was developed in an electronic form which was distributed to the emails of primary school teachers in the National School Net and to educational portals and electronic lists used by teachers, following the practices reported in the existing literature [57].

When designing the questionnaire, an effort was made to make it short and understandable, including only the necessary questions for the research. Before responding to the questionnaire, teachers were handed an informed consent statement which provided them with information concerning the research aim, the processing and confidentiality of the data and their ability to withdraw from the research at any time.

Concerning sample size, it should be noted that there are several ways to determine it, depending on the data available. As data such as the standard deviation of the dependent variable were not known a priori, we chose to use a more general approach, that proposed by Saunders et al. [59], in order to determine the sample size. This approach is based on the estimated total population of the research and the significance level, which in the present study was set at 5%, in accordance with all published research in the scientific field. Thus, the minimum acceptable sample in order to be representative in the context of the present research was set to 225 observations [59]. Finally, 285 valid responses were collected.

Respondents' demographics are provided in Table 2 and will provide the needed information regarding the sample and its representativeness. Initially, concerning respondents' gender, it appears that almost all of them are female (90.53). This observation can be justified by the type of educational unit under study, since the percentage of females employed in primary schools exceeds 90%. As far as this study is concerned, this result confirms the representativeness of the research in terms of gender.

Concerning respondents' age, it appears that most of the survey participants (56.5%) are over 45 years old. Taking into account the fact that the 25–35 age group received the lowest percentage, a low rate of absorption of young primary school teachers in the labor market is apparent.

Referring to the educational level of the examined teachers, it is revealed that more than half of them (52.63%) hold a master's degree, a fact that indicates a high level of education.

Table 2. Respondents' demographics.

		% Percent
Gender	Male	9.47
	Female	90.53
Age	25–35	11.2
	35–45	32.3
	45–55	40.7
	55–65	15.8
Level of education	Bachelor's degree	45.26
	Master's degree	52.63
	Doctoral degree	2.11
Years of experience	Less than 5 years	10.9
	5–10 years	8.4
	10–15 years	13.1
	15–20 years	25.5
	20–25 years	20.1
	25–30 years	11.1
	More than 30 years	10.9
ICT certification	Yes	90.18
	No	8.82
Type of unit	Public	97.89
	Private	2.11

Furthermore, regarding the level of knowledge, ICT certification was also considered. Based on the research results, 90.18% of the examined teachers hold certifications in ICT. Another characteristic of the respondents examined refers to the type of unit at which they are employed. According to the data in Table 1, 97.89% of them are employed in public units.

Last, it was found that 67.7% of the examined teachers reported they had experience of 15 years or more. In addition, it is noteworthy that teachers with experience of between 5 and 10 years were the least represented in the teacher sample (8.40%). This fact is correlated with the time period of the sample collection in relation to the years of experience of the specific group of the sample, who were most impacted by the time period when there was limited recruitment due to the economic crisis and the fiscal adjustment measures applied in the country.

4. Results and Discussion

4.1. Research Components

Initially, principal components analysis was performed. The purpose of this multi-variable statistical analysis is to analyze the research variables in order to find a new set of variables by the identification of groups with strong correlations between all the variables within each one of these groups. Furthermore, in this way, the total number of variables will be reduced to a smaller one, without losing significant information [60].

In order to carry out the principal components analysis, the appropriateness of the data should first be examined. According to the results of Table 3, the data examined were considered sufficient and suitable for this analysis, since, on the one hand, the Kaiser–Meyer–Olkin value was equal to 0.920, and on the other hand, the *p*-value of Bartlett's sphericity test was equal to 0.

Table 3. Kaiser–Meyer–Olkin and Bartlett’s test of sphericity results.

Statistical Test		Values
Kaiser–Meyer–Olkin		0.920
Bartlett’s test of sphericity	Chi-Square <i>p</i> -value	18,378.311 0.000

Based on the results of the principal components analysis, four components were extracted, as follows:

1. emotions from using ICT;
2. perceived impact of ICT on society;
3. perceived contribution of ICT to productivity;
4. perceived effectiveness of ICT in education;
5. perceived impact of ICT on students.

