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Understanding factors related to Chilean students' digital skills: A mixed methods analysis

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ABSTRACT

For new generations to fully integrate and participate in an increasingly technology-rich society they must become digitally literate. Education systems have a role to play in this, especially given the growing evidence of a digital divide. Through this study, we look to identify and characterize factors related to the digital skills of 10th grade Chilean students, as measured by a national standardized test. A mixed methodology was used to explore these factors and provide a more detailed analysis. Statistical analysis was performed using a Hierarchical Linear Model to determine which factors explain student performance on the test. In addition to this, a qualitative analysis was also carried out using an exploratory case study. The purpose of this case study was to take a more in-depth look at the characteristics of high and low-performing students on the digital skills test. This was done by analyzing their activities, perceptions and motivations when using technology. The quantitative results revealed that the most important factors in developing digital skills are having access to a computer at home, linguistic capital, socioeconomic status, and years of experience using a computer. The qualitative study also revealed that students who scored highly on the test were generally able to focus and concentrate on their school assignments when using the Internet. These students also adopted cognitive and organizational strategies in order to be more effective. Our findings should be further investigated in order to support the design of school activities that aim to develop students' digital skills.

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1. Introduction

Information and communication technologies (ICT) have changed the way in which contemporary societies are organized. Modern societies have shifted from an economy based on commodities and manual labor to an economy based on knowledge and highly qualified human capital. Societies have also shifted from a culture based on time and space to a culture based on the virtualization of social interactions and the development of interactive, horizontal networks of communication (Castells, 1996). Furthermore, ICT have been given a central role in home and family life, both in terms of socio-demographics as well as dynamics, lifestyles and cultural expectations and attitudes (Livingstone & Helsper, 2007). The new role of ICT has given rise to new ways of communicating, socializing and learning, both inside and outside school (Erstad, 2012; Furlong & Davies, 2012).

Within this context, the ability to use ICT and work with information may be considered 'the indispensable grammar of modern life' (Wills, 1999, p.10), as well as an important 'capability for learning' (Hague & Payton, 2010, p. 11). Both of these views place strategic importance on digital literacy for new generations. The former view is important for preparing students to fully participate in society, while the latter is important for developing their capacity for lifelong learning. On the one hand, digital literacy allows students to successfully find and select relevant information and facilitates access to subject knowledge in different formats (e.g. text, video and image). On the other hand, digital literacy may also have an impact on what students know about school subjects and the skills required to independently develop subject knowledge (Hague & Payton, 2010).

The definition of digital literacy is still under discussion. However, most researchers agree that it includes the skills required for solving information and communication problems in a digital setting (i.e. searching, evaluating, summarizing, analyzing and presenting information) (Ananiadou & Claro, 2009; Ferrari, 2013; Fraillon, Schulz, & Ainley, 2013; Van Dijk & Van Deursen, 2014). There is also some consensus that digital literacy includes sharing and collaborating with others by using digital tools (Ananiadou & Claro, 2009; Anderson, 2008; Fraillon & Ainley, 2011). Nevertheless, little is known about how children, teenagers and adults become skilled in solving information and communication problems in a digital setting. There is a tendency to assume that digital skills develop spontaneously. There is also little attention paid to these skills within school systems (Prensky, 2001). However, research has shown that it is unlikely new generations will develop these skills without adult guidance (Brand-Gruwel, Wopereis, & Vermetten, 2005; Brand-Gruwel, Wopereis, & Walraven, 2009b; Duijkers, Gulikers-Dinjens, & Boshuizen, 2001; Hirsh, 1999; Walraven, Brand-gruwel, & Boshuizen, 2008). Teachers have also increasingly reported that young students are not as competent or skilled as they might seem. In fact, research on information problem solving has shown that while students may have the ability to find information using digital technology, they struggle to define information problems, specify proper search queries and evaluate the information that they find (Brand-Gruwel, Wopereis, & Walraven, 2009a; Van Deursen & Van Diepen, 2013; Walraven et al., 2008). The aforementioned studies have shown that it is not possible to suggest that young people possess the characteristics of a 'digital native'. It therefore seems reasonable to assume that there will be differences in the way young people access, use and benefit from these technologies. In this sense, the OECD and other researchers have warned against the emergence of what they call a "second digital divide" (OECD, 2010). This divide is defined as the difference between students who have the necessary skills and abilities to effectively use ICT and those who do not. Furthermore, several studies have demonstrated that once access to technology is equal, the differences in how effectively it is used depend on other factors. In particular, these factors have been shown to relate to social, cultural and economic variables (Hargittai, 2008, 2010; Van Deursen & Van Dijk, 2013).

