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THE DISCOURSE ON THE INTEGRATION OF ICT IN STEM EDUCATION: APPROACHES EXPRESSED IN TEXTS ON EDUCATION IN GREECE (1984-2006)

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Abstract:
The views on the integration of Information and Communication Technologies (ICT) in education move towards various approaches regarding the aims and/or the nature of computerization that could be adopted in the Greek curricula, during the period 1984-2006, in which the most important curricular reforms related to this integration were completed. By employing the methodological tool of Aviram & Tami, this research carries out a quantitative and qualitative analysis of texts published in the Greek scientific Journal "Contemporary Education" and studies the discourse formulated about the integration of ICT in Greek Science, Technology, Engineering and Mathematics (STEM) education. This analysis attempts to distinguish and "map" the different approaches expressed by the articles' authors on this integration. The research results revealed a strong tendency of Greek STEM education to attach primarily didactic and administrative approaches to ICT integration leading to micro level changes. It is quite interesting that – during the time period of this study - none of authors' approaches were adopted a systemic view, in the direction of extensive changes in the Greek educational system, in order to facilitate the integration of ICT in STEM education.

Keywords: ICT in Science, Technology, Engineering and Mathematics education, discourse, approaches in ICT

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1. Theoretical framework

The relatively recent integration of Information and Communication Technologies (ICT) in education leads to perceptions about technologies which determine teachers' attitudes and approaches towards them (Aviram & Tami, 2004), and the study of the attitudes towards the integration of ICTs in Greek Science, Technology, Engineering and Mathematics (STEM) education offers a mapping of certain general trends expressed by groups that influence ICT emerge education (Nikolakopoulou, Koustourakis, Komis & Ravanis, 2016). Aviram & Tami's framework (2004) could, also, offer a complete understanding of the general trends in the discourse on the integration of ICT in Greek STEM education coming from the approaches of groups, whose thinking and action influence educational applications.

Discourse according to Foucault's theoretical schema expresses the dominant view on an issue of social, scientific or educational interest, such as the utilization of ICTs in the pedagogical process for teaching school subjects (Willcocks, 2006). This discourse could be expressed by the social agents in both their oral and written texts (Foucault, 1978, 1991). The dominant view on an educational topic appears as "truth" guiding the educational reforms in sectors such as school knowledge and pedagogy (Foucault, 1972, 1978; Jones & Ball, 1994). In fact the discourse *"undergoes constant changes as new utterances are added to it"* (Foucault, 1991, p. 54). So various ideas on a specific topic are communicated and expressed by the agents who perform in the social, scientific and educational fields. Therefore it is important to pinpoint and analyse the diverse aspects of a topic that are released in the content of scientific journals with wide resonance among the teachers of primary and secondary education, such as the Greek journal "Contemporary Education" (Nikolakopoulou et al., 2016). Note that the specific teachers, who belong to the Pedagogical Recontextualizing Field (PRF) (Bernstein, 2000; Koustourakis & Panagiotakopoulos, 2010), are obliged to apply the educational reforms in the microlevel of their classrooms. The educational reforms in Greece that focus on the integration of ICTs in the educational process implement the decision of the European Union on education (Koustourakis, 2007). These changes in the area of school knowledge and pedagogy are shaped by the actions of the Greek Ministry of Education that belongs to the Official Recontextualizing Field (ORF) (Bernstein, 2000; Koustourakis, 2011). More specifically, for the integration of the ICTs in the educational process faculty members from the Departments of Education who came from the sector of the ICTs and pedagogy (Koustourakis & Panagiotakopoulos, 2008), and who belong to the PRF (Bernstein, 2000) participated, working in the ORF (Koustourakis, 2007). Thus, it is important to study the written statements of the PRF members in the articles that are published in the pages of scientific journals with wide resonance in educational circles, such as "Contemporary Education". Specifically, in these articles we can pinpoint "their attitudes" and "their approaches" to the integration of ICTs in Greek STEM education (Nikolakopoulou et al., 2016). An evident feature is that people tend to 'attribute meaning' to whatever they observe and experience, while according to

Aviram and Tami (2004), whatever their conception of *"what to change?"* with technology is, the same is expressed in the physical attitudes of *"how to change"* it. Moreover, the digital era is not going to disappear and the need for education to respond to the growing digital tide is rapidly increasing and becomes "*a forced choice….. – a decision we cannot avoid*" (Aviram & Eshet-Alkalai, 2006). Therefore, in this context, the "*approaches one adopts regarding the aims and/or the nature of the computerization of education"* are particularly interesting (Aviram & Tami, 2004), as expressed by the periodical scientific press, thus mapping the different views found in the development, use and change management of eLearning projects. In this case we have to study all the varied approaches that are expressed carefully, i.e. the general literature orientations which can be classified as follows:

(**a) ICT, Curriculum, Pedagogy and Teaching.** A variety of approaches are used for the development of eLearning projects showing that the pedagogical advantages of ICTs vary within specific contexts (Aaron, Dicks, Ives & Montgomery, 2004). ICTs offer new learning opportunities for the students ("eLearning"), develop the teacher's professional capabilities ("ePedagogy") and strengthen the institutional capacity ('eEducation') (Ezziane, 2007). If developed and implemented under an appropriate approach, ICT is beneficial for the teachers, students and education administrators although, effective integration of NTs in education is a "*complex, multifaceted process that involves not just technology…….. but also curriculum and pedagogy, institutional readiness, teacher competencies, and long-term financing….*" (Tinio, 2002, p. 3). It is said that the use of ICTs transforms the teacher's role from a "*sage on the stage*" into a "*guide on the side*", and the student has to change from being a passive content-receiver into an active-learner, a "*stakeholder in the learning process*" (Nawaz, 2014, p. 14). Moreover, Deaney, Ruthven & Henessy (2006, p. 459) examine teachers' "practical theories" concerning the contribution of ICT to the educational process in terms of five key themes: (a) broadening classroom resources and reference, (b) enhancing working processes and products, (c) fostering more independent pupil activity, (d) mediating subject thinking and learning and (e) improving pupil motivation towards lessons. Some researchers claim that classroom teachers tend to use technology "*by just adapting it to their pre-existing methods and practices, by simply using it to do what they have always done although in fact they often claim to have changed their practice*" (Cuban 2001, p. 6). So we found "*evidence of reshuffling the pack of cards, but little evidence of anybody trying a new game"* (Goodson, Knobel, Lankshear & Mangan 2002, p. 28), while, on the other hand, innovation and qualitative teaching upgrade seem to remain *"written on paper"*, especially in countries with a centralised curriculum and a corresponding lack of professional autonomy (Boilevin & Ravanis, 2007; Mabejane & Ravanis, 2018). However, it is important to note that "*technology itself is not likely to improve ineffective teaching practices*" (Tee & Lee, 2011, p. 101).

