Teachers' information and communication technology competences: A structural approach

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ABSTRACT

Teachers' information and communication technology (ICT) competences are a key variable to integrate such resources into the teaching-learning process. One problem with teachers' ICT competences is the proliferation of various frameworks which entail a lack of definition of these competences. The objective of this article is twofold: to establish a basic framework that shapes the subsets of ICT competences (technological and pedagogical) in all teachers at all levels (Primary, Secondary and Higher Education); to determine how various personal and contextual factors influence these subsets. For this purpose, a study of secondary analysis has been made with data from two survey design studies on teachers' ICT competences that collect information from a sample of 1095 male and female Primary, Secondary and Higher Education teachers in the Valencian Community (east Spain). A Multiple Indicators and Multiple Causes Model (MIMIC) was used to validate the teachers' ICT competences model. The study results indicated that teachers' ICT competences form a unique set composed of two subsets, technological competences and pedagogical competences. Moreover, the technological competences influenced the pedagogical ones. We also found that personal and contextual factors have a relevant impact on the competences subsets. This article helped clarify and delimit the framework of teachers' ICT competences. Besides, this basic model of ICT competences should be a key element for teacher training in ICT. This article also shows how the influence of personal and contextual factors must be considered when designing training plans.

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1. Introduction

Information and communication technologies (ICT) have profoundly changed our society and are the basis of today's knowledge society. Education has not remained indifferent to this change, at least not as far as two aspects are concerned: the impact of citizens training and the education system itself. The former refers to the challenge faced by the education system to train citizens for a society in which ICT form part of their lives. The latter corresponds to how ICT are integrated into the education system and their use in teaching-learning processes.

Such a profound transformation in education, and consequently in the education system itself, has been accelerated by various education administrations from different countries. Nevertheless, the introduction of ICT into the education system

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over the last two decades has not involved development and impact that was expected of them, despite its potential (Ertmer & Ottenbreit-Leftwich, 2010; Hixon & Buckenmeyer, 2009; Kirkup & Kirkwood, 2005; Ramboll Management, 2006; Sandholtz & Reilly, 2004; Whitworth, 2012), requiring empirical evidence which provides the benefits of these investments in use of ICT in schools and the education system (Bilbao-Osorio & Pedró, 2009). To a certain extent, the paradox of Cuban, Kirkpatrick, and Peck (2001) has been fulfilled, that of good ICT access, but poor ICT use. This has led to some countries promoting plans to integrate these educational resources (Eurydice, 2011; Office of Educational Technology, 2010). Apart from improving infrastructures, teachers and teacher training become a fundamental point for ICT integration, just as Angeli and Valanides suggested (2009).

Consequently, teachers are the key element to introduce ICT into educational practice. Without these essential agents, integration of technological resources would never take place, as this responsibility is assumed essentially by teachers (Ertmer, 2005; Pelgrum & Law, 2003; Stensaker, Maassen, Borgan, Oftebro, & Karseth, 2007; UNESCO, 2011; Voogt, Knezek, Cox, Knezek, & ten Brummelhuis, 2013). Clearly, these agents need to master them to be able to implement them in their teaching practice. This implies that teachers acquire the technological and pedagogical knowledge and skills needed in order to integrate ICT into their teaching practice. In other words, teachers have to be technologically and pedagogically competent in such resources because if not, they will be unable to include them in their day-to-day educational practice (Buabeng-Andoh, 2012; Guzman & Nussbaum, 2009; Kabakci Yurdakul & Coklar, 2014; Markauskaite, 2007; Okojie, Olinzock, & Okojie-Boulder, 2006; Wastiau et al., 2013).

The need for competent teachers in ICT has meant that several models of competence in ICT – digital competence, digital literacy (Hall, Atkins, & Fraser, 2014; Krumsvik, 2011, 2014; Tondeur et al., in press; Wastiau et al., 2013) – have been proposed in recent years for teachers. These different proposals (explained later) have entailed certain lack of definition of the same construct, as Hall et al. (2014) also pointed out. This is due to the differences among them; e.g. those developed by the International Society for Technology in Education [ISTE] (2008), UNESCO (2011), or Technological Pedagogical Content Knowledge (TPACK). Overall these models are defined according to a general basis, which means that they can be applied to all teachers in the education system, from Primary Education to Higher Education, just as UNESCO indicates (2011). Nevertheless, one of the main questions to arise from these models is if the ICT competences of all the teachers in the Education System actually maintain certain common and basic aspects or, if diversity exists, if completely different competence models are required in various parts of the Education System. This led this article to pose the following questions:

- Does a basic ICT competences model exist for teachers?
- Is the basic model common for all teachers at all levels of education?
- Do personal and contextual factors influence the ICT competences model?

This article deals with these questions as it tackles the definition of a basic ICT competences model for teachers, and also at verifying if this proposed model takes the same structure for all teachers from Primary Education to Higher Education. It is a matter of providing a theoretical and conceptual framework for the ICT competence map to help teachers understand the integration of such resources into classes. In this way, the various suggestions made to obtain a simpler and more contextualised definition of teachers' ICT competences (Ottestad, Kelentrić, & Guðmundsdóttir, 2014), empirically validate a framework of ICT competence (Tondeur et al., in press), mitigate lack of knowledge on integrating educational technology (Angeli & Valanides, 2009) and the need to build a new robust theoretical framework for this purpose (Chai, Ng, Li, Hong, & Koh, 2013) are covered. More specifically, it is a matter of integrating suggestions from various approaches, such as limitations in research works by teachers being trained (Chai, 2010), teachers' knowledge of ICT integration (Hsu, 2010), call to action to develop and employ teacher training models in ICT in class (Voogt, Knezek, et al., 2013; Voogt, Fisser, et al., 2013; Voogt, Erstad, et al., 2013), verifying a unit model (UNESCO, 2011), or the need to develop complex models with interrelated factors (Karaca, Can, & Yildirim, 2013).

Moreover, competences are an essential component if compared with other variables; for instance, the relation between use and competences (Chai, 2010; Law & Chow, 2008; Sipilä, 2014), with ICT integration in classroom (Hew & Brush, 2007; Inan & Lowther, 2010; Vanderlinde, Aesaert, & van Braak, 2014), attitudes (Knezek & Christensen, 2008; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012) and students' use of ICT for learning during lessons (Wastiau et al., 2013).

This work proposes an ICT competences model for all teachers in the Education System (Primary Education, Secondary Education and Higher Education) in order to know if the stable structure of ICT competences remains. Besides, knowledge of teachers' level of ICT competences is essential to be able to present realistic proposals that adapt to teachers' specific requirements. Such knowledge will allow the development of more general teacher training plans for ICT as the proposed ICT competences models can be taken as references. Moreover, having a common model for all levels of education –non-university and university-will facilitate the evaluation of the progress, training efficacy and investment made in integrating ICT into education.

1.1. The framework of teachers' ICT competences and characteristics

As mentioned earlier, teachers are the main agents to integrate ICT into the teaching-learning process. ICT competences are a key factor to enable teachers to change their educational practice and to implement these technologies in their educational