There are also home-level and individual factors that explain differences in students' digital skills. Van Deursen and Van Dijk (2011) found that age and level of education were the main determinants of both operational internet skills (e.g. using browsers) and formal internet skills (e.g. knowing how to navigate the Internet). They also showed that years of experience using the Internet was only relevant for operational internet skills. With regards to content-related internet skills (i.e. knowing how to find the information they are looking for and using this information strategically), the authors found that level of education was the most important factor. They also found that age and experience were not significant for these types of skills. Similarly, Van Deursen and Van Diepen (2013) carried out a study of content-related internet skills among high school students. They showed that performance at school was the most important factor, while years of experience using the Internet and weekly hours of use were not significant. Hatlevik, Ottestad, and Throndsen (2014) found that higher levels of mastery orientation and self-efficacy (i.e. motivation) were predictors of students' digital skills. This was also the case for the students' family background (i.e. language integration and the number of books at home). In addition to this, Litt (2013) confirmed the importance of level of education and socioeconomic status as strong predictors for the development of these skills. This evidence suggests that those in more privileged positions take fuller advantage of the opportunities provided by the Internet.

Only a few countries other than Chile (e.g. Australia and France) have developed national performance tests to assess students' digital skills. The results of the International Computer and Information Literacy Study (ICILS) were published recently, with 21 countries taking part (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014). This was done under the auspices of the IEA (International Association for the Evaluation of Educational Achievement). These national-level assessments have been consistent in showing the importance of individual and home-level characteristics in explaining student performance in a digital context. In particular, these characteristics include the students' economic, social and cultural capital, as well as the ICT resources they have available at home. However, quantitative analysis of national-level assessments can only provide general evidence of these factors. In order to design strategies to develop digital skills in schools, more in-depth information is needed regarding the characteristics of ICT use (e.g. how students go about doing their schoolwork). In fact,

research has started to reveal a more nuanced picture of the underlying sociocultural (Claro et al., 2012; Hatlevik et al., 2014; Van Deursen & Van Diepen, 2013) and cognitive processes (Azevedo & Jacobson, 2008; Greene, Yu, & Copeland, 2014; Hatlevik et al., 2014; Lazonder & Rouet, 2008) relating to students' ICT activities.

Considering the above, in this study we aimed to provide a deeper understanding of the factors that explain the differences in digital skills among students. To achieve this, mixed methods research was used to study the results from a national standardized digital skills test. This test was administered in Chile at the end of 2011 and taken by students in 10th grade (aged around 15). Quantitative analysis was used in the study to identify the most relevant factors associated with student performance. Qualitative analysis was also used to describe the characteristics of the factors related specifically to students' ICT activities (i.e. the strategies they use to complete their schoolwork). In particular, in this study we look to answer two research questions:

1. What are the factors related to individual and home-level characteristics of Chilean students that explain their results on a digital skills test?
2. What are the characteristics of the factors related to students' ICT activities (i.e. the strategies they use to complete their schoolwork) that are significant in explaining the performance by Chilean students on a digital skills test?

By answering the aforementioned research questions, we look to provide a more in-depth analysis of the differences in digital performance by students. We also look to offer empirical evidence regarding the characteristics of students' ICT activities.

2. Methodology

Quantitative and qualitative methods were used to identify and define the factors related to achievement on a digital skills test (ICT SIMCE). These methods are described and justified below, as well as the instruments and variables that were used.

2.1. Quantitative analysis model

The analysis of the factors that explain student performance on a digital skills test was based on data from questionnaires that were administered to students and parents (or guardians). These questionnaires were administered by the Chilean Ministry of Education (Mineduc) at the same time as the test. The student questionnaire contained several questions regarding their ICT activities at home and therefore excluded students who did not have access to a computer at home. So as not to exclude such students from our study, two types of analysis were conducted using a Hierarchical Linear Model (HLM) (Goldstein, 1995). The aim of the first of these analyses was to investigate the effect of having access to a computer at home, controlling for socioeconomic status. The second analysis involved a set of variables related to the students' individual and home-level characteristics, as well as their use and perception of ICT.

HLM was used because of the nested structure of the data from the digital skills test, i.e. students were grouped by school. Using an HLM model allowed for the introduction of a non-observable variable, in this case the so-called *school effect* (Goldstein, 1995). The *school effect* is a variable that is shared by students attending the same school, after controlling for the students' individual and home-level characteristics. It is important to highlight that this type of model assumes exogeneity between the covariates and the school effect, which must be justified by design (Manzi, Martín, & Van Bellegem, 2014). One criterion for selecting these covariates is that they are correlated with the score on the digital skills test, but not with the school effect. This selection was made by taking into consideration the theory regarding the use of ICT and its effect on learning (specified in Section 2.1.2).

