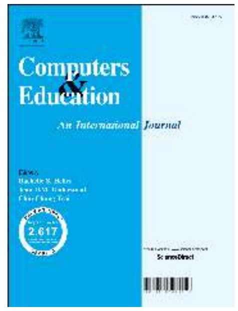


The Contribution of Pupil, Classroom and School Level Characteristics to Primary School Pupils' ICT Competences: A Performance-based Approach

Koen Aesaert, Daniël Van Nijlen, Ruben Vanderlinde, Jo Tondeur, Ines Devlieger, Johan van Braak

PII: S0360-1315(15)00092-5

DOI: 10.1016/j.compedu.2015.03.014

Reference: CAE 2822

To appear in: *Computers & Education*

Received Date: 27 September 2014

Revised Date: 23 January 2015

Accepted Date: 4 March 2015

Title

The Contribution of Pupil, Classroom and School Level Characteristics to Primary School Pupils' ICT Competences: A Performance-based Approach

Authors

Koen Aesaert[a] *, Daniël Van Nijlen[b], Ruben Vanderlinde[a], Jo Tondeur[c], Ines Devlieger[d], Johan van Braak[a]

[a] Department of Educational Studies, Ghent University, Henri Dunantlaan 2, B9000 Ghent, Belgium

[b] Faculty of Psychology and Educational Sciences, Katholieke Universiteit Leuven, Dekenstraat 2, B3000 Leuven, Belgium

[c] Research Foundation Flanders (FWO), Ghent, Belgium

[d] Department of Data Analysis, Ghent University, Henri Dunantlaan 1, B9000 Ghent, Belgium

* corresponding author: Department of Educational Studies, Ghent University, Henri Dunantlaan 2, B9000 Ghent, Belgium. Tel.: +32 9 264 62 52; Fax: + 32 9 264 86 88. E-mail address: koen.aesaert@ugent.be (K. Aesaert)

The Contribution of Pupil, Classroom and School Level Characteristics to Primary School Pupils' ICT Competences: A Performance-based Approach

Abstract: The central aim of this study was to investigate which pupil, classroom and school level characteristics are related to primary school pupils' actual ICT competences. A sample of 378 pupils in 58 schools in Flanders (the Dutch speaking part of Belgium) completed a performance-based ICT competence test in order to measure their actual proficiency in retrieving and processing digital information, and in communicating through a computer. To gather information on the factors at each different level, questionnaires were administered to the pupils, their parents (n=378), their teachers (n=83) and the ICT coordinators (n=58) of the schools. Pupils on average have a low to medium score on the developed ICT competence test. The results of a hierarchical regression analysis with multilevel design show that the differences in ICT competences can be mainly attributed to differences in pupil level characteristics. The results indicate that especially non-ICT related pupil characteristics are associated with differences in primary school pupils' ICT competences, such as introjected regulation, controlling learning style, analytic intelligence, sex and socioeconomic status. Furthermore, the final model also indicates that parental ICT attitudes are related to primary school pupils' ICT competences. With regard to the classroom level characteristics, educational use of ICT as an information tool is significantly related to pupils' ICT competences.

1. Introduction

Within the context of 21st century skills and our information society, the importance of being digitally competent is reflected in international and national policies for educational ICT use (European Commission, 2007; ISTE, 2007; Kozma, 2008). These policies for educational ICT use have introduced ICT competences in national and school curricula (Authors, 2013), i.e., the integration of ICT competences in educational curricula or the development of ICT curricula has formalized the status of ICT competences as educational outcomes. In this regard, Thomas and Knezek (2008) state that ICT competence standards and attainment targets define the achievement expectations for students, and as a consequence ICT competences are considered as educational outcomes.

Educational effectiveness research has shown that pupils' educational outcomes are multilevel in nature (Creemers & Kyriakides, 2008), i.e., differences in pupils' educational outcomes are attributed to factors at different levels, including the pupil, the classroom and the school level. However, with regard to ICT competences as educational outcomes, few studies have taken into account this multilevel aspect. In other words, very few studies have explicitly investigated whether the teacher or the school matters in the development of pupils' ICT competences. Claro et al. (2012) state that besides elaborating on the traditionally used pupil level factors, such as SES, computer access, daily use and confidence in performing ICT-related activities, future research should also focus on the impact of pupils' basic cognitive skills or teachers' particular pedagogical practices that might foster ICT competences.

The purpose of this study is to investigate the degree to which certain factors at the pupil, classroom and school level can explain differences in primary school pupils' ICT competences. As such, we aim to discover whether the teachers and schools play an important part in developing pupils' ICT competences. In order to measure primary school pupils' actual ICT competences – the dependent variable of this study - a performance-based digital test was used. As such, this study tackles the problem of self-reported bias that indirect measures of ICT competence or ICT self-efficacy suffer from. The pupil, classroom and school level characteristics that make up the independent variables of this study were drawn from the Extensive Digital Competence (EDC)-model (Authors, 2014). Measurements of ICT competences mostly target students from secondary and higher education (Meelissen, 2008). Moreover, research in terms of national and international curricula for early childhood and primary education indicates that ICT competences should already be taught at an early age. As such, the focus of this study is on primary school pupils' ICT competences.

2. Theoretical framework

2.1 ICT competences

In his analysis of literacies for the digital age, Martin (2006) explains that the concept of ICT literacy – and the accompanied perception of ICT competences - has gone through a three-stage evolution of *mastery, application* and *reflection.*

In the *mastery* phase (until the mid-1980s) ICT literacy was perceived as knowledge of how the computer works (computer science) and skills on how to master and program it. ICT or computer literacy emphasized learning about information technology rather than learning with or through computers (Carleer, 1984). Tannenbaum and Rahn (1984) expressed this as having a fundamental understanding of the components of the machine, of its history, of the principal application, and as acquiring hands-on skill in programming language.

As operating systems and software applications became more user friendly and products of mass usage, ICT literacy shifted into a more *application* oriented phase (until the late 1990s). Rather than on specialist knowledge, ICT literacy focused on practical basic competences to apply common software in education, work, leisure and home (Martin, 2006). Here it should be noted that skills incorporated in both the mastery and application stage have a technical-procedural dimension. In this context, Hakkarainen et al. (2000) combine the elements of both phases and describe technical ICT skills as students' mastery skills of ICT applications ranging from file management and text processing to authoring tools and programming.

In the third and now dominant *reflective* phase, the focus of ICT literacy has shifted from basic skills and use of applications to a more evaluative and critical use of computers. The acquisition of basic ICT knowledge and skills is considered insufficient in terms of coping with the changes in our ever evolving contemporary society (Voogt, 2008). For instance, retrieving data from the Internet not only requires knowledge of search engines, but it also requires the ability to distinguish between relevant and irrelevant data (Eshet, 2002). From this perspective, ICT competences can be situated in the 21st century skills movement. Rather than mastering basic ICT skills, ICT competence concerns problem solving, information processing, critical thinking, and creative and innovative ICT use (European Commission, 2007). For example, ISTE's National Educational Technology Standards for Students are organized into the following six categories: 1) Creativity and Innovation; 2) Communication and Collaboration; 3) Research and Information Fluency; 4) Critical Thinking, Problem Solving, and Decision Making; 5) Digital Citizenship; and 6) Technology Operations and Concepts (ISTE, 2007). According to Markauskaite (2007), ICT literacy refers to the interactive use of 1) general cognitive capabilities, and 2) technical capabilities in order to successfully complete cognitive information and ICT-based tasks. Definitions of ICT literacy in general cover both sets of capabilities in different areas of problem solving and other generic activities, such as the ability to use technology and communication tools to identify, access, manage, integrate, evaluate and create information, such that individuals can function proficiently in our knowledge society (ETS, 2002; European Commission, 2007). Furthermore, Markauskaite's (2007) description of ICT literacy is strongly related to the notion that the mastery and application phases are subordinate to the reflective phase (Martin, 2006) i.e., the technical and application oriented skills need to be mastered in order to come to the more critical, higher-order ICT competences. Within the context of the reflective phase, this study perceives ICT competence as a multilayered and complex construct. An ICT competence refers to a higher-order learning-process oriented competence used in complex, authentic and unpredictable situations, and is underpinned by technical and application ICT knowledge and skills (Authors, 2013).

Research on the assessment of ICT competences can be divided into studies using self-reported measures of ICT competence or ICT self-efficacy (indirect measurement) and studies using an observation or performance-based approach (direct measurement) (Litt, 2013). The literature indicates that most of the research is directed towards self-reported measures of ICT competences or ICT self-efficacy. However, such indirect measures can suffer from validity problems as their results are based on pupils' own judgment and expectations of successfully performing computer and internet related tasks (Hargittai, 2005; Meelissen, 2008; Merritt, Smith, & Di Renzo, 2005). As self-report data do not always accurately reflect pupils' actual ICT competences, conclusions drawn from such studies can be misleading. On the other hand, direct measurement methods gather data on pupils' actual performance by analyzing observable, performance-based data, such as simulation-based tasks or portfolios (Messick, 1994). Such tasks are more authentic and therefore considered as more valid (Wirth, 2008). In order to tackle the validity problem of self-report bias, this study used a direct measure to assess primary school pupils' actual ICT competences. This direct measure is based on an analysis of pupils' performance on simulation-based hands-on tasks with a computer (Authors, 2014).

2.2 Digital information processing and communication

In order to measure the complexity of an ICT competence in a direct and valid way, a performance-based test with authentic tasks was used in this study. Details on the development and validation of the test can be found in Authors (2014). Because the administration of a performance-based test takes time, it was not feasible to measure all of the competences included in the broad construct of ICT competence. For example, the construct of ICT competence not only refers to the ability to locate, manage or process digital information, but also refers to more creative and expressive forms of digital media production and social online activities (Ito et al., 2009). Digital information processing and digital communication were chosen as ICT competences to be measured because these are identified as two essential reoccurring themes in national and international ICT frameworks and curricula (Voogt & Roblin, 2012).

A literature review was conducted to identify the higher-order competences that make up both of these themes (AASL, 1998; ACRL, 2000; Ananiadou & Claro, 2009; Brand-Gruwel, Wopereis, & Vermetten, 2005; Eisenberg & Johnson, 2002; Eisenberg, 2005; ETS, 2002; Fraillon & Ainley, 2010; ISTE, 2007; Kuiper, 2007; Madden, Ford, Miller, & Levy, 2006; NCREL, 2003; Puustinen & Rouet, 2009; Savolainen, 2002; Somerville, Smith, & Macklin, 2008; Tsai & Tsai 2003; Tsai, 2009). With regard to digital information processing, the higher-order competences in this study concern getting access to digital information, transforming digital information and creating digital information. The higher-order competences for digital communication refer to communicating in a socially acceptable way, communicating in an understandable way and the dissemination of information by the use of computers. An overview of the higher-order competences and the related technical and application oriented ICT skills can be found in Appendix a.