In order to examine the reliability of the above components, Cronbach’s alpha coefficient was used. Based on the results of Table 4, the reliability of the extracted components was confirmed.

Table 4. Cronbach’s alpha values for the extracted components.

Component	Cronbach’s Alpha Value	Variables in the Component
Emotions from using ICT	0.718	5
Perceived impact of ICT on society	0.938	6
Perceived contribution of ICT to productivity	0.908	7
Perceived effectiveness of ICT in education	0.942	10
Perceived impact of ICT on students	0.835	10

It should be noted that the extracted components fit well with the questionnaire’s sections presented above. This fact can be explained by taking into account that the questionnaire was reviewed based on the number of components extracted during the pilot study that was formerly carried out.

4.2. Descriptive Analysis

4.2.1. Emotions from Using ICT

In this part of the paper, a descriptive analysis of the research variables is provided. It should be noted that only the variables found to be statistically significant for any of the extracted components were analyzed.

In addition to the percentages of positive, negative and neutral responses, the mean values and the standard deviations, an evaluation index is included in the following table. This index is a part of a total of three indices introduced by Maravelakis et al. (2003) [61] aiming to provide a remedy to the problem of measuring the tendency of opinions expressed through qualitative scale variables. All three indices are based on the relation of relative frequencies between values reflecting positive and negative opinions. In the present research, the following evaluation was used:

$$I_3 = \frac{P_+ + P_n}{P_- + P_n} \tag{1}$$

where P_+ represents the cumulative relative frequency of positive responses, P_- is the cumulative relative frequency of negative responses and P_n the cumulative relative frequency of neutral responses. It is easy to understand that when the above index takes values greater than 1, the positive responses tend to dominate over the rest.

Initially, teachers’ perceived emotions from using ICT were explored.

According to the above Table 5, the emotions from using ICT appear to be positive, in general. The interviewed teachers showed a particular interest in the use of technologies

to acquire new knowledge themselves. In addition, their interest in ICT is strong, and they consider the use of these technologies pleasant, to a large extent. These findings are a positive indication of the direction of the diffusion of educational innovation through the adoption of ICT.

Table 5. Descriptive statistics on teachers’ emotions about using ICT.

Variable	% Responses			Mean	Standard Deviation	Evaluation Index
	Negative	Neutral	Positive			
I enjoy using ICT	9.47	10.53	78.95	5.58	1.38	4.47
I am willing to learn a lot about ICT	10.9	5.60	81.70	5.66	1.43	5.29
Learning about ICT is unpleasant for me	82.1	10.18	7.72	2.04	1.48	0.19
I like to learn things using ICT	8.4	7.02	84.56	5.75	1.38	5.94
Working with ICT makes me feel uncomfortable	76.1	12.30	11.70	2.41	1.52	0.27

4.2.2. Perceived Impact of ICT on Society

The second of the extracted components refers to the impact of ICT on society. Based on the examined teachers’ responses as presented in Table 6, most of them expressed positive views on the impact of ICT on society, since all the questions of the component have a negative meaning. Thus, it can be stated that teachers are not afraid that ICT will lead them to lose their skills, while at the same time, they do not think that ICT will reduce people’s creativity. However, despite the fact that they are not the majority, there are several teachers who seem to believe in the possibility that ICT will isolate people and that they have the potential to control their lives.

Table 6. Descriptive statistics on the perceived impact of ICT on society.

Variable	% Responses			Mean	Standard Deviation	Evaluation Index
	Negative	Neutral	Positive			
I am afraid that if I start using ICT, I will become dependent on it and lose my skills	68.4	14.39	17.19	2.77	1.62	0.38
ICT makes society more inhuman by treating everyone as a number	62.8	19.30	17.89	2.98	1.63	0.45
ICT isolates people by inhibiting normal social interactions between users	44.9	20.35	34.74	3.73	1.71	0.84
ICT has the potential to control our lives	43.9	17.89	38.25	3.79	1.78	0.91
Working with ICT makes me feel isolated from people	60.4	16.84	22.81	3.04	1.68	0.51
Using ICT reduces people’s creativity	69.8	14.04	16.14	2.71	1.63	0.36