2.1.1. Instruments

The instruments used in this study were:

- *2011 Chilean digital skills test (ICT SIMCE).* The aim of this test was to determine the level of development of digital skills among Chilean students. The test assessed 12 skills across three dimensions: Information (as a source and as a product), Communication (transmitting information) and Ethics and Social Impact (ethical dilemmas and the personal/social impact of new technologies) (Mineduc, 2011). The test simulated a virtual environment where students could access common applications such as a word processor, spreadsheet and internet browser, as well as web-based applications such as email. The students had to use these applications to carry out several tasks. A unifying theme (ecology) provided the 32 questions on the test with a certain level of continuity.
- *Student questionnaire.* Students answered this questionnaire immediately after the test. The questionnaire included 16 questions relating to the students' access to, use and perception of ICT.
- *Parent/guardian questionnaire.* A questionnaire was sent to the parents or guardians of the students before the students took the digital skills test. The answers to this questionnaire were collected during the test. The questionnaire included 24 questions about the parents' level of education, household income, household possessions and their perception of ICT, among others.

2.1.2. Description of the variables

The dependent variable in both adjusted models is the students' score on the 2011 digital skills test. This is a continuous variable with distribution between 121 and 384 points and a mean of 265 points (Table 1, Appendix). The covariates included in the first model are socioeconomic status and access to a computer at home. The covariates included in the second model are the students' previous score on a national Language test (2005 Language SIMCE), socioeconomic status (SES), household cultural possessions, self-taught ICT activities, years of experience using a computer, frequency of ICT activities at home, and self-perception of ICT skills. All of the covariates included in the model were justified as exogenous (not correlated) to the school effect. This means that they are not associated with school practices that could affect ICT skills. Firstly, the 2005 Language SIMCE test was applied when students were in 4th grade, six years before taking the digital skills test. This can therefore be considered as a form of language capital that is not related to secondary school ICT practices. Secondly, socio-economic status, cultural possessions and access to a PC at home are all home-level characteristics that relate to a student's family, context and background. These characteristics can therefore not be related to the school effect. Thirdly, the years of experience using a computer would be endogenous if the school were the first place where students learned to use and indeed used a computer. However, this does not seem to be the case. The percentage of students declaring that they learned to do basic ICT activities (such as searching for information, organizing files and sending emails) from their teachers is very low (between 7.7% and 16.8%). This suggests that the vast majority of students first learned to use a computer outside of school. Next, the frequency of some ICT activities was considered endogenous to the school effect. This is because the activities were related to schoolwork (e.g. searching for information to do homework or accessing an online encyclopedia to study). However, using social networks, accessing websites with personal accounts, chatting and downloading media or software are all activities that are not required nor promoted by the school. Finally, although the school may have an impact on how frequently ICT is used for schoolwork, this should not be the case for the students' perception of self-efficacy in performing these activities. Chilean schools do not explicitly support or promote increased self-efficacy regarding activities such as using search terms to find information on the Internet, creating or editing documents, or collaborating with friends.

A breakdown of the covariates that are used in this study is included below:

- *2005 Language SIMCE test.* The results from the national Language test administered to the students when they were in 4th grade. It is a continuous variable with a distribution between 119 and 365 points and a mean of 271 points (Table 1, Appendix).
- *Socioeconomic Status (SES).* An indicator constructed using an unrotated principal component analysis of three variables that, when analyzed together, demonstrated good reliability: father's level of education, mother's level of education, and household income. In this case, Cronbach's alpha for the standardized variables is 0.82. The eigenvalue of the first component is 2.24, which explains 74.8% of the variance (see Tables 2 and 3 in the Appendix). A score was estimated based on this first component, which was then standardized as a value between 0 and 10, where a higher score indicated higher socioeconomic status (Table 1, Appendix).
- *Household cultural possessions.* An indicator based on the estimated score from a factor analysis (principal component factor) of three types of possessions. The first factor explains 53.5% of the variance (eigenvalue = 1.6), with a loading of 0.78 for classical literature books; 0.77 for poetry books; and 0.63 for works of art (see Tables 4 and 5 in the Appendix). Cronbach's alpha for the set of possessions is 0.56, and therefore this indicator should be interpreted with caution. The estimated score was standardized as a value between 0 and 10, where a higher score indicated a larger number of household cultural possessions (Table 1, Appendix).
- *PC at home.* A dichotomous variable related to the presence or absence of a computer at home. 75% of students declared that they had a computer at home that could be used for doing school assignments.
- *Self-taught ICT activities.* An indicator of student autonomy when learning to use ICT. This indicator corresponds to the number of activities on the computer that students reported as having learned to do on their own (such as using search terms to look for information on the Internet). It is a continuous variable with a range between 0 and 9, and a mean of 4.8 activities (Table 1, Appendix).
- *Years of experience using a computer.* A categorical variable from the student questionnaire, with ranges of time using a computer: less than a year (8.35%), between 1 and 3 years (32.2%) and more than 4 years (59.44%).
- *ICT related activities.* A categorical variable corresponding to the frequency with which the students carry out different activities on the computer at home (Table 6, Appendix). The scale ranges from “never” to “every day”. This question was only answered by students that reported having a computer at home.
- *Self-perception of ICT skills.* A categorical variable corresponding to the students' self-perception of their ICT skills. This relates to three different tasks and is based on a scale ranging from “I don't know how to do this” to “Very easy” (Table 7, Appendix). As the lower frequency category (“I don't know how to do this”) would be used as the reference category in the HLM model, it was preferable for this category to have at least a certain level of frequency. For the three variables that used this scale, the percentage of students who reported: “I don't know how to do this” was between 1.2% and 8.7%, which is very low. This category was therefore combined with the following category “Very difficult”.