2.3 Factors related to ICT competences: the EDC-model

As mentioned in the introduction, few studies have looked at ICT competences from more than just one level. Zhong (2011) investigated whether the ICT penetration rate of a country and its educational expenditure (context level), the school type and ICT access at school (school level); and the gender, socioeconomic status, previous ICT experience and ICT access at the pupil's home (pupil level) were related to the self-reported digital skills of secondary school students. Sackes, Trundle and Bell (2011) found that computer access at school and gender are positively related to the development of young children's computer skills, whereas SES and computer access at home are not. Furthermore, early research of Compeau and Higgins (1995) and Fagan, Neill and Wooldridge (2003) indicates that factors at the meso level – such as organizational support – can be related to self-perceived computer skills or computer self-efficacy. Although all these studies have great value for the initial identification of factors at different levels related to ICT competences, the majority is conducted using indirect measures of ICT competence.

Similar to the limited number of studies investigating factors related to ICT competences from a multilevel perspective, almost no models exist that indicate which factors at different levels (e.g., pupil, classroom and school level) are related to pupils' ICT competences. In order to cope with this problem and to study pupils' ICT competences from different levels, Authors (submitted) developed the Extensive Digital Competence (EDC) model (see Figure 1).

This conceptual model consists of pupil, classroom and school level factors that are expected to relate to primary school pupils' ICT competences. Pupils' ICT competences are considered as the output or dependent variable of the model and refer to the integrated unit of 1) higher-order communication and information processing skills and knowledge; and 2) technical and application ICT knowledge and skills. Within the framework, the output variable of ICT competence is considered as an actual measure as well as a self-reported measure such as ICT-self-efficacy. In this study, only the actual measure of ICT competence is considered as dependent variable. The pupil, classroom and school level characteristics that make up the independent variables of the model are categorized into six clusters: ICT-related school characteristics; ICT-related classroom characteristics; ICT-related pupil characteristics, ICT-oriented home situation characteristics, sociocultural and economic characteristics and general educational pupil characteristics. We will elaborate on the different characteristics of the EDC-model in section 4.2. Instruments.

[Please insert Figure 1 here]

Figure 1: The EDC-model

3. Research objective

The aim of this study is to investigate the degree to which differences in primary school pupils' actual ICT competences can be attributed to differences in certain characteristics at the school, classroom and pupil level. These characteristics make up the independent variables of this study and are based on the EDC-model of Authors (submitted). Primary school pupils' actual ICT competences were measured using the performance-based ICT competence scale of Authors (2014). This study elaborates on earlier research on factors related to ICT competences by using a direct and standardized measure of ICT competence as well as a multilevel approach for the identification of possibly related factors.

4. Method

4.1 Sample

In order to measure the level of primary school pupils' ICT competences, the performance-based test was administered to a representative sample of 378 sixth graders from 83 classes in 58 schools in Flanders, the Dutch speaking part of Belgium. In order to guarantee school representativeness to the total Flemish school population, a stratified sample design was used. The total Flemish school population was explicitly stratified for school size (small school < 180 pupils; large school ≥180 pupils) and educational network (subsidized public-authority education, subsidized private-authority education and official public education). Further, the schools were implicitly stratified for province (five provinces in Flanders). Based on the two explicit stratification factors, a 2 x 3 –matrix of six school subpopulations (strata) was created. In each stratum, the schools were sorted according to province. From the different strata, the schools were randomly selected. Finally, pupils were randomly selected in each school, with an average of 6.52 pupils/school. Of the pupils, 50.0% were male and 50.0 % were female. Ages ranged from 10.79 to 13.85 years old (M=12.06, SD=0.46).

In order to investigate the effect of the factors at the pupil, classroom and school level, surveys were administered to the pupils that conducted the performance-based test (n=378), their parents (n=378), their sixth grade teacher (n=83) and the ICT coordinator (n=58) of their school. Of the teachers, 31.3% were male and 68.7% were female. Teaching experience ranged from 2 to 38 years (M= 18.15 SD=10.33). Of the ICT coordinators, 78.2% were male and 21.8% were female.

4.2 Instruments

4.2.1 Dependent variable

As mentioned above, this study focuses on ICT competence as the use of a computer to process and communicate digital information. To measure the dependent variable in a direct way, the ICT competence scale of Authors (2014), based on the EDC-model, was used. The 27 items of this scale focus on higher-order learning-processing ICT competences as well the underlying technical and application ICT skills that pupils need to process digital information and to communicate in a digital way. All items are performance-based in nature and integrated in a simulation-based computer environment. This means that pupils need to demonstrate their ICT competence by actually interacting with computer applications and software.

Figure 2 shows the interface of a task in which pupils were asked to ask their teacher for information via e-mail. All items of the ICT competence scale have a binary answer-format depending on the pupils answering the items correctly or incorrectly. An extensive outline of the development of the software and the Item Response Theory analysis for the validation of the scale can be found in Authors (2014). The items can be found in appendix A. Some items are listed more than once as they were measured through different tasks in the test.

[Please insert Figure 2 here]

Figure 2: General task interface of the performance-based ICT competence test

4.2.2 Independent variables

The independent variables of this study refer to the pupil, classroom and school level characteristics of the EDC-model.

ICT related pupil characteristics refer to the degree to which pupils value the use of ICT outside the school. The following two factors were included in this study:

- *'ICT experience'* is defined as the weekly time spent on a computer/internet outside the school. In the EDC-model this is operationalized as the number of hours per week that children use a computer and the Internet at home.
- The *'pupils' ICT attitude'* (5 items) scale of Authors (submitted) measures the degree to which pupils perceive 1) themselves as personally interested and confident computer users; and 2) the use of computers as useful.

In the category *ICT oriented home situation characteristics*, factors refer to parental investments that can have an impact on the child's ICT competences. The following three characteristics are integrated in the EDC model:

- The '*parental ICT support*' scales of Authors (submitted) measure the degree to which parents try to control and socialize their child's ICT use. The first scale *'active ICT support'* (13 items) measures the degree to which parents provide assistance by doing ICT activities together with their child as well as communicate with their child about ICT use. The second scale *'ICT rules'* (5 items) assesses the degree to which parents impose rules to their children about their ICT use and discuss them. Both scales are based on the work of Valcke, Bonte, De Wever and Rots (2010) about Internet parenting styles.

- *'Parental ICT attitude'* is defined as the parents' beliefs about the general importance and usefulness of being able to work with a computer. The '*parental ICT attitude'* (5 items) scale of Authors (submitted) measures the degree to which parents believe that the development of ICT competences is useful for their child and will result in educational, social and economic profits.
- *'ICT availability'* refers to the opportunities that parents create for their children to develop ICT competences by providing them with the necessary technological infrastructure. In the EDC-model, and in this study, this is operationalized as having no internet access at home, having internet access only through a computer that is shared by all family members, having internet access only through a private computer, and having internet access through both a private and shared computer.

The *general educational pupil characteristics* are derived from a more psychological point of view. They refer to non-ICT-related psychological-educational pupil background characteristics that can have an influence on pupils' outcomes, such as ICT competences. A distinction is made between the following three characteristics:

- *Learning motivation* was measured using the four adapted self-determination theory-scales of Vandevelde, Van Keer and Rosseel (2013). The items of the four scales represent the constructs of *extrinsic regulation* (3 items), *introjected regulation* (4 items), *identified regulation* (4 items) and *intrinsic motivation* (4 items). These were adapted from the academic self-regulation scale (Ryan & Connell, 1989; Vansteenkiste, Sierens, Soenens, Luyckx & Lens, 2009) and validated by Vandevelde et al. (2013) for their use in primary education. Authors (submitted) adapted the *amotivation* (4 items) scale of the Academic Motivation Scale of Vallerand et al. (1992) as a fifth construct for its use in primary education.
- The *learning style* scales of Authors (submitted) were adapted from the learning by reading strategy scales of the PISA 2009 student background questionnaire (Schleicher, Zimmer, Evans, & Clements, 2009). The scales include *'control'* (3 items), *'memorization'* (3 items), and *'elaboration'* (3 items) as three ways of learning. The control scale measures the degree in which students report whether they learn by planning, monitoring and regulating their learning process. The memorization scale assesses the extent to which pupils indicate whether they learn by repeating the learning material and learning key words. The elaboration scale measures the degree to which pupils report whether they learn by connecting the learning subject to related areas of thinking or by finding alternative solutions (OECD, 2004).
- *Analytic intelligence* refers to a pupil's ability to deal with novelty and to adapt their thinking to a new cognitive problem without relying on declarative knowledge derived from schooling or previous experience (Carpenter, Just, & Shell, 1990). In the EDC-model, analytic intelligence is perceived as a measure of aptitude and assessed with the non-verbal Raven Standard Progressive Matrices Test (60 binary items) (Raven, Raven, & Court, 2003).

The EDC-model includes the *sociocultural and economic characteristics sex, age and socioeconomic status*. SES was coded as the highest educational level of the mother. A distinction was made between having no primary education diploma, having a primary education diploma, having a lower secondary education diploma, having a higher secondary education diploma, and having a college or university degree.

ICT related classroom characteristics can be divided in two types. The first set of characteristics refers to the teacher's own ICT knowledge, skills, attitudes and the degree in which he takes initiative in developing them. The second set of characteristics focuses on the conditions that the teacher creates in the classroom in order for pupils to develop ICT competences.

- The '*Teachers' ICT competencies* (5 items) scale of Authors (2010a) was used in this study. The items express the degree to which teachers consider themselves technical, organizational and pedagogically-didactically competent for integrating ICT into the classroom.
- The *'Teacher's ICT attitude'* (5 items) scale of Authors (submitted) is similar to the parental ICT attitude scale. As such, these items measure the degree to which teachers believe that the development of ICT competences will result in educational, social and economic profits for pupils.
- *'Teachers' ICT professional development'* (4 items) is defined as the initiatives that teachers take in order to improve their ICT competences and the integration of ICT in education (Authors, 2010a).
- *'Logistic appropriateness'* was measured using the ICT -infrastructure (4 items) scale of Authors (2010a). This scale measures the degree to which teachers are pleased and satisfied with the ICT equipment available in the class and in the school.
- *'ICT use'* refers to the way in which pupils use ICT in the classroom. Authors (2010a) revised the '*computer use in primary education'* scales of Authors (2007). The scales make a distinction between three types of ICT use in the classroom (i.e., the use of ICT as an information tool, the use of ICT as a learning tool and the use of basic ICT skills).
- *'ICT experience'* as an ICT-related classroom characteristic refers to the number of lessons in which children are given the opportunity to work with a computer in the classroom.

