CURRICULAR DEVELOPMENT AND ICT: FROM TECHNOLOGICAL DEFICIT TO METHODOLOGICAL DEFICIT

Fernando Albuquerque Costa, University of Lisbon, Portugal

Introduction

The way the main aspects of the information society are dealt with in school and how the young are being prepared to act socially and in such a professionally fluid and constantly changing context are crucial questions that today's teachers and educators cannot ignore.

As several national and international studies seem to indicate, even in wealthier countries with a long history of teacher training, there remains a big deficit in how teachers are prepared to exercise their profession, especially from the methodological point of view (Costa, 2008; Franssila & Pehkonen, 2005; Wallin, 2005). Not only does the use of digital technologies in educational practices continue to be much lower than one would expect, in view of the investments made, but there is also a glaring lack of guidance as regards how they should be taken advantage of, which leads to irregular usage that is not in accordance with the main theoretical principles underlying the constructivist framework of these countries' national curriculums (Costa & Peralta, 2006).

Preparing teachers to use the digital technologies in their educational practices is not merely a technical question of how well they master the technologies. Moreover, the way this issue usually ends up being tackled in conventional training gives us strong evidence that the strategies for professional development implemented are ineffective from the methodological point of view. In other words, even after attending the training programmes provided, the teachers and educators continue to have big doubts about what ICT can be used in education, and why and how ICT can improve their pupils' learning (Peralta & Costa, 2007). We believe the essential question lies in the way the teacher training has been designed and its obvious ineffectiveness to properly prepare the teachers (Costa, 2008; Costa et al., 2006).

Given the diversity of the curricular areas in which the technologies may be used, the different phases and stages of teachers' careers, and the wide range of perspectives they have about what teaching and learning comprises, and how to incorporate ICT into this process, we always considered it strange that these multiple factors were not specifically incorporated into teacher training. Given that these differences are of crucial importance in the teaching practices of teachers and educators, what we propose is the outline of a framework of thinking that will allow us to identify and characterise the different kinds of pedagogical intervention using ICT that can be useful when it comes to designing the training.

Background

In Portugal, as the has made obvious by studies on continuous training, *learning the tools* was an aspect that was strongly focused on in the initiatives organised by PRODEP – Educational Development Programme for Portugal (Brito, Duarte, & Baía, 2004; Santos, 2001). Although one can speculate about the reasons behind such a low incidence of training initiatives in which the trainer would expose the teachers to the pedagogical use of the technologies available (only around 10%), we believe that this may result from the convergence of two easily verified facts.

We refer, on the one hand, to the absence of structured programmes specifically designed to prepare the trainers charged with carrying out the training (Felizardo, 2012; Felizardo & Costa, 2012), meaning it was left to their own initiative to discover and explore the tools as and when they appeared. However, we believe the chief reason behind this usage, and which in most of the cases we have discovered, is simply the interest and curiosity triggered by the technological development in the area of information technology, above all shown in the attentive monitoring of the innovations that have arisen and that can be used.

Although one may think that given their preparation and pedagogical concerns, the fascination with the technological potential in these early adopters would give them a strategic advantage to transfer this potential into the teaching and learning field, this generally did not happen. It was not the case the majority of the time, although the trainers continued to be granted the individual freedom as to what specific guidelines should be transmitted to teachers in this area, with the advantages and disadvantages that such a flexible and liberal approach entailed.

A first factor is linked precisely to the fact that this approach is in itself inconsistent and erratic, and above all prisoner to the pressure exercised by the technological industry and by the fast pace at which new tools are launched onto the market, not even allowing time for proper pedagogical experimentation and assessment.

This aspect is intrinsically linked to a second factor derived from the absence of a framework that would allow the trainers to go beyond teaching the tools to the teachers who, for an array of reasons, seek to initiate themselves in information technology. While on the one hand it would seem to make sense to start this initiation by learning the tools, given the state of almost absolute technological ignorance of most of the teachers and educators, the fact that there is no suitable framework in place naturally gives rise to situations where the topics taught are repeated and are unsuitable given the progress the teachers have made, and it also does not allow an articulated and systematic coverage of all the potential interested parties in each particular context.