(b) ICT, Administrative and Organizational process. Successful integration of ICTs in educational settings is not automatic and depends on the management of changes demanded by the NTs (Aaron et al., 2004) as well as involving a consistent supply of resources. Williams et al. (2000) argue that mechanisms need to be put in place to ensure that teachers have adequate access to support whilst others indicated that using ICT allowed 'obvious and dramatic' changes in classroom organisation and management. Collins (1991, p. 19) points out that many people would argue that it is more useful to spend resources on the development of good educational software, teacher training or computer co-ordinators in order for technology to be effectively introduced into schools and he finally agrees that the presence of computers at school may gradually lead teachers and students to use them. Tondeur, Braak & Valcke (2007, p. 962) show that even the teachers "*mainly focus on the development of technical ICT skills"*. American studies conclude that the integration of technology by teachers also moves between "*new-progressive visions and organizational realities*" (Cuban, 1989, p. 217), whilst others discuss the access to technology and the availability of infrastructure to facilitate ICT use as the most important first steps even though there are numerous other important factors "*that come into play in the quality of people's access, such as education and training, language and literacy, bandwidth, hardware and software, and even Web design*" (Miller, 2001).

ICT-related change is the most critical issue for the contemporary educational institutions because this change not only determines the form of education but also its nature and future prospects for the coming generations (Aviram & Tami, 2004). For example, one of the most apparent organizational changes is the transformation of "blue-collar" employees into "white-collar" workers (Ezziane, 2007). Nowadays access to infrastructure is not a critical factor in eLearning (thereby filling the hardware-divide), but "*rather the access should empower the users to get knowledge, skills, and consistent support of organizational structures*" (Nawaz, 2014, p. 21). There are studies which reveal that ICT works well in some schools and hardly at all in others due to school factors (Baylor & Ritchie, 2002). As a step forward, school policies should define their organizational vision and actions more clearly in view of planned change (Senge, 2000). Moreover, ICT integration depends on *"school-related policies, such as an ICT plan, ICT support and ICT training which have a significant effect on class use of ICT. In addition, the findings from the interviews indicate that school policies are often underdeveloped and underutilized"* (Tondeur Keer, Braak & Valcke, 2008, p. 212). It is suggested that "*school culture, defined as "the basic assumptions, norms and values, as well as cultural artifacts that are shared by school members, which influence their functioning at school"* (Maslowski, 2001, p. 5) is an important consideration in terms of ICT integration. Other ICT-related school factors can also be connected to school improvement approaches besides the degree of ICT training (e.g. Tondeur et al., 2008, p. 214) and the ICT-related support, like the cooperation between-schools. The teachers' beliefs, which could affect ICT integration into the classroom (Goktas, Yildirim & Yildirim, 2009) have been "*a key area*" (Gao, Wong, Choy & Wu, 2010).

(c) The cultural process of ICT integration. When computers began to be used in education in the early 1980s, it was unclear how important they would be in our society. Of course, it is really difficult to assess the impact of ICTs on education, as education is a complex system of relationships, checks and balances. It is widely pointed out that this framework is not a neutral field, within which teaching and learning take place (Underwood & Dillon, 2004, p. 213). Some researchers emphasize ICTs' contribution to changing thinking, values, human culture (Kommers & Simmerling, 2008, p. 47) and consequently the way people learn. Aviram & Eshet-Alkalai (2006) focus on the digital literacy skills that are necessary for effective and mindful learning in the digital environments and believes that there is a choice which *"is not just between two categories of skills or literacies; it is rather a choice between two cultures, (a) one favouring rationality, continuity, criticism, abstract thinking, individuality, authenticity, systematic planning, and thinking; and (b) the other favouring fragmentation, spontaneity, concrete visual processing of knowledge, connectedness, reproduction, and branching associative thinking"*. They finally underline that *"logical-linear thinking is a necessary and maybe also sufficient condition for rationality, while branching thinking is only a "helpful condition"*. So, understanding the change depends on the way we focus our attention on culture rather than on the computer (Papert, 1987, p. 23). Bell (1973, p. 188-189) talks about technocracy and draws attention to the fact that "*technological progress has poisonous effects"*.