2.1.3. Sample

An initial sample of 8,936 students from 467 high schools was used for the quantitative analysis. However, only 4,273 students completed a valid questionnaire that could be used for this study. This was because of what the Ministry of Education regarded as random technical failures that occurred during the test (i.e. test not saved on the USB drive). This sample was used to analyze the effect of having access to a computer at home. The remaining analyses were conducted using a sample of the 2,078 students that reported having access to a computer at home and provided information on all of the covariates included in the model. In this case, information was lost due to incomplete responses to the questionnaire. Weighting for geographic region (15 regions) and type of school (public, subsidized or private) were calculated and applied to all of the analyses.

2.2. Qualitative analysis

The design of the qualitative analysis was based on an exploratory case study (Yin, 2009). The significant factors related to the students' ICT activities were determined using the results from the quantitative analysis. The main objective of the qualitative analysis was to study the characteristics of these factors in greater depth through semi-structured interviews. The study was conducted in two stages: the aim of the first stage was to characterize the students' general use of ICT, while the aim of the second stage was to focus on a more in depth characterization of their activities, perceptions and motivations when using technology.

2.2.1. Sample

A purposeful sample of 17 students (6 females and 11 males, from 11th grade, with an average age of 16) was chosen for the first stage using two selection criteria. The first of these criteria was that the students had to have taken the test the previous year, while the second was that the group had to include students with high, medium and low academic performance. Performance in this case was determined by the students' average grades from the previous year.

For the second stage, an intentional sample of six students (three females and three males, from 11th grade, with an average age of 16 was selected from two of the schools that participated in the first stage. The students from one of the schools had high SES, while the students from the other had low SES. The selection criterion for this stage was the students' performance on the digital skills test in 2011. In this case, three students that achieved a basic level on the digital skills test were selected, as well as three that achieved an advanced level. These levels were determined by referencing the scale used by the Ministry of Education (for details see: ENLACES, 2012).[1]

The students from both samples were selected from four high schools that participated in the digital skills test in 2011. In total, a sample of 23 students was selected for the qualitative study (8 of them female and 15 male).

2.2.2. Procedures

Data was collected for the first stage between September and November 2012 (second school semester). During this stage, weekly group interviews with the students from each school were carried out, as well as a final semi-structured interview with each student. In addition to this, students were also asked to keep a daily log to record their ICT activities. These logs were collected each week for the duration of the three month period in which data was gathered. A total of 27 group and 17 individual interviews were conducted, with 322 logs collected. The interviews were conducted by members of the research team. In each group interview, the four or five participating students were asked about their main ICT activities for the week. In the final interview, each student was asked to describe their ICT activities more extensively, including what they did, how they did it and why, focusing mainly but not exclusively on school-related ICT activities. Furthermore, the researchers referred to the data from the logs and previous interviews during these interviews in order to detect inconsistencies in the students' answers and ensure validity of the data that was collected (Creswell, 2007).

In the second stage, which took place in May 2013, members of the research team conducted semi-structured interviews with students, both individually and in pairs. The selection of topics for the second stage interviews was informed by the results from the quantitative analysis and first stage of the qualitative analysis. The aim of these topics was mainly to understand the strategies that students used, as well as their perceptions of the ICT activities. All of the interviews were recorded and transcribed during both stages.

The data was analyzed using the qualitative analysis software NVivo10. It should be noted that the analyses did not take gender differences into account. It is also worth noting that this study adhered to ethical standards throughout the entire process. This included obtaining signed consent forms from the participating schools and teachers, as well as from the students and their parents. Furthermore, the researchers ensured the confidentiality of the information that was collected and emphasized the voluntary nature of their participation.