4.2.3. Perceived Contribution of ICT to Productivity

Table 7, below, provides the descriptive statistics concerning the variables of the component about ICT’s contribution to productivity. Most of the examined teachers consider ICT knowledge as a valuable skill, and they recognize ICT’s contribution to helping them learn more things and to supporting them in almost all subject areas. Their opinions are also positive regarding the impact of ICT on improving the quality of life, as well as their contribution to saving time. However, they do not agree to the same extent regarding the increase in their productivity with the use of ICT. More specifically, approximately half of them estimated that ICT could increase their productivity. However, if we examine the contribution to productivity based on all the variables of the component, teachers’ perceptions are positive. Such perceptions can lead teachers to be receptive to increasing ICT use.

Table 7. Descriptive statistics on the contribution of ICT to productivity.

Variable	% Responses			Mean	Standard Deviation	Evaluation Index
	Negative	Neutral	Positive			
ICT would increase my productivity	15.79	29.12	53.09	4.74	1.41	3.38
ICT would help me learn more things	5.96	10.18	82.86	5.55	1.18	5.40
I believe that ICT provide essential tools in both educational and work environments	5.26	6.32	87.42	5.89	1.17	5.68
ICT can be a useful educational aid in almost all subject areas	5.26	5.26	88.47	5.93	1.14	5.71
ICT improves the overall quality of life	11.58	16.14	71.28	5.22	1.40	4.92
Knowing how to use ICT is a valuable skill	4.91	4.21	89.88	5.97	1.16	5.83
ICT would probably save me time and work	8.07	14.74	75.19	5.48	1.37	4.21

4.2.4. Perceived Effectiveness of ICT in Education

Regarding the effectiveness of ICT in education as presented in Table 8, a common point for teachers is the positive contribution of ICT use to the preparation of teaching resources and materials, as well as the opinion that ICT use can help teachers to improve their teaching by introducing more up-to-date teaching material. The percentage of teachers who claimed to be aware of the opportunities offered by ICT for effective teaching is also high.

Table 8. Descriptive statistics on the effectiveness of ICT in education.

Variable	% Responses			Mean	Standard Deviation	Evaluation Index
	Negative	Neutral	Positive			
I find teaching easier using ICT	14.7	20	65.26	5.02	1.45	2.46
I know the opportunities that ICT offers for effective teaching	6.7	9.82	83.51	5.52	1.21	5.65
ICT-supported teaching makes learning more effective	10.2	18.25	71.58	5.27	1.36	3.16
The use of ICT helps teachers improve teaching with more up-to-date material	5.6	8.42	85.96	5.75	1.2	6.73
The use of ICT improves the quality of teaching	8.8	17.19	74.04	5.36	1.37	3.51
The use of ICT helps in the preparation of teaching resources and materials	5.3	7.37	87.37	5.76	1.18	7.48
The use of ICT enables students to be more active and participate in the lesson	10.5	19.3	70.18	5.23	1.4	3.01
I have more time to meet the needs of students if ICT is used in teaching	14.7	26.67	58.6	4.8	1.46	2.06
I think using ICT in teaching is a waste of time	85.6	8.07	6.32	2.01	1.32	0.15
Classroom management is out of control if ICT is used in teaching	80.6	13	6.39	2.15	1.33	0.21

It is also worth noting that three out of five teachers believe that the use of ICT in the educational process will contribute to saving time and to better meeting the needs of students. In the same direction, Casillas Martín et al. (2020) [62] estimated that the use of ICT in education can contribute to reducing teacher fatigue while simultaneously improving learning outcomes. The same researchers also estimated that saving time and reducing teachers’ workload with the use of ICT could be a motivation for teachers to adopt ICT.

4.2.5. Perceived Impact of ICT on Students

The descriptive statistics concerning teachers’ perceptions of ICT’s impact on students are provided in Table 8, below. Based on the data in Table 9, it becomes obvious that the teachers who participated in the research expressed mainly positive perceptions of the impact of ICT on students, as also reported by other researchers [63,64]. In particular, the vast majority of them believe that ICT helps students to successfully seek new knowledge and information for their education and to expand their knowledge. In addition, the lesson becomes more exciting, and there are improvements in students’ confidence and participation in the class, and, therefore, they learn better. Taking into account standard deviations, it can be concluded that most of the respondents share the same perceptions.