(d) ICT integration in STEM education. A series of studies highlight the potential for ICT to be used in the teaching process, notably in STEM education (Mathematics, Natural Sciences, etc.) as cognitive or mental tools, in order to support cognitive processes (Davis et al., 1997). The National Council of Teachers of Mathematics (2000) provides descriptive insights into how technology could be incorporated into mathematics teaching, as it provides visual images of mathematical ideas, facilitates the organization and analysis of data, and calculates efficiently and accurately. It can support research by students in geometry, statistics, algebra, counting and numbering which permits students to focus on decision making, reflection, justification, and problem solving. Thus, students save valuable time to engage in in-depth study of learning contents as well as in problem-solving strategies. Educational software promotes and implements model-based teaching, since its major teaching applications are representations of scientific models and model-based activities. By using models, the students can solve complex problems as autonomous workers, and the teacher acquires the role of mentor, while at the same time he can better understand the problems his students face (Ergazaki, Zogza & Komis, 2007; Vorvilas, Karalis & Ravanis, 2011; Ntalakoura & Ravanis, 2014; Tzavara & Komis, 2015). Modelling also reveals learning difficulties, while at the same time enhancing learning, especially when students themselves are model makers (Ravanis, 2005; Kampeza & Ravanis, 2009). A determinant goal of modelling is *"the construction of meaningful understanding and the challenge of conceptual change"* (Jimoyiannis & Siorenta, 2007, p. 244). Students learn so by using already existing models, but mainly by building their own models. It is

believed that improving problem solving capacity is a key objective of modern educational systems and a framework for integrating ICT into education based on computational modelling environments (Dimitracopoulou & Komis, 2005).

Aviram & Tami (2004) recognise as *"approach"* in the discourse on the integration of ICTs into education, the approach "*one adopts regarding the aims and/or the nature of the computerization of education*" and as analysing approaches to ICT in education, they distinguish seven categories:

1. Administrative approach, perceives the sheer existence of technology as progress and as an important aim, and focuses on the quantity and quality of equipment but not on any other possible aim.

2. Curricular approach stems from the conception of technology as serving some specific curricular aim and distinguishes between two forms: (a) The *disciplinary form,* in which ICT is an important tool, a separate subject matter required, which is usually taught in computer labs. (b) The *integrative form* in which ICT is an integral part of the prevailing curriculum, and it is made to take advantage of the teaching/learning of the current curricular subjects.

3. Didactic approach stems from the conception that ICTs can lead to the introduction of new didactic or teaching/learning methods like active, research-oriented, or constructivist methods.

4. Organizational approach is based on the understanding that the introduction of ICT in schools should involve organizational changes in school, consisting of more flexible attitudes to time, place, authority, roles and curriculum.

5. Systemic approach maintains that the merging of ICT and education requires organizational changes on the level of the whole system – in the direction of more distance-learning, virtual schooling, changing the attitude towards time, place, curriculum, on a systemic level.

6. Cultural approach stems from the recognition that the ICT revolution is a deep cultural revolution changing our lives and bound to lead to deep changes in education.

7. Ideological approach starts from basic values that are perceived to be the most basic social and educational aims, judges the social cultural and educational situation in their light and strives to fulfil them through the educational process.

The present research aims at the investigation of the authors' approaches in research and theoretical texts, which come from the PRF and the Greek university scientific press between 1984-2006, relating to the aims and/or the nature of the computerization of Greek STEM education.

2. Research Question and Methodology

In this research we will focus on the description of the authors' approaches, in order to answer the following research question: what are the changes in the shaping of the discourse on the incorporation of ICTs in Greek STEM education, with regard to the integration objectives, during the time period we focus our interest on?

The scientific journal "Contemporary Education" the content of which our research is focused on, belongs to the PRF (Bernstein, 2000; Nikolakopoulou et al., 2016) and publishes articles whose authors belong to the PRF as well, presenting a variety of approaches on the integration of ICTs in STEM education in the Greek schools of Primary and Secondary Education. So, studying the content of the specific articles we can pinpoint the effective statements that constitute the dominant discourse that expresses the "truth" (Foucault, 1972, 1978, 1991) on the incorporation of ICTs in the STEM educational process.

This research focuses on texts published in the pages of the journal "Contemporary Education" between 1984 (the start of the integration of ICT in Greek education) and 2006 (a period during which a wide relevant European Union Community Support Framework program was implemented in Greece). The qualitative and quantitative Content Analysis was performed and the "theme" used as a unit of analysis for data recording and the 'article' used as context unit, because the approaches of the articles' authors on ICTs in STEM education were sought across the whole article (Kripendorff, 2004). The articles were analysed with the digital software Nvivo 8. The units of analysis were classified according to one of the following seven categories of analysis, which emerge from Aviram & Tami's (2004) theoretical schema revealing the authors' approaches to ICTs: (a) Administrative approach, (b) Curricular approach, (c) Didactic approach, (d) Organizational approach, (e) Systemic approach, (f) Cultural approach, (g) Ideological approach.

3. Results

The ICTs in STEM education were highlighted in the content of 97 articles released in the pages of the journal "Contemporary Education" during the period 1984-2006, representing all the possible approaches to the specific topic. These findings reveal both the changes in the discourse on ICTs in education and the variety of aspects that comprise its "truth" (Foucault, 1978). In our analysis we distinguished 3 groups of authors, who all come from the PRF and focus their interest on ICT (Bernstein, 2000; Koustourakis & Panagiotakopoulos, 2008, 2010). They are: (a) faculty members in Greek Universities, who chiefly approach the issue through research, (b) teachers specialised in STEM Education and (c) teachers specialised in Social Sciences and Humanities. Next we will present the results of the content analysis on the approaches towards ICT as they are expressed in the articles, as much from a quantitative as from a qualitative perspective.

3.1. The quantitative perspective

In the content of the 97 articles published in the journal "Contemporary Education" 1206 references to authors' approaches to the integration of ICTs in Greek STEM Education are pinpointed. As Table 1 shows, the majority of the authors adopt a didactic approach (35%), while those who adopt administrative approaches follow with a high percentage

too (26.8%). A satisfactory number of authors (19.6%) have ideological approaches to the integration of ICT in STEM education, whilst curricular and cultural approaches are adopted to an equal extent (8.25%). Organizational approaches are rarely adopted (2.1%). The fact that the systemic approaches as well as related references are non-existent is remarkable and expresses a strong absence of views on any changes at the level of the Greek educational system, something which is to be expected, as the attitudes of the authors' are at most conservative and agnostic (Nikolakopoulou et al., 2016).