2.2.3. Data analysis

In general, content analysis methods (Cohen, Manion, & Morrison, 2007) were used to analyze the data from the semi-structured interviews gathered during the two stages. The variables from the quantitative analysis were used in the first

[1] Note that due to ethical considerations, the information on the students' performance on the test was not shared with the school. The researchers therefore asked each school for a specific group of students to interview.

stage as initial codes to be identified in the transcripts from the student interviews. In particular, the researchers looked for occasions when the students talked about topics that could be associated with the variables of interest. Once identified, the relevant quotes were gathered and content analysis was performed for each set of quotes. This was done with successive revisions made by two of the team's researchers until the new codes became saturated. In order to ensure reliability, the codes were discussed by two researchers until a consensus was reached (Creswell, 2007). When a consensus was not reached, a third researcher was involved as an external judge. This process resulted in units of meaning for each of the variables that were identified in the quantitative analysis. These units were then used to shape the design of the interviews for the second stage.

In the second stage, researchers analyzed the transcripts by looking for occasions when the students described their ICT activities. Such occasions included the students talking about the strategies they used and their perception of the activities. The quotes that described each activity were grouped and content analysis was then performed for each set of quotes. To ensure reliability (Creswell, 2007), this analysis was carried out by two researchers with successive revisions until they reached a consensus regarding the characteristics of the activities. The interview transcripts for high and low-performing students were analyzed separately. This was because the aim was to characterize the activities for each group of students, as well as to understand the differences in their strategies and perceptions.

3. Results

3.1. Quantitative analysis

The results from the HLM model 1 show that, when controlling for socioeconomic status, students who have a computer at home achieve better scores than those who do not (an average of 8.76 points). The results from the null model are presented in Table 8 and the results from model 1 are presented in Table 9.

The results from the second adjusted HLM model are shown in Table 10. Model 1 explains 25% of the total variance in ICT test performance, whereas Model 2 explains 78% of the variance between schools and 41% of the individual variance (between students from the same school) (Table 11).

In terms of their home-level characteristics, students from families with higher SES and more cultural possessions performed better on the digital skills test (Table 10). With regards to their individual characteristics, students with a higher previous score on the national Language test (2005 Language SIMCE) performed better on the digital skills test.

In relation to their autonomy and experience using ICT, students with more autonomy and more experience performed better on the digital skills test. Furthermore, there was a significant difference between students who have been using computers for between one and three years, and those who have been using them for less than a year. This difference is even greater between the latter group and students who have been using computers for more than four years.

In terms of their use of ICT, students who use social networks every day and frequently send messages via social networks (i.e. a few times a week) performed better than those who never do either of these activities. However, students who chat every day and download music, programs or games from the Internet performed worse than those who never do those activities.

In relation to the students' self-perception of their ICT skills, the results were contradictory. Students who reported finding it easy or very easy to use search terms to look for information on the Internet, as well as to create or edit documents, performed significantly better on the test than those who do not know how to do these things or find them very difficult. However, students who declared finding it easy or very easy to collaborate online with other students performed worse on the digital skills test than those who answered that they find it very difficult or that they do not know how to do it. These results, as well as those related to ICT factors, were analyzed in greater detail in the qualitative study.

Three elements were considered in order to explore the most important factors in explaining the students' results on the digital skills test. Firstly, previous research (San Martín, E., Claro, M., Cabello, T., & Preiss, D., 2013) demonstrated the importance of SES and Language SIMCE test scores for ICT SIMCE scores. Secondly, the model 1 coefficients were standardized (using the continuous version of the variables) by following the method proposed by Hox (2002) in order to compare them on a common scale. This standardization showed that the variables that had the greatest effect on performance on the digital skills test were the students' previous performance on the national Language test (2005 Language SIMCE), SES, and years of experience using a computer (Table 12 in the Appendix).

Table 8
Null model.

	Coefficient	**Std. Err.**	**p-value**
Constant	248.04	1.46	<0.001
Variance components	**Estimate**	**Std. Err.**	**95% Conf. Int.**
Student-level	1,519.32	50.78	1,454.07–1,587.50
School-level	842.01	34.03	748.13–947.67
Intra-class correlation	0.357		
AIC	91,837.2		

Table 9
Model 1 for 2011 ICT test (n = 4,273).

Variable	Coefficient	Std. Err.	p-value
SES group (vs. E-highest)			
D	−9.43	2.38	<0.001
C	−26.28	2.96	<0.001
B	−30.59	3.25	<0.001
A (lowest)	−46.04	3.26	<0.001
PC at home	8.76	1.77	<0.001
Constant	269.50	3.00	<0.001
Variance components	**Estimate**	**Std. Error**	**95% Conf. Int.**
Student-level	1,434.03	41.88	1,354.24–1,518.10
School-level	334.37	39.32	265.54–421.04
Intra-class correlation	0.19		
AIC	45,187.78		
N	4,273		

Finally, the percentage of variance explained by only these three variables and the full model (Model 2) were analyzed. The results showed that the model using these three variables explained 34.8% of the individual variance, while adding all of the other covariates only increased individual variance to 41.3%, i.e. an additional 7%.