A third factor, a consequence of the previous two, is of capital importance in our opinion. It derives from the fact that there has never been a forum for a systematic discussion of the pedagogical and didactic issues involved in the introduction of the new technologies, both for the teaching practices and at the level of the schools' management and functioning structures.

Apart from a few exceptions, such as the reflection working group set up as part of the MINERVA project (Ponte, 1994), or initiatives of a more limited geographical or temporal scope (Ramos et al., 2002; Dias et al., 2002), we can say that over the past twenty-five years of work regarding the integration of technologies in Portugal's schools, the pattern has been one of a strong focus on f the practices without any prior theoretical reflection, with a glaring absence of a systematic reflection about these practices that could underpin and consolidate the most profitable and significant initiatives that have been implemented in real teaching and learning situations.

If we add a lack of clear guidelines about how to use ICT in school, which is the responsibility of the decision-making authorities from which one would expect a strategically structured action, we find a fourth factor explaining the superficial nature and inconsistency in the proposed pedagogical use of ICT, not least because of the lack of assessment, consolidation and dissemination of the positive results of the initiatives carried out over the years.

We are referring not only to the centralised authorities responsible for defining the curriculum, but also and especially to the institutions in charge of the initial training of teachers and educators which, as we know through studies published in 1996 and 2004, never looked upon the issue of introducing ICT in schools as a crucial strategic aspect for the development of teachers (Ponte & Serrazina, 1998; Matos, 2004), the schools themselves, and therefore the country.

Although one cannot ignore the role played by different Ministry of Education departments and services to facilitate the introduction of ICT, through several incentives to purchase and increase the use of computers, often based on the presentation of well thought-out projects by the teachers and schools (Costa & Jorge, 2011; GEPE/ME, 2007; DAPP/ME, 2004), we believe too for too long the educational community was provided with no clear, consistent and well grounded vision about the role of the technologies in education (Cruz, 2010).

As we have argued in other areas (Costa, 2003; 2004; 2008), one would expect more determination in creating the conditions for an indispensable debate about the expectations and challenges, in terms of innovation and change, that the potential of the digital technologies in a network engenders for schools. After all, it is precisely the school, in articulation with the teacher training institutions and the research centres, which is the ideal place to converge the theoretical and practical knowledge needed to bring about structured and sustainable innovation and change.

Indeed, we cannot think of a more appropriate place to carry out this reflection, especially if we want a systematic analysis of the issue, and the respective theoretical foundations, as sustainable bases for the changes that the use of ICT supposes and implies when one aims to go beyond the mere automation of traditional practices (Weston & Bain, 2010).

If we want to make technologies the drivers of change in schools (ETS, 2007; Castells, 2002, 2007; Moura & Carvalho, 2006; DAPP/ME, 2004), what is at stake is the need for changes, both in conceptual terms regarding the learning and a curriculum that was built for the paper

and pencil era (Valente, 2011; p.30), and in terms of the teachers and pupils' time and space (Fisher et al., 1996). To sum up, the questions are what should be learned in schools today and how should it be taught, or to put it another way, what is the role of school in today's society.

Types of ICT usage for curricular purposes

As one can conclude from many studies in this area, the issue of using technologies in school is essentially a pedagogical question. One of these studies (Abrami et al., 2006) aimed to measure the impact of technology on learning on a global scale, over the last forty years, based on second-order meta-analysis, i.e. taking as a reference a vast set of meta-analyses carried out in different parts of the world. The conclusion was that enhanced learning, when it occurs, is not explained by the kind of technology used, but rather mainly by variables of a pedagogical nature and how each of the aspects inherent to the organisation and implementation of the teaching and learning is tackled. In other words, the methodological aspect.

Although one can cast doubt on the results of these studies looking at the effects on learning of using ICT, because they are solely based on the creation, artificially to a greater or lesser degree, of experimental devices to be compared with "technology-free" classes, it is interesting to note the way they open up a diversity of dimensions and factors that are at play in the study of different pedagogical situations that used technologies.