Table 1: Scientific articles and references by approach to ICT category

	Approaches in the authors' discourse						
	Admini-strative	**Curricu-lar**	**Didactic**	**Organi-zational**	**Cultural**	**Ideolo-gical**	
Articles	26 (26.80%)	8 (8.25%)	34 (35.05%)	2 (2.06%)	8 (8.25%)	19 (19.59%)	97 (100%)
References	304 (25.21%)	55 (4.56%)	559 (46.35%)	32 (2.65%)	103 (8.54%)	153 (12.69%)	1206 (100%)

* "Systemic" approaches were not found

Table 2 illustrates the correlation between the authors' specialisation and the opinions expressed through the content of the scientific journal, and it follows that those are mainly moving within the framework of a didactic approach to integrating ICT into Greek education and as formulated primarily by science teachers and some humanities teachers, whilst an ideological approach "discourse" is mainly formulated by a significant number of University members. It also emerged that the curricular approach is mainly supported by a minority of STEM teachers.

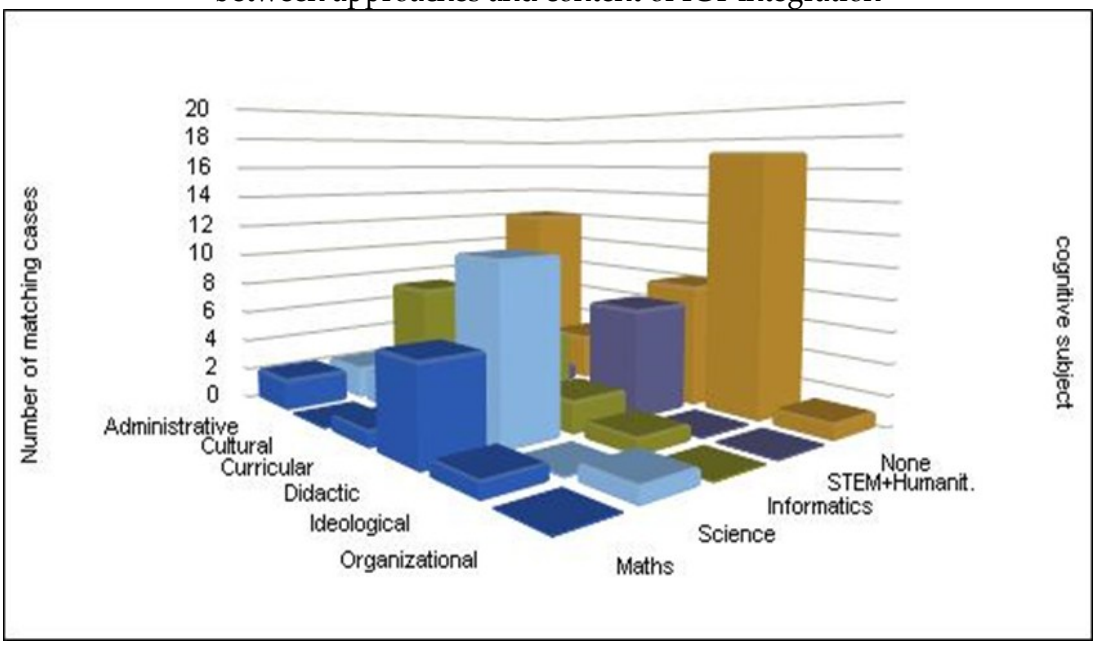
Table 2: Correlation between approaches and scientific specialisation of authors in their writings on the integration of ICTs in STEM education

Approaches in the authors' articles	**Authors' specialisation**			F
	University Member	Teacher in STEM Education	Teacher in Social Sciences and Humanities	
Administrative	7	15	4	26
Curricular	0	7	1	8
Didactic	5	23	6	34
Organizational	1	0	1	2
Systemic	0	0	0	0
Cultural	2	4	2	8
Ideological	10	9	0	19
Total	25	58	14	97

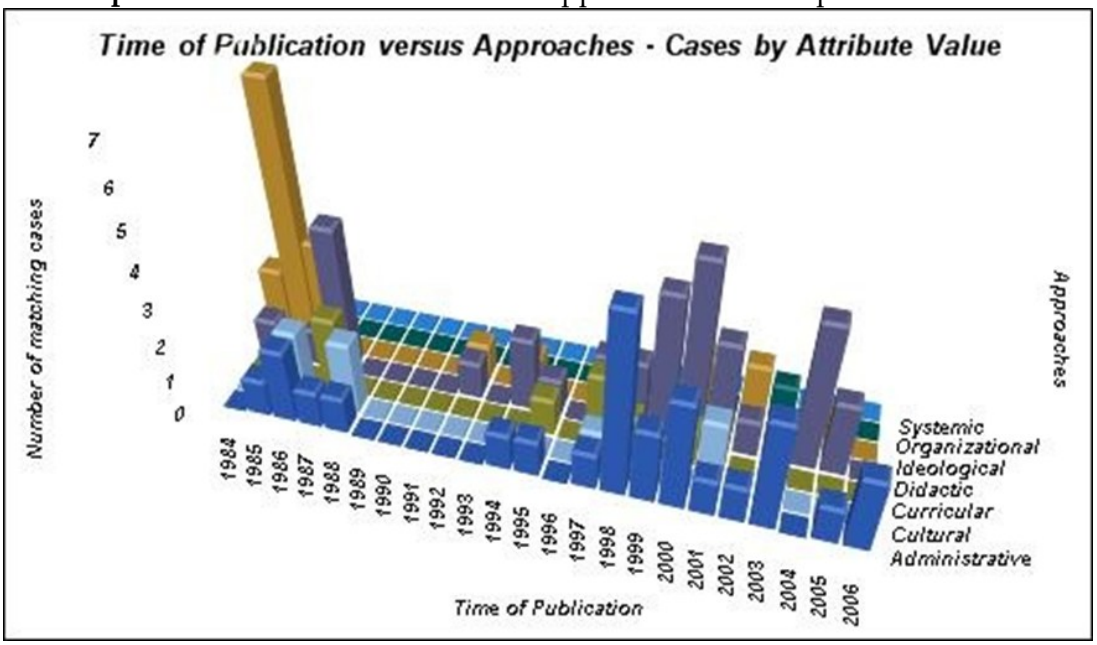
The above findings suggest a clear correlation between the authors' specialization, their approach and according to Bernstein's (1991, 2000) theory the orientation code, which is adopted in the author's texts. As Bernstein (2003, p. 18) argues *"different locations generate different interactional practices, which realize different relations to the material base and so different coding orientations"*. Therefore, it is expected that different authors' locations in the division of labour and pedagogy in the educational field (e.g. teachers in Primary or Secondary Education – University faculty members) will generate different orientations to meanings when drafting their texts and hence the expression of various and different approaches. From this point of view, a school teacher who works in Primary or Secondary Education, moves within a pedagogical and teaching labour orientation that regulates the interactional practices in the microlevel of their school classes and therefore their writings on the integration of ICT in didactics and in daily school practices may be aimed at renewal. Moreover, the university faculty members' gravity is within a more complex division of labour, which regulates practices in relation to a generalized material basis - which includes the overall division of scientific work and research activities in their scientific field - and therefore they may choose to write on wider interest subjects and so they could usually follow a more ideological approach to the issue.