Table 10
Model 2 for 2011 ICT test (n = 2,078).

Variable	Coefficient	Std. Err.	p-value
Socioeconomic Status (SES)	3.16	0.49	<0.001
Household cultural possessions	0.83	0.29	<0.001
Years of experience using a computer (vs. Less than a year)			
Between 1 and 3 years	13.11	3.39	<0.001
More than 4 years	19.87	3.91	<0.001
Self-taught ICT activities (autonomy)	0.84	0.28	<0.001
2005 Language SIMCE	0.37	0.02	<0.001
How often do you use your computer at home to visit a website where you have a personal account (e.g. social networking sites)? (vs. Never)			
A few times a month	−0.24	3.49	0.95
A few times a week	4.96	3.22	0.12
Every day	10.44	3.90	0.01
How often do you use your computer at home to send messages using social networks? (vs. Never)			
A few times a month	5.54	3.28	0.09
A few times a week	6.43	2.92	0.03
Every day	5.69	3.46	0.10
How easy was it to use key words to search for information on the Internet? (vs. I don't know how to do this + Very difficult)			
Difficult	3.40	4.95	0.49
Easy	8.68	3.73	0.02
Very easy	11.53	3.90	<0.001
How often do you use your computer at home to chat? (vs. Never)			
A few times a month	1.22	5.20	0.81
A few times a week	−6.13	4.71	0.19
Every day	−10.58	4.77	0.03
How often do you use your computer at home to download music, films, games or programs? (vs. Never)			
A few times a month	−10.64	3.63	<0.001
A few times a week	−10.36	3.71	0.01
Every day	−12.99	4.69	0.01
How easy was it to create or edit documents (e.g. write reports or do school assignments)? (vs. I don't know how to do this + Very difficult)			
Difficult	13.61	7.70	0.08
Easy	23.16	6.58	<0.001
Very easy	26.25	6.73	<0.001
How easy was it to use key words when collaborating with friends or classmates (e.g. using shared documents online)? (vs. I don't know how to do this + Very difficult)			
Difficult	−0.90	3.89	0.82
Easy	−8.21	2.76	<0.001
Very easy	−7.04	3.34	0.04
Constant	102.76	9.17	<0.001
Variance components	**Estimate**	**Std. Error**	**95% Conf. Int.**
Student level	891.16	35.09	824.97–962.65
School level	185.91	28.73	137.34–251.67
Intra-class correlation	0.173		
AIC	20,814.82		

Table 11
Variance explained by model 1 and model 2.

	Model 1	Model 2
Percentage of variance explained at the school level	60.29%	77.92%
Percentage of variance explained at the student level	5.61%	41.35%
Total percentage of the variance explained by the model	25.11%	54.39%

3.2. Results of the qualitative analysis

Having established the significant factors related to ICT activities in the quantitative analysis, the students' strategies and perceptions regarding these factors were further investigated through the qualitative analysis. In terms of use, it was observed that students tend to do similar things on the computer, regardless of SES and performance on the digital skills test. In particular, they chat and use social networks, as was identified in the quantitative analysis, but they also search for information on the Internet. Nevertheless, there are differences between high and low-performing students on the test in terms of the way in which they perform these tasks.

Regardless of SES, high-performing students use social networks to coordinate with other students, complete assignments and exchange school resources. For example, some students in this group said:

> **Student 1:** Yes, in fact we always coordinate our schoolwork … and we [agree to] talk at a certain time and chat on Facebook and we all agree [on what we will do].
>
> **Student 2**: It's like only Facebook, we use it to keep in contact, then, for example, right now, to do the [school] assignments. Instead of calling, sometimes they don't answer, so you leave them a message on Facebook and we know that they will log on to send things, and … sometimes they are online right then to do the tasks. So communication is easier.

Furthermore, high-performing students use chat as a way to exchange information on schoolwork. However, these students are also aware that this could be a distraction and therefore regulate their use of chat. This is mainly because it seems to distract them from academic activities. In this sense, one of these students said:

> **Student:** I realized that they always talk to me, they always start the conversation, they say R, and I say what? Or they ask for something, things like that, they always talk to me, and I close the conversation because I have to go, because they are all chatting and I'm not.

As can be seen in this quote, the student complains that her classmates always chat, interrupting her from what she is doing.

Furthermore, these students also filter information on the Internet using various strategies which they have developed in order to search, select and evaluate the web sites they visit. When asked about how they search when given an assignment, one of them said:

> **Student**: well, if the assignment involves a question, I search for the fact, I don't search for the question itself, because, you can search for it, but you get answers from Yahoo answers. I always search for the main topic and then I start to read about it and then to search for it.
>
> **Researcher**: And if you don't find a good website among the first couple of sites in the search results, what do you do?
>
> **Student**: I keep searching. First I keep looking, almost always on the first page [of the search results] because these are the most visited and, if they are, it is because the information is good and, knowing this, I keep looking. Otherwise I keep searching by widening the query [adding more key words to the search] and trying to search for what is asked in more concrete terms.