ICT-related school characteristics refer to organizational factors that could affect the teaching and learning of ICT competences at school. Four ICT-related school factors are included in the EDC-model:

- The *'roles of the ICT coordinator'* (19 items) scales of Authors (2010b), refer to the tasks that the ICT coordinator can fulfill in a school. A distinction is made between the ICT coordinator as a planner, budgeter, educationalist and technician.
- The *'school's ICT vision and policy'* (7 items) scale of Authors (2010a) was used to measure the degree to which the school has 1) a clear vision on the place of ICT in education; and 2) a policy and policy plan with regard to ICT integration.
- *'ICT support'* at the school level is defined as the degree to which technical and pedagogical ICT support, and ICT coordination are arranged at the school. The ICT support and coordination (7 items) scale of Authors (2010a) were used in this study.
- *'ICT infrastructure'* is operationalized as the ratio between the total number of computers available to the pupils at the school and the number of pupils at the school.

4.3 Analytic approach

The pupils of the sample (level 1) are nested in classes (level 2), which are in turn nested within schools (level 3). In order to take this hierarchical structure of nested variables into account, multilevel modeling in which the dependent variable is allowed to vary at three levels - i.e., the pupil, classroom and school level - would be advised. However, the level 2 sample size (of maximum three teachers per school) is too small and would produce inaccurate estimates and standard errors. Consequently, it was decided to use a two-level design (pupil and classroom level) to investigate the effects of the different characteristics of the EDC-model. The average sample size was 4.55 students per classroom (with a minimum of 1 and a maximum of 12 students/classroom).

Considering the EDC-model, eight models are tested in this study. First, an unconditional null model (model 1) was tested in order to investigate whether a multilevel approach is advisable compared to a single level linear regression. Following this, ICT related pupil characteristics (model 2), ICT oriented home situation characteristics (model 3), general educational pupil characteristics (model 4), sociocultural and economic characteristics (model 5), ICT related classroom characteristics (model 6) and ICT related school characteristics (model 7) were added to the following six models. Finally, the pupil level factor ICT self-efficacy was added to the final model (model 8). This was considered necessary as previous research indicates that ICT self-efficacy is positively related to ICT use and performance (Barbeite & Weiss, 2004; Torkzadeh, Chang, & Demirhan, 2006). Nevertheless, this was done in a separate model because ICT-self efficacy is considered as an indirect measure of ICT competence and as a dependent variable within the EDC-model. The ICT-self-efficacy scale (18 items) of Authors (submitted) was used for this purpose. Factors that did not significantly contribute to the model were removed from the analysis of the subsequent models. Using this stepwise approach enabled us to check for the additional value of each subset of variables to the model as well as to the proportion of explained variance (Gorard, 2003). The difference in deviance of two models – a test statistic having a chi-squared distribution (Snijders & Bosker, 2012) - is used to check model improvement. More specifically, a decrease in the deviance between consecutive models indicates model improvement.

5. Results

5.1 Primary school pupils' ICT competences

The dependent variable 'primary school pupils' ICT competence' was measured using the ICT competence scale of Authors (2014). This unidimensional scale was developed using Item Response Theory. This measures the degree to which primary school pupils are competent at locating and processing digital information, and communicating through a computer. Pupils who are less competent in ICT are located at the bottom of the scale whereas the more competent pupils are located at the top of the scale (see Table 1). The unit and origin of the scale are fixed at zero mean and one unit variance. Each bar on the histogram represents the frequency of pupils within a certain ability score interval of 0.2 points on the ICT competence scale, i.e., each bar covers the number of students with a certain ICT competence level.

The average ability score of the 378 pupils is -0.08 (SD= 0.06) with a maximum ability score of 1.90 and a minimum score of -2.96. The results in Table 1 indicate that the majority of pupils have a medium to low-medium score on the ICT competence scale. No pupils are located in the highest ability intervals, whereas about 10 % seem to be located in the lowest levels of the scale.

[Please insert Table 1 here]

Table 1: Frequencies of primary school pupils on the ICT competence scale

5.2 Factors related to ICT competences

5.2.1 Descriptive statistics and reliability of the instruments

In order to check the psychometric quality of the independent variables that were integrated in the regression model, Cronbach's alphas are presented in Table 2. Except for the learning style scales, all instruments have an acceptable to good internal consistency with alphas varying between .68 and .91. This means that the findings with regard to the learning style items should be interpreted with caution. As can be seen in Table 2, the correlation coefficients between the exploratory variables were rather low, indicating that the assumption of no perfect multicollinearity was not violated. As such, the measures were acceptable for use in a regression analysis.

With exception of age, ICT experience and ICT infrastructure, all means are located on a scale with a theoretical minimum of 0 and a maximum of 100. Analytic intelligence (minimum= 0; maximum=60) and the dependent variable ICT competence (minimum= -3; maximum=3) were expressed on their original scale. Because the factor ICT support (school level) was measured at the teacher level, an aggregated measure at the school level was calculated using the mean over teachers within a school. In order to check whether teachers' reported ICT support was shared at the school level, the intraclass correlation coefficient (ICC= (between mean square–within mean square)/between mean square) was calculated as an index of mean rater reliability (Van Houtte, 2004). As the ICC had a value of .60, it did not meet the cutoff score of .70 (Dixon & Cunningham, 2006). Consequently, the aggregated measure of ICT support was not considered as a reliable school level factor and was removed from further analysis. This was to be expected since the number of teachers per school only varies between 1 and 3. According to Snijders and Bosker (2012) the reliability of aggregated variables decreases as the number of micro-units per macro-unit decreases.

[Please insert Table 2 here]

Table 2: Descriptives, reliability coefficients and and correlates of the used scales

5.2.2 The regression model

Model 1: the null model

As mentioned above, the level 2 sample size was too small to allow ICT competence to vary at three levels. As such, the null model was only allowed to vary at the classroom and pupil level. No independent pupil (level 1), classroom (level 2) and school (level 3) variables were added to the two-level random intercepts model. As such, the intercept of this model -0.079 represents the overall mean ability in ICT competence of all pupils in all classes. The results in Table 3 indicate that the within-class variance (pupil level; σ^2_{e0}=.803, χ^2= 152.144 d*f*=1, p<.001) significantly differs from zero, but the between-class variance (classroom level; σ^2_{u0}=.069, χ^2= 3.021 d*f*=1, p=.082) does not. Only 7.91 % of the total variance is attributed to differences between classes and 92.09 % to differences between pupils. Although the between class variance is not significant, the ICC has a value .079. As this is above .05, it supports the use of multilevel modeling (Snijders & Bosker, 1999). Moreover, the difference in deviance between the single level model and the two level null model, indicates that the null model fits the data better(χ^2=4.50, d*f*=1, p<.005). As such, multilevel analysis was used to model the data adequately.

Model 2: ICT related pupil characteristics

In the second model, the ICT related pupil characteristics, ICT experience and pupil's ICT attitude, were added as extra explanatory variables to the fixed part of the model. However, both ICT experience and pupils' ICT attitude did not lead to a significantly higher mean level of ICT competence (χ^2= .677, d*f*=1, p=.411 and χ^2=.095 = d*f*=1, p=.758 respectively). Consequently, both factors were omitted for the subsequent analyses.

Model 3: ICT oriented home situation characteristics

In the third stage of model specification, the model was extended by adding the factors: parental active ICT support, parental ICT rules, parental ICT attitude and ICT availability at home. With regard to ICT availability, 'having no internet access at home' was chosen as the reference category. As such, model 3 allows us to investigate whether the degree to which the home situation as ICT oriented affects pupils' score on the ICT competence test.

Because there was no significant effect of parental active ICT support (χ^2=.053, d*f*=1, p=.820), parental ICT rules (χ^2=.920, d*f*=1, p=.337), and ICT availability (i.e., shared computer: χ^2=.394, d*f*=1, p=.530; private computer: χ^2=1.190, d*f*=1, p=.275; shared and private: χ^2=.729, d*f*=1, p=.393) in model 3a, these factors were not used in model 3b. Parental ICT attitude significantly contributed to the model (χ^2=9.620, d*f*=1, p<.01).

In model 3b, the intercept -0.102 represents the overall mean ICT competence of pupils who have parents with an average score on the ICT attitude scale. The positive slope of parental ICT attitude indicates that with every increase of one unit, the mean level of ICT competence slightly but significantly increases by 0.009. Adding parental ICT attitude resulted in a significantly better fit of model 3b over the null model (χ^2=101.030, d*f*=1, p<.001).

Model 4: general educational pupil characteristics

Subsequently, the subscales with regard to learning motivation and learning style, as well as analytic intelligence were added to the model. With regard to learning motivation, introjected regulation was the only factor that made a significant contribution and was retained in model 4b. The results indicate that the more students' learning is driven by negative feelings of shame and guilt, or positive feelings of pride towards others, the lower their score on the ICT competence scale (mean=-0.092 - 0.008= -0.100, χ^2= 14.211, d*f*=1, p<.001).

With regard to learning style, the techniques of memorization and elaboration were not significantly related to pupils' ICT competences, and thus removed from further analysis. On the other hand, planning, monitoring and regulating the learning process (control) leads to a significantly higher mean level of ICT competence (mean= -0.092 +0.007=-0.085, χ^2= 9.590, d*f*=1, p<.01). We stress that these results should be interpreted with caution, as the internal consistency of the learning style scales was rather low.

Finally, a significant positive relation was found for analytic intelligence. The positive slope indicates that every increase with one point on the Raven Progressive Matrices Test is reflected in a substantial increase of the mean level of ICT competence by 0.059 (mean= -0.092 +0.059=-0.033, χ^2= 58.380, d*f*=1, p<.001). The intercept -.092 of model 4b represents the overall mean for ICT competence across pupils with an average score on parental ICT attitude, introjected regulation, control and analytic intelligence. Compared to model 3b, the addition of these factors resulted in a significantly better model fit (χ^2=138.28, d*f*=3, p<.001).

Model 5: sociocultural and economic characteristics

In the fifth model, the demographic factors sex, age and highest educational level of the mother (reference category: no primary education diploma) were added as final pupil level variables to the fixed part of the model.

Because age did not make a significant contribution (χ^2=.481, d*f*=1, p=.488), it was no longer integrated in model 5b. However, sex was related to pupils' ICT competences in favor of girls. Girls have a significantly higher mean level of ICT competence than boys (mean=-1.119 + 0.287=-0.832, χ^2=10.263, d*f*=1, p<.01). A significant relationship with socioeconomic status was observed in favor of pupils having a mother with a lower secondary education diploma (mean= -1.119 +0.766=-0.353, χ^2= 5.207, d*f*=1, p<.05), of pupils having a mother with a higher secondary education diploma (mean=-1.119 +.826=-.293, χ^2= 6.480, d*f*=1, p<.01), and of pupils having a mother with a higher education degree (mean=-1.119 +1.063=-0.056, χ^2= 10.667, d*f*=1, p<.01) as compared to pupils having a mother without any degree. ICT competences of pupils having a mother with a primary school degree did not significantly differ from the competences of pupils having a mother without any educational degree. These results indicate that the higher the educational degree of the mother, the higher is the mean level of ICT competence of the pupils. Model 5b was a significant improvement to model 4b (χ^2= 40.595, d*f*=5, p<.001).

