European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available online at: www.oapub.org/edu

DOI: 10.46827/ejes.v10i6.4838 Volume 10 | Issue 6 | 2023

NEGLECTED AND MISALIGNED: A STUDY OF COMPUTER SCIENCE TEACHERS' PERCEPTIONS, BELIEFS AND PRACTICES TOWARDS PRIMARY ICT

Helen Drenoyianni[1i],
Nikos Bekos[2]
[1]Associate Professor,
School of Primary Education,
Aristotle University of Thessaloniki,
Greece
[2]IT Teacher & Trainer,
Centre of Pedagogical Research & Praxis,
Aristotle University of Thessaloniki,
Greece

Abstract:
The present study attempts to explore aspects of teachers' personal practical knowledge by investigating computer science teachers' perceptions, beliefs, and practices towards Primary ICT just before a curriculum transition period and the replacement of the former program of studies with a "Computer Science" curriculum. For the needs of this investigation, an exploratory sequential mixed methods design was employed. Semi-structured interviews were conducted with 33 computer science teachers, while 157 were surveyed by means of a questionnaire developed from the analysis of qualitative data. The findings of the study indicated that there is a misalignment between the policy rationale towards ICT, teachers' understanding of ICT and the implementation of ICT in the primary classroom. Due to teachers' lack of professional-pedagogical knowledge, contextual factors and policy decisions, which consistently neglect teachers' needs and personal practical knowledge, CS teachers have developed their own ways of theorizing, conceptualizing and practicing education in ICT. These findings are discussed within the light of the corresponding literature and suggest that structural and curricular transformations in digital education are condemned to carry within them the seeds of their own dismissal when they are not ingrained in the reality of classroom practice and on teachers' practical knowledge, which entails their involvement in the design and formulation of any intended changes.

Keywords: computer science teachers, ICT literacy, primary education, teachers' practical knowledge, mixed methods

[i] Correspondence: email edren@eled.auth.gr

1. Introduction

Discussions about the integration of digital technologies into the primary school curriculum have a long history. During the past 30 years a significant number of differentiated terms, such ICT capability, ICT literacy, Computer Science, Computing and digital literacy, have been initiated by policymakers and used in their rhetoric about the role and rationale of digital technology's incorporation into education. This is clearly not by chance, as changes in the use of terms signify transitions in the content and the meaning of this integration and denote shifts in the direction of educational policies at national and international levels. As economic, vocational and market-driven priorities evolve, so does educational policy rhetoric and reform associated with digital technologies.

Contemporary reconsiderations about the status of digital technologies in education appear to focus on the revival of computer science and argue for the inclusion of computing in both primary and secondary education (Fluck et al, 2016; Passey, 2017; Webb et al, 2017). *"A mixture of pressure from industry and lobbying by interest groups has led to resurgent interest in computer science"* (Royal Society, 2017: 16). In countries, like England, this renewed interest led to narratives against the former ICT curriculum presenting it as *"academically weak"* and *"vocationally useless*" and cultivated (Larke, 2019: 1139) its final replacement with the subject of Computing in England's national curriculum. On the other hand, alternative considerations appear to promote a balanced view towards the dichotomy ICT / digital literacy versus Computer Science /Computing. International and European wide frameworks, such as the European Digital Competence Framework (Vuorikari et al, 2022) and the ISTE Standards for Students (ISTE, 2016) seem to endorse the development of various "literacies of the digital" as well as aspects of programming and computational thinking. Following such recommendations several countries have already reformed -or are in the process of reforming- their curricula in order to align their national policies to international trends (Ottestad and Gudmundsdottir, 2018). Apparently, ongoing curriculum reform related to digital education is currently the mainstream tendency across Europe, while curriculum approaches towards the integration of "digital competence" into school curricula vary considerably (Eurydice, 2019), with education systems including it as a cross-curricular theme, as a discrete school subject, as part of the competencies incorporated into other school subjects or as a blend of these approaches (Eurydice, 2019).

In short, the diversity of perspectives appears to support the idea that the field of education and digital technologies is going through a transition stage, which is as awkward, challenging and uncertain, as any in-between period of change. On the other hand, shifting periods are also times for reflection, for in every transition there is a dialectic between continuity and change, which needs to be thoroughly analyzed and properly understood before any structural or other kinds of transformations take place (Wickham, 2010). The process of accounting for this dialectic and identifying the roots of change inside continuity goes beyond the scope of this paper. However, a critical dimension in this dialectic, which is largely neglected in contemporary discourses about reform in the area of digital technologies is concerned with teachers' beliefs, understandings and implementation of past and present policies. Narratives of digital education curriculum development are mainly presented by theorists and subject specialists, are almost always dehistoricized and remain substantially in the sphere of influence of policymakers and administrators. Nevertheless, what is often not accounted for is that these policy directives and initiatives, which are created without consideration of the research data from the classroom field, without reflection on the history and the realistic implementation of past efforts and to a large extent without the involvement of educators, are bound to be fragmentary and disputable. Due to teachers' enactment upon the externally imposed "intended" curriculum, the distance between what policymakers and administrators envisage and what students realistically experience may be quite considerable (Gerhke, Knapp and Sirotnik, 1992). Curriculum filtering, modification and adjustment are expected to take place as teachers interpret official mandates through their personal practical knowledge (Craig, 2011; Clandinin & Connelly, 1992; Priestley & Phillipou, 2018), which is found in their professional practices and may be perceived as the particular way *"in which anyone teacher reconstructs the past and the intentions of the future to deal with the exigencies of a present situation"* (Connelly and Clandinin, 1988: 25).

Within this context, the present study attempts to explore aspects of teachers' personal practical knowledge just before the beginning of a curriculum transition period by investigating the experiences and beliefs of a challenging population with distinctive attributes. In particular, the study focuses on computer science teachers' views of, beliefs about and implementation practices of the Greek ICT Curriculum for Primary education, which according to government mandates will be soon replaced by an "ICT and Computer Science" curriculum.

2. Policy background - Literature review

The incorporation of digital technologies into the Greek school curriculum and the process of their integration may be clearly associated with the multidisciplinary orientation and academic tradition of the Greek curriculum. Thus, the official policy embraced and implemented since the 90's was and still is circumscribed to the inclusion of distinct subjects with their own uniform and compulsory curriculum at both primary and secondary levels of education that are taught by computer science (CS) teachers.

With respect to primary education, the latest in effect curriculum dates back to 2010, when a subject with the title "Technologies of Information and Communication" was introduced to the compulsory program of studies, that was to be taught for two hours per week to all primary grades by subject specialist teachers. However, this subject differed in a number of ways from previous developments in the area, as well as other national curriculum subjects. Firstly, following EU recommendations and international tendencies at the time, the 2010 ICT Curriculum endorsed an 'ICT Literacy" perspective and focused on the development of digital skills as well as the enhancement of learning capabilities through the use of digital tools, services, and equipment. In terms of subject matter, the curriculum was structured across four strands, namely the use of ICTs as cognitive tools, as means of problem-solving, as technological tools and as a social phenomenon (MoE, 2010; 2011). Secondly, the instructional guidelines accompanying the curriculum anticipated that the subject was clearly oriented toward laboratory work and should be delivered through practical activities and cross-curricular projects. It was recommended that students should be active, while learning experiences should be meaningful and contextualized, in the sense that they should be drawn from and be related to the contents of all primary curriculum subjects. Student progress would be evaluated through formative methods of assessment. Thirdly, in contrast to all other primary school subjects, the delivery of the ICT curriculum was not supported by a uniform, official and compulsory school textbook (MoE, 2010; 2011; Jimoyiannis, 2011; Piliouras et al., 2010).