The same conclusion can be derived from the results of the ACOT (Apple Classrooms of Tomorrow) project, one of the biggest studies ever carried out about how teachers learn to use the technologies (Sandholtz, Ringstaff & Dwyer, 1997). It was a study of a longitudinal nature, in contrast to the aforementioned experimental studies, and covered a sufficient time-span for multiple and wide-ranging explorations of the computer in the classroom. One could observe that the changes in the teachers' practices were above all linked to the methodological alterations that the teachers had time to test out as they gradually introduced the technologies into their classes (Hayes, 2007). Therefore, it is through the very process of experimenting new strategies for teaching the pupils, and reflecting on what works and what does not work, and about what adjustments need to be made, that the transformation takes place.

Although other variables have been identified and may also be present whenever considering the use of ICT by teachers or educators, such as personal experience in using the technologies and the training received (Wozney, Venkatesh, & Abrami, 2006), the motivation and confidence to use the computer (Peralta & Costa, 2007, Chen & Chang, 2006), the perception about the benefits of the computer (Sang et al., 2010), the fears and anxiety about having to change their practices (Kay, 2008, Mueller et al., 2008, Wood et al., 2008), we believe there are two nuclear dimensions to be considered in the analysis from a curricular viewpoint: on the one hand, the teachers' pedagogical conception and stance, and on the other hand, the way the teachers understand and use the technology for the learning objectives.

In the belief that these two dimensions are of crucial importance in the teaching practices of teachers and educators, we propose outlining a framework of thinking that will allow us to identify different kinds of pedagogical work with technologies, so as to facilitate the guidance to be subsequently developed in the training of teachers and educators.

As can be seen in Figure 1 (Orthogonal reference tool to analyse the kind of ICT uses for educational purposes based on the teacher's pedagogical conceptions and the function attributed to the technologies), based on the variations that can exist (a) in the teachers' pedagogical conceptions and the way they usually organise the teaching and learning process, conjugated with (b) what they know and think about the technologies and how they use them with the pupils, we are able to identify and characterise four different kinds of pedagogical interventions when using the ICT for curricular purposes.
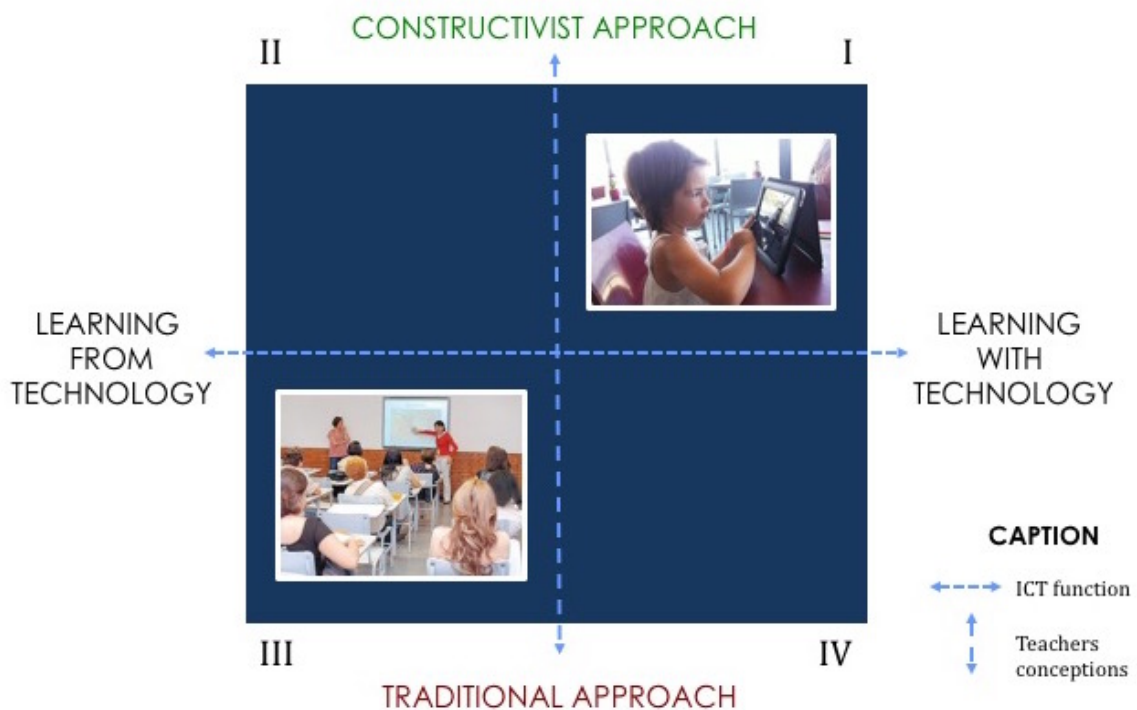