Model 6: ICT related classroom characteristics

In this stage of model specification, the ICT related classroom characteristics, i.e. ICT competences, teacher's ICT attitude, ICT professional development, logistic appropriateness, ICT use as information tool, ICT use as a learning tool, ICT use for basic skills and ICT experience were integrated into the model. With exception of ICT use as an information tool, none of these factors made a significant difference to the model. Consequently, all of them were eliminated for further use in model 6b. The positive slope 0.008 indicates that pupils who are regularly given the opportunity to use ICT in the classroom as an information tool have a higher score on the ICT competence scale (χ^2= 6.169, d*f*=1, p<.05). Adding the factor ICT use as an information tool leads to a significant improvement of the model fit in comparison with model 5b (χ^2= 42.155, d*f*=1, p<.001).

Model 7: ICT related school characteristics

In the seventh model, ICT related school characteristics were added as explanatory variables to the fixed part of the model. As can be seen in Table 3, none of the added variables contributed to the model in a significant way (ICT coordinator as planner: χ^2= 0.011, d*f*=1, p=.92; ICT coordinator as a budgeter: χ^2= 2.900, d*f*=1, p=.089; ICT coordinator as a technician: χ^2= 1.519, d*f*=1, p=.218; ICT coordinator as an educationalist: χ^2= 0.720, d*f*=1, p=.396; school's vision and policy on ICT: χ^2= 1.813, d*f*=1, p=.178; ICT infrastructure: χ^2= 0.635, d*f*=1, p=.426). Consequently, all ICT related school factors were removed from the model.

Model 8: adding ICT self-efficacy

In the final stage, ICT self-efficacy was added to the model. Although this factor is situated at the pupil level, it was integrated at the end of the analysis. The reason for doing this was because within the EDC-model, ICT self-efficacy is considered as a dependent variable, i.e., an indirect measure of ICT competence. The positive slope 0.013 indicates that sixth-grade pupils who consider themselves as more competent in ICT have higher actual ICT competences (χ^2=13.023, d*f*=1, p<.001). Compared with model 6b, the addition of ICT self-efficacy leads to significant model improvement (χ^2=61.890, d*f*=1, p<.001).

In order to explore the proportion of variance explained by each model, the squared multiple correlation coefficient R^2 was calculated (see Table 4). ΔR^2 was used to investigate the proportion of variance explained by each subset of variables that was integrated in the subsequent models. As a two level model was used, the proportion of explained variance is divided into the explained variance at the student level and at the classroom level. R^2_1 at the student level is defined as the proportional reduction of error for predicting an individual outcome with $[R^2_1=1-((\sigma^2_{e0}+\sigma^2_{u0})_{\text{conditional model}}/(\sigma^2_{e0}+\sigma^2_{u0})_{\text{unconditional model}}))]$. R^2_2 at the classroom level is defined as the proportional reduction of error for predicting a group mean $[R^2_2=1-(((\sigma^2_{e0}/\tilde{n})+\sigma^2_{u0})_{\text{conditional model}}/((\sigma^2_{e0}/\tilde{n})+\sigma^2_{u0})_{\text{unconditional model}}))]$ (Jee-Seon, 2009; Snijders & Bosker, 1999).

As the variance at the classroom level was not significant, we are only interested in the variance at the student level R^2_1 . As can be seen in Table 4, model 3b only accounted for 0.92% of the variance in primary pupils actual ICT competences. Adding the educational pupil factors introjected regulation, controlling learning style and analytic intelligence resulted in a substantial increase of 24.08% of variance explained. Compared to the model 4b, the proportion of explained variance rises with 6.31% in model 5b, due to the addition of sex and SES. Adding the classroom characteristic ICT use as an information tool increased the proportion of variance explained with 2.29%. In the end, ICT self-efficacy added another 2.64%, leading to a final model that explains 36.23% of the variance in primary pupils ICT competences.

[Please insert Table 3 here]

Table 3: Estimates and standard errors from the random intercept model (dependent variable: pupils' ICT competences)

[Please insert Table 4 here]

Table 4: Proportion of variance explained

6. Discussion and conclusion

The main aim of this study was to explore the degree to which differences in primary school pupils' actual ICT competences are related to differences in certain pupil, classroom and school level factors. The results indicate that the majority of sixth graders have a medium to low score on the developed ICT competence test, with only a slight minority performing at a more advanced level. These findings support the results of Van Deursen and Van Diepen (2013) who found that secondary students' level of information and strategic Internet skills have much room for improvement. It is interesting to consider these findings within the context of the debate about pupils as digital natives. The widely accepted and popular claims that a generation of digital natives exists, and that education must make fundamental adaptations in order to cope with the needs of this generation, are merely based on assumptions with a weak empirical foundation (Bennett, Maton, & Kervin, 2008; Jones, Ramanua, Cross, & Healing, 2010). One of these assumptions is that digital natives possess sophisticated digital knowledge and competences. However, according to Bennet et al. (2008) these ICT competences are far from universal among young people and its complexity and diversity should be studied more intensively. The results of this study show that the majority of primary school pupils have a medium to low score on the performance-based ICT competence test with regard to retrieving, processing and communicating digital information. This indicates that digital natives are perhaps not as computer and internet savvy as it is often assumed. Moreover, this indicates that pupils do not develop high levels of ICT competence simply by using ICT at home or in informal settings, and that formal education in this matter is required. If education must make fundamental adaptations to the needs of this generation, the content of these needs should be reconsidered. Educational adaptations should not only reflect the skills that teachers do not yet possess, but especially the higher-order skills and competences that pupils do not yet possess. As such, professional development should not only focus on teachers' ICT competences, but also – and perhaps primarily - on initiatives that help teachers develop the ability to identify low levels of specific ICT competences of their pupils.

The results of the regression analysis indicate that a large proportion of the variance is situated at the pupil level, while only small and non-significant differences can be observed between classes. These results suggest that no shared levels of ICT competences exist for particular classes and that ICT competences mainly can be considered as a pupil phenomenon. A possible explanation is that pupils, in general, still do not use ICT intensively enough in the classroom in order for it to make a difference in the development of their ICT competences. For example, the results of this study indicate that primary school sixth graders on average are given the opportunity to use ICT in only three to four lessons per week and that this frequency of opportunity is not related to pupils' ICT competences. Consequently, it would be interesting to conduct a similar study in which the frequency or intensity of ICT use in the classroom is being controlled. More specifically, future research could investigate the degree to which the effect of certain classroom and school level characteristics is being mediated through the intensity of ICT use in the classroom. For example, it can be expected that pupils that have a very ICT competent teacher and that are given enough opportunities to learn from the teacher, will have better ICT competences compared to pupils that also have a very ICT competent teacher but are not given the opportunity to benefit from his or her competence.

The stepwise approach in the regression model made it possible to identify the specific pupil and classroom level factors of the EDC-model that relate to primary school pupils' ICT competences. With regard to ICT related pupil factors, ICT self-efficacy seems to explain a part of the variance in primary school pupils' ICT competences. The higher primary school pupils' ICT self-efficacy, the better they score on the ICT competence test. Similarly, Hargittai and Shafer (2006) found that Actual Net Skills are positively related to Self-Assessed Net Skills. Similarly, Tsai and Tsai (2003) found that pupils with higher ICT self-efficacy also have better online information processing strategies. However, this relationship between the directly and indirectly measured ICT competences of pupils requires more detailed investigation. For example, future research could explore whether the discrepancy between pupils' self-perceived and actual ICT competences is related to their actual level of ICT competence. More specifically, can it be assumed that the degree to which pupils are able to make a valid judgment of their own ICT competences is related to their actual competences?

With respect to motivation to learn, the results of this study indicate that pupils whose learning is driven by negative feelings of shame and guilt, or positive feelings of pride towards others, are less proficient in digital information processing and communication. These results are in line with other findings that indicates that introjected regulation is linked to less positive outcomes in other domains (Boiché, Sarrazin, Grouzet, Pelletier, & Chanal, 2008). As these pupils put pressure on themselves, their behavior is associated with feelings of compulsion and conflict. These pupils' lower proficiency in ICT competence can possibly be explained by the fact that introjected regulation predicts a set of undesirable outcomes such as superficial cognitive processing, lower achievement and less engagement in adaptive metacognitive strategies such as concentration (Vansteenkiste et al., 2009).

With regard to these metacognitive strategies, the results of this study also indicate a positive relation between the 'control' learning style and pupils' ICT competence. The more pupils report that they plan, monitor and regulate their learning process while learning, the higher their ability in digital information processing and communication. The fact that these pupils have better scores is possibly explained by the fact that different aspects of information processing, such as locating and judging information, require metacognition (Eisenberg, 2005). These results indicate that in order to produce digitally competent pupils, schools should go further than addressing basic ICT skills and even higher-order ICT competences. Just as it is the case with other subjects, general educational pupil characteristics such as learning style and learning motivation seem to be related to pupils' ICT competences, and should therefore also be stressed within educational ICT use. For example, in order to diminish pupils' introjected regulation, teachers must create conditions that allow their pupils to feel ICT competent. In this context, Ryan and Deci (2000) state that pupils who are directed to perform tasks they are not developmentally ready to master, will remain introjectedly regulated. As such, it is important that teachers can analyze the ICT competence level of their pupils and provide them with challenging but feasible ICT exercises. Pupils who successfully complete these tasks will perceive themselves as more competent. This perceived competence will lead to internalization of regulation, i.e., to more intrinsic motivation, which in turn will yield better ICT competences.

Furthermore, the results of this study indicate that analytic intelligence is related to pupils' level of ICT competence. The better a pupil can deal with novelty and adapt his or her thinking to new cognitive problems, the higher he or she scored on the test. Although this was to be expected, we did not find any other empirical study in the literature that provides evidence for the relationship between cognitive ability and ICT competences. Moreover, we consider it an advantage that analytic intelligence was taken into account in the conducted analyses, as this likely produces more accurate estimates for the other relationships that were found.