Table 9. Descriptive statistics on teachers’ perceptions on ICT adoption in education.

Variable	% Responses			Mean	Standard Deviation	Evaluation Index
	Negative	Neutral	Positive			
ICT allow students to be more creative and have more imagination	19.3	24.91	55.79	4.73	1.5	1.83
The use of ICT helps students find relevant knowledge and information for learning	5.6	7.02	87.37	5.65	1.15	7.48
The use of ICT encourages students to communicate more with their classmates	20.7	21.4	57.89	4.65	1.54	1.88
The use of ICT increases students’ confidence to actively participate in the classroom	12.6	17.89	69.47	5.05	1.36	2.87
Students learn more effectively with the use of ICT	14.4	18.6	67.02	4.99	1.39	2.59
The use of ICT helps to expand students’ knowledge	6	9.47	84.56	5.56	1.15	6.08
The use of ICT helps to improve students’ ability especially in reading and writing	26.3	22.11	51.58	4.44	1.6	1.52
Students are better controlled using ICT	32.3	29.12	38.6	4.09	1.57	1.1
The use of ICT enables students to better express their ideas and thoughts	25.6	25.96	48.42	4.36	1.58	1.44
The use of ICT promotes the active and engaging lesson for the best learning experience of the students	10.9	14.39	74.74	5.29	1.41	3.52

4.3. Self-Efficacy and ICT Use

In the present research, ICT use was considered as a 7-point Likert scale variable referring to the frequency of ICT use in educational practice, as reported by other researchers as well [35,65,66]. Based on Figure 1, below, it becomes obvious that the majority of teachers use ICT in educational practice at high levels. This result demonstrates a better level of ICT adoption by teachers, since lower levels of ICT acceptance were reported in the results of research carried out just a couple of years earlier than the present one [19].

Concerning self-efficacy, it can be measured in various ways and can be considered as a multidimensional construct as well [67]. However, in this research, self-efficacy was measured using a 7-point Likert scale variable. More specifically, in this research, the approach of Player-Coro [35] was used. Based on this approach, teachers’ self-efficacy was measured using a Likert scale question about their self-evaluation of their efficacy at using ICT in the educational process.

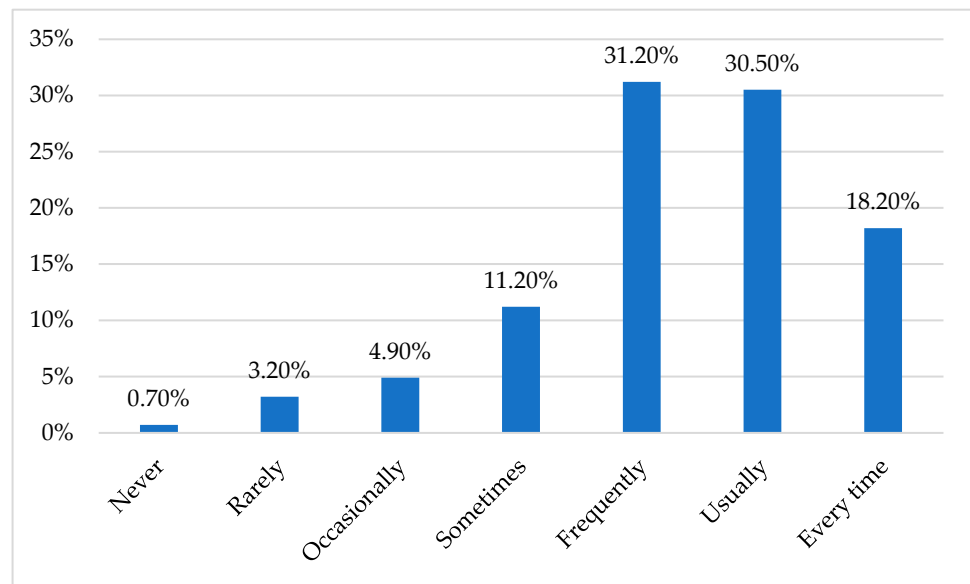


Figure 1. Use of ICT in educational practice.

