

## 26 - TPACK: Challenges for Teacher Education in the 21st Century

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**Abstract:** In this paper we reflect on the impact of ICT in educational systems, and the importance of preparing Portuguese teachers to the challenges of the learning society. In order to contribute for the definition of a national program for the professional development of teachers in ICT, we present some international programs for the professional development of teachers in ICT discussing results on current implementation. We then present the recently launched Portuguese Plan of ICT Competences for teachers that define levels of digital literacy and certification. In order to add new insights into current discussion on the topic we present a review of literature on a theoretical framework that has shown effective for the integration of ICT into the classroom: the TPACK. Examples of successful experiences in different curricular areas already implemented and tested with will be presented and discussed in order to help Portuguese teacher educators in the design of activities to be carried out in education programs for in service teachers.

**Keywords:** Teachers training, Information and Communications Technologies, Technological Pedagogical Content Knowledge.

### INTRODUCTION

Teachers can't stay indifferent to changes happening in the educational panorama, driven by the developments in Information and Communication Technologies (ICT's). We need to rethink pedagogical practices, methods and strategies, in a way that contributes to classroom innovation, and that presupposes curricular integration of ICT's.

The importance of curricular integration of ICT's is a recurring question in the educational policies level, both on a national and international scale. On this matter, many international organizations, namely the European Commission and the Unesco (in the Education domain), became aware of the need to answer the advent of the Information Society. As Silva (2001) tells us, Unesco, on the "Education, a treasure to discover. International Committee for Education on the 21 Century report for Unesco", coordinated by Jacques Delors, drew attention to the impact that ICT's may have in renovating the Educational System, as to the response they must provide to the multiple challenges of the Information Society, recommending that "educational systems must provide an answer to the multiple challenges of information societies, in a continuous enrichment of knowledge and the exercise of a citizenship adapted to the demands of our time perspective" (Unesco, 1996).

In June, 2008, a report was published by *The International Society for Technology in Education*, where the new National Standards in Educational Technology, aimed at teachers, were presented. (ISTE, 2008a) In that document, new recommendations are made to teachers, in the manner as to make them accountable for their part as creators of pedagogical experiences involving the use of technologies to learn and teach.

Although teachers recognize the value of ICT's in education, there are still some barriers for its effective use. Thus, in 2006, in the Report on the Impact of ICT's in European Schools (European Schoolnet, 2006), these barriers were identified, being divided in three categories: i) teacher level barriers – meaning those that are related directly with the approach and attitude relating to ICT's by the teacher; ii) school level barriers – the absence and low quality of infrastructures, the limited access to technological equipment, low levels of participation in technological projects by the school and the absence of ICT's integration in school strategies; and iii) educational system level barriers – strict structure of the traditional school system and the existence of rigid curricula (European Schoolnet, 2006).

In this paper we reflect on the impact of ICT in educational systems, and the importance of preparing Portuguese teachers to the challenges of the learning society. In order to contribute for the definition of a national program for the professional development of teachers in ICT, we present some international programs for the professional development of teachers in ICT discussing results on current implementation.

We then present the recently launched Portuguese Plan of ICT Competences for teachers that define different levels of teacher digital literacy and ways to get a certification. In order to add new insights into current discussion on this topic, we present a review of literature on a theoretical framework that has shown effective for the integration of ICT into the classroom: the TPACK. Examples of successful experiences in different curricular areas already implemented and tested will be presented and discussed in order to help Portuguese teacher educators in the design of teaching activities to be carried out in education programs for in service teachers.

## **INTERNATIONAL PROGRAMS FOR TEACHER EDUCATION ON ICT**

With the objective of trying to overcome the existing barriers in School, and facing the importance of developing and certifying teachers competences in ICT, many international organizations have produced standards that became the base for the teacher's formation and certification processes.

The European Computer Driving Licence (ECDL Portugal, 2010) is an ICT competences certification model, for many users, allowing the identification of competences and knowledge of each user, in the efficient use of the main computer applications. The qualification is acquired by passing an exam created around the contents of seven formative modules: introduction to computers, computer use and file management, text processor, spreadsheets, databases, presentations, and Internet and e-mail. Although this model "simplifies the certification, and internationalizes it, the detachment from the teacher's professional situation, from the national reality, are some of the critical points in this model" (GEPE, 2008).