From Graph 1, it is concluded that there is an absence of a link between the inclusion of ICT and a specific cognitive subject, which is mainly reflected in the articles of the ideological approach (90% of its texts), a large number of the authors of which are university faculty members and the content of their texts (according to Bernstein's analysis above) is expected to be more general and non-specific.

Graph 1: Graphic depiction of the correlation between approaches and content of ICT integration



Graph 2: The distribution of authors' approaches over the period 1984-2006



Graph 2, shows a significant tendency towards *didactic* and *administrative* approaches respectively during the periods 1984-87 and 1985-88. An increase in the trend towards these approaches in the writings is also observed in 1994-2006. Additionally, in the period 1984-86, it is observed that there is a proportionally higher trend amongst authors to adopt the *ideological* approach for integrating ICT into the educational context and STEM education, as in this period 63.2% of all texts were published, with a peak in 1985, probably because the issue of computer integration in education between 1984 and 1987 is a major Greek, European and international topic of discussion. Throughout the period of 1984-2006, a sporadic and random presence of a textual *cultural* approach is found. The authors' interest is revived in 1993-1994, with the first proposals in favour of the formal and universal introduction of ICT into Greek education in 1992-93. In the period 1994-2006, the increasing trend, in intensity as well as in duration, in the authors' writings for *administrative* and *didactic* approaches, which reaches a peak in 2000, is probably related to the international emphasis on ICT and the technological literacy of students and citizens.

3.2. The qualitative perspective

The articles in which the ***didactic approach*** was dominant were based on four main assumptions**:**

1) ICTs can be exploited to support children's learning because they *"facilitate active learning"* (Makridou-Bousiou & Tsopoglou, 2001, p. 128), and they allow them to *"develop different processes of understanding*" (Antoniou-Kritikou, 1998, p. 87) *"to check cases... to discover / confirm laws"* (Nikolopoulou, 2000, p. 121). Furthermore, they create a new *"authentic learning environment"* (Karaminas, 2001, p. 77), which includes *"open environments"*, *"virtual workshops"* (Jimoyiannis et al., 1995, p. 121) *"exploratory learning... where students learn to work collectively"* (Karaminas, 2001, p. 77). They assure learning

where *"the student works on his own at his own pace and receives direct feedback on his answers"* (Sentele & Pagge, 2002, p. 119) and through links with the *"pre-existing knowledge"* and *"the framework of everyday life"* (real world), thanks to the possibility of introducing the student *"into a virtual world... and direct interaction with the objects"* (Bakas, 2005, p. 149), they contribute to learning taking place where *"the student's exploration discovers inconsistencies between the existing representation of the knowledge and his experience*" (Tsolakidis & Fokidis, 2004, p. 121).

2) They enhance the presentation of the content of children's learning: (a) through visualization, modelling and simulation, where, *"as Levi, P. emphasizes,"the synthetic image helps to perceive abstract models of natural phenomena... processes that could only be intellectually perceptible, understandable through a crude decoding work... today they emerge directly in the apparent sensible world thanks to the virtues of digital images"* (Komis, 1997b, p. 55), (b) through the *"use of multiple representations of mathematical concepts... they help to put the abstract into practice"* (Stylianou & Meletiou-Mavrotheri, 2003, p. 56).

3) By incorporating ICTs, the student-teacher communication relationships change, *"their degree of involvement changes"* (Stylianou & Meletiou-Mavrotheri, 2003, p. 56). *"The teacher becomes an instructor"* (Antoniou-Kritikou, 1998, p. 88), *"and coordinator of the pupils' learning activities"* (Jimoyiannis, 1998, p. 111), *"to mediators"* (Pedagogical Institute, in Karaminas, 2001, p. 84), understanding that *"even the teacher is a student too"* (Vlontaki, 1987, p. 92).

4) They adopt two categories of views about the reasons for ICT emerging education. The first one refers to the benefits of integrating ICT into education itself, *"... they can contribute to a more efficient management of educational processes, and ... to the process of learning in several areas of knowledge"* (Makridou-Bousiou & Tsopoglou, 2001, p. 126). In the second category of reasons for incorporating ICT into the educational context and teaching of science, common justifications are, for example, preparing students for *"tomorrow"* (Chourmousiadis 1986, p. 81; Michaelidis, 1994, p. 64) *"if they prepare their young members"* (Michaelidis, 1994, p. 62), for *"their educational, social and professional development"* (Michaelidis, 1997, p. 71), all of which demonstrate the modern necessity of developing digital competences and harmonizing people with the *"knowledge society"* and thus developing the pupils' *"prospective"* identities, so that there will be sufficient *"future workers"* in the *"existing intense economic competition in the world"*, something which conceals a plan for subordinating school to market needs (Apple, 2001, p. 53).