The data of the above Table 10 indicate that most of the examined teachers evaluate positively their efficacy at using ICT in educational practice. Considering the low standard deviation, it is evident that this result does not vary among teachers at a high level.

Table 10. Teachers’ self-efficacy.

% Responses			Mean	Standard Deviation	Evaluation Index
Negative	Neutral	Positive			
8.1	14	77.9	5.28	1.17	7.17

In order to examine the relationship between the above-mentioned variables, their ordinal nature was considered; thus, Spearman’s correlation coefficient was initially used.

Based on the results provided by the Spearman’s correlation coefficient (p -value = 0.000; $\rho = 0.596$), a statistically significant correlation which is moderately positive was found.

However, it should be noted that the correlation coefficient examined the relationship between two or more variables, without taking into account any dependent variables. This fact led to the need for further investigation in order to obtain a complete understanding of the relationship between the variables under consideration. Taking into account the fact that the dependent variable, which was the use of ICT during the educational process, was categorical, an ordinal regression model was used.

In order to develop the appropriate model, for the independent variable, a number of pseudo-variables equal to its degrees of freedom should be created in order to examine their statistical significance. For each of the pseudo-variables, the values will start from 1 and reach -1 with 0’s in between, so that, in total, all values of the scale are covered. Thus, since we had a 7-point Likert scale, the values of the first pseudo-variable were 1, 0, 0, 0, 0, -1 , of the second 0, 1, 0, 0, 0, 0, -1 and so on.

Based on the results provided in Table 10, it can be concluded that self-efficacy has a statistically significant effect on the use of ICT in the educational process. This conclusion results from the fact that the p -values of all the values of the independent variable are equal to 0.

Furthermore, the examination of the results provided in the Expected B column reveals that as the level of self-efficacy increases, the level of ICT use increases as well. For example, for a teacher who declares a moderately high level of self-efficacy ($C_1 = 6$), the chances of

using ICT in the educational process are 0.215 higher, compared to someone who declares a somewhat high level of self-efficacy ($C_1 = 5$).

According to the results of the R-squared pseudo-R-squared coefficients (Cox and Snell = 0.295; Nagelkerke = 0.313), a relatively low level of self-efficacy justifies the use of ICT in the educational process results.

Thus, it becomes clear that self-efficacy has an important role in the adoption of ICT during teaching, as reported in the relevant literature [7]. The relatively low level of effect, however, shows that the adoption of ICT during teaching is influenced by many factors.

Based on the above-mentioned results presented in Table 11, research hypothesis H_1 , “teachers’ perceived self-efficacy is positively correlated with ICT use in the educational process”, is accepted.

Table 11. Ordinal regression model for the examination of the effect of self-efficacy on ICT use in the educational process.

	Wald Chi-Square	p-Value	Expected B	95% Confidence Interval	
				Lower	Upper
$C_1 = 1$	59.381	0.000	0.000	0.000	0.000
$C_1 = 2$	17.021	0.000	0.004	0.000	0.057
$C_1 = 3$	88.418	0.000	0.005	0.002	0.014
$C_1 = 4$	68.107	0.000	0.022	0.009	0.055
$C_1 = 5$	51.538	0.000	0.064	0.03	0.136
$C_1 = 6$	17.281	0.000	0.215	0.104	0.444
			1		
Model fitting		Chi-square	143.246		
		df	6		
		p-value	0.000		
Goodness of fit	Pearson	Chi-square	219.534		
		df	30		
		p-value	0.000		
Pseudo R-Square		Cox and Snell	0.295		
		Nagelkerke	0.313		

4.4. Perceived Effectiveness of ICT in Education and ICT Use

In order to analyze the effects of the perceived effectiveness of ICT in education on ICT use in the educational process, the relevant component concerning the effectiveness of ICT in education was used.