The International Society for Technology in Education (ISTE, 2008b) has produced a generic standard and a group of specific standards for teacher's formation and competences on use of ICT certification programs. This project arose from the analysis of a questionnaire given in the USA about what should teachers know about ICT and what should they be capable of doing with them, so they could improve efficiently the learning of their pupils. This standard is organized in five dimensions: i) Facilitate and Inspire Student Learning and Creativity; ii) Design and Develop Digital-Age Learning Experiences and Assessments; iii) Model Digital-Age Work and Learning; iv) Promote and Model Digital Citizenship and Responsibility; v) Engage in Professional Growth and Leadership. This standard allows integration of both technical and pedagogical competences, allowing for change and autonomy in the building of knowledge, as for creativity from both teachers and students.

The project ICT Competency Standards for Teachers (UNESCO, 2008), is based in the assumption that the use of ICT in education will contribute to the improvement in education, thus being presented as a central factor in educational, social and political progress. This project incorporates the educational principles in de ISTE developed standard, arguing that teachers are responsible for developing ICT competences in students as well as access, selection and organization of information and communication, also being capable of solving problems and act creatively. This standard is constituted as an array of ICT competences: political vision, curricula and evaluation, pedagogy, ICT, organization, administration and professional development of teachers. This standard aims to be the basis for benchmarks and specific indicators in three approaches: i) digital literacy approach, ii) knowledge increase approach, iii) knowledge creation approach. It also attributes ICT with the role of changing the educational practices, because of their educational, curricular and administrative integration within schools.

Finally, the Smart Classrooms Professional Development Framework (Queensland Government, 2009) is part of a government plan to improve student, teacher and schools learning, from Queensland Government, in Australia. This standard has a common objective: serve as a standard for teacher's work, in order to achieve improvement in learning results and social improvement, acting as an impetus to the development of teacher's skills, so he can be an agent in the transformation of the teaching and learning process, in all levels of education. It also encourages the use of new methods, integrating ICT and pedagogy, with the objective of improving learning and student results. This standard has three levels of certification: ICT Certificate, Digital Pedagogy Licence and Digital Pedagogy Licence Advanced. ICT Certificate recognizes basic teacher skills in a learning context. Digital Pedagogy Licence recognizes the digital skills of teachers that use ICT in a way to improve the teaching and learning process. Digital Pedagogy Licence Advanced certifies the digital skills of teachers who are leading the transformation of the learning process through use of ICT.

Although many strong points have been found in both these standards, contextual reasons advise against adoption of any of these standards to the Portuguese reality. These reasons go from the educational models and teacher training reasons to questions of institutional, administrative and political order. The PTE proposal is based on the international view of the role of ICT, the teacher's role as a user of digital technologies in a responsible and educational interesting way, the objectives proposed for the PTE, as well as the situation in which schools work in our country (GEPE, 2008).

## **THE PORTUGUESE PLAN OF ICT COMPETENCES FOR PORTUGUESE TEACHERS**

The “ICT Skills” project is the “cornerstone of the strategy for teacher training in innovating their educational practices with the help of information and communication technologies”, developing a training and certification system in ICT skills, in order to recognize ICT skills of at least 90% of teachers (GEPE, 2008).

In the Implementation Study for the “ICT Skills” Project (GEPE, 2008), and so that teachers acquire the skills of Teacher of the 21st Century, as defined in the study, a continuous formation model was proposed, taking into account the regulations that govern the professional activity of teachers. In order to enable the application of skills this formation ensues, some recommendations were defined: i) the need to integrate ICT through all school life, so as they are naturally perceived, ii) the need to ICT are a part of all subject areas, iii) the need for quality resources, diversified, and adequate to the development of curricula, iv) the need for adequate infrastructure, fit for the demands of teaching work with ICT, v) the need for the direction of school boards to develop a clear leadership, encouraging the use of ICT.

Through Decree No. 731/2009, of July, 7, the Portuguese Government creates the normative conditions to execute the teacher ICT skills training and certification program, with the objective of: i) promote the generalization of digital and educational skills with the use of ICT, ii) provide ICT training in a coherent and articulate manner, iii) recognize ICT skills acquired outside the continuous teacher training framework.

Thus, the ICT skills training courses were organized in three levels: level 1 – digital skills training; level 2 – educational and professional skills with ICT training; and level 3 – advanced ICT skills in education training. The training course in digital skills (level 1) is composed by one of three alternative courses defined in the Decree. The training course in educational and professional skills with ICT (level 2) is composed by two mandatory training courses and two optional training courses. Finally, the advanced ICT skills in education training course (level 3) is composed by master and doctorate programs, run by higher education institutions.