With regard to the sociocultural and economic pupil characteristics, both SES and sex were related to pupils' ICT competences, taking their cognitive ability into account. With respect to sex, girls seem to have the upper hand when it comes to digital information processing and communication. As such, this study provides evidence that tackles the traditional assumption of the gender gap in which computer and Internet use has been deemed a more male activity. Looking at the specific type of ICT competences that were tested in this study, our results are supported and possibly explained by earlier findings that state that e-mailing and online communication are the most popular computer activities for girls (Tsai & Tsai, 2010; Volman, Van Eck, Heemskerk, & Kuiper, 2005). Tsai and Tsai (2010) found that girls have about the same confidence as boys in their Internet exploration ability, but significantly higher confidence in their online communication ability. Our results confirm and elaborate the validity of these findings, through measuring ICT competences in a direct way. Moreover, the results of Hohlfeld, Ritzhaupt and Barron (2013) show that secondary school female students produced higher results than their male counterparts on the Student Tool for Technology Literacy, a performance-based assessment. The current study provides evidence that direct assessments can shed a different light on the gender issues concerning ICT competences and that future research should (re)address this subject as more valid assessment techniques and instruments become available. With regard to SES, the results of this study indicate that the higher the educational degree of the mother, the higher the mean level of pupils' ICT competence in digital information processing and communication. These results are in line with other studies indicating a significant positive relationship between pupils' ICT competences and SES (Vekiri, 2010; Volman, 2005). However, the results of this study elaborate on these previous findings, as they show a significant relationship between SES and ICT competence, taking the pupil's cognitive ability into account. As such, these results stress the importance of taking SES - e.g. parents' educational level - into account when studying pupils' ICT competences.

Finally, the degree to which pupils use ICT as an information tool in the classroom is positively related to pupils' digital information processing and communication skills. Although significant variance was only situated at the pupil level, this demonstrates that the type of technological activities that teachers organize in the classroom *do* matter in the establishment of ICT competences. However, these results must be interpreted with caution. Normally, it would be expected that the use of ICT as an information tool in the classroom would explain variance at the classroom level rather than at the pupil level. Although no significant variance was found at the classroom level, it is still possible that the use of ICT as an information tool is more likely related to the insignificant differences at the classroom level than to the variance at the pupil level. As such, the use of a single level model may have hidden the true contribution of the use of ICT as an information tool, as the differences at the classroom level could have been transferred to the pupil level. Further research should investigate whether other specific types of technology use in the classroom are also related to other corresponding types of ICT competences. Findings from such studies could inform teachers about how to adapt their technology use in the classroom, such that pupils can learn the specific ICT competences they do not yet possess.

It is advised to replicate this study with a larger sample size in which the ratio between pupils, teachers and schools is taken into account. This will not only improve the reliability and validity of the results, but also permit a three-level analysis in which ICT competences are allowed to vary at the pupil, classroom and school level. Although this study is hindered by its relatively small sample size, we believe that the results are an important step forward into the identification of factors related to differences in pupils' ICT competences. As the results are based on the analysis of performance-based rather than self-perceived ICT competence data, they add to the literature on ICT competences. Moreover, this study yielded results that contrast with research on self-perceived ICT competences. For example, most of the research on self-perceived ICT competences has identified significant relationships between pupils' ICT attitude (or dimensions of it) and ICT self-efficacy (Compeau & Higgins, 1995; Durndell & Haag, 2002; Pamuk &Peker, 2009; Wu & Tsai, 2006). However, in this study no such relationship was found between pupils' ICT attitude and their actual ICT competence. These results support the findings of Bunz, Curry and Voon (2007), which indicate that students' computer anxiety is negatively related to their self-perceived computer-e-mail-WEB-fluency, but not to their actual computer-e-mail-WEB-fluency. This illustrates that accurate, direct and valid measures of ICT competence are required when studying ICT competences and factors related to them. By conducting this study, we hope to contribute to unraveling differences in pupils' ICT competences and encourage other researchers to use a performance-based approach.

References

Authors, 2007.

Authors, 2010a.

Authors, 2010b.

Authors, 2013.

Authors, 2014.

Authors, submitted.

American Association of School Librarians (AASL) and the Association for Educational Communications and Technology (AECT) (1998). *Information Literacy Standards for Student Learning.* Chicago: American Library Association.

Ananiadou, K., & Claro, M. (2009). *21st century skills and competences for New Milennium Learners in OECD countries*. Paper presented at the *New Millennium Learners* Conference – *21st Century Skills and Competencies,* Brussels.

Association of College and Research Libraries (ACRL). (2000). *Information Literacy Competency Standards for Higher Education*. Retrieved from http://www.ala.org/acrl/standards/information-literacycompetency

Barbeite, F.G., Weiss, E.M. (2004). Computer self-efficacy and anxiety scales for an Internet sample: testing measurement equivalence of existing measures and development of new scales. *Computers in Human Behavior, 20*(1), 1-15.

Bennett, S., Maton, K., & Kervind, L. (2008). The 'digital natives' debate: A critical review of the evidence. *British Journal of Educational Technology, 39*(5), 775-786.

Boiché, J.S., Sarrazin, P.G., Grouzet, F.M.E., Pelletier, L.G., & Chanal, J.P. (2008). Students' Motivational Profiles and Achievement Outcomes in Physical Education: A Self-Determination Perspective. *Journal of Educational Psychology, 100*(3), 688-701.

Brand-Gruwel, S., Wopereis, I., & Vermetten, Y. (2005). Information problem solving by experts and novices: analysis of a complex cognitive skill. *Computers in Human Behavior, 21*(3), 487-508.

Bunz, U., Curry, C., & Voon, W. (2007). Perceived versus actual computer-email-web fluency. *Computers in Human Behavior, 23*(5), 2321-2344.

Carleer, G.J. (1984). Computer Literacy in the Netherlands. *Computers & Education, 8*(4), 401-405.

Carpenter P.A., Just, M.A., & Shell, P. (1990). What One Intelligence Test Measures: A Theoretical Account of the Processing in the Raven Progressive Matrices Test. *Psychological Review, 97*(3), 404-431.

Claro, M., Preiss, D.D., San Martin, E., Jara, I., Hinostroza, J.E., Valenzuela, S., … Nussbaum, M. (2012). Assessment of 21st century skills in Chile: Test design and results from high school level students. *Computers & Education, 59*(3), 1042-1053.

Compeau, D.R., & Higgins, C.A. (1995). Computer Self-Efficacy: Development of a Measure and Initial Test. *MIS Quarterly, 19*(2), 189-211.

Creemers, B.P.M., & Kyriakides, L. (2008). *The dynamics of educational effectiveness. A contribution to policy, practice and theory in contemporary schools*. New York: Routledge.

Dixon, M.A., & Cunningham, G.B. (2006). Data aggregation in multilevel analysis: A review of conceptual and statistical issues. *Measurement in Physical Education and Exercise Science, 10*(2), 85-107.

Durndell, A., & Haag, Z. (2002). Computer self-efficacy, computer anxiety, attitudes towards the Internet, and reported experience with the internet, by gender, in an East European sample. *Computers in Human Behavior, 18*(5), 521-535.

Eisenberg, M.B., & Johnson, D. (2002). Learning and Teaching Information Technology Computer Skills in Context. *Eric Digest,* ED465377. Retrieved from http://www.ericdigests.org/2003-1/skills.htm.

Eisenberg, M.B. (2005). Information Literacy: Essential Skills for the Information Age. *Journal of Library & Information Technology, 28*(2), 39-47.

Eshet, Y. (2002). Digital literacy: A new terminology framework and its application to the design of meaningful technology-based learning environments. In P. Barker, & S. Rebelsky (Eds.), *Proceedings of EDMEDIA, 2002 World Conference on educational Multimedia, Hypermedia, & Telecommunication* (pp. 493-498). Chesapeake, VA: AACE.

Educational Testing Service (ETS) (2002). *Digital transformation: A framework for ICT literacy. A report of the International ICT Literacy Panel.* Princeton: ETS, Center for Global Assessment.

European Commission (2007). Key Competences for Lifelong Learning. European Reference Framework. Luxembourg: Office for Official Publications of the European Communities.

Fagan, M.H., Neill, S., & Wooldridge, B.R. (2003). An empirical investigation into the relationship between computer self-efficacy, anxiety, experience, support and usage. *Journal of Computer Information Systems, 44*(2), 95-104.

Fraillon, J., & Ainley, J. (2010). *The IEA International Study of Computer and Information Literacy (ICILS).* Retrieved from http://www.iie.cl/wp-content/uploads/2013/11/2013-007-AE-ICILS-2013-Descripcion_detallada_del_proyecto.pdf.

Gorard, S. (2003). What is multilevel modeling for? *British Journal of Educational Studies, 51*(1)*,* 46-63.

Hakkarainen, K., Ilomäki, L., Lipponen, L., Muukkonen, H., Rahikainen, M., & Tuominen, T. (2000). Students' skills and practices of using ICT: results of a national assessment in Finland. *Computers & Education, 34*(2), 103-117.

Hargittai, E. (2005). Survey Measures of Web-Oriented Digital Literacy. *Social Science Computer Review, 23*(3)*,* 371-379.

Hargittai, E., & Shafer, S. (2006). Differences in Actual and Perceived Online Skills: The Role of Gender. *Social Science Quarterly, 87*(2), 432-448.

Hohlfeld, T.N., Ritzhaupt, A.D., & Barron, A.E. (2013). Are gender differences in perceived and demonstrated technology literacy significant? It depends on the model. *Educational Technology Research & Development, 61*(4), 639-663.

International Society for Technology in Education (ISTE) (2007). National Educational Technology Standards for Students, second edition. Washington: ISTE

Ito, M., Baumer, S., Bittanti, M., Boyd, D., Cody, R., Herr-Stephenson, B., Horst, H.A., Lange, P.G., Mahendran, D., Martinez, K.Z., Pascoe, C.J., Perkel, D., Robinson, L., Sims, C., & Tripp L. (2009). *Hanging Out, Messing Around, and Geeking Out. Kids Living and Learning with New Media. The John D. and Catherine T. MacArthur Foundation Reports on Digital Media and Learning.* Cambridge, Massachusetts: MIT Press.

Jee-Seon, K. (2009). Multilevel analysis: an overview and some contemporary issues. In R. E. Millsap, & A. Maydey-Olivares (Eds.), *The Sage handbook of quantitative methods in psychology* (pp. 337–361). London: Sage.

Jones, C., Ramanau R., Cross, S., & Healing, G. (2010). Net generation or Digital natives: Is there a distinct new generation entering university? *Computers & Education, 54*(3), 722-732.

Kozma, R. (2008). Comparative Analysis of Policies for ICT in Education. In J. Voogt & G. Knezek (Eds.). *International Handbook of Information Technology in Primary and Secondary Education* (pp. 1083-1096). New York: Springer.

Kuiper, E. (2007). *Teaching web literacy in primary education*. Unpublished doctoral dissertation, Free University, Amsterdam, The Netherlands.