The emphasis on the ***administrative approach*** is based on the following four fundamental assumptions**:**

1) The depiction of the *"existing state of informatics and the application of new technologies... in terms of: mechanical equipment ... human resources ... more general infrastructure of schools ..."* (Tsolakidis, 1998, p. 89), the acquisition and expenditure of equipment for informatics, *"registering and exploring the technical and ergonomic characteristics of the workshops in schools ... the technical characteristics of the equipment (hardware and software)"* (Jimoyiannis & Theodorou, 2000, p. 33), as well as the informatics laboratories e.g. *"the relative position of the monitors... ergonomic design and layout of work of computers..."*

(Marmaras & Poulakakis, 1999, p. 110), are issues raised in the context of the developing debate.

2) Topics of discussion for the authors of the administrative approach are also *"the equipping of schools with computers, the use of computers, the teaching of informatics ... the perspectives of teaching informatics"* (Tsolakidis, 1998, p. 91), "*the investigation of the degree of anxiety, fear or threat"* (Koustourakis et al., 2000, p. 5) and "*pedagogical training in the use of appropriate educational software"* (Jimoyiannis, 2002, p. 61), *"drawing up a plan for the use of computers and the organization of the staff that will work with them"* (Bairaktaris, 1985, p. 94), *"the development-exploration of attitudes, reactions to ICT"* (Tsolakidis, 1998, p. 95) with the aim of strengthening the feeling of *"self-sufficiency in the use of the computer"* (Konidari, 2005, p. 153).

3) The authors also focus on the development and design of educational software/ teaching material, its technical characteristics and its evaluation, on the *"short presentation of some programs"* (Gasparakis, 1987, p. 97), the *"designing of educational software"* Dimitrakopoulou, 1998, p. 116), the *"best quality of educational programs used*", on the search for the reasons for the *"lack of valuable educational software"* and on *"providing opportunities for developing appropriate software"* (Baourakis, 1998, p. 99).

4) Matters of general discussion are the utilization and organization of computers eg *"a central executive body that is the" Computer Training Center"... it has to be staffed by teachers... trained in computer matters... it supplies and distributes the hardware, it procures, produces and distributes the software"* (Bairaktaris, 1985, p. 95), but also the users' and use issues, e.g. *"children... to get information... to create works"* (Kotopoulis, 2006, p. 147), *"used for administrative support... of the director*" (Tsolakidis, 1998, p. 94).

The authors who adopt ***ideological approaches*** for the integration of ICTs, critically and sceptically approach (i) technology - technocracy, (ii) society and (iii) education. In this context, the following topics are discussed:

1) The prevalence of "*technocratism"* (Milios, 1985, p. 65), concluding that *"technocracy" constitutes the dominant "moment of ideology... the social progress" and..." the end of ideologies"* (Noutsos, 1985, p. 55). They identify the *"shift of the center of sovereign ideology from the "needs of the individual"... to the "needs of the economy and society"* (Milios, 1985, p. 62) and therefore the function of education within the economy.

2) They deconstruct characteristics of the "Knowledge Society", the way in which *"lack, use or abuse... create... inequality issues*" (Kyridis & Drosos, 2000, p. 49) and a "*generation of* new-poor *and electronically illiterate"* (Chronopoulou & Giannopoulos, 2000, p. 8). They are sceptical about every reference "to the" Information Society "*that... will ultimately subordinate the social functions to the full control of the central authority*" (Chronopoulou & Giannopoulos, 2002, p. 49), revealing the underlying dimension of the social control exercised in every aspect of human life in order to ensure the "flexible adaptability... of the information society... *which is an essential requirement of the profitability of capital in the present stage of the development of capitalist production*" (Chasapis, 2000, p. 54).

3) The authors reveal that the integration of ICTs into the educational context promotes the *"systematic and organized supervision of the content of studies"* (Drenogianni & Kaskalis,

2005, p. 160) and the *"crushing control over methods and teaching subjects"* (Filippou, 1986, p. 86), the transfer of "*instrumental"* and not humanitarian knowledge *"through the development of SOFTWARE under central state control"* (Filippou, 1986, p. 86). They disclose that ICTs lead to cultural uniformity, as they *"promote a massive ego, a mass consciousness, assimilation and dissolution of the person in an impersonal system of values, beliefs, behaviours"* (Michalakopoulos, 1984, p. 21). They finally conclude that ICTs' inclusion in education *"is not such a simple, colourless, neutral and non-political affair"* (Raptis, 1994, p. 14).

In the thinking of the authors who adopt ***cultural approaches***, the following fundamental arguments prevail:

1) With the incorporation of ICTs, a new "communication society" is created that brings about the *"overthrowing of existing ideas, spiritual values and principles and the imposing of new ones*" (Dapontes et al., 1986a, p. 70) as well as *"a kind of 'reality-based' tunnelling"* (1986a, p. 72). It changes men's cultural environment, the nature of work, *"ultimately affecting even the structure of the family"* (1986b, p. 71).

2) The ICTs raise concerns that *"it is possible for our structures, our organization, even our intellect, inherited from a very different past, to be poorly adapted"* (Ziamos, 1988, p. 104). ICTs change our lives, "stirring" in new non-linear ways *"the particular mechanisms of thought and expression"* (Komis, 1997a, p. 31) and there is scepticism as to whether they will bring *"more freedom to the movement of thought"* (1997a, p. 31).

3) The importance of the efficiency and effectiveness of integrating ICT into education is critical to the authors of the cultural approach, and they argue that *"Media is not the starting point for change but its purposes are"* (Euler, 2003a, p. 5). They judge the prevailing perception of progress because *"an aesthetically, politically or environmentally degenerated society, is not a progressive society, no matter how ... technically equipped it is"* (Dapontes et al., 1986b, p. 71).