Initially, the above relationship was examined using Spearman’s correlation coefficient. Based on the coefficient’s results (p -value = 0.005; $\rho = 0.267$), a statistically significant correlation which is moderately positive was found.

Using an ordinal regression model, the above relationship was then further examined, considering ICT use in the educational process as the dependent variable.

The results of Table 12 confirm the existence of a statistically significant relationship between the examined variables. The relationship is positive and, based on the value of the Estimate column, for every increase in the degree of perceived effectiveness of ICT in education by a teacher, the probability of using ICT in the educational process also increases by 0.235.

Based on the above results and teachers’ perceptions of ICT adoption in education, which show that they believe that the use of ICT in the classroom contributes positively to the learning process and enables students to be more active and have greater interest and participation in class, as reported by other researchers as well [68], the positive relationship between the perceived effectiveness of ICT in education and their use by teachers is conceptually documented.

Thus, research hypothesis H₂, “the perceived effectiveness of ICT is positively correlated with its use in the educational process”, is accepted.

Table 12. Ordinal regression model for the examination of the effect of perceived effectiveness of ICT in education on ICT use in the educational process.

	Wald Chi-Square	p-Value	Estimate	95% Confidence Interval	
				Lower	Upper
Perceived effectiveness of ICT in education	4.825	0.028	0.235	0.025	0.445
Model fitting		Chi-square	4.869		
		df	1		
		p-value	0.000		
Goodness of fit	Pearson	Chi-square	1629.283		
		df	1703		
		p-value	0.000		
Pseudo R-Square		Cox and Snell	0.116		
		Nagelkerke	0.117		

4.5. Teachers’ Perceptions of ICT and ICT Use

In order to examine the effect of teachers’ perceptions of ICT on the level of ICT use in the educational process, teachers’ perceptions must be conceptually defined initially. To do, so the following extracted components were used:

1. emotions from using ICT;
2. perceived impact of ICT on society;
3. perceived contribution of ICT to productivity.

Initially, Spearman’s correlation coefficient was used. Based on the results provided in Table 13, a positive statistically significant correlation is reported between all the examined perceptions and the use of ICT in education. The correlation of ICT use in the educational process with the emotions regarding using ICT is moderate, while its correlation with the perceived contribution of ICT to productivity and perceived impact of ICT on society is low.

Table 13. Spearman’s correlation coefficient results for the relationship between teachers’ perceptions of ICT and ICT use in the educational process.

Components	Level of ICT Use in Educational Process	
	p-value	Spearman’s rho
Emotions from using ICT	0.000	0.443
Perceived contribution of ICT to productivity	0.000	0.285
Perceived impact of ICT on society	0.000	0.108

To further analyze the above reported relationships, the following ordinal regression model was then examined. In this model, ICT use in the educational process was considered as the dependent variable.

Based on the results provided in Table 14, it is confirmed that all the examined teachers’ perceptions of ICT have a statistically significant effect on their use of ICT during the educational process.

Table 14. Ordinal regression model for the examination of the effect of teachers’ perceptions of ICT on the level of ICT use in the educational process.

	Wald Chi-Square	p-Value	Estimate	95% Confidence Interval	
				Lower	Upper
Emotions from using ICT	66.976	0.000	0.997	0.758	1.235
Perceived contribution of ICT to productivity	16.785	0.000	0.458	0.677	0.239
Perceived impact of ICT on society	6.293	0.012	0.279	0.497	0.061
Model fitting		Chi-square df p-value	117.098 4 0.000		
Goodness of fit	Pearson	Chi-square df p-value	2679.645 1700 0.000		
Pseudo R-Square		Cox and Snell Nagelkerke	0.337 0.352		

Based on the values in the Estimate column, the variable with the highest impact on the use of ICT in the educational process is the one concerning the emotions from using ICT, as it emerged from Spearman’s correlation coefficient as well.

Moreover, the above results show that the examined components have an overall moderate influence on the use of ICT in the educational process, taking into account the values of the corresponding pseudo-R-squared coefficients (Cox and Snell = 0.337; Nagelkerke = 0.352).