Figure 1. Orthogonal reference tool to analyse the kind of ICT uses for educational purposes based on the teacher's pedagogical conceptions and the function attributed to the technologies

The four kinds if ICT usage found correspond precisely to the four quadrants defined by cross-referencing the two orthogonal axes, one representing the continuum referring to the *teacher's teaching model*, ranging from constructivist at one end to traditional at the other end, and the other representing the continuum referring to the *type of technology use*, ranging from technology to transmit information (learning from technology), to technology as a tool to aid and support the pupil's thought processes (learning with technology).

In quadrant I, we can succinctly describe the teacher as someone who knows and uses tools that help him to think, along the lines of what Jonassen labelled *cognitive tools* (2007), but also a teacher who systematically reflects on what he does and how he does it, and based on this reflection introduces changes whenever necessary, thus improving his practice. This is a teacher who centres his activity on the pupils, granting them a leading role in their learning.

In quadrant II, we are in the presence of a teacher who also centres the activity on the pupils and reflects on what he does on a regular basis, although he does not yet have knowledge about the specific tools, or how to use them appropriately to encourage, develop and enhance the pupils' ability to think, create, solve problems, express themselves, communicate, interact and collaborate with others.

In quadrant III, the teacher understands and uses the technology essentially to support the process of transmitting knowledge to the pupils, whereby the computer is largely used as a substitute and mediator, be it in the transmission of knowledge or in the way the learning is consolidated, through exercises, educational games or other kinds of strategies, essentially reactively responding to the stimuli presented.

Finally, in quadrant IV, we have a teacher who knows that tools are available that may be used to support and expand the thinking process, but who ends up using them inappropriately, with no consistent theoretical basis underpinning this goal, as well as not doing so in accordance with his own traditional method of teaching.

Advancing in the analysis of the proposal presented herein, and holding up quadrants I and III against each other, one can glean two opposite kinds of ways the technologies are used. One is a *rich* usage (quadrant I), compared to *poor* usage (quadrant III), although we believe we cannot discern, in either case, inconsistency between the kinds of technology usage and the theoretical principles underlying the model of work followed by the teacher.

In the first case the teacher values his pupils' work with technology, enabling a *rich* learning, and is therefore the most powerful usage one can implement in the school. It is in accordance, indeed, with what some authors call "learning with technology" (Papert, 2007; Jonassen, 2007). As can be seen, this is a much more ambitious perspective, but also comprises a much more demanding task both for the pupils and the teacher.

It is especially challenging for teachers, who have to leave their comfort zone and make a big effort to bring about the changes that this perspective implies in relation to the ways teachers usually work when in the opposite quadrant, i.e. quadrant III.

From the point of view of the pupil's learning and development, it is the perspective closest to what is recognised as being the across-the-board digital skills inherent to citizenship in a society heavily based on information and knowledge. Deep down, it is a question of thinking about the pupils as capable of analysing, assessing and deciding about the problems they face, pupils who use the digital technologies to access the information they need and are able to select in line with previously established criteria, pupils able to reflect on what they are

learning and how they are learning, in order to develop autonomous and self-regulated learning strategies, pupils who are able to communicate, interact and collaborate with others, pupils who can express themselves, who can imagine and create using the different forms of representation and the respective combinations that the digital tools allow them. To sum up, we are talking about pupils for whom it make sense to put the technology, which they already use routinely and skilfully, at the centre of the school activities and objectives.

In terms of innovation, change and transformation of the teaching practices, it is also at the top of the diagonal that connects these two quadrants that the maximum point is located, which we can call the "transforming potential" of the ICT. In other words, where it is more likely a teacher is open to change, recognises what has to be done to bring this change about, and is willing to make the effort this implies, constructing a vision of the point of arrival, when we are talking about a teacher or educator who is markedly constructivist.