The ***curriculum approach*** is adopted by the authors in the form of two supplementary sub-approaches:

1) The Disciplinary Form. The introduction of Informatics as a discipline is based on a discussion about:

1a) the need for the acquisition of technology literacy: *"the course finally focuses on the learning of some" packages"... the management of Accounting Sheets ... Databases"* (Zamanis, 1997, p. 76), *"to get in touch with a variety of educational software"* (Drosos & Kyridis, 2000, p. 16).

1b) the necessity of a *"special pedagogy and teaching"* of Informatics (Efstathopoulos, 1987, p. 81-82), as a *"science at birth"*, as Daglilelis (1987, p. 74) has characteristically mentioned.

2) The Integrative Form: The introduction of ICTs as a teaching tool in order to teach other cognitive subjects is discussed as follows:

2a) as a teaching tool to teach other cognitive subjects and is focused on the teaching of STEM and in particular on *"investigating the effectiveness of N.T. as a means of teaching in mathematics" (*Mavridou, 1995, p. 12), in *"Physics, Chemistry, Informatics and Technology*

teaching" (Arpajanis 1997, p. 198), and "as *an educational tool for the teaching of other subjects (Mathematics, Physics, Language, Environmental Education, Technology)"* (Jimoyiannis, 1998, p. 111).

2b) The authors' references to the integration of new technologies into the educational "process" (Jimoyiannis, 1998, p. 112) and the investigation of their *"efficacy"* as a teaching tool even in students' *"performance" seem quite interesting.*

The small percentage of authors adopting ***organizational approaches*** in texts on the integration of ICTs in education is based on issues concerning:

1) The critical attitude of the authors towards the aim and objectives of Science education, which is *"Scientific and Technological Literacy for All"*, to *"respond in the best possible way to the requirements of modern life"* (Karidas & Koumaras, 2002, p. 103) and the need for objectives on a *"crisis capacity method and social crisis capacity... to construct self-organized tasks... to obtain the required information ... teamwork of solidarity"* (Euler, 2003b, p. 125).

2) Authors suggest changes in the organization and management of education, the classroom and learning e.g. the *"organization of learning in 45-minute time frames and fragmented branches"* (Euler, 2003b, p. 125), whilst it is considered necessary for them to "*redevelop schools (traditional classrooms and laboratories)"* (Karidas & Koumaras, 2002, p. 115).

3) The path to alternative innovative learning processes, e.g. *"learning-on-demand" "just-in-time"* and *"evaluation"* (Euler, 2003b, p. 125), in forms of co-operation, interdisciplinary approach, *"the scientifically relevant approach to research, a cross-thematic approach*" (Karidas & Koumaras, 2002, p. 113), the technically involved communication of the learner with other persons in the Networks where *"he/she moves more or less anonymously... free from penalties, ...may lead to different influences on those who communicate*" (Euler, 2003b, p. 130).

4. Discussion and Conclusion

In this article we endeavoured to investigate the discourse on ICTs in Greek STEM education as expressed by the agents of the PRF (University faculty members and teachers from the realm of sciences and humanities) (Bernstein, 2000; Koustourakis & Panagiotakopoulos, 2010) published in the journal *"Contemporary Education"* during the period 1984-2006. The specific Greek scientific journal permeated the field of Primary and Secondary Education teachers thus contributing to the dissemination of ideas on the particular subject.

The research findings revealed a discontinuity between the discourses on ICT integration in Greek STEM Education (Foucault, 1978) on the grounds that there are six different approaches to the specific topic. Moreover, the didactic and the administrative approaches to the integration of ICT into education hold the most prominent position among the several approaches.

The emergence of the ***didactic approach as a dominant approach*** to the integration of ICT into Greek education has a rather multifaceted interpretation. The promising improvement in the teaching and learning process and the lifting of the stagnation that exists in the form of Greek education, with the integration of ICTs, as well as the fact that the authors of the texts - the majority of them STEMs teachers - "have the potential" to access, develop initiatives, and formulate relevant "discourse" and action, are all attractive and important data. In addition, changes in teaching and learning methods and the inclusion of ICT in "didactics" are a rather *"inexpensive field"* of ICT integration in STEM education, which may be "promoted" by the official education policy, in the context of its convergence with the corresponding European policy, as it does not really threaten the purposes and content of education.

The authors of the didactic approach highlight multiple goals in integrating ICT into the educational context and science teaching, i.e. (a) the shift from learning as an externally guided to learning as a self-regulating process (b) Improving the presentation of the content of children's learning through the visualization, simulation and modelling of phenomena, processes, etc., the emergence of new student-centred exploratory, cooperative and evolving environments (c) Shifting towards a more democratic communication framework, in which the teacher works as a mediator and towards a symmetrical teacher-pupil communication relationship. The didactic approach authors propose the integration of ICT in the teaching of science, in particular in Physics and Mathematics, according to findings of other researchers too, since computers are traditionally considered to be related to these sciences (Jimoyiannis & Komis, 2007).

Remaining within a *"collection code"*, i.e. a curriculum containing distinct subjects (Bernstein, 1991, 2000) is proposed, and is expected of the authors with mainly conservative attitudes to ICT integration (Nikolakopoulou et al., 2016), who have "strongly committed" identities regarding the specific subjects they teach and their possible transition to an integrated code can trouble them and / or "frighten" them, as much as the creation of new "recognition rules" that this entails, and which are most likely unknown to teachers and students. We come to the conclusion that *"it is possible for the culture of computing to colonise some areas of the curriculum. In most areas, however, the antecedent subject subculture in effect colonizes the computer and uses it to teach the existing subject in the existing way. In the face of established practice, the computer becomes just "another tool""* (Goodson et al., 2002, p. 28).