In summary, the delivery of the 2010 ICT Primary Curriculum may be perceived as a challenging and demanding enterprise for it required considerable expertise in instructional design. Among others, the process of teaching the subject expected from CS teachers: (a) to be familiar with all primary subjects in order to design interdisciplinary and contextually meaningful learning activities and cooperate with primary teachers, (b) to have knowledge and skills in the design and implementation of project-based learning and its many manifestations, (c) to be able to transform ICT curriculum goals into everyday learning experiences and organize subject matter into short, medium and long term planning schemes of work, (d) to have knowledge and experience in designing, organizing and creating efficient and effective educational materials, and (e) to be aware of formative methods of assessment and evaluation, forms of interdisciplinarity and learner-centered methods of teaching. However, only a few highly skilled primary teachers in the country would have been in position to fulfill such expectations. Due to long-term education policies that promoted teachers' "*deskilling*" (Apple, 2017; Apple and Jungck, 1990), the vast majority of teachers have been alienated from the process of planning and designing everyday learning experiences, as they implement the learning activities contained in the official textbooks provided and approved by the Greek state. Considering this, one may clearly realize the difficulties that CS teachers would encounter in delivering the subject, for an additional reason. Subject specialist teachers in the country are university graduates in a relevant field of specialization, having little or no studies in education sciences (OECD, 2017; Liakopoulou, 2011). In particular, Greek CS teachers may be described as a population with outstanding university qualifications holding a Bachelor's degree in Computer Science, Information Technology, Computer Engineering or STEM related disciplines, yet have little education on curriculum and instruction, educational theory, classroom pedagogy and the organization, culture and context of primary education. Moreover, within the context of a regularly adopted measure of the Greek education authorities [through which the surplus of teachers in one education level is minimized without creating new teaching posts needed in another (Stylianidou et al., 2004; OECD, 2011)], the vast majority of primary CS teachers have been transferred in 2013 (MoE, 2013) from secondary schools to elementary education posts.

After the establishment of the 2010 ICT curriculum till the autumn of 2021, no significant policy changes have taken place, except the publication of a ministerial order in 2016 (MoE, 2016), that reduced the instruction time allocated to the ICT subject from two hours to one hour per week across primary education. In the years following the introduction of the Primary ICT subject, few small-scale studies have been conducted with the aim to describe CS teachers' characteristics and experiences with the subject. The results of these studies may be summarized as follows:

a) The great majority of Primary CS teachers lack pedagogical competence qualifications (Mpelesiotis et al, 2013). They perceive professional pedagogical knowledge as necessary and require training in teaching methods, pedagogical subject knowledge and classroom management (Panselinas et al, 2015; Gogoulos et al, 2011; Mpelesiotis et al, 2013; Vloutis, 2018; Theodorou, 2012a; Daraviga, 2018; Tziafetas et al, 2013)
b) Most teachers reported that they use the ICT curriculum in preparing instruction (Panselinas et al, 2015; Gogoulos et al, 2011), yet they perceive it as a bureaucratic document that they are "obliged" to use (Kallivretaki, 2016). Teachers face considerable difficulties in teaching the subject and adapting to the needs of primary school children (Terpeni et al, 2014). There is increased variation in both the perception of the ICT curriculum and its delivery (Kallivretaki, 2016; Fessakis & Karakiza, 2011; Tziafetas et al, 2013; Drenoyianni, 2014; Bekos, 2021)
c) The most significant barriers that teachers report are regarded with the lack of official school textbooks and instructional materials for the delivery of the subject, limited instructional time, lack of adequate equipment and dated infrastructure, high student/computer ratio, high student/teacher ratio, and lack of technical support which increases their extracurricular duties (Panselinas et al, 2015; Gogoulos et al, 2011; Mpelesiotis et al, 2013; Vloutis, 2018; Michalakopoulos, 2021; Kallivretaki, 2016; Tziafetas et al, 2013; Terpeni et al, 2014; Bekos, 2021)
d) According to teachers, the teacher training they received while in service was inadequate, as it was mostly theoretical with limited practical examples and hands-on activities (Theodorou, 2012b; Trapsioti, 2009).

Even though the results of the above studies may seem relevant to the Greek context alone, in reality, other studies conducted in different parts of the world and within a different policy framework appear to report similar concerns. Teachers' perceptions of the ICT/Computing curricula are moderate and variable (Vanderlinde & van Braak, 2011; Barnes & Kennewell, 2017; Larke, 2019; Royal Society, 2017). CS teachers lack educational expertise whereas teachers without a background in CS lack sufficient subject-specific technical knowledge (Royal Society, 2017; Bottino, 2020; Sentance & Csizmadia, 2017). Poor classroom facilities and resource-related challenges are reported (Sentance & Csizmadia, 2017; Mc Farlane, 2019), and gaps are found in professional development opportunities (Royal Society, 2017; Sentance & Csizmadia, 2017; McFarlane, 2019; Larke, 2019). Teachers express low confidence and low self-efficacy and require detailed lesson plans, more structured curricula and suitable resources (Stringer et al, 2022; Lockwood & Mooney, 2017; Royal Society, 2017).

The challenges identified in relevant research efforts, appear to affirm that the integration of digital technologies into the school curriculum requires systemic and structural changes, considerable investments and well-thought-out policies, firmly consolidated in the reality of educational practice. In this reality, national curriculum tradition and ideology, established structures, organizational contexts, recruitment routines and teachers' pedagogical beliefs, professional competence and occupational status may be perceived as multilevel filters which translate and transform policy visions and affect policy understanding and implementation in practice.

3. Materials and Methods

Within the context of the aforementioned framework and in recognition of the immense role of teachers' personal practical knowledge in the employment and application of policy initiatives, the study presented in this manuscript investigated teachers' perspectives towards the ICT curriculum, their conceptualizations of ICT literacy and their self-reported classroom implementation of the ICT subject. For the needs of this investigation, an exploratory sequential mixed methods design was employed (Bryman, 2017; Creswell & Plano Clark, 2018). Therefore, the study was performed in two successive, yet synergistic phases.

The initial phase was focused on the collection of qualitative data. Semi-structured interviews were conducted with a quota sample of 33 computer science teachers who were serving in tenured primary school posts throughout the country. The interviews lasted approximately 2 hours each and were guided by an interview protocol. The protocol's questions were divided in three main topics of discussion concerned with the description of teachers' classroom practices, teachers' perceptions of the ICT curriculum and teachers' constructs of the term "ICT Literacy". The narrative data collected were then analysed through the employment of thematic analysis (Bryman, 2017). The codes, the categories and the themes identified in the analysis were used as a basis for the construction of a questionnaire, which was in turn utilized in the following phase of the study.

In the second phase of the study, quantitative data were collected. The questionnaire developed from the analysis of qualitative data was self-administered and delivered by means of an online survey. Despite the researchers' intentions to collect census data, the final number of teachers who participated in the survey and filled in the questionnaire was 157 computer science teachers. The survey participants represented 12,5% of the total population (N=1257) of primary CS teachers in the country. The questionnaire contained 40 main questions, which were divided in 6 thematic areas: Background and demographics, content of instruction, methods and forms of instruction, educational materials, barriers and challenges, perceptions of the ICT curriculum.

Quantitative data were analysed using descriptive statistics and in turn, they were merged with the original qualitative data in order to be summarized and interpreted.

4. The findings of the study

4.1 The participants' profile

The total number of computer science teachers taking part in both phases of the research was 190 (33 in the qualitative and 157 in the quantitative). The great majority were aged between 30 and 49. The average age of the respondents was 42 and only one participant was younger than 30.

Table 1: Aspects of the participants' profile

Gender		Previous Education experience		Qualifications Background	
Male	58%	General upper secondary	27%	Computer Science (4 year degree)	49,5%
		Vocational upper secondary	31,5%	Information Technology (5 year degree)	15,5%
Female	42%	Lower secondary	33%	Computer Science Polytechnic (3 year degree)	23,5%
		No education experience	8,5%	Other + Training in Computer Science	11,5%

A high percentage of teachers had been teaching in Primary education for less than 9 years (88 %), yet they had considerable teaching experience in secondary schools. 91.5 % had been serving in various secondary education posts before transferring to primary education. As regards teachers' education background, 88.5% held a CS or IT qualification (Table 1). In general terms despite the non - representativeness of the sample, its distribution appeared to mirror the synthesis and the characteristics of the total population in terms of gender, graduate studies and geographical region of service.