Litt, E. (2013). Measuring users' internet skills: A review of past assessments and a look toward the future. *New Media & Society¸15*(4), 612-630.

Madden, A. D., Ford, N. J., Miller, D., & Levy, P. (2006). Children's use of the internet for information seeking. What strategies do they use and what factors affect their performance? *Journal of Documentation, 62*(6), 774-761.

Markauskaite, L. (2007). Exploring the structure of trainee teachers' ICT literacy: the main components of, and relationships between, general cognitive and technical capabilities. *Educational Technology Research & Development, 55*(6), 547 – 572.

Martin, A. (2006). Literacies for the digital age: preview of Part 1. In A. Martin & D. Madigan (Eds.). *Digital Literacies for Learning* (pp. 3-26). London: Facet Publishing.

Meelissen, M. (2008). Computer attitudes and competencies among primary and secondary school students. In J. Voogt, & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (pp. 381-395). New York: Springer.

Merritt, K., Smith, K.D., & Di Renzo, J.C. (2005). An Investigation of Self-Reported Computer Literacy: Is It Reliable? *Issues in Information Systems, 6*(1), 289 – 295.

Messick, S. (1994). The Interplay of Evidence and Consequences in the Validation of Performance Assessments. *Eduational Researcher, 23*(2), 13-23.

North Central Regional Educational Laboratory (NCREL) (2003). *enGauge 21st Century Skills: Literacy in the Digital Age.* Naperville, IL: North Central Regional Educational Laboratory.

OECD (2004). *Learning for Tomorrow's World. First Results from PISA 2003*. Paris: OECD Publications.

Pamuk, S., & Peker, D. (2009). Turkish pre-service science and mathematics teachers' computer related self-efficacies, attitudes, and the relationship between these variables. *Computers & Education, 53*(2)*,* 454-461.

Puustinen, M., & Rouet, J. F. (2009). Learning with new technologies: Help seeking and information searching revisited. *Computers & Education, 53*(4)*,* 1014-1019.

Raven, J., Raven, J.C., & Court, J.H. (2003). *Manual for Raven's Progressive Matrices and Vocabulary Scale - Section 1: General Overview*. San Antonio, TX: Harcourt Assessment.

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology, 57*(5), 749-761.

Ryan, R.M., & Deci, E.L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development and Well-Being. *American Psychologist, 55*(1), 68-78.

Sackes, M., Trundle, K.B., &Bell, R.L. (2011). Young children's computer skills development from kindergarten to third grade. *Computers & Education, 57*(2), 1698-1704.

Savolainen, R. (2002). Network competence and information seeking on the internet. From definitions towards a social cognitive model. *Journal of Documentation, 58*(2), 221-226.

Schleicher, A., Zimmer, K., Evans, J., & Clements, N. (2009). *PISA 2009 Assessment Framework : Key Competencies in Reading, Mathematics and Science*. Paris: OECD Publishing.

Somerville, M. M., Smith, G. W. & Macklin, A. S. (2008). The ETS iSkills™ Assessment: a digital age tool. *The Electronic Library, 26*(2), 158-171.

Snijders, T., & Bosker, R. (1999). Multilevel analysis. An Introduction to basic and advanced multilevel modeling. London: Sage Publications.

Snijders, T., & Bosker, R. (2012). *Multilevel Analysis (2nd ed.). An Introduction to Basic and Advanced Multilevel Modeling.* London: Sage Publications Inc.

Spencer, N.H., & Fielding, A. (2000). An Instrumental variable consistent estimation procedure to overcome the problem of endogenous variables in multilevel models. *Multilevel Modelling Newsletter, 12*(1), 4-7.

Tannenbaum, R.S., & Rahn, B.J. (1984). Teaching Computer Literacy to Humanities and Social Science Students. *Academe, 70*(4), 19-23.

Thomas, L.G., & D.G. Knezek (2008). Information, communications, and educational technology standards for students, teachers, and school leaders. In J. Voogt, & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (pp. 333-348). New York: Springer.

Torkzadeh, G., Chang, J.C., & Demirhan, D. (2006). A contingency model of computer and Internet self-efficacy. *Information & Management, 43*(4), 541-550.

Tsai, M.J., & Tsai, C.C. (2003). Information Searching Strategies in Web-Based Science Learning: The Role of Internet Self-Efficacy. *Innovations in Education and Teaching International, 40*(1), 43 – 50.

Tsai, M.J. (2009). Online Information Searching Strategy Inventory (OISSI): A quick version and a complete version. *Computers & Education, 53*(2), 473-483.

Tsai, M.J., & Tsai, C.C. (2010). Junior High School Students' Internet Usage and Self-Efficacy: A Re-examination of the gender gap. *Computers & Education, 54*(4), 1182 – 1192.

Valcke, M., Bonte, S., De Wever, B., & Rots, I. (2010). Internet parenting styles and the impact on internet use of primary school children. Computers & Education, *55*(2), 454-464.

Vallerand, R.J., Pelletier, L.G., Blais, M.R., Brière, N.M., Senécal, C.B., Vallières, E.F. (1992). The Academic Motivation Scale – A Measure of Intrinsic, Extrinsic, and Amotivation in Education.

Vandevelde, S., Van Keer, H., & Rosseel, Y. (2013). Measuring the complexity of upper primary school children's self-regulated learning: A multi-component approach. *Contemporary Educational Psychology, 38*(4), 407-425. doi: http://dx.doi.org/1.1016/j.cedpsych.2013.09.002.

Van Deursen, A., & van Diepen, S. (2013). Information and strategic Internet skills of secondary students: A performance test. *Computers & Education, 63,* 218-226.

Van Houtte, M. (2004). Tracking effects on school achievement: A quantitative explanation in terms of the academic culture of school staff. *American Journal of Education, 110*(4), 354-388.

Vansteenkiste, M., Sierens, E., Soenens, B., Luyckx, K., Lens, W. (2009). Motivational profiles from a self-determination perspective: the quality of motivation matters. *Journal of Educational Psychology, 101*(3), 671-688.

Vekiri, I. (2010). Socioeconomic differences in elementary students' ICT beliefs and out-of-school experiences. *Computers & Education, 54*(4), 941-950.

Volman, M., van Eck, E., Heemskerk, I., & Kuiper E. (2005). New Technologies, new differences. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. *Computers & Education, 45*(1), 35-55.

Voogt, J. (2008). IT and curriculum processes: Dilemmas and challenges. In J. Voogt, & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 117-132). New York: Springer.

Voogt, J., & Roblin, N.P. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies, 44*(3), 299-321.

Wirth, J. (2008). Computer-Based Tests: Alternatives for Test and Item Design. In J. Hartig, E. Klieme, & D. Leutner (Eds.), *Assessment of Competencies in Educational Contexts* (pp. 235-252). Cambridge: Hogrefe & Huber.

Wu, Y.T., & Tsai, C.C. (2006). University Students' Internet Attitudes and Internet Self-Efficacy: A Study AT Three Universities in Taiwan. *Cyber Psychology & Behavior, 9*(4), 441-450.

Zhong, Z.J. (2011). From access to usage: The divide of self-reported digital skills among adolescents. *Computers & Education, 56*(3), 736-746.

Appendix A

Item	Description higher-order competences and technical skills
	Higher-order learning-process oriented competence
Item 1	Pupils use ICT applications to ask a question or deliver a message of which the content is understandable for the receiver
Item 2	Pupils can assess and judge the relevance of the information that was found for answering a question
Item 3	Pupils use the title and textual information found in the results of a conducted search
Item 4	Pupils use ICT applications to ask a question or deliver a message in a social acceptable way
Item 5	Pupils can judge the reliability of digital information
Item 6	Pupils can generate a new information product by comparing and synthesizing information that was found elsewhere
Item 7	Pupils can use a search engine by entering more correct search terms derived from a task or question
Item 8	Pupils can deliver information to others by using a non-structured format such as a e-mail
Item 9	Pupils can assess and judge the relevance of the information that was found for answering a question
Item 10	Pupils can integrate new information into existing information products
Item 11	Pupils formulate a subject of a mail/forum that refers adequately to its content
Item 12	Pupils can use a search engine by entering one correct search term derived from a task or question
Item 13	Pupils formulate a subject of a mail/forum that refers adequately to its content
Item 14	Pupils can deliver information to others by using a structured format such as a digital form
Item 15	Pupils can deliver information to others by using a structured format such as a digital form
Item 16	Pupils can configure a search engine to improve an intended search for figures or other media files
Item 17	Pupils can use a search engine by entering one correct search term derived from a task or question
Item 18	Pupils can efficiently use an URL
	Technical and application oriented ICT skills
Item 19	Pupils can answer an e-mail to one known person
Item 20	Pupils can send an e-mail to more known persons
Item 21	Pupils can add an attachment to an e-mail
Item 22	Pupils can use basic software commands such as copying and pasting a text
Item 23	Pupils can react on a forum
Item 24	Pupils can save and retrieve a file from a specific location
Item 25	Pupils can use basic software commands such as copying and pasting an image
Item 26	Pupils can start a topic on a forum
Item 27	Pupils can delete an e-mail

Items of the ICT competence scale of Authors (2014)

Ability interval	Ability scale	Visual representation (x=3 pupils)	Pupils *(%)*
]2.8, 3.0]	3		0 *(0.00)*
]2.6, 2.8]			0 *(0.00)*
]2.4, 2.6]			0 *(0.00)*
]2.2, 2.4]			0 *(0.00)*
]2.0, 2.2]	2		0 *(0.00)*
]1.8, 2.0]			1 *(0.26)*
]1.6, 1.8]		x	5 *(1.32)*
]1.4, 1.6]		xxx	9 *(2.37)*
]1.2, 1.4]		xx	8 *(2.11)*
]1.0, 1.2]	1	xxxxxxx	21 *(5.54)*
]0.8, 1.0]		xxxxxx	20 *(5.28)*
]0.6, 0.8]		xxxxxxxxx	29 *(7.65)*
]0.4, 0.6]		xxxxxxxxx	27 *(7.12)*
]0.2, 0.4]		xxxxxxxxxxxxxx	42 *(11.08)*
]0.0, 0.2]	0	xxxxxxxxxx	31 *(8.18)*
]-0.2, 0.0]		xxxxxxxxxxxxx	41 *(10.82)*
]-0.4, -0.2]		xxxxxxxx	24 *(6.33)*
]-0.6, -0.4]		xxxxxxxx	26 *(6.86)*
]-0.8, -0.6]		xxxxxxx	21 *(5.54)*
]-1.0, -0.8]	-1	xxxx	12 *(3.17)*
]-1.2, -1.0]		xxxx	14 *(3.69)*
]-1.4, -1.2]		xxxx	13 *(3.43)*
]-1.6, -1.4]		xx	7 *(1.85)*
]-1.8, -1.6]			2 *(0.53)*
]-2.0, -1.8]	-2	xx	7 *(1.85)*
]-2.2, -2.0]			5 *(1.32)*
]-2.4, -2.2]		xx	6 *(1.58)*
]-2.6, -2.4]		x	5 *(1.32)*
]-2.8, -2.6]			0 *(0.00)*
]-3.0, -2.8]	-3		2 *(0.53)*

