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Primary school pupils' ICT competences: Extensive model and scale development

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ABSTRACT

In search of factors that affect pupils' ICT competences, research has developed and empirically validated several conceptual frameworks. Although these frameworks are valuable ways of initially identifying factors related to pupils' ICT competences, they do not take into account the broader classroom and school context in which pupils are embedded. Moreover, most frameworks and their corresponding instruments focus on post-primary education. This study first presents a multilayered model that can be used to guide future studies that try to explain why some primary-school pupils are more effective in acquiring ICT competences than others. Factors are situated on the pupil, classroom and school level. Second, this study provides future research with a range of reliable measurement instruments to identify factors related to primary school pupils' ICT competences. These factors were drawn from the developed multilayered model. A survey was conducted in a large sample of primary school pupils ($n = 2413$), their parents ($n = 2267$) and their teachers ($n = 134$). The results of the replication exploratory and confirmatory factor analyses indicate a good factorial validity and reliability of the developed scales.

1. Introduction

ICT plays an important role in developing a person's skills of collaboration, social interaction, information retrieval and civic participation (Zhong, 2011). As such, people (in particular, learners) should master advanced ICT competences (Aesaert, Vanderlinde, Tondeur, & van Braak, 2013). In the context of the 21st century skills movement, the European Commission defined the use of ICT as one of the eight key competences for lifelong learning (i.e., a competence that people need for personal fulfillment, active citizenship, social cohesion and employability in a knowledge society (European Commission, 2008)). Recent research indicates that the variability in ICT competences is related to the degree to which people benefit from the use of computers (Hargittai & Hinnant, 2008). For example, people who lack ICT competences tend to use online public services less frequently than those who are digitally skilled (van Deursen & van Dijk, 2009). Hargittai and Hinnant (2008) found that people with higher self-reported levels of knowledge of online-related terms are more likely to visit websites that can have a substantial influence on the development of their human and financial capital. Consequently, the disparity in digital competence might exacerbate existing social inequalities (van Deursen & van Dijk, 2011). These studies indicate the importance of mastering ICT competences and underline their importance as educational outcomes next to traditional curriculum content and attainment targets. Recently, certain national governments have recognized this importance and have designed and issued ICT curricula for their schools. Thus, gaining ICT competences is becoming a compulsory educational outcome and schools and teachers are being entrusted with the responsibility of providing pupils with equal opportunities for developing them (Vanderlinde, van Braak, & Hermans, 2009).

Next to national governments, research on ICT in education has also been paying more attention to this notion of ICT competences. However, in such research two problems seem to arise. First, studies that have identified factors related to ICT competences mostly focus on the pupil level and do not take into account the larger educational and social context (i.e., the context in which pupils develop such competences) (Bunz, Curry, & Voon, 2007; Hargittai & Shafer, 2006; van Deursen & van Dijk, 2011). However, nowadays it is widely accepted

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that research investigating the impact of certain factors on educational outcomes – such as ICT competences – should be multilevel in nature (Creemers & Kyriakides, 2008), reflecting a pupil, classroom, school and overall context level. At present, research on ICT competences, is mainly directed towards pupil level factors (e.g. sex, ICT attitude, out of school ICT experience (van Deursen & van Dijk, 2011; Kuhlemeier & Hemker, 2007; Wu & Tsai, 2006)) and less towards factors at the classroom level (e.g. ICT experience in the classroom, ICT competences of the teacher (Claro et al., 2012; Evers, Sinnaeve, Clarebout, van Braak, & Elen, 2009)), school level (e.g. availability of an ICT coordinator, a school's policy on educational ICT use (Berge, Hatlevik, Kløvstad, Ottestad, & Skaug, 2009; Vanderlinde, Dexter, & van Braak, 2012)) and general or overall context level (e.g. ICT penetration rate of a country, educational expenditure (Zhong, 2011)). The second problem is that most studies are conducted in the context of post-primary education (Meelissen, 2008). However, in terms of national and international curricula for early childhood and primary education, research indicates that ICT competences should already be taught at an early age (Aesaert et al., 2013). Therefore, this study focuses on ICT competences in the context of primary school. As such, the purpose of this study is twofold:

- First, to develop a multilayered, extensive conceptual model that integrates school, classroom, and pupil level factors that are likely related to primary school pupils' ICT competences. The conceptual nature of our model is emphasized as well as its need for empirical validation in future research.
- Second, to develop and validate a range of quantitative research instruments that can be used to measure the factors integrated in the said conceptual model.