In addition to this, the results show that high-performing students judge the quality of the web sites (e.g. they prefer sites that contain scientific information and references, and discard wikis or blogs) and compare multiple sources (at least three websites). For example, when asked about how to judge the quality of a website, one student answered:

> **Student**: When the source is not just what one person said, but the result of an investigation, a page [reporting] a research paper or scientific study, or something like that. Otherwise I search for many sources and look for the one that has the most matches, and that is my result.

High-performing students also make summaries of the information they find. They do so by comparing various sources, taking the main ideas and adapting the contents according to their understanding of them. This is complemented by their ability to edit and structure the format of their work, paying special attention to the details.

Unlike high-performing students, while low-performing students also use social networks to do school assignments, they tend to get distracted and lose focus on the task at hand. This can be observed in the following exchange:

Researcher: And are these chats with your classmates about the schoolwork or do you chat about other things?

Student: Sometimes, I mean in the beginning we do, but then we get distracted.

Researcher: You get distracted … it's more fun to talk about football.

Student: No, about life.

Researcher: Parties?

Student: Yes, for example, what's happening on Friday night.

This happens because they hold simultaneous conversations on various topics of interest, as well as downloading games and videos to entertain themselves. They also use the Internet to search for information, but adopt simple strategies. These strategies tend to be aimed at finding the "finished assignment" by visiting "typical" sites such as Wikipedia and Yahoo! Answers, without applying any sort of selection or evaluation criteria. Low-performing students also limit themselves to directly copying the contents of their work, making only minor changes to the formatting. One of the students in this group said:

Student: Well, nowadays the majority of school tasks and assignments are on the Internet, so it's easy to search them, find them and then copy and paste them.

Notwithstanding the above, high-performing students differ from low-performing students in terms of how they value group work using digital media. High-performing students assign such tasks a negative value as it means tending to the needs of less "responsible" students. Low-performing students, on the other hand, suggest that collaborating using digital media provides an opportunity for getting information and solving problems related to an assignment. For example, one of the students in the latter group values Facebook as a medium for getting the right answers to the schoolwork from his more knowledgeable classmates, he said:

Student: Yes, sometimes [Facebook] is useful because I get the links for the assignments, I ask the classmates that know more than me for the links.

Finally, the general perception of ICT skills reported by students in the interviews is consistent with the skills reported by the test. Therefore, students who performed better on the test see themselves as being more able when it comes to using word processors and creating presentations. Spreadsheets, however, are regarded as being difficult to use by all of the students.

4. Discussion

The objective of this study was to define the individual and home-level factors that influenced the performance of 10th grade Chilean students on the 2011 digital skills national test (ICT SIMCE). The aim of this test was to measure the students' ability to solve information and communication problems in a digital setting. Two HLM models were used to identify the most relevant factors. The first model was used to determine whether there is a relationship between having access to a computer at home and the score on the test. The second model was used to identify factors related to the students' individual and home-level characteristics, as well as their use and perception of ICT, that explain the scores on the ICT SIMCE. In addition to this, an exploratory case study was conducted in order to describe the ICT-related variables that were defined by the quantitative analysis as being significant.

The most important finding from the quantitative analysis is that high performance on this digital skills test is mainly related to having access to a computer at home. It is also related to the family's socioeconomic status, how many years the students have been using such technology, and their linguistic capital (i.e. the students' score on the Language SIMCE test taken six years previously). To a much lesser extent, performance on the digital skills test is also positively related to other variables such as the students' cultural possessions, as well as their self-perception of their ICT skills. These results are consistent with previous studies reported by the literature and suggest that, as with other areas of education, students' digital skills are strongly linked to their economic, social and cultural background. The results also suggest that, while not sufficient in itself, easy and early access to technology could significantly help the development of students' digital skills.

In terms of the variables related to how students use technology, the quantitative results are mixed. On the one hand, the results from the digital skills test are positively related to use of social networks, while being negatively related to using messaging applications and downloading music or programs. In this case, the qualitative study helped us understand these results by indicating that differences in performance are not characterized by how often different applications are used, rather than by what students report with respect to how and why they are used. In effect, high-performing students reported using social networks as a means to communicate with classmates to organize their schoolwork. They do so by focusing on the task at hand and not on conversations about other topics. Furthermore, when searching for information on the Internet, high-performing students adopt a critical attitude in terms of the validity and reliability of the results. Such students also use more sophisticated search terms.