4.2 Teachers' conceptions of "ICT Literacy"

One of the main issues raised in the discussions with CS teachers regarded their personal and individual conceptualizations of the term "ICT Literacy". Despite the interviewer's attempt to guide the conversation towards this direction, almost all participants avoided explicit references to the defining characteristics of what it means to be literate in ICT. Instead, teachers preferred to discuss in detail their views on the primary ICT school subject. In particular, teachers' viewpoints could be divided into three central categories of thought. Half of the interviewees supported the idea that the primary school subject of ICT should be changed and be understood as a subject directly related to computational thinking, algorithms, coding, programming and STEM education.

> *"First of all, I would change the name (of the subject). I would call it computer science. We have discussed this many times with the children. They look at the program of studies and*

ask 'what is ICT?' … (The subject) should drift away from simple use ... It should be more scientific." (Teacher 12)

"This thing with ICT is a bit general, it can refer to anything and nothing. In my mind it has to do with using technologies not with computer science … With my students, I refer to the subject as computer science, I do not call it ICT. For me, it is computer science." (Teacher 23)

A different line of thought was expressed by almost a third of the interviewees who commented that the ICT subject is concerned with the development of knowledge, abilities and skills related to digital literacy and that is what should be expected from primary school children. Programming may be perceived as an interesting activity, yet it cannot constitute the core of the ICT subject, due to children's age and learning readiness.

"In primary school, I wouldn't change the subject matter. I don't believe that somebody can teach rigorously computer science or concepts like networking in primary school … (I'm inclined) more towards the use of technologies, various software applications." (Teacher 18)

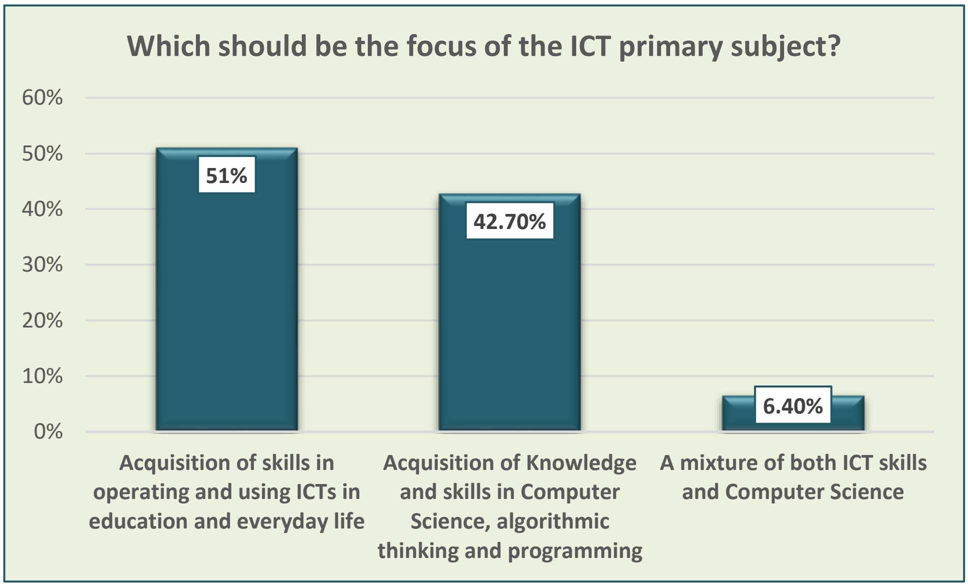
"Listen to me, we cannot teach science in primary school children… Digital Literacy. This is what I teach to the children. This is my subject…For me the subject matter is concrete, it's meaningful and dilemmas of the type teaching Word or teaching Excel or teaching programming, are pointless." (Teacher 31)

Finally, a few teachers voiced a combination of rationales by stating that both ICT and computer science are important and should co-exist in primary education. Some suggested that younger students should become familiar with computers and the use of various applications, while older children may focus on programming and computational thinking. Others commented that all students should attend a compulsory ICT skills development course, and the ones who develop a special interest for the subject, should be given opportunities to attend programming and CS courses.

"In lower grades (students) should be given incentives so as to use the computer with no fear and use it properly… In the 3rd and 4th grades basic concepts like user interface, photo editing, video editing, multimedia applications (should be taught). In higher grades, web 2.0 applications seem to me important as well as programming, algorithms and robotics." (Teacher 2)

"There should be a division between computer use/ICT and Informatics as a science. That is what is needed in school, especially primary school. Both should be taught simultaneously." (Teacher 30)

The survey data collected appear to confirm the existence of these three viewpoints about the primary ICT subject (Graph 1). Even though the percentages of teachers supporting each position differ significantly from the ones reported in interviewing data, it is still notable that teachers seem to be divided between an ICT versus Computer Science perspective.



Graph 1: Teachers' viewpoints about the focus of the ICT subject

Nevertheless, the key issues that need to be raised are concerned with teachers' actual perceptions of ICT literacy. Participants seemed unaware of the term or unfamiliar with its dimensions in the corresponding literature. Their main frame of reference to "ICT Literacy" appears to originate from a loose perception of the primary ICT subject. Within this line of reasoning when they were asked about their thoughts towards the concept of ICT literacy, their responses focused on the contents of the primary ICT subject. Furthermore, evident in the narratives offered is the tendency to trivialize and somehow downgrade the wide-ranging competencies entailed in ICT literacy by equating them with the acquisition of simplistic skills in operating computers and generic applications. On the other hand, teachers who supported the development of digital skills kept on emphasizing that this was appropriate in the context of primary education alone. In summary, teachers' views of the subject and in turn their indirect understandings of ICT literacy were not in alignment with either the contents and the scope of the official ICT curriculum or the related literature. In fact, they illustrate a number of misconceptions about both the curriculum subject and the meaning of being literate in ICT and these misconceptions seem to endorse an unnecessary and unproductive divisiveness among the multifaceted options and dimensions of both ICT literacy and computer science.

4.3 Teachers' views of the ICT Curriculum

A part of the discussions undertaken with CS teachers was focused on their judgments towards the contents and the methods described in the official ICT curriculum. The vast majority of the teachers interviewed reported that they espoused the contents of the ICT curriculum to a high degree by stating that they implement around 70% of the subject matter described in it. Questionnaire data also illustrated that the total average degree of compliance to the contents of the ICT curriculum was quite high, yet responses were also variable with 28 participants declaring that they implement 50% or less of the curriculum and another 50 teachers reporting a medium-level of adoption (Table 2).

Table 2: Teachers' self-reported percentages of ICT Curriculum subject matter implementation

I implement…	No of survey participants	Percentage of survey participants
Up to 25% of the curriculum subject matter	4	2.5%
From 26% to 50% of the curriculum subject matter	24	15.3%
From 51% to 75% of the curriculum subject matter	58	37%
From 76% to 100% of the curriculum subject matter	71	45.2%

A minority of teachers expressed feelings of rejection and refusal towards the curriculum, while some others considered it quite adaptable and assumed that it was not obligatory to follow it. However, the great majority commented that even though they take into account the curriculum recommendations, in practice they need to adapt its contents to their students' needs, to the particular conditions of the school they are working into and their own professional needs and perspectives.

> *"It (the curriculum) didn't impress me. I do not remember it, that is how much interesting I found it. To tell you the truth the program of studies is not followed. Within the way that I teach, I'm not interested in the curriculum."* (Teacher 18)

> *"The primary computer science teacher is free to launch his or her own program of studies. There is great freedom, because the ministry proposes, it does not impose whatever exists in it (the curriculum). So, you are autonomous, you can create your own program of studies and I think that more or less everyone implements his or her own curriculum"* (Teacher 9)

> *"Surely, the program of studies is not strict. It depends on the school conditions. When I first started at this school, I found lots of weaknesses. Subject matter that was to be taught in 3rd or 4th grades, I started teaching it in 5th and 6th grades… there isn't a strict curriculum like the one we used to have in lower or upper secondary education."* (Teacher 14)

> *"In general, the ministry's mandates are great in theory, but I had to adapt them to my program of teaching."* (Teacher 7)

The medium degree of compliance with the ICT curriculum and teachers' reported practice of developing their own study program may be directly related to their beliefs and opinions about the curriculum. When they were asked to determine its quality and judge its value through the use of adjectives, many participants initially commented positively on its attributes and characterized it as *"comprehensive"*, *"suitable"*, *"appropriate"*, *"properly oriented"* and *"well-thought-out for primary school ages"*. However, this preliminary favorable judgement was accompanied by secondary thoughts raising concerns. The objections expressed pertained to the adequacy and applicability of the subject matter. According to teachers, some units, such as the ones related to concept mapping, the defining characteristics of technological terms, or the use of spreadsheets could not be delivered either due to younger students' incapacity to understand or because of students' lack of interest. Thus, the curriculum needs to be updated and modernized. Furthermore, learner-centered forms of teaching cannot be applied due to the lack of adequate instruction time, while limited infrastructure and outdated equipment represent additional obstacles. Moreover, one of the most frequently reported barriers was concerned with the organization of subject matter in the curriculum and the lack of teaching guidance.