2. ICT competences

The notion of 'competence' has been conceptualized in different ways in the literature, and can be categorized as those which follow a *theoretical* perspective and those which follow an *operational perspective* (Westera, 2001). From a theoretical perspective, a competence is defined as a basic cognitive structure that is distinguished from, but facilitates specific behaviors or performances. From an operational perspective, competences refer to higher-order skills or behaviors employed in complex and unpredictable situations. According to Westera (2001), these competences include knowledge, skills, attitudes, metacognition and strategic thinking.

Markauskaite (2007) considers ICT literacy and ICT competences from an operational perspective. The author defines them as the interactive use of 1) general cognitive abilities, and 2) technical abilities which function to successfully complete cognitive-information and ICT-based tasks. ICT competence scales largely focus on subcategories of computer and internet use, such as web navigation and web editing skills (Bunz, 2004), hardware operating skills (Donker & Reitsma, 2007), higher-order information processing skills, online communication skills (Liang & Tsai, 2008), online exploration (Tsai & Tsai, 2010), and basic and maintenance skills (Verhoeven, Heerwegh, & De Wit, 2010). van Deursen and van Dijk (2011) consider ICT competences from the perspective of a range of internet skills, including operational internet skills (basic skills), formal internet skills (navigation and orientation), information internet skills (locating required information) and strategic internet skills (taking advantage of the internet). The authors particularly stress the hierarchical structure of these categories, i.e., information and strategic internet skills, which are content related and depend on the operational and formal internet skills, which are considered medium related. This means that one needs to possess the medium-related skills in order to properly employ the content related skills.

In this study, ICT competences are considered from an operational perspective, where the integrated, hierarchical structure of skills is taken into account. This means that ICT competences refer to higher-order learning processing competences that integrate technical and application skills (Aesaert et al., 2013). The technical and application skills refer to the use of basic software, such as saving a text, sending an e-mail, word processing, etc. (Volman, van Eck, Heemskerk, & Kuiper, 2005). The higher-order learning processing skills refer to the ability to be creative, innovative, solve problems and think critically with a computer, such as communicating and searching, synthesizing and evaluating information in a digital context (Claro et al., 2012; European Commission, 2008). With this definition of ICT competences, the question arises as to what factors contribute to explaining differences in these complex abilities.

3. Research aims

As mentioned, most studies on ICT competences focus solely on pupil level factors and do not take into account the multilayered structure in which they are embedded. Zhong's (2011) study is an exception, as the author offers a well-considered overview of factors at the context level (i.e., ICT penetration rate of a country, educational expenditure), the school level (i.e., school type, ICT access at school) and the pupil level (i.e., socioeconomic status, ICT access at home, previous ICT experience, gender) that are understood to affect pupils' self-perceived ICT competence (defined as ICT self-efficacy) in secondary schools. However, in Zhong's (2011) study certain important factors are not taken into account, such as teachers' ICT competences, the schools' ICT policy, or the support that pupils receive at home when they work with a computer. The latter factor can be considered as important, as some single level studies already found a positive relationship between pupils' ICT competences and the support they receive at home (Vekiri, 2010). With respect to teachers' ICT competences and a school's ICT policy, the literature has repeatedly stated these factors promote the integration and effective use of ICT in the classroom (Hew & Brush, 2007; Tondeur, Van Keer, Van Braak, & Valcke, 2008). As such, it can also be expected that these factors are related to pupils' ICT competences through the use of ICT in the classroom. Further, Zhong's study (2011) used a self-perceived rather than an actual, performance-based measure of ICT competence. Such measures of pupils' judgment of their competence can have problems related to validity, particularly with respect to self-reported bias (Ballantine, McCourt Larres, & Oyelere, 2007).

The present study attempts to elaborate on Zhong's (2011) research in three ways: 1) ICT competence is conceptualized by means of a self-perceived *and* an actual measure of the construct; 2) a model is developed within the context of primary education; and 3) more factors are integrated at the pupil, classroom and school level. Consequently, *the first aim of this study is to develop an extensive model that contains factors related to primary school pupils' ICT competences at the school, classroom and pupil level*.