Based on the above results, research hypothesis H₃, “teachers’ perceptions of ICT are positively correlated with the degree of its use in the educational process”, is accepted.

4.6. Teachers’ Demographics and ICT Use

In order to examine the impact of teachers’ demographics on ICT use in the educational process, an ordinal regression model was developed, as in all the above cases.

The results of Table 15 indicate a low impact of teachers’ demographics on ICT use in the educational process.

More specifically, age has a partially statistically significant effect on the degree of use of ICT in the educational process, as only the first two groups were found to affect it. This result, based on the corresponding values in column Expected B, shows that the younger a teacher is, the more likely they are to use ICT in the educational process. This result has been reported in several cases in the relevant literature.

In addition, the type of unit (public or private) where teachers are employed also has an impact on the degree of use of ICT in the educational process. Based on the values obtained by the above variable and the values of the Expected B column of Table 9, we conclude that if a teacher works in a unit in the private sector, they have a 0.123 higher probability of using ICT in the educational process, compared to someone who works in a unit of the public sector. This can be justified by the fact that, usually, private units provide more ICT tools to teachers than public ones.

Consequently, based on the above results, research hypothesis H₄, “teachers’ demographics influence the degree of ICT use in the educational process” is partially accepted, only in terms of the variables concerning the type of unit and the age of the teachers.

Table 15. Ordinal regression model for the examination of the effect of self-efficacy on ICT use in the educational process.

	Wald Chi-Square	p-Value	Expected B	95% Confidence Interval	
				Lower	Upper
Type of unit = 1	16.038	0.000	0.004	−0.213	0.816
Type of unit = 2	9.527	0.002	0.123	−0.165	1.376
Years of experience = 1	5.73	0.117	0.056	0.033	0.121
Years of experience = 2	2.489	0.115	0.152	0.027	0.457
Years of experience = 2	0.078	0.781	0.217	0.172	0.307
Years of experience = 3	1.067	0.302	0.426	2.105	3.568
Years of experience = 4	1.003	0.317	0.456	0.322	0.752
Years of experience = 5	1.313	0.252	1.555	0.313	2.196
Years of experience = 6	0.609	0.428	2.172	1.543	3.346
Years of experience = 7			1		
Age = 1	0.194	0.006	1.392	0.142	2.804
Age = 2	0.425	0.024	0.64	0.188	0.895
Age = 3	0.835	0.361	0.568	0.177	0.747
Age = 4			1		
Level of education = 1	0.056	0.812	1.138	0.937	1.195
Level of education = 2	0.278	0.598	1.009	0.692	1.201
Level of education = 3			1		
Model fitting		Chi-square df p-value	30.196 14 0.007		
Goodness of fit	Pearson	Chi-square df p-value	361.919 406 0.000		
Pseudo R-Square		Cox and Snell Nagelkerke	0.101 0.105		

5. Conclusions, Implications and Future Research Directions

It is evident that understanding the relationship between the use of ICT and teachers’ perceptions can help us to make more effective decisions regarding the integration of ICT in education [8].

The aim of the present research was to analyze primary school teachers’ perceptions of ICT and how they affect their use of them. To do so, primary research was carried out analyzing the responses of 285 primary school teachers to the research questionnaire.

First, concerning the profile of primary education teachers, a clear tendency to improve their educational level was observed, as more than half of the teachers who participated in the research hold a master’s degree, while the vast majority of them hold a certification in ICT. Consequently, teachers nowadays have a high level of education and qualifications, which means that the application of ICT in the educational process can be more easily facilitated than some years ago. Moreover, it was found that in contrast to the findings of research carried out a couple of years before the present one [19], a higher level of ICT adoption by teachers was recorded. Therefore, it is now important to strengthen the willingness of teachers to use ICT.