Table 1: Frequencies of primary school pupils on the ICT competence scale

	M	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Factors at the pupil level																		
1. Sex	-	-	1.00															
2. Age	12.06	-	.12*	1.00														
3. Amotivation	24.47	.79	-.18**	.01	1.00													
4. Extrinsic regulation	44.29	.86	-.10	.06	.42**	1.00												
5. Introjected regulation	44.70	.71	-.11*	.08	.23**	.38**	1.00											
6. Identified regulation	82.92	.81	.15**	-.02	-.54**	-.25**	.00	1.00										
7. Intrinsic motivation	61.87	.88	.20**	.01	-.43**	-.27**	.14**	.63**	1.00									
8. Control	71.63	.60	.16**	-.11	-.28**	-.14*	.07	.40**	.34**	1.00								
9. Memorization	53.73	.57	.11*	-.04	-.13*	-.03	.09	.32**	.20**	.33**	1.00							
10. Elaboration	34.87	.66	-.11*	-.03	.05	.01	.19**	.21**	.20**	.23**	.20**	1.00						
11. Analytic intelligence	45.32	.81	.01	-.06	-.10	-.13*	-.12*	-.02	-.01	.04	-.14**	-.19**	1.00					
12.Parental active ICT support	54.51	.91	.02	-.11	-.04	-.07	.05	.03	.11	.04	.00	.03	-.01	1.00				
13. Parental ICT rules	74.56	.85	.04	-.12	-.02	.01	.03	.07	.07	.05	-.03	.03	.07	.53**	1.00			
14. Parental ICT attitude	73.58	.82	.05	-.04	.01	.04	-.07	-.05	-.04	.00	-.04	-.09	.06	.12*	-.06	1.00		
15. ICT experience	7.75	-	-.02	.15*	-.04	-.09	-.13*	.05	.03	-.01	.09	.06	-.08	-.01	-.21**	.16**	1.00	
16. Pupil's ICT attitude	68.53	.83	-.34**	-.08	.12*	.09	.15**	.06	.00	.02	.06	.10	-.07	.04	.01	.09	.09	1.00
Factors at the classroom level																		
17. ICT competences	69.18	.83	-.02	-.04	.04	-.07	.00	-.06	-.03	.03	-.05	-.07	.13*	.05	-.01	.12*	-.03	.05
18. Teacher's ICT attitude	66.27	.80	.03	.08	-.12*	-.04	.04	.15**	.11*	.08	.14**	.02	.03	-.01	.03	-.05	-.09	.04
19. Professional development	58.07	.84	.03	-.10	-.08	-.02	.01	.06	.03	.04	.02	-.06	.14**	.05	-.03	.08	-.11	.02
20. Logistic appropriateness	66.30	.82	.01	-.20**	-.02	-.05	-.06	-.06	-.07	.07	-.04	-.08	.14**	-.05	-.03	-.04	-.15**	-.03
21. ICT use as information tool	45.00	.68	.04	-.01	-.07	-.02	.05	.03	.05	.03	.00	-.02	.08	.01	-.03	.06	-.16**	.04
22. ICT use as learning tool	53.23	.78	-.04	-.08	-.01	-.02	-.03	.07	.12*	.04	.03	.04	.00	.06	.11	.02	.01	-.02
23. ICT use basic skills	46.04	.70	.07	-.07	.00	-.05	.01	.01	.11*	.07	.05	.02	.04	.01	.05	.09	-.13*	-.01
24. ICT experience	3.53	-	.02	-.05	-.06	.02	-.02	.08	.10	.04	-.10*	.00	.13*	.04	.14*	.01	-.09	.03
Factors at the school level																		
25. ICT coordinator: planner	61.04	.91	.04	-.19**	-.01	-.08	-.09	-.02	-.05	.13*	-.05	-.10	.10	.02	.02	-.01	-.13*	-.01
26. ICT coordinator: budgeter	48.94	.82	.03	-.06	.02	-.08	-.12*	-.09	-.08	-.06	-.10	-.08	.06	.04	-.11	-.02	-.06	-.06
27. ICT coordinator: technician	83.33	.91	.03	.01	-.02	-.09	-.07	.02	.12*	-.06	.01	-.03	-.01	.11	-.02	.00	.12*	-.03
28. ICT coordinator: educationalist	63.27	.89	.00	-.10	-.03	-.12*	-.10	-.08	-.13*	.08	-.13*	-.06	.09	-.02	-.03	-.09	-.08	-.03
29. Vision and policy on ICT	62.67	.89	.06	-.04	-.11	-.11	-.07	.00	-.05	.08	-.05	-.11	.09	.01	-.03	-.04	-.06	-.02
30. ICT infrastructure	.23	-	-.02	-.02	.02	.00	-.05	.00	-.04	-.07	.00	.01	-.05	.06	-.03	-.06	.07	-.02
31. Pupils' ICT competences	-.08		.20**	-.10	-.12*	-.15**	-.22**	.08	.05	.16**	-.04	-.16**	.43**	.07	.03	.16**	.04	-.02
32. ICT self-efficacy	80.98	.88	-.09	-.05	-.12*	-.06	-.04	.13*	.01	.08	.10	.15**	.11*	.02	.03	.09	.21**	.38**

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Factors at the classroom level																
17. ICT competences	1.00															
18. ICT attitude	.18**	1.00														
19. Professional development	.51**	.30**	1.00													
2.ICT infrastructure	.38**	.16**	.44**	1.00												
21. ICT use as information tool	.26**	.30**	.46**	.41**	1.00											
22. ICT use as learning tool	.20**	.28**	.26**	.24**	.34**	1.00										
23. ICT use basic skills	.29**	.25**	.31**	.27**	.49**	.54**	1.00									
24.Computer experience	.14**	-.04	.09	.03	.18**	.25**	.27**	1.00								
Factors at the school level																
25. ICT coordinator: planner	.19**	-.01	.32**	.54**	.36**	.17**	.32**	.21**	1.00							
26. ICT coordinator: budgeter	-.07	-.29**	.22**	.21**	.15**	-.02	-.10	-.01	.40**	1.00						
27. ICT coordinator: technician	-.09	-.13*	.11*	-.27**	-.12*	.10	-.07	-.03	-.06	.34**	1.00					
28. ICT coordinator: educationalist	.09	-.21**	.07	.26**	.05	-.19**	.02	.22**	.70**	.51**	-.11*	1.00				
29. Vision and policy on ICT	.22**	-.03	.26**	.16**	.17**	-.24**	-.01	.06	.32**	.09	-.19**	.44**	1.00			
30. Infrastructure	-.05	-.09	-.05	.10	-.10	.03	-.23**	-.23**	-.03	.12*	.16**	-.09	.06	1.00		
31. Pupils' ICT competences	.15**	.02	.09	.18**	.15**	-.01	.07	.09	.14**	.00	-.17**	.12*	.18**	-.02	1.00	
32. ICT self-efficacy	-.04	.03	-.04	-.07	-.05	-.14*	-.11*	-.11*	-.08	-.13*	-.07	-.02	.04	-.04	-22**	1.00

Table 2: Descriptives, reliability coefficients and correlates of the used scales,* correlation significant at the .05 level, ** correlation significant at the .01 level

	Model 1 (null)	Model 2	Model 3a	Model 3b	Model 4a	Model 4b
Fixed						
Intercept (cons)	-.079 (.056)	-.061 (.061)	-.368(.406)	-.102 (.059)	-.072 (.050)	-.092(.050)
Pupil						
ICT experience		.007 (.009)	-	-	-	-
Pupil's ICT attitude		.001 (.002)	-	-	-	-
					-	-
Parental active ICT support			.001 (.003)	-	-	-
Parental ICT rules			.003 (.003)	-	-	-
Parental ICT attitudes			.010 (.003)**	.009 (.003)**	.010 (003)***	.009 (.003)**
ICT availability (categ)						
- Internet shared computer			.257 (.409)	-	-	-
- Internet private computer			.606 (.556)	-	-	-
- Internet shared & private			.353 (.414)	-	-	-
Amotivation					.001 (.003)	-
Extrinsic regulation					-.001 (.002)	-
Introjected regulation					-.006 (.002)*	-.008 (.002)***
Identified regulation					.002 (.004)	-
Intrinsic motivation					.000 (.003)	-
Control					.010 (.003)***	.007 (.002)**
Memorization					-.003 (002)	-
Elaboration					-.003 (.002)	-
Analytic intelligence					.058(.008)***	.059 (.008)***
Sex (categ)						
Age						
SES education mother						
- Primary						
- Lower secondary						
- Higher secondary						
- Higher education						
Classroom						
ICT competences						
Teacher's ICT attitude						
Professional development						
Logistic appropriateness						
ICT use as information tool						
ICT use as learning tool						
ICT use basic skills						
ICT experience						
School						
ICT coordinator: planner						
ICT coordinator: budgeter						
ICT coordinator: technician						
ICT coordinator: educationalist						
Vision and policy on ICT						
ICT Infrastructure						
Random						
Classroom level σ^2_{u0} (between)	.069(.040)	.096	.077	.083	.044	.043
	7.91%	(.047)*	(.045)	(.044)	(.032)	(.032)
Pupil level σ^2_{e0} (within)	.803(.065)***	.725	.741	.781	.530	.611
	92.09%	(.066)***	(.068)***	(.067)***	(.051)***	(.054)***
Model Fit						
Deviance (2-log)[a]	1016.386	819.757	802.730	915.353	650.028	777.068
χ^2	4.50			101.03		138.28
df	1			1		3
p	<.005			<.001		<.001
Reference	Single level model			Null model		Model 3b