> *"How can you explain to children what a concept map is? I've tried (to explain) once. I did not attempt it for a second time."* (Teacher 3)

> *"Children cannot manage email accounts when they are young."* (Teacher 5)

> *"It (the curriculum) should be fleshed out with computational thinking, computer science, algorithms and programming in higher grades."* (Teacher 29)

> *"Teaching time is not enough. The subject matter is too extensive for the time allocated to the subject. The organization of time and subject matter is completely wrong. How can you implement projects with one hour per week?"* (Teacher 22)

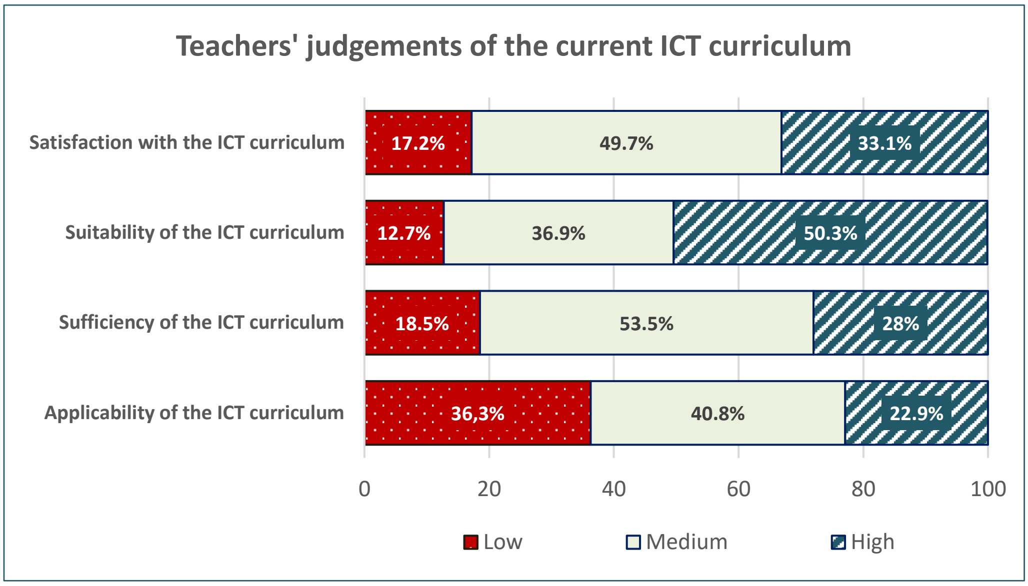
> *"If there isn't an appropriate computer lab, the subject matter cannot be delivered."* (Teacher 6)

> *"The program of study is confusing. The ministry developed a program without considering students' background, logistics and technical support. All these are upon us"* (Teacher 14)

> *"What bothers me is that the same content is taught in different grades. What is the meaning of this practice? The creation of a website is repeated in 3rd, 4th, 5th and 6th grade. I want this to become more specific, to know what exactly to teach per grade."* (Teacher 24)

> *"Every teacher needs to create his own activities, worksheets and lesson plans. All of these belong to me. What was the support that the ministry provided to me? The teaching objectives alone. The ways and the know-how of doing all these were left to me."* (Teacher 33)

Evident in the comments above is teachers' difficulty to identify differences in the formulation of learning objectives, to understand the spiral design of the curriculum by implementing the same contents with deepening complexity or in different situations and conditions, and organize subject matter into short-term and long-term action plans to ensure balance, continuity and progression in its the delivery. Due to the lack of professional-pedagogical competencies in instructional design, many teachers perceived the curriculum as repetitive, chaotic and impracticable and commented that it should be accompanied by a uniform school textbook, which would help in clarifying what exactly needs to be taught, at which grade, and with what ways. Survey data appear to confirm this request as 86 participants (54.8%) reported that the guidelines provided for the organization of subject matter per grade are obscure and 122 teachers (77.7%) declared that the development and use of an official textbook is necessary. Moreover, the quantitative data collected affirm the idea that teachers judged the quality of the curriculum as average in terms of applicability (Mean= 1.8 out of 3), sufficiency (Mean = 2/3), suitability (Mean = 2,3/3) and general satisfaction (Mean = 2,1/3) (Graph 2).



Graph 2: Teachers' judgements of the ICT curriculum

In conclusion, 133 CS teachers (84.7%) stated that the official ICT curriculum needs to be modified, for it cannot be considered satisfactory in its current form.

4.4 Classroom implementation practices of the ICT curriculum

Teachers' tendency to equate ICT literacy with the acquisition of lower-order technical and operational skills, similar to the ones developed in ECDL-like courses, was reflected in their self-reported teaching practices and their descriptions of the subject matter taught per grade. In the qualitative data collected teachers' references to the content of instruction were focused on specific software applications. As such when questioned about what they teach in each grade the vast majority responded that 6- and 7-year-old children are familiarized with the basic use of a computer system, learn about ergonomics and are taught how to use painting software. In the 3rd and 4th grades, they teach word processing and a bit of concept mapping, while 10- and 11- year-olds are taught how to create a PowerPoint presentation, how to operate a spreadsheet in Excel, how to manage an email account, use browsers and search engines, as well as how to use multimedia editing software. Little emphasis was dedicated to the development of technological knowledge and most teachers reported that technological concepts and terminology cannot be properly taught and understood by children younger than 8 or 9.

> *"In higher grades, 5th and 6th, I use the middle school textbook to explain the internal parts of a computer and clarify in mechanical terms what a computer is."* (Teacher 27)

> *"Familiarization with the keyboard, to learn how keys are arranged … the objective is to feel at ease with the mouse, to use the keyboard to type in Greek and English, punctuation, intonation."* (Teacher 11)

> *"With painting software, we work on specific exercises. We may give them a pattern and ask them to continue it… we may paint pictures about the seasons or our city."* (Teacher 16)

> *"I teach them how to make a table, put pictures in cells or information, titles, to edit the table …we created, for example, a meal plan for the week or our school schedule."* (Teacher 21)

Clearly, responses with respect to curriculum coverage indicate the adoption of a tool-based or application-based perspective towards the subject. However, this kind of perspective is not in alignment with the recommendations of the ICT curriculum, which recognizes the necessity of technical and operational skills, yet identifies literacy in ICT as a mixture of cross-curricular cognitive processes and higher-order abilities, and proposes a problem-solving approach and an interdisciplinary project-based strategy towards their instruction.

On the other hand, approaches to programming appeared to be more playful. Almost all CS teachers interviewed and 80% of the survey participants reported that they teach programming skills using visual programming environments, such as EasyLogo, Kodu and Scratch. Children's familiarization with programming may begin as early as 6 or 7 years of age, but the vast majority of teachers seem to start teaching programming from 4th grade and on. According to participants' accounts the development of programming skills focuses on the analysis of solutions to a logic problem using a blend of three programming structures, namely the sequence structure, the loop structure and the selection structure. Many report that programing instruction is based on students' wish to learn how to make games.