From technological deficit to methodological deficit

As a result of this line of thinking, and as shown in Figure 2 (Type of ICT usage for curricular purposes, types of deficit and transforming potential), one can also draw conclusions about two kinds of deficit that should be distinguished (ISTE, 1998), given their direct implications for those responsible for designing the training: on the one hand we have what is usually recognised as "technological deficit", which we define as the gaps in knowledge about the technologies and how to manipulate them; on the other hand we have what we have called "methodological deficit", which we define as gaps observed in the level of pedagogical knowledge about these technologies, i.e. what they are for and how to use them to improve and consolidate the pupils' learning. This final factor has crucially important implications for the design and implementation of the curriculum, and therefore calls for greater effort aimed at bringing about professional development, both from teachers and training managers.

Despite the differences that we can anticipate between the two different kinds of technology usage deriving from each of the four quadrants, we believe there is no discernable deficit in quadrants I and III, simply because we can accept that there is consistency between how the ICT are used and the kind of dynamics underpinning each of the models in question, the constructivist model, in quadrant I, and the traditional model, in quadrant III.

Considering the teacher in quadrant IV to be a traditional teacher, who knows how to manipulate the technology and uses it, but who in doing so uses it inappropriately relative to what one would expect in the working model where he is located (theoretical-methodological inconsistency), we believe we start to see the emergence of a prevailing "methodological deficit", as we have labelled it. This is a teacher who can benefit decisively from being made aware of the inconsistency between the type of teaching he gives precedence to and the way he uses the tools. He should be encouraged to search for more appropriate technologies and to start deliberate experimentation and transformation of his current practices, built on the knowledge he has about the tools, which should not merely be substitutes for the transmission of knowledge.
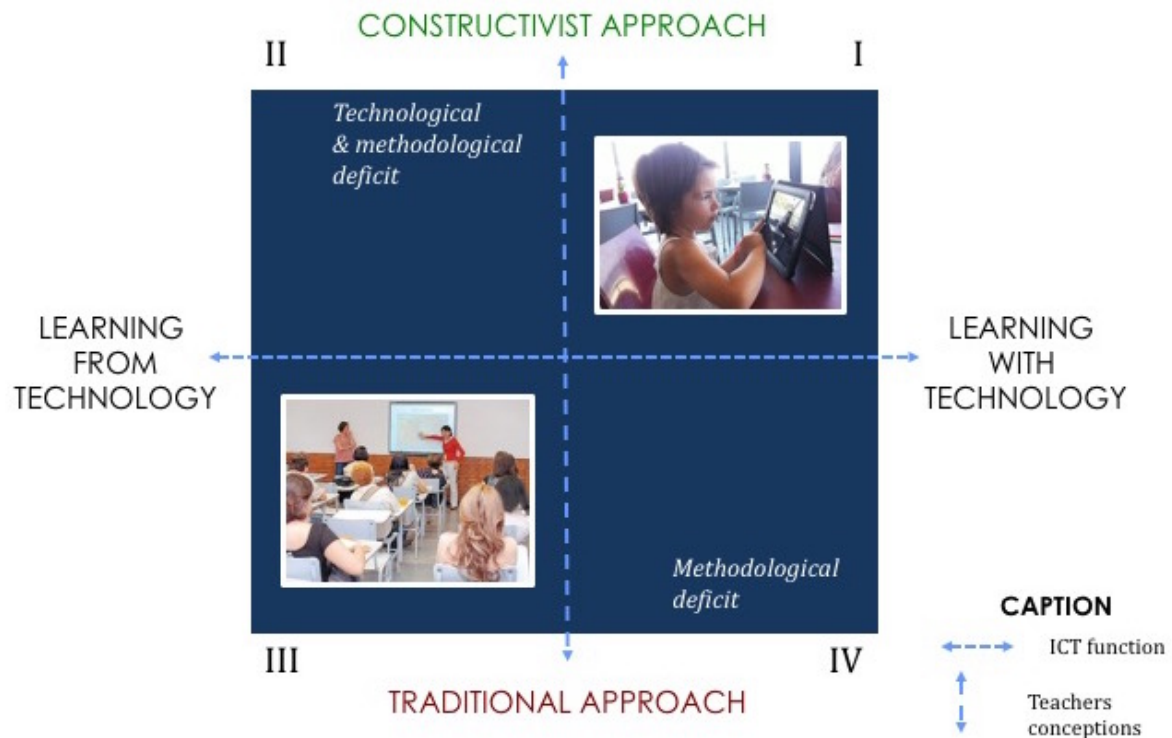
Figure 2. Types of ICT usage for curricular purposes, types of deficit and transforming potential