In parallel with these training courses, three ICT Skills certificates were created, so the knowledge acquired by teachers could be certified: i) Digital skills certificate – this certificate recognizes the knowledge acquired by the teacher that allow him to use ICT in teaching and learning processes, being assigned by the recognition of acquired skills, namely by validation of professional or associated skills, or by recognition of his formative history; ii) Educational and professional skills with ICT certificate – certifies the acquired knowledge of teachers that incorporate ICT in their practices, exploring them as an educational and pedagogical resource, and mobilizing them to developing new teaching strategies. Assigned through recognition of formative paths and in sequence of a positive evaluation of the teacher’s digital portfolio; iii) Advanced ICT skill in education certificate – recognizes the acquired knowledge that enables the teacher to innovate in his educational practices, manage and think about his experiences, in an investigative manner and with the objective of sharing and cooperation with the educative community. Assigned to teachers who have a masters or doctorate degree in the Educational Sciences area.

Issuing of these certificates is responsibility of the director of the training centre from the schools association, after application from the teacher, submitted to the director of the school group where he is working.

Although the ICT Skills Plan defines a basic framework for teacher ICT certification, there still much to do to establish what will be the practice of training in the field. In fact, more important than certifying is to make sure teachers actually use ICT as real educational tools in the classroom, capable of helping students building knowledge (Jonassen, 2007). Also, as suggested by Baylor and Ritchie (2002), continuous formation of teachers in the ICT level should enable teachers with “the opportunity to learn and observe new teaching with ICT methods, share questions and problems with others, and explore new ideas with experts and peers” (Baylor & Ritchie, 2002, p. 410). This same idea of importance in the sharing of experiences and worries with the peers, meaning what we could call a “cooperation culture” between teachers, constitutes a professional development strategy that encourages teachers to think about the practices, to a peer shared learning that promotes multiple skills and a genuine desire for change (Hargreaves, 1998).

On the other hand, integrating technology in the classroom is more effective when the learning is significative, that is, when teachers are capable of linking contents with teaching processes, in a way that promotes the learning from students in the content itself (Jonassen, Howland, Marra & Crismond, 2008). TPACK is a very recent theoretical standard that arose from the need to answer efficiently the question of how to integrate ICT in the curricula as an efficient learning tool. It seems to us important and timely to present this theoretical standard and what investigation shows about its implementation in the educational field; it will be a way to give some practical clues to the implementation of an ICT skills standard and contribute for Portuguese teachers definitively integrate ICT in their curricula.

## THE TPACK MODEL

The Technological Pedagogical Content Knowledge, TPACK for short, has revealed itself as the theoretical standard of excellence for an effective integration of ICT in the teaching and learning processes (Graham, Burgoyne & Borup, 2010). The basic premise where it stands assumes that the teacher's attitude when it comes to technologies is multi-purpose and that an optimal combination for its integration in the curricula results of a balanced mix of scientific (or content) knowledge, educational knowledge and technical knowledge (Koehler & Mishra, 2008).

Shulman (1986) developed a theoretical framework for teacher education by introducing the concept of pedagogical content knowledge (PCK). Shulman argued that a distinctive form of teacher-practitioners' professional knowledge, which he referred to as PCK, exists and this knowledge builds upon, but is different from, subject matter knowledge. In Shulman's view, PCK is a form of practical knowledge that is used by teacher practitioners to guide their actions in highly contextualized classroom settings. This form of practical knowledge involves for one hand an understanding of how to structure and present the subject matter to be learned, on the other hand an understanding of the common conceptions, misconceptions, and difficulties that learners encounter when learning particular subject matter, and finally knowledge of the instructional strategies that are effective at addressing students' learning needs in particular classroom circumstances. According to Shulman, PCK builds on disciplinary knowledge and is, therefore, a critical constitutive element in the knowledge base of teaching within a specific discipline.

Mishra & Koehler (2006), enhancing Shulman's (1986) theoretical standard, added Technology as an integrated component of teacher's knowledge as to teach in a more effective way, so creating the above described TPACK. In this new standard, the combination of content, education and technology forms "an integrated whole, a 'Total PACKage' as it was, for helping teachers take advantage of technology to improve student learning" (Thompson & Mishra, 2008, p. 38).

Figure I, adapted from Koehler & Mishra (2008) represents the concept of TPACK in a graphical way as being the result of intersecting the teachers' knowledge in three levels: curricula and content knowledge, education methods knowledge, and technological skills.