> *"We do a lot of Scratch in 6th grade… how the environment looks, that is divided in 3 spaces, to understand what we can do in each space, what are the instructions. It took me 1-2 hours. Then I showed them simple things, such as how to draw a rectangle, how the cat moves and turns, some small moves."* (Teacher 11)

> *"Children want to make games…so through this we learn how to use events, instructions and the rest. I always try to use students' wish to learn how to construct games."* (Teacher 8)

> *"In the 1st and 2nd grades I talk to them about computer science concepts, but in a friendly way. I use the robots in bitsbox.com, so once a month we do this. I bring in class some activities and we work initially with symbols and later with numbers, because the children do not know much about writing."* (Teacher 27)

A few teachers indicated that they had experimented with the use of educational robotics, but as they commented, even though activities with robotics kits are extremely interesting, they require excessive time, plenty of resources and expensive specialized equipment that does not exist in schools. Lack of appropriate teaching time, lack of adequate resources and equipment and increased number of students have been reported as major obstacles affecting the efficiency and effectiveness of teaching the subject. As the CS teachers reported, it is nearly impossible to implement project-based approaches within the limit of an hour per week (80% of survey participants). Consequently, their teaching approaches are quite traditional, following a simplified version of direct instruction. Within the frame of a deductive approach which fosters the quick development of psychomotor skills, most lessons begin with a demonstration, or an exemplary execution accompanied by an explanatory narration and continue with task assignment that is related to the introductory demonstration and entails the completion of several lab exercises.

> *"I usually have a short worksheet, I explain the objectives, what we need to do, what is the purpose of our assignment. I may start with a short presentation and then I let them work on their own."* (Teacher 17)

> *"I demonstrate it on the projector and then the class must do an exercise on the skill that I showed them."* (Teacher 3)

According to survey data, this kind of lesson structure is followed by 90% of teachers. The implementation of other formats of teaching, such as questioning and forms of discussion, is reported by an equally significant number of teachers and their utilization seems to run across all phases of instruction. Video presentations as well as forms of dramatization and role playing seem to be used when the subject matter taught is related to understanding technological terms, internet safety and concepts or programming instructions.

> *"Internet safety…we will do some role-playing, we will assign roles to students, one is the victim the other is the perpetrator. The lesson becomes more experiential, rather than theoretical."* (Teacher 32)

> *"In the beginning, I showed them on the projector, I explained the instructions, the algorithms and then I pretended to be a robot and I asked them to give me orders so as to make me move to the door of the classroom."* (Teacher 20)

With respect to project implementation, many of the teachers interviewed referred to them as one of the most valuable and meaningful approaches to teaching at the primary level, which they cannot utilize as much as they would like due to teaching time limitations and lack of resources. However, when they were asked to describe examples of the projects, they have implemented they referred to forms of classroom work that are directed by the teacher, may be thematically related to one or more school subjects, last much longer than exercises and activities and give students the opportunity to practice skills they have acquired in previous courses. Most - if not all - of the project examples offered in the discussions with teachers entailed searching, organizing and presenting information about a theme (eg. recycling, Olympian gods, touristic attractions of a city, climate change) or collecting data, analyzing them and presenting findings (e.g. collecting data about injuries at school, gender differences, bullying).

> *"In groups of 2-3 they chose a theme of their preference, like the 10 biggest cities of the world, the most beautiful islands in Greece, a theme about ecology or recycling…and they presented their work for other children to see…"* (Teacher 16)

> *"In the 5th and 6th grades, I teach Excel and by the end of the year, we conducted research on issues related to schooling. We administered questionnaires then the children collected them and produced graphs and tables. We also used Word to write about the project and PowerPoint to present it."* (Teacher 34)

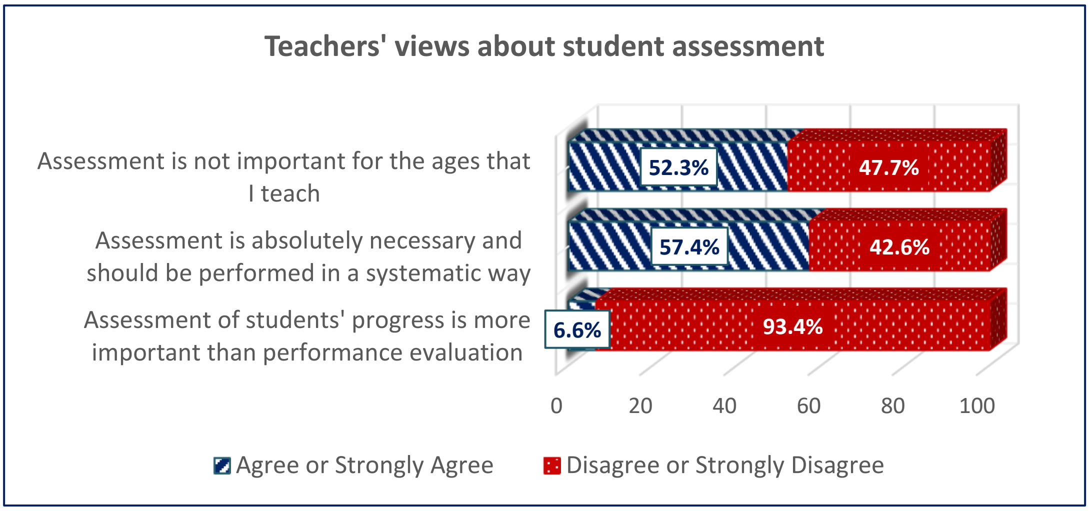
Projects were mainly understood as a long-term activity that gave the opportunity to practice skills already taught through direct instruction. Their relation to other school subjects was largely superficial and did not provide the context for meaningful use of ICT tools and applications. In other words, they were not related to problem-solving forms of project-based learning, as they did not require the application of a technology solution to a real-world problem, or a realistic situation and they were heavily guided and directed by the teacher.

As regards students' assessment CS teachers expressed worrying views related to the status of their subject in primary education. Most of them admitted that the context of primary education is quite different from the one they were used to in secondary schools and reported that student assessment is not systematically implemented (77.7% of survey participants). Their subject is perceived as subordinate, the logic of exams and testing is not acceptable and the appraisal of student performance with grades lower than "excellent" is almost prohibitive and is negatively received and remarked by both parents and students. Parental interest for children's performance in the ICT subject is extremely low.

> *"Anyway, the issue of assessment at primary school is for me an unsuccessful procedure. That's why all get an A. It is deteriorating. Especially in the subject of computer science, as in all other subjects taught by subject specialist teachers, parents and children believe that we do not have the right to put a grade lower than A. If they see a B they feel alienated"* (Teacher 12)

> *"A minority of parents come and ask me to describe what I think about their child. This is justified by the fact that I teach them for only an hour per week"* (Teacher 15)

On the other hand, CS teachers appeared confused about the scope and the methods of student performance evaluation and expressed contradictory thoughts about assessment. Some of the views reported illustrated a lack of familiarization with the curriculum recommendations and claimed that there are no official guidelines for evaluation or that *"every teacher applies his or her own teaching practices and naturally his or her own assessment methods"*. Furthermore, and in conflict with the official guidelines, the vast majority agreed with the view that grading (summative evaluation) is more significant than evaluation of student progress and growth (formative assessment). More than half of them agreed that student assessment is not important in the case of primary school children. Yet, at the same time, an equivalent percentage of teachers believed that assessment should be performed in a systematic way (Graph 3).



Graph 3: Teachers' views about student assessment in ICT

In conclusion, the data collected appear to support the idea that CS teachers have developed their own ways of understanding, conceptualizing, implementing and practicing education in ICT. Their lonesome ride is reinforced by the fact that their collaborations with other subject specialists and primary teachers within the school organization, - if and when they exist (44% of teachers surveyed) -, may be described as weak, trivial and incidental. However, the main reasons are founded on the feelings of powerlessness and abandonment they encountered after their transfer to primary education.

> *"I serve 13 years in education. No one, not a headteacher, not a primary teacher, not a computer science teacher, not a school advisor has ever come to ask me "What do you teach in your classroom?" Not even once. That for me is paradoxical. It is a curse. This fact alone illustrates the level of interest that education authorities have for children's education."* (Teacher 32)

> *"There is no recipe, and everyone works based on his or her intuition, unfortunately… I have functioned more with intuition, instinct and experience. Little children are unpredictable and do not express their thinking."* (Teacher 10)

> *"I didn't have a problem with subject knowledge…We read, we struggle, we help each other, we found a way of dealing with the subject, but no one has informed us about what shall we do in the classroom, how primary school works, how it operates. That looked like mountains for me."* (Teacher 28)

As most teachers admitted in both questionnaires and interviews, the lack of professional development regarding curriculum and instruction, the context of primary education, the management of young children, practical professional knowledge on child psychology and pedagogy, combined with the indifference they experienced from the public administrators and educational authorities have been and still are major obstacles and barriers to the delivery of the ICT subject.