The research results showed that self-efficacy plays an important role in ICT use in the educational process. This is a result reported in a significant part of the relevant literature, where in several cases, self-efficacy is considered as the most important factor to motivate teachers’ use of ICT in the educational process [69,70]. Thus, it is crucial to further support and update the knowledge and skills of teachers using ICT, in order to contribute even more to the diffusion of innovation via the use of ICT in their educational environments. This can be achieved through seminars and specially designed training programs. Based on the findings of Hatlevik and Hatlevik [71], it must be highlighted that,

regarding programs aiming to update the knowledge and skills of teachers using ICT, it is not enough to address their general knowledge and skills; they must be designed in a way wherein teachers can improve their special knowledge of ICT and skills in the use of ICT for educational purposes. This can be even more important when taking into account the specific characteristics and needs of primary education. Consequently, the development of more primary-education-centered applications like educational software or interactive platforms are needed [72,73]. The introduction of augmented reality should be taken into consideration as well, as it is reported to allow students to experience the real world [74].

Another important result that provides a strong motivation for the application of ICT in education is the positive view of teachers on the effectiveness of ICT in education. Since effectiveness is one of the most important factors for supporting the application of ICT in education, it is proposed that decision-makers should pay even more attention to the use of ICT in the educational process. Teachers must be provided with all the necessary infrastructure, so that they can use ICT without any distraction. The promotion of ICT benefits involving seminars and training programs would increase the perceived effectiveness of ICT. At the same time, hardware such as interactive whiteboards would provide extra motivation for adopting ICT, since it has been found that it can significantly improve the learning process [75].

Moreover, since the curriculum of primary education in Greece is currently being reformed, curriculum designers must develop the new curriculum in a way such that ICT will have a central role in educational activities, so that ICT's effectiveness can become even more evident. In the same way, teachers' perceptions of ICT can be strengthened, since they have been found to play a significant role in the use of ICT in the educational process as well.

The above results indicate the way in which the diffusion of educational innovation is affected by the use of ICT. At the same time, these results provide directions for the strengthening of ICT use, through the support of teachers and educational units. It should be noted that higher support is needed in public schools, since the research results indicate that teachers at public schools have lower probabilities of using ICT in the educational process.

In the context of this research, future research directions arise. First, a limitation of the present research is that it concerns exclusively primary education. It would therefore be useful to repeat this research including secondary education in order to have a better image of the diffusion of educational innovation using ICT in the educational system of the country.

The next limitation, based on which the relevant future research direction is developed, has to do with the fact that in the research sample, the vast majority of participants were employed in public units. Consequently, the results are more representative of public than private primary schools. For this reason, it is recommended that future research should emphasize public and private schools. More specifically, since evidence about the higher possibility of using ICT in private schools has already been obtained in the present research, a cluster analysis could be implemented in future research so as to both indicate possible differences and provide specific suggestions for each cluster of teachers.

Moreover, since a shortcoming of the present research is the fact that self-efficacy was measured using a single variable, it is proposed that in future research, a multidimensional construct of self-efficacy be used, as reported in relevant cases of the existing literature [76]. Special components regarding the specific ICT knowledge and skills needed for primary education would be useful in such a case.

The implementation of educational innovation through the use of ICT can significantly affect students. Especially during the last few years, the educational process has become unimaginable without the use of ICT [77]. ICT applications have been found to support students to personalize the information presented to them, to contribute to students' autonomy, self-learning and creativity, to trigger collaborative work, and finally to promote active learning, in which students are the protagonists of their learning process [78,79].

Thus, in addition to analyzing teachers' perceptions, another significant avenue for future research is to analyze students' perceptions of ICT and motivations to use ICT in the educational process. Based on the existing literature, such motivations could be the interest, digital competence, autonomy, and social interaction generated by ICT applications [77]. Based on the above recommendations, the elements affecting students' evolutionary growth in using ICT and the potential need for alterations in practice should be analyzed in future research as well.

In conclusion, based on the results of the present research, it is apparent that the application of ICT can contribute to the learning process. Teachers also play a critical role in education, apart from students. No ICT diffusion is possible without the input of teachers, which means that teachers should have all the necessary tools and knowledge, as outlined above. Of course, the high percentage of ICT knowledge certification is encouraging.

The application of ICT in education is complex, and many factors must be considered for their effective use in the learning process. Teachers and students, who are the two potential user groups of ICT in education, must be treated properly in order that they not only accept, but also contribute to the effective use of, ICT and encourage the diffusion of innovation.

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