The results from the qualitative study suggest that students with good results on the digital skills test are able to avoid distractions and remain focused on completing their school assignments, while taking full advantage of digital media. As

suggested by Pedró (2012), ICT can be a source of both support and distraction for young people, and in this case, students who scored higher on the digital skills test where able to focus on the former and avoid the latter. The interviews with the high-performing students in the qualitative stage of the study also suggest that high-performing students on this test tend to be high-achieving students in school subjects as well. The interviews also indicate that these academic characteristics (a mix of cognitive skills and habits, as well as organizational skills) is what allows high-performing students to discriminate and make more appropriate use of the opportunities for information and communication provided by the Internet in order to meet their personal objectives. These results are consistent with other studies such as Hatlevik et al. (2014), who found that mastery of goal orientation predicts the level of a student's digital skills.

In summary, in addition to the economic, social and cultural factors identified in the quantitative analysis, the results of the qualitative study provide evidence to suggest that high-performing students in the digital skills test are not characterized by performing ICT activities more frequently. Instead, they show cognitive and behavioral characteristics that shape the quality of how these activities are performed.

The results of this study provide evidence to public policy and lead us to suggest the need to ensure access to ICT at home. This is because having such access provides the foundation for developing digital skills. Furthermore, the study also reveals the need to make further progress in research that can help understand the way in which high-performing students use ICT for schoolwork. This can be achieved by taking into consideration the underlying cognitive and organizational strategies, so as to integrate these into school activities. Schools have a relevant role to play in this, especially in countries like Chile, where, as this study shows, economic, social and cultural capital strongly influence student performance.

Finally, it should be highlighted that a limitation of this study is that, given the design of the student survey, the sub-sample used in the second model only included students who have access to a computer at home. The interpretation of these results is therefore only applicable to this group.

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Appendix

Table 1
Descriptive statistics for the model's continuous variables (n = 2,078).

Variable	Mean	Std. Dev.	Min	Max
Digital skills test (SIMCE ICT)	264.74	44.79	121	384
2005 Language SIMCE test	271.05	48.58	119.34	364.77
SES	4.97	1.97	0	10
Household cultural possessions	5.51	2.95	0	10
N° of self-taught ICT activities	4.82	2.91	0	9

Table 2
Principal component analysis for SES.

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.245	1.835	0.748	0.748
Comp2	0.410	0.065	0.137	0.885
Comp3	0.345	.	0.115	1.000

Table 3
Principal component loadings for SES variables.

Variable	Component 1	Component 2	Component 3	Unexplained
Years of education (mother)	0.577	−0.593	0.562	0
Years of education (father)	0.586	−0.179	−0.790	0
Household income	0.569	0.785	0.244	0

Table 4
Factor analysis for household cultural possessions.

Component	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	1.605	0.806	0.535	0.535
Factor 2	0.799	0.202	0.266	0.801
Factor 3	0.597	.	0.199	1.000

Table 5
Rotated factor loadings for household cultural possessions.

Variable	Factor 1	Uniqueness
Classic literature books	0.780	0.392
Poetry books	0.772	0.405
Works of art	0.633	0.599

Table 6
Activities using ICT (n = 2,078).

	Never (%)	A few times a month (%)	A few times a week (%)	Every day (%)
Frequency of use at home to visit a website with a personal account	9.10	12.03	28.10	50.77
Frequency of use at home to send messages via social networks	13.8	15.07	31.91	39.22
Frequency of use at home to chat	5.76	9.55	30.84	53.85
Frequency of use at home to download music, films, games and programs from the Internet	8.09	19.04	37.52	35.35

Table 7
Self-perception of ICT skills (n = 2,078).

	I don't know how to do this + very difficult (%)	Difficult (%)	Easy (%)	Very easy (%)
Using search terms to find information on the Internet	6.84	8.17	38.09	46.90
Creating or editing documents	1.76	3.99	41.71	52.54
Collaborating with friends or other classmates	11.40	11.27	37.94	39.40

Table 12
Standardized coefficients for variables in model 2 (n = 2,078).

Covariates	Standardized coefficients
Socioeconomic Status (SES)	0.18
Years of experience using a computer	0.13
2005 Language SIMCE	0.43
Self-taught ICT activities (autonomy)	0.04
Household cultural possessions	0.06
How often do you use your computer at home to visit a website where you have a personal account (e.g. social networking sites)?	0.10
How often do you use your computer at home to send messages using social networks?	0.05
How easy was it to use key words to search for information on the Internet?	0.09
How often do you use your computer at home to chat?	−0.09
How often do you use your computer at home to download music, films, games or programs?	−0.06
How easy was it to create or edit documents (e.g. write reports or do school assignments)?	0.09
How easy was it to use key words to collaborate with friends or classmates (e.g. using shared documents online)?	−0.05

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