5. Discussion of findings – Recommendations

The investigation of teachers' beliefs, perceptions and practices towards the primary ICT subject appears to support the idea that there is a misalignment between the policy rationale towards ICT, teachers' understanding of ICT and the practice of ICT in the primary classroom. CS teachers avoided discussions about the concept of ICT literacy per se. From their indirect comments on the ICT school subject, it may be inferred that they are not familiar with the term's conceptual dimensions. In their perceptions, ICT is equated with mechanical familiarization with a set of low-level psychomotor skills, while their practices endorse this perspective by adopting an application-based rationale. Within this context, opinions regarded with the school ICT subject appear to be dichotomized, as half of the teachers endorse a tool-based perspective as suitable for primary children and the remaining half support the idea of a computer science perspective. Teachers' loosely defined ideas about literacy in ICT and computer science have been reported in other studies (Kallivretaki, 2016; Kordaki & Komis, 2000). Some also report the espousal of traditional teaching in the delivery of the subject (Kallivretaki, 2016; Theodorou, 2012a; Tziafetas et al, 2013), difficulties in the adoption of a critical, cross-curricular approach (Tziafetas et al, 2013), and mixed beliefs about student assessment (Fessakis & Karakiza, 2011). Similarly, the teaching approaches described in this study may be characterized as traditional and deductive related to direct instruction. On the other hand, instructional activities are hands-on and laboratory-based, while the development of programming skills is widely appreciated and practiced. Yet, the forms of interdisciplinarity applied are superficial, opinions about assessment are confusing and project-based work is understood as a long-term activity suitable for practicing low-level skills instead of supporting a problem-solving rationale.

The explanations provided in the literature (Kyritsakas, 2008; Theodorou, 2012a) target on CS teachers' lack of pedagogical competence, which causes them to operate on the basis of their own autobiographical memories and to adopt the teaching style and the norms that they themselves experienced as students. Most perceive themselves not as teachers who deliver a school subject, but as professionals in science who teach it (Kyritsakas, 2008). As a consequence, they appear to construct their own arbitrary versions of meaning for the school curriculum, their own teaching theory and individualistic interpretations of teaching methods and learning approaches (Kallivretaki, 2016; Theodorou, 2012a; Trapsioti, 2009). The findings of this study seem to support these interpretations. On the other hand, the majority of teachers indicated a number of obstacles in curriculum delivery and admitted that children's needs and school contextual constraints force them to adapt and modify it. Many reported partial compliance with the curriculum and declare that due to the conditions experienced in primary education they feel compelled to formulate their own program of studies.

Admittedly, a part of the misconceptions and misalignments identified in the present study may be related to teachers' lack of professional-pedagogical knowledge. Yet, the role of contextual factors and policy directives, which consistently ignore teachers' practical knowledge in combination with the absence of appropriate professional development opportunities, needs to be considered in this equation. Research suggests that teachers' practical knowledge may be perceived as a construct formed by three main constituents: (a) teachers' past experiences, (b) teachers' perceptions of the current teaching situation, and (c) teachers' vision of what teaching should be like (Duffee and Aikenhead, 1992; Elbaz, 1983). Our CS teachers' views, beliefs and implementation practices towards the Greek ICT Curriculum for Primary education, may be partly understood and interpreted through the lenses of these three landscapes of thought and experience.

CS teachers' past experiences in education and teaching may be directly associated with their ways of knowing and may be held responsible for the development of values, beliefs and rules of practice (Connelly and Clandinin, 1985). Their exceptional qualifications in Computer Science and Information Technology in combination with their lengthy experience in secondary schools and the shortage of professional-pedagogical knowledge, may be reflected in the difficulty to conceptualize literacy in ICT, the endorsement of programming coupled with the need to change the title of the ICT subject, the inability to understand curriculum design and content and the tendency to implement practices that are well known from secondary schools. The influence of these past experience projections in combination with the influence imposed by the expectations of the current teaching situation of primary education, appear to form teachers' instructional decisions. Requirements related to the official curriculum directions and constraints related to the primary school environment (limited teaching time, lack of appropriate equipment, young children's diverse abilities and needs and inadequate professional development), lead teachers to adopt an experiential and intuitive teaching profile, to develop their own definitions of both pedagogical and ICT related terms and to translate the 'intended' policy guidelines into an array of personally constructed differentiated practices which may range from simplistic skills acquisition to computer science concepts acquirement. Apparently, computer science perspectives towards the ICT subject are largely related to teachers' educational background and represent their vision of what teaching should be like in the primary subject, which in turn fuels decisions on instructional practice. Yet, for a significant number of other teachers having the same educational background their vision of the ideal course has been negotiated through the experience gained within the context of teaching primary school children. As a consequence of teaching the subject, teachers' new contextualized experiences interact with older constructs formed by their background knowledge (Dufee and Aikenhead, 1992; Arzi and White, 2008) to create different visions related to the tool or application-based perspectives which are perceived as more suitable for the primary school context. These visions are necessarily reflected on these teachers' classroom practices and motivate them to experiment with more active instructional approaches, such as forms of project teaching, game-like activities and formative assessment.

So where does this analysis lead us to and why is it important? Teachers' practical knowledge is a fundamental factor in the improvement of educational practice (Connelly et al, 1997; Ross & Chan, 2016). Teachers are not the mere executors of the programs of study, the guidelines and the materials that subject specialists and curriculum designers have developed far from the classroom. They are key stakeholders, who negotiate meaning and enact upon the official mandates through their personal, professional and educational frames of reference. Analysing these frames of reference and understanding the process and the ways in which they affect teachers' beliefs, instructional decisions and everyday classroom practices is of immense importance for the improvement of teaching and the identification of what education students receive. Through this kind of analysis adequate and more effective professional development opportunities can be designed, teacher recruitment practices may be better informed and enhanced, and educational policy may be planned in ways that involve teachers *"by working with them rather than on or against them"* (Clandinin, 1985:383). In this study for example, the authorities' decision to transfer computer science teachers with no pedagogical competence and without appropriate preparation and support from high schools to primary schools to do the job of a highly skilled educator was unfortunate; and unfortunate decisions involving teacher workforce are bound to cause confusion, misconceptions and necessarily misalignments of practice with the official policy guidelines, such as the ones described in this study and others (Barnes & Kennewell, 2017; Larke, 2019; Royal Society, 2017). On the other hand, policy decisions related to curriculum changes may end up in equally devastating outcomes, especially when these decisions are not ingrained in the reality of current classroom practice and do not consider teachers' practical knowledge, by involving them in the design and formulation of the intended changes. One may imagine what kinds of new misconceptions and misalignments may be raised by the replacement of the Greek ICT curriculum with the academically oriented, rigorous and significantly more demanding "Computer Science" primary curriculum (Drenoyianni, 2022). A glimpse of the possible outcomes may be traced in studies describing teachers' perceptions of computational thinking, the challenges entailed in the implementation of computing and the need for developing sound pedagogical and instructional approaches (Fessakis and Prantsoudi, 2019; Denny et al, 2019; Sentence and Csizmadia, 2017; Royal Society, 2017).

6. Conclusions

In conclusion, the findings of the present study argue for the importance of investigating teachers' practical knowledge through the analysis of their beliefs, perceptions and practices towards digital education. As it has been illustrated teachers' practical knowledge is largely neglected in policy reform discourses, yet it is a critical factor determining the size and the range of the gap between what policymakers design and what is realistically implemented in the classroom environment. Thus, any structural and curricular transformations envisaged at the policy level, need to be rooted in data from the classroom field and on teachers' beliefs, understandings and implementation of past and present policies, otherwise, they will carry within them the seeds of their own dismissal.