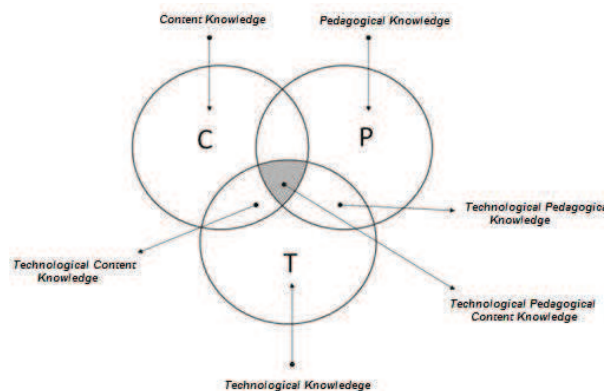


Figure I: TPACK Model

In theoretical terms and according to Koehler and Mishra (2006, 2008), TPACK results of the intersection of three different types of knowledge:

- Pedagogical Content Knowledge: meaning the ability to teach some curricula content;
- Technological Content Knowledge: meaning the ability to select the most adequate technological resources to communicate some curricula content;
- Technological Pedagogical Knowledge: meaning knowing how to use those resources in the teaching and learning process.

The TPACK concept, for Harris and Hoffer (2009) is an amplification of the pedagogical content knowledge concept presented by Shulman in 1986, and one that, in a way, revolutionizes the form as, today, the professional development of a teacher that is a competent one in his teaching area is processed.

The accelerated advance of computer and Internet use as support tools for the teaching and learning process require the need for a framework that supports those what must be the skills for a teacher that uses ICT as educational tools in the classroom, as stated by Jonassen (2007).

According to Koehler and Mishra (2008), TPACK is the basis for effective use of technology in teaching, and a condition for efficiently inserting ICT in the learning activities. Deep understanding and mastery of teaching techniques are needed so that technology is used to build knowledge by the student and not as support for the teacher to teach. This way, according to the same authors, teacher training must be steered to development of TPACK in a gradually and spiraling way, starting with the simpler technologies that teachers already know (and for which they may already have skills in the TPACK level), in the way to ever more complex and sophisticated applications. The main objective is that the teacher is enabled to make informed decisions in the planning of his teaching with technologies activities, which implies:

- Choosing teaching objectives;
- Decision making in the pedagogical level, taking into account the learning experience;
- Selecting and sequencing the teaching activities;
- Selecting the formative and summative evaluation strategies adequate to the adopted pedagogical strategy;
- Selecting the best resources and tools to help students benefit from the planned learning activities.

## **DEVELOPMENT OF TPACK IN EDUCATIONAL SCENARIOS**

Use of TPACK as a theoretical framework has increased in the last few years, as it proposes a structured approach to the complex nature of ICT and teaching (Cox, 2008). In the last few years we saw the emergence of several studies, which want to investigate the development of TPACK in educational scenarios.

The investigation developed by Figg and Jaipal (2009) disassembles TPACK, focusing in the Technological Knowledge components: Technological Knowledge, Technological Content Knowledge and Technological Pedagogical Knowledge, so that it provides the operational definitions of those components. Furthermore, concrete examples are presented, that may be used to obtain effective integration of technology in the classroom context, as well as to highlight the influence that Technological Pedagogical Knowledge has in the successful implementation of technology in the educational practice of future teachers.

In 2006, Norway performed a curricula reformulation – The Knowledge Promotion – using TPACK as basis for the project, where teachers cooperated with other teachers, the school administration and students. This reform arrived from the need to alter the way the majority of teachers used ICT, through intensive training processes, in a way to enhance their TPACK. The main objective was that students acquired basic digital literacy skills, so they could actively participate in the knowledge society, including the capacity for ICT use (Engelien et al., 2009). In the end of these processes and modifications, they came to the conclusion that digital literacy must be implemented in all curricula, thus being considered as important as reading and writing (Krumsvik, 2008 cit. Engelien & Stundal, 2010). “They went from being primarily digitally illiterate to being representatives for good teaching with technology” (Engelien & Stundal, 2010). Although the final objective is the development of a system or organization, the participants are people, driving to that a personal mastery is need to change practice, among school directors, teachers and students. Teachers’ TPACK is vital so that the proposed objectives are achieved, among them digital literacy, one of five basic skills.

Engelien, et al. (2009) analyzed this reform, using the TPACK model to explain how complex objectives may be segmented, worked on thoroughly and again reunited. In the analysis they concluded that this reform allowed thinking and development of knowledge about the use of technology in school. Also concluding that TPACK has a useful framework that helps to understand the complexity of the demands made to teachers.