Looking at technology from the point of view of its potential to transform current teaching practices involves first of all the professional decision to want to change direction to a model that is clearly centred on the pupil and where the pupils are made to take the initiative, and the teaching is not simply laid on for them. As well as being a process that demands a lot of time, it implies a conception of using technology that is not aimed merely at replacing the resources traditionally used to teach and learn. It implies, in contrast, a perspective aimed at discovering new and different ways of doing things, preparing the young so that they themselves can contribute to the innovation required to solve the problems they will face in the future.

In quadrant II, we believe the inconsistency between the kind of tools used and the constructivist teacher's working model is of a different nature to the previous one in terms of methodological deficit, as it is not so much a question of inappropriate use, but mainly down to the lack of knowledge about the tools that can expand and enrich the work the teacher carries out with his pupils, encouraging relevant and significant activities for these pupils, therefore affording them the aforementioned centrality in the learning process. We are therefore in the presence of a methodological deficit in close connection with a technological deficit which, as defined above, manifests itself precisely in the gaps concerning knowledge of technologies and how to manipulate them. In practice, the work that would have to be done with the teachers located in quadrant II would have to involve first the learning of tools that could be included in the category of "cognitive tools", so that afterwards, and only afterwards, can work be carried out as regards the methodological aspects, i.e. how should these

technologies be articulated and integrated into the pupils' activity: when is it pertinent and useful to use them, and for what specific purposes, in what context, for example, in terms of time and space, what forms of social organisation should the work involve, and what role should the teacher perform, etc.

Final considerations regarding the design of training

When the goal of the training is to prepare the teachers to use the information and communication technologies in their teaching practices, most of the time we observe situations in which teachers and educators are viewed as a single entity, regardless of their teaching area, their professional experience and their conceptions about teaching and learning, or even their prior knowledge and specific experience in using technology for curricular purposes.

These and other variables affect the work of the trainers, making it very difficult for them to adjust the strategies and activities to the individual needs of the teachers doing the training, both from the point of view of their knowledge and technical skills as regards the operational and functional manipulation of the tools, and in terms of the particularities deriving from the subject area they teach, but above all with respect to the way or ways they can be integrated into the teaching and learning process.

While the first of these variables has not given rise to many problems in implementing the training, given that it is not the technical issues related to learning the tools that cause the difficulties, the same cannot be said when the idea is to work with teachers and educators on the pedagogical exploration of these tools, i.e. how to use them for curricular purposes.

The proposal presented here intends to construct a tool enabling the training managers, and the trainers in particular, to prepare their action more appropriately and effectively, based on a prior analysis of the needs of the trainees they will be working with in each situation. In other words, the training should be based on the articulated analysis of the two dimensions proposed herein: on the one hand, the conceptions and current pedagogical practices of the teachers and educators involved, and on the other hand their conceptions and their current practices of using technology in the teaching and learning process.

Based on this analysis, we are convinced that each trainer will be in a better position to adjust his own training and guidance strategies, in accordance with the four different types or profiles we arrived at, adapting them to what each of these profiles could represent for each trainee or group of trainees, namely in terms of distinguishing between the two kinds of deficit identified: the technological deficit, which above all calls for the learning of the tools, and the methodological deficit, which as we have seen, involves not only learning how these tools can be incorporated into the school work, but also presupposes a change in attitude that requires time and effort by the teachers and educators, especially if the goal is to explore the pedagogical practices that actually take advantage of the enormous pedagogical potential of ICT, showing a willingness to experiment and create new and more stimulating teaching and learning environments. And it is based on this work of exploring, experimenting and

reflecting on what works and what does not work, that professional decisions should be made that force a move towards innovation, change and transformation of processes.

Although deriving from empirical work and reflection over a number of years, the framework of thinking presented herein to read and understand the needs of the teachers in the ICT area, and to support the decisions about which strategies trainers should select to prepare them, it is merely a proposal provided for all who would like to and are able to put it to the test in a real training context.

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