On the other hand, this study attempted to explore teachers' viewpoints through the adoption of a mixed methods design. Despite its many limitations, which are concerned with its non-representative samples, as well as the utilization of non-standardized research tools, it needs to be noted that the mixture of quantitative and qualitative data has advanced the process of understanding and interpreting findings. Bearing in mind that most of the research in this area is performed through survey methods, it is significant to indicate that the richness of the descriptions and the insight gained from qualitative data is necessary for the conceptualization of survey data.

Finally, the study's results support the idea that digital education in all of its curriculum forms and variations is an excessively demanding and perplexing endeavor. The qualifications needed on the part of educators seem among others to involve subject-specific knowledge requirements, exceptional pedagogical competences, broad knowledge on integrated curriculum design and transdisciplinary instruction. Beyond educators, considerable investments in resources and infrastructure, alignment of policy with school contextual constraints are needed, otherwise, it is difficult to see how any of the visions proposed at the policy level may be realized.

Funding statement
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Competing interests
The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval statement
All procedures performed in studies involving human participants were in accordance with the ethical standards of Aristotle University of Thessaloniki – School of Education. Informed consent was obtained from all individual participants involved in the study.

About the Author(s)
Dr. Helen Drenoyianni is Associate Professor at the Department of Primary Education, Aristotle University of Thessaloniki. She holds a PhD and an MEd from the School of Education, University of Birmingham and has received her BEd degree from the University of Athens. Her main research interests are concerned with ICT in education, digital literacy and critical pedagogy, educational policy, curriculum design and development, teacher education and professional development

Dr. Nikos Bekos is a member of the Centre of Pedagogical Research & Praxis (CPRP) at Aristotle University of Thessaloniki. He holds a PhD from the School of Education, Aristotle University of Thessaloniki, an MEd from the University of Manchester and a BEd from the Department of Physics at the University of Ioannina. His main research interests are concerned with digital literacy, computing education and the use of ICT in secondary education curricula.

References

Apple, M. W. (2017). Curricular form and the logic of technical control: building the possessive individual. In Apple, M. (Ed), *Cultural and economic reproduction in education* (pp. 247-274). London: Routledge. ISBN 9781315227252.

Apple, M. W., & Jungck, S. (1990). "You don't have to be a teacher to teach this unit:" Teaching, technology, and gender in the classroom. *American Educational Research Journal*, *27*(2), 227-251.

Arzi, H. J., & White, R. T. (2008). Change in teachers' knowledge of subject matter: A 17-year longitudinal study. *Science Education*, *92*(2), 221-251.

Barnes, J., & Kennewell, S. (2017). Investigating teacher perceptions of teaching ICT in Wales. *Education and Information Technologies*, *22*(5), 2485-2497.

Bekos, N. (2021). *Information and communication technologies (ICT) literacy in primary education*. Unpublished PhD Thesis, Aristotle University of Thessaloniki. Available at: https://www.didaktorika.gr/eadd/handle/10442/49718

Bottino, R. (2020). Schools and the digital challenge: Evolution and perspectives. *Education and Information Technologies*, *25*(3), 2241-2259.

Bryman, A. (2016). *Social research methods*. London: Oxford University Press.

Clandinin, D. J. & Connelly, F. M. (1992). The teacher as curriculum-maker. In Jackson, P.W. (Ed) *Handbook of research on curriculum: A project of the American Educational Research Association*, 363–401. New York: Macmillan.

Clandinin, D. J. (1985). Personal practical knowledge: A study of teachers' classroom images. *Curriculum inquiry*, *15*(4), 361-385.

Connelly, F. M. & Clandinin, D. J. (1988). *Teachers as curriculum planners: Narratives of experience*. New York: Teachers College Press.

Connelly, F. M., Clandinin, D. J., & He, M. F. (1997). Teachers' personal practical knowledge on the professional knowledge landscape. In *Teaching and teacher education*, *13*(7), 665-674.

Connelly, F. M. & Clandinin, D. J. (1985). Personal practical knowledge and modes of knowing: Relevance for teaching and learning. In Learning the ways of knowing. National Society for the Study of Education. Chicago: The University of Chicago Press.

Craig, C. J. (2011). Teacher professional development through a teacher-as-curriculum maker lens. In Proceedings of the 15th biennial of the international study association on teachers and teaching (ISATT), 'Back to the future: Legacies, continuities and changes in educational policy, practice and research', Braga (pp. 342– 352). University of Minho.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). Sage.

Daraviga, D. V. (2018). The views of Computer Science teachers (PE19-20) in primary and secondary education for pedagogical and didactic competence. (Master's Thesis, University of the Aegean). Available at: https://hellanicus.lib.aegean.gr/handle/11610/19003

Denny, P., Becker, B. A., Craig, M., Wilson, G., & Banaszkiewicz, P. (2019). Research this! Questions that computing educators most want computing education researchers to answer. In *Proceedings of the 2019 ACM conference on international computing education research* conference (ICER '19), *August 12–14, 2019, Toronto, ON, Canada.* ACM, New York, NY, USA, (pp. 259-267). https://doi.org/10.1145/3291279.3339402

Drenoyianni, E. (2022). The new Programs of Study: Comments and initial judgements in the education press – The case of the Primary Computer Science Curriculum. In the Proceedings of the conference *"Contemporary Trends and Developments in Education Sciences" of the Hellenic Education Society (HES)*, January 27th to 29th, Athens.

Drenoyianni, H. (2014). Conceptions or Misconceptions? The Greek ICT rationale through teachers' perceptions of and discussions about ICT in the primary school. In Grollios, G., Liambas, A., and Pavlidis, P. (Eds) *"Critical Education in the Era of Crisis" (pp. 207-249, Vol. 2).* Proceedings of the IV International Conference on Critical Education, Aristotle University of Thessaloniki - Faculty of Education.

Duffee, L., & Aikenhead, G. (1992). Curriculum change, student evaluation, and teacher practical knowledge. In *Science Education*, *76*(5), 493-506.

Elbaz, F. (1983). Teacher Thinking: A study of practical knowledge. New York: Nichols

Eurydice/European Commission/EACEA (2019). *Digital Education at School in Europe.* Eurydice Report. Luxembourg: Publications Office of the European Union.

Fessakis, G., & Karakiza, T. (2011). Pedagogical beliefs and attitudes of computer science teachers in Greece. In *Themes in Science & Technology Education*, *4*(2), 75-88.

Fessakis, G., & Prantsoudi, S. (2019). Computer Science Teachers' Perceptions, Beliefs and Attitudes on Computational Thinking in Greece. In *Informatics in Education*, *18*(2), 227-258.

Fluck, A., Webb, M., Cox, M., Angeli, C., Malyn-Smith, J., Voogt, J., & Zagami, J. (2016). Arguing for Computer Science in the School Curriculum. *Educational Technology & Society, 19* (3), 38–46.

Gehrke, N. J., Knapp, M. S., & Sirotnik, K. A. (1992). In search of the school curriculum. *Review of Research in Education*, *18*, 51–110.

Gogoulos, G., Nalmpandi, T., Panselinas, G. & Kolokotronis, D. (2011) Teaching ICT in Primary school: Computer science teachers' views who serve at All-day schools with EAEP curriculum. In the e-Proceedings of the 5th Panhellenic Conference of

Computer Science Teachers, April 2011, University of Ioannina. ISSN 1792-1511. Retrieved from: http://synedrio.pekap.gr/praktika/5o/pdkap.sch.gr/praktika/ergasies/30.pdf

ISTE (2016). ISTE Standards for Students. Retrieved from https://www.iste.org/standards/for-students

Jimoyiannis, A. (2011). The new programs of studies for ICT in compulsory education. Symposium conducted at the meeting of the New School Program of Studies and Its Pilot Implementation, Athens, Greece (in Greek). Ministry of Education and Religious Affairs. http://ebooks.edu.gr/ebooks/v2/ps.jsp

Kallivretaki, A. (2016) Primary – Secondary Computer Science teachers' views about the curriculum and their teaching approaches. (Master's Thesis, Hellenic Open University). Available at: https://apothesis.eap.gr/handle/repo/33306

Kordaki, M. and Komis, V. (2000). ICT teachers' perceptions about the nature of the subject and the way of its introduction in Education. Proceedings, 2nd Conference ICT "Information and Communication Technologies in Education" (pp.572-582). Patra, October 2000

Kyritsakas, E. (2008). The integration of ICT in the Greek school: The positions and the views of primary and secondary education syndicalists and the members of the scientific associations for the infusion of ICT in education: the official positions of syndicalist federations and scientific associations. (Master's Thesis, University of Thessaly). Available at: https://core.ac.uk/download/pdf/132805639.pdf

Larke, L. R. (2019). Agentic neglect: Teachers as gatekeepers of England's national computing curriculum. *British Journal of Educational Technology*, *50*(3), 1137-1150.