Other investigations were performed in more specific curricula. In the Geography area, Doering & Veletsianos (2009) designed three educational online environments to help students and teachers on effectively using geospatial technologies in the classroom context. These environments are built to help teachers with a limited formation in teaching Geography through technology, using TPACK as basis for their investigation. In Mathematics, use of TPACK has been the target for some studies. Niess (2008) does an analysis on the efforts taken by other investigators directed to the preparation of Mathematics teachers on teaching with technologies. This study concludes that, to the majority of teachers, teaching in a work context gives them the opportunity of teaching in the 21st century, because if education must adapt and prepare their students to live and work in the 21st century, teachers need to be prepared to integrate emerging technologies as learning tools. New programs and training must guide them in learning about ICT, training them in teaching new curricula, at the same time using technology, and guiding the development of student understanding. “This in-service education needs to focus on developing and extending the knowledge, skills and dispositions described in TPACK (Niess, 2008). Schmidt, Seymour, Sahin & Thompson (2008) have also reflected about TPACK development in PreK-6 Teachers. To these investigators, TPACK acts like a new form of knowledge that requires teachers not only to understand the complexity of relations between

technology, pedagogy and content, but also propose solutions for their practices. Also Bauer (2010) reflects on the use of TPACK with Music teachers, since, and taking into account the use of technology theme has been a very interesting topic among music teachers, they still don't use the technology in the classroom intensively. This investigator proposes a research-base conceptual framework for pre-service and in-service music educators. He concludes that music teachers should be open to new ideas and ways of doing things, and demonstrate the will to use a convergence between technology and musical pedagogy.

With the advance in the various investigations, some activities to bring closer the integration of technology in education have been presented. Hofer et al. (2009) developed and executed six activities to the K-6 literacy, secondary English, foreign language, mathematics, science and social studies areas, showing who they can help teachers develop student knowledge by integrating technology. These activities focus in raising awareness for all possibilities of technology support in specific curricula. At the same time, they aim to help teachers in choosing and combining different learning activities so that students are helped to acquire the basic skills in the matter, taking into account the learning needs and preferences of the students. This investigation suggests that, only when teachers are familiar with a full range of learning activities types inside a specific content, they can wisely choose and execute in an effective way the adequate activity. The six learning activity types introduced represent the effort of the authors to identify the different types of learning activity in the diverse curricula areas, so that educational technology may be used as support for teaching and learning

The investigation made by Harris and Hofer (2009) also presents diverse activities for the use of ICT, based on TPACK. These activities work as conceptual planning for teachers. "Each activity type captures what is most essential about the structure of a particular kind of learning action as it relates to what students do when engaged in that particular learning-related activity" (Harris & Hofer, 2009). Thus, they propose a taxonomy, from their studies. They divide these activities in seven types:

- i) knowledge building activity types – example given: read text, view presentation, group discussion, field trip, etc.;
- ii) convergent knowledge activity types – answer questions, create a timeline, a map, complete charts, take a test, etc.;
- iii) written divergent knowledge expression activity types – write an essay, a report, craft a poem or a diary, etc.;
- iv) visual divergent knowledge activity types – create a picture or a mural, an illustrated map or draw a cartoon;
- v) conceptual divergent knowledge expression activity types – develop a knowledge Web, generate questions or develop a metaphor;
- vi) product-oriented divergent knowledge expression activity types – produce an artifact, build a model, create a newspaper, etc.;
- vii) participatory divergent knowledge expression activity types – do a presentation, do a performance, engage in historic play or engage in civic action.

In the knowledge building activity types, teachers have a variety of activities that allow to enable students in the social studies content building and process knowledge. Through expressions of knowledge analysis, teachers can determine what students learnt. These activities may be combined so plans can be created for use in a specific class. When teachers are familiar with these activities, they can choose, combine and use effectively these activities to develop learning situations, thus building their TPACK in a practical way (Harris & Hofer, 2009).

## **FINAL REMARKS**

In this paper we presented a review of the research that intends to give new insights in the process of the implementation of a national program for the professional development of teachers in Portugal. After discussing several European programs that were recently developed we present the framework that was created for the certification of Portuguese teachers in ICT.

However, if certification is important, even more important is to design effective programs that prepare teachers to empower students with the advantages that technology can bring to any citizen of our global society. This requires teachers that integrate the technologies as cognitive tools in the daily classroom routines. The TPACK model as shown to be one of the most relevant theoretical frameworks for the design of effective training programs for teachers in ICT, because it faces an holistic development of teacher knowledge – content, pedagogy and technology – that is crucial for the integration of the technologies into the curriculum.

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