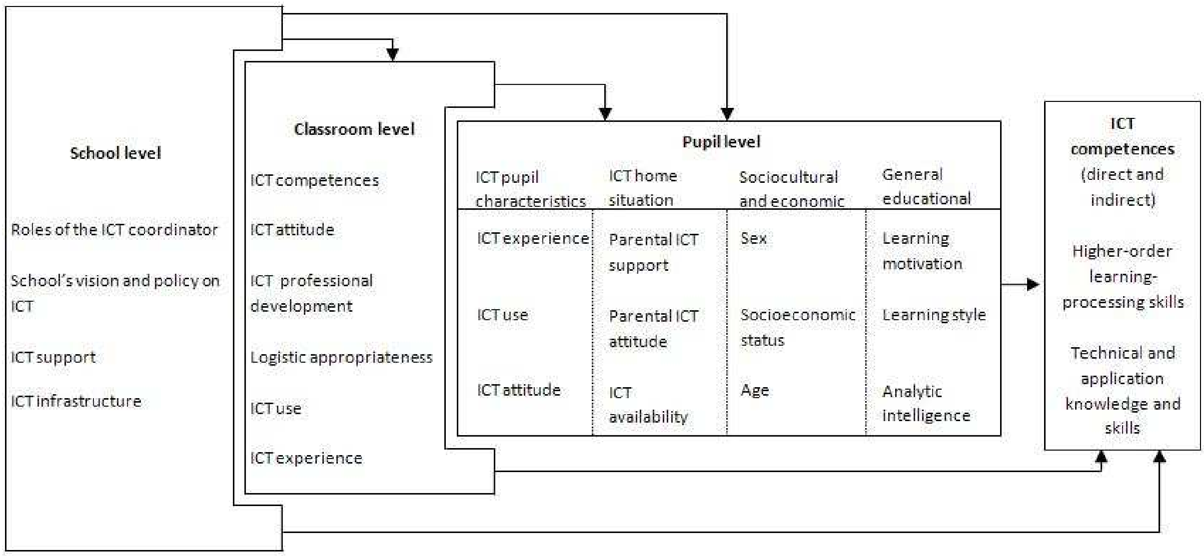
	Model 5a	Model 5b	Model 6a	Model 6b	Model 7	Model 8
Fixed						
Intercept (cons)	-1.123 (.310)***	-1.119 (.319)***	-1.134 (.316)***	-1.121 (.313)***	-1.199 (.311)***	-.981 (.337)**
Pupil						
ICT experience	-	-	-	-	-	-
Pupil's ICT attitude	-	-	-	-	-	-
Parental active ICT support	-	-	-	-	-	-
Parental ICT rules	-	-	-	-	-	-
Parental ICT attitudes	.008 (.003)**	.008 (.003)**	.007(.003)	.007(003)*	.007 (.003)**	.006 (.003)*
ICT availability (categ)						
- Internet shared computer	-	-	-	-	-	-
- Internet private computer	-	-	-	-	-	-
- Internet shared & private	-	-	-	-	-	-
Amotivation	-	-	-	-	-	-
Extrinsic regulation	-	-	-	-	-	-
Introjected regulation	-.005 (.002)*	-.007 (.002)***	-.008 (.002)***	-.008 (.002)***	-.007 (.002)***	-.006 (.002)**
Identified regulation	-	-	-	-	-	-
Intrinsic motivation	-	-	-	-	-	-
Control	.005 (.002)*	.006 (.002)*	.006 (.002)**	.006 (.002)**	.005 (.002)*	.005 (.002)*
Memorization	-	-	-	-	-	-
Elaboration	-	-	-	-	-	-
Analytic intelligence	.054 (.008)***	.058 (.008)***	.057 (.008)***	.057 (.008)***	.058 (.008)***	.049 (.008)***
Sex (categ)	.310 (.095)***	.287 (.090)**	.263 (.093)**	.253 (.091)**	.255 (.091)**	.279 (.093)**
Age	-.072 (.104)	-	-	-	-	-
SES education mother						
- Primary	.602 (.436)	.701 (.432)	.635 (.430)	.669 (.427)	.725 (.419)	.557 (.457)
- Lower secondary	.756 (.329)*	.766 (.336)*	.833 (.334)*	.803 (.331)*	.928 (..329)**	.685 (.353)
- Higher secondary	.826 (.317)**	.826 (.325)**	.891 (.324)**	.885 (.319)**	.946 (.318)**	.742 (.342)*
- Higher education	1.132 (.318)***	1.063 (.325)**	1.051 (.324)***	1.049 (.320)**	1.118 (.320)***	.931 (.343)**
Classroom						
ICT competences			.003 (.003)	-	-	-
Teacher's ICT attitude			.001 (.003)	-	-	-
Professional development			-.005 (.003)	-	-	-
Logistic appropriateness			.003 (002)	-	-	-
ICT use as information tool			.010 (.004)*	.008 (.003)*	.008 (.004)*	.011 (.004)**
ICT use as learning tool			-.005 (.003)	-	-	-
ICT use basic skills			.001 (.003)	-	-	-
ICT experience			-.006 (.024)	-	-	-
School						
ICT coordinator: planner					.000 (.003)	-
ICT coordinator: budgeter					-.005 (.003)	-
ICT coordinator: technician					-.003 (.002)	-
ICT coordinator: educationalist					.004 (.004)	-
Vision and policy on ICT					.004 (.003)	-
ICT Infrastructure					.481 (.604)	-
ICT self-efficacy						.013 (.004)***
Random						
Classroom level σ^2_{u0} (between)	.000 (.000)	.019 (.027)	.000 (.000)	.004 (.024)	.000 (.000)	.000 (.000)
Pupil level σ^2_{e0} (within)	.566 (.048)***	.580 (.052)***	.574 (.047)***	.575 (.052)***	.549 (.046)***	.556 (.047)***
Model Fit						
Deviance (2-log)[a]	635.356	736.473	673.408	694.318	644.721	632.428
χ^2		40.595		42.155		61.916
df		5		1		1
p		<.001		<.001		<.001
Reference		Model 4b		Model 5b		Model 6b

Table 3: Estimates and standard errors from the random intercept model (dependent variable: pupils' ICT competences)

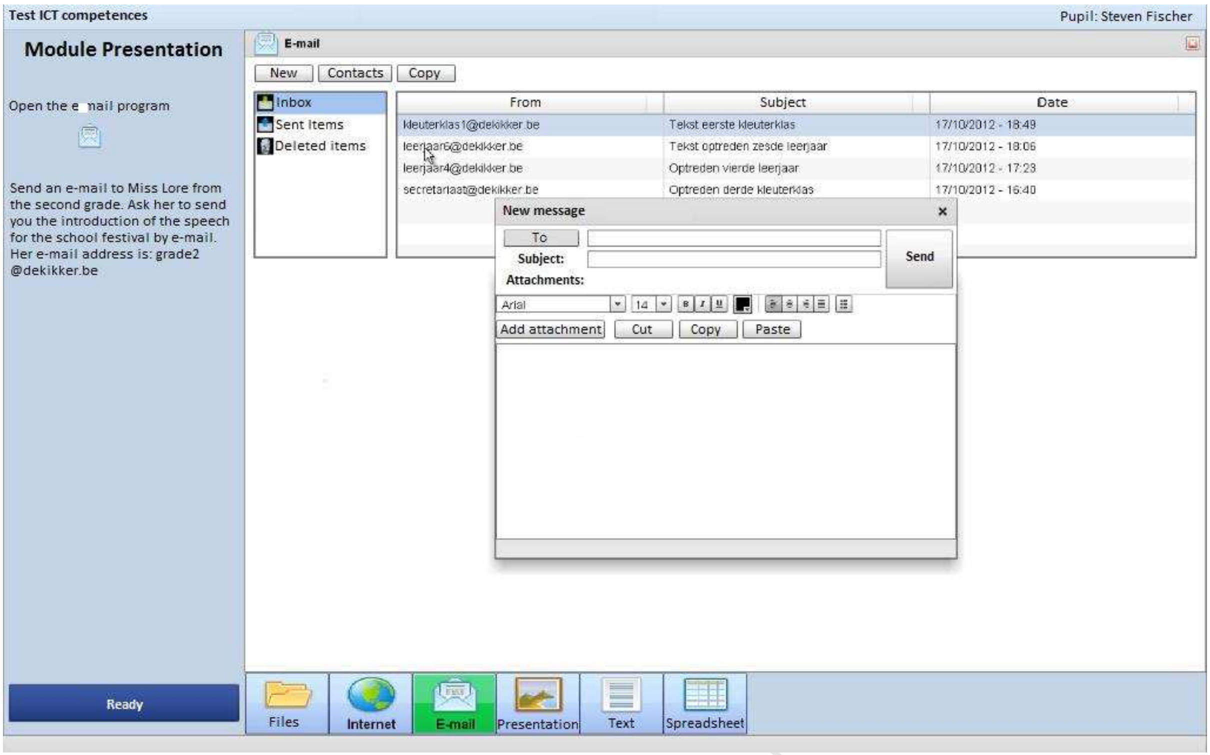
* significant at the .05 level; ** significant at the .01 level; *** significant at the .001 level

	Model 3b	**Model 4b**	**Model 5b**	**Model 6b**	**Model 8**
R^2_1 (proportion of variance explained at the student level)	0.92	25.00	31.31	33.60	36.24
ΔR^2_1		24.08	6.31	2.29	2.64
R^2_2 (proportion of variance explained at the classroom level)	3.73	27.28	40.33	46.89	50.22
ΔR^2_2		23.55	13.05	6.56	3.33

Table 4: Proportion of variance explained



School level
Roles of the ICT coordinator
School's vision and policy on ICT
ICT support
ICT infrastructure
Classroom level
ICT competences
ICT attitude
ICT professional development
Logistic appropriateness
ICT use
ICT experience
Pupil level
ICT pupil characteristics
ICT home situation
Sociocultural and economic
General educational
ICT experience
Parental ICT support
Sex
Learning motivation
ICT use
Parental ICT attitude
Socioeconomic status
Learning style
ICT attitude
ICT availability
Age
Analytic intelligence
ICT competences (direct and indirect)
Higher-order learning-processing skills
Technical and application knowledge and skills


Test ICT competences
Pupil: Steven Fischer
Module Presentation
Open the e-mail program
Send an e-mail to Miss Lore from the second grade. Ask her to send you the introduction of the speech for the school festival by e-mail. Her e-mail address is: grade2 @dekikker.be
Ready
E-mail
New
Contacts
Copy
Inbox
Sent Items
Deleted items
From
Subject
Date
kleuterklas1@dekikker.be
Tekst eerste kleuterklas
17/10/2012 - 18:49
leerjaar6@dekikker.be
Tekst optreden zesde leerjaar
17/10/2012 - 18:06
leerjaar4@dekikker.be
Optreden vierde leerjaar
17/10/2012 - 17:23
secretariaat@dekikker.be
Optreden derde kleuterklas
17/10/2012 - 16:40
New message
To
Subject:
Attachments:
Send
Arial
14
Add attachment
Cut
Copy
Paste
Files
Internet
E-mail
Presentation
Text
Spreadsheet

Pupil, class and school factors are examined as antecedents of ICT competences.

Pupils score low-medium on a performance-based ICT competence test.

ICT competence is a pupil rather than a class or school phenomenon.

Non-ICT related factors e.g. cognitive ability, SES are related to ICT competences.

Parents' ICT attitude and educational ICT use are related to ICT competences.