It is important that they adopt -to a large extent- the ***administrative approach*** in order to ensure the appropriate infrastructure (physical and human) for the integration of ICT in education, perhaps because they believe that *"increasing the quantity and quality of resources will also have an impact on teachers' perceptions of computer use in education*" (Twining, 2002, p. 35), as quite often *"changes in behaviour precede rather than follow changes in faith"* (Fullan, 1992, p. 128). It appears that at the beginning of the educational change, it was widely accepted that since the teachers had access to material and education, ICT integration into the classroom would follow (Fisher, Dwyer & Yuan,

1996) and so in the initial period 1997-2000, authors widely adopted administrative approaches.

In the administrative and didactic approach of some authors, as well as the curriculum approach of others, there is *an inclusion of a "dominant" optimistic, techno-centric argument* for the integration of ICT in STEM education, according to which the computer component by definition constitutes progress, something "good" which due to the fact that it *"quickly conquers the world… schools cannot ignore it*".

Significantly fewer authors develop a deconstructive and sceptical discourse, i.e. an ***ideological approach*** orientated towards philosophical or critical social thinking, with regard to the crucial role of new technologies in controlling education and learning (content, methods, etc.) as well as the orientation of individuals, their behaviour and choices. They underline the ongoing mediation as a result of new ways of producing and transmitting knowledge and its implications for human life and education, thus revealing the "panopticism" of ICT and their contribution to the "homogenization" of the human personality (hybridization). Aviram (1993) notes the necessity of an ideological perspective ... as a critique and evaluation.

The "discourse" on the integration of ICT in the educational context reveals how rarely authors express their *opinions about the curriculum and the adoption of a* ***curriculum approach,*** which highlights the fact that they hold a latent belief that this field belongs to "*state authority*", to the bodies of the ORF (Bernstein, 2000). Hennessy, Ruthven & Brindley (2005 p. 157) clarify that "*classroom teachers have historically had little to say ... for using ICT within their schools, and for defining their role within the subject curricula. This is especially true in countries with a centralized curriculum and a corresponding lack of professional autonomy*".

When the authors *formulate objectives about ICT integration in the curriculum, these take two forms*: (a) ***the disciplinary form*** that addresses the development goals of the students' technological literacy and the specific didactic of informatics and (b) ***the integrative form***, that informatics is a tool for teaching other subjects and particularly science. The inclusion of ICT in the educational context in the same forms is also highlighted by other scientists (Aviram & Tami, 2004).

The ***cultural approach****, though equally as rare as the curriculum approach, is of particular interest* as other authors find that ICTs create a *"defining environment that modifies the nature of organizations, societies and individuals living in it"* (Aviram, 2000, p. 342), and bring about changes in ideas, values and principles, in the way people live and think, in the conception and transmission of "knowledge". In the light of the cultural approach, they also judge the concepts of 'effectiveness', of "efficiency" of ICT integration in education, of "progress", which a priori was considered to be beneficial to the individual and they highlighted the "non-neutrality" of technology that changes our lives and our culture.

Besides stressing the importance which is attributed internationally to changes in the level of the school for ICT integration, *our study reveals the insignificant appearance of* ***organizational approaches***. Very few authors refer to the rigid space and time

structures of the Greek school or note the need for their re-examination. It seems that the Greek school will probably also inhibit the successful integration of ICT in the learning and educational process through its defined "cellular organization", i.e. the existence of strict timetables and boundaries between classes and departments (rigorous space and time constraints), which do not facilitate access to and interaction of ideas and factors in the learning process (teachers and pupils), but significantly reduce their connexion within education and among the participants in education (Cuban, 2001). Aviram (2000, p. 338), with *"rigid loco centricity"* describes *"the unconditional dominance of the principle of unity of time and place in the school"*. In our opinion, the widespread absence of interest from the authors of the texts in organizational changes reflects a *"latent"* tendency to accept the organization of schools *"as it is"*, probably due to the *"centralization"* of Greek education and the authors' dominant conservative attitude to ICT integration (Nikolakopoulou et al., 2016). The teachers' focus on the micro level of the classroom, on the teaching and their lessons, as well as the usual absence of *"communities of practice"*, where issues could be raised more widely beyond the "fixed interests" of the Greek teachers, which are ultimately focused on their students, their teaching and their class, contributes to this. It is stated that *"a radical breaking of the organizational "glass ceiling" (i.e. school's modern organizational structure) is now preventing the true adaptation of education to postmodernity"* (Aviram, 2000, p. 338),

Finally, our study reveals the *total absence of a* ***systemic approach*** among the authors of the studied texts, as is to be expected and it follows from the above, since the adoption of change objectives at the level of the educational system *«in the direction of allowing more distance-learning or even virtual schooling, thus changing the attitude towards time, place, curriculum and other connected attributes of the system on a systemic level»* (Aviram & Tami, 2004, p. 4-8) does not become a feasible option for the Greek social and structural-functionalist educational reality and therefore for the developing discourse.

This research highlighted the goals of university members and teachers for the integration of ICT into education as reflected in their texts between 1984 and 2006. As in the case of the study of the authors' attitudes (Nikolakopoulou et al., 2016), this implies the study of the possible influence of similar perceptions on the political-educational choices made both during that time and in the subsequent years up until today. It also allows for the study of possible changes in relevant texts today, and thus helps us to assess the weight of the experience of any such application in the approaches of current researchers and teachers. In conclusion, with the completion of the mapping of all of the approaches and attitudes of the authors, as envisaged in the framework of Aviram & Tami (2004), i.e. the views about the aims/nature of the computerization of education and the extent of the changes that the integration of ICT can bring into the educational process we have a comprehensive picture of the general trends in the opinions expressed by groups whose thought and actions affect any educational applications. The possible combinations of these may provide us in a clear and complete way with

the views of the "*discourse*" formulated and in general with a thorough model of ICT integration in Greek educational reality for the period 1984-2006.

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