Liakopoulou, M. (2011). Teachers' pedagogical competence as a prerequisite for entering the profession. *European Journal of Education*, *46*(4), 474-488.

Lockwood, J., & Mooney, A. (2017). Computational Thinking in Education: Where does it fit? A systematic literary review. ArXiv preprint. Retrieved from https://doi.org/10.48550/arXiv.1703.07659

McFarlane, A. E. (2019). Devices and desires: Competing visions of a good education in the digital age. *British Journal of Educational Technology*, *50*(3), 1125-1136.

Michalakopoulos, C. A. (2021). Secondary and primary ICT teachers' points of view as regards the computing/informatics/computer science course in Greece: similarities and differences between regional units. (Master's Thesis, University of Thessaly). Available at: https://ir.lib.uth.gr/xmlui/

MoE - Ministry of Education and Religious Affairs. (2013). Decision on the number of teacher posts transferred from Secondary Education to Primary Education. Available at: http://dide.pre.sch.gr/portal/index.php/2012-01-20-00-16-41/mnu-aposp-metath/1313-metatajeis-2013

MoE - Ministry of Education. (2010). Operation of 800 primary schools with a unified, reformed curriculum. Ministerial Decision. Revised F.E.K. 3/609/60745/G1/28.06.2010, with F.E.K. 804/06.09.2010, F.E.K. 1048, B12-7-2010 with F.E.K.3/724/71442/G1/18-6-2010. Ministry of Education and Religious Affairs.

MoE - Ministry of Education. (2011). Programme of studies for ICT in primary education. Pedagogical Institute of Athens.

MoE - Ministry of Education. (2016). Organization and Operation of Kindergartens and Primary Schools. Presidential Decree 79/2017 – FEK 109/A/1-8-2017. Available at: https://dipe-v-ath.att.sch.gr/Aug2017/28/PD_NIP_DIM79%202017.pdf

Mpelesiotis, V., Kanidis, E., Karakiza, T., Ladias, A. & Nalmpandi, T. (2013) Panhellenic investigation for the ICT subject in All-day primary schools with EAEP curriculum. In the e-Proceedings of the 5th CIE2013 Conference on Informatics in Education, October 2013, Computer Science Department, University of Pireus. ISBN 978-960-6759-92-5 Available at: http://events.di.ionio.gr/cie/images/documents13/CIE2013_proceedings/data/cie2013_415.pdf

OECD. (2011). Education policy advice for Greece, strong performers and successful reformers in education. OECD Publishing. https://doi.org/10.1787/9789264119581-en

OECD. (2017). Education policy in Greece: A preliminary assessment. Organization for Economic Co-operation and Development Publishing.

Ottestad, G. & Gudmundsdottir, G. B. (2018) Information and Communication Technology Policy in Primary and Secondary Education in Europe. In J. Voogt et al. (eds.), Handbook of Information Technology in Primary and Secondary Education, Springer International Handbooks of Education, https://doi.org/10.1007/978-3-319-53803-7_92-1

Panselinas, G., Kolokotronis, D., Gogoulos, G., & Nalmpandi, T. (2015) Computer Science in All-day primary schools with Uniform-Reformed Educational program (EAEP): Investigation of the views and the experiences of computer science teachers. In Learning with Technologies, 1, 1-10. Retrieved from: https://mag.e-diktyo.eu/i-pliroforiki-sta-oloimera-dimotika-m/

Passey, D. (2017). Computer science (CS) in the compulsory education curriculum: Implications for future research. *Education and Information Technologies*, *22*(2), 421–443.

Piliouras, P., Simotas, K., Stamoulis, E., Fragaki, M., & Kartsiotis, T. (2010). Material for the training of computer science teachers who will teach at the 800 all-day primary schools with uniform, reformed school curriculum. Ministry of Education and Religious Affairs – OEPEK (In Greek).

Priestley, M., & Philippou, S. (2018). Curriculum making as social practice: Complex webs of enactment. *The Curriculum Journal*, 29(2), 151– 158.

Ross, V., & Chan, E. (2016). Personal practical knowledge of teacher educators. in J. Loughran & M.L. Hamilton (eds.), *International Handbook of Teacher Education* (pp.3-33). Springer, Singapore. DOI 10.1007/978-981-10-0369-1_1.

Royal Society. (2017). *After the reboot: Computing education in UK schools*. Issued: November 2017 DES4633 - ISBN: 978-1-78252-297-3. Retrieved March 2018 from https://royalsociety.org/topics-policy/projects/computing-education/

Sentance, S., & Csizmadia, A. (2017). Computing in the curriculum: Challenges and strategies from a teacher's perspective. In *Education and Information Technologies*, *22*(2), 469-495.

Stringer, L. R., Lee, K. M., Sturm, S., & Giacaman, N. (2022). A systematic review of primary school teachers' experiences with digital technologies curricula. *Education and Information Technologies*, 1-23. Retrieved from: https://doi.org/10.1007/s10639-022-11127-z

Stylianidou, F., G. Bagakis and D. Stamovlasis (2004), Attracting, developing and retaining effective teachers: Country background report for Greece. Athens, February 2004.

Terpeni, E., Georgiou, S., and Orovas, X. (2014) A review of Computer Science in Primary Education: Yesterday, Today, Tomorrow. Proceedings of the 8th Pan-Hellenic conference of Computing Teachers, Volos, 28-30 March 2014. Available at: http://synedrio.pekap.gr/sites/synedrio.pekap.gr/files/ergasies/1Terpeni3-full.pdf

Theodorou, A. (2012a). Research in the Didactics of Computer Science: A Critical Perspective. (Master's Thesis, University of Ioannina). Available at: https://olympias.lib.uoi.gr/jspui

Theodorou, D. (2012b). Exploring perceptions of Computer Science Teachers about the accomplishment of the principles of adults' education during the educational program "Training of Computer Science Teachers". (Master's Thesis, Hellenic Open University). Available at: https://apothesis.eap.gr/handle/repo/20068

Trapsioti, A. (2010). A year after the training: Computer science teachers' use of new knowledge and skills in the classroom. In the e-proceedings of the 2nd Conference of Imathia "Digital and Internet applications in education", April 2010, Veria. ISBN: 978-960-99301-0-9. Available at: https://www.ekped.gr/praktika10/plir/088.pdf

Tziafetas, K., Avgerinos, A., & Karakiza, T. (2013). Views of ICT Teachers about the Introduction of ICT in Primary Education in Greece. Turkish Online Journal of Educational Technology-TOJET, 12(1), 200-209.

Vanderlinde, R., & van Braak, J. (2011). A new ICT curriculum for primary education in Flanders: Defining and predicting teachers' perceptions of innovation attributes. *Journal of educational technology & Society*, *14*(2), 124-135.

Vloutis, D. (2018). The curriculum of ICT in primary education and its implementation framework. (Master's Thesis, University of the Aegean). Available at: https://hellanicus.lib.aegean.gr/handle/11610/21285

Vuorikari, R., Kluzer, S. and Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens, EUR 31006 EN, Publications Office of the European Union, Luxembourg. ISBN 978-92-76-48882-8, doi:10.2760/115376, JRC128415.

Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Sysło, M. M. (2017). Computer science in K-12 school curricula of the 2lst century: Why, what and when? *Education and Information Technologies*, *22*(2), 445-468.

Wickham, C. (2010). Historical transitions: A comparative approach. *The Medieval History Journal*, *13*(1), 1-21.