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Comparing marginal effects of Chilean students' economic, social and cultural status on digital versus reading and mathematics performance

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ABSTRACT

This paper provides evidence that helps understand the digital divide in education. It does so by comparing the effect of economic, social and cultural status (ESCS) on the digital skills of Chilean students compared with mathematics and language. This comparison is made using national standardized tests. The marginal effect of a group of variables measuring student ESCS was compared both as a whole and separately using multivariate linear regression analysis. The results show that the marginal effect of ESCS as a whole on students' digital skills was equal to the effect on mathematics and greater than the effect on language. Furthermore, the results show that the parents' level of education was the most relevant factor of ESCS for explaining student performance on the digital test, more so than for mathematics and language. These findings challenge the belief that the Internet would reduce economic, social and cultural inequalities in new generations. Instead, they reveal that the gap among Chilean students tends to perpetuate or widen when comparing performance in mathematics and language with performance in the digital domain. At the same time, by comparing national test results, this paper offers empirical evidence for the existence of a second digital divide in the field of education, a concept which is widely discussed at a theoretical level but with little empirical support to date.

1. Introduction

For some, access to the Internet represents the promise of a more democratic and equitable society; for others it is a potential source of cultural and social inequality, giving rise to the so-called digital divide (Castells, 2001; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Selwyn & Facer, 2007; Van Dijk, 2006; Warschauer, 2012). In this context, the adoption of Information and Communication Technologies (ICT) by educational systems has been partly inspired by a social rationale that sees schools as leveling access to the opportunities provided by ICT and digital literacy. As several authors have reported, the concept of the digital divide was initially defined in dichotomous terms as the distance between those that have access to ICT and those that do not (Di Maggio et al., 2004; Hargittai, 2008; Selwyn, 2004; Van Dijk, 2006). To reduce this gap, schools have been equipped with computers and the Internet. In some countries, such as Uruguay, Peru and Haiti, One-to-One programs have been implemented to provide children from low-income families with access to a personal computer (Näslund-Hadley, Kipp, Cruz, Ibarrarán, & Steiner-Khamsi, 2009; Severin & Capota, 2011). However, evidence today shows that as quantitative access increases and levels-out, qualitative disparities appear in the way in which technology is used. These disparities are not only financial, but also cognitive, social, and cultural, leading to the concept of a 'second digital divide' (OECD, 2010). This concept represents a more refined approach that shows that the benefits of using ICT depend not only on access, but also on the conditions of the individual and their ability to

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take advantage of the opportunities provided (Hargittai, 2008; OECD, 2010; Selwyn, 2004; Selwyn & Facer, 2007; Van Dijk, 2006). In this sense, the concept of digital divide goes from being one-dimensional to multidimensional. It also accounts for factors that are extrinsic and extrinsic to technology, such as individual skills or digital literacy (Ferro, Helbig, & Gil-Garcia, 2011).

An important question in the field of education is how the second digital divide relates to other differences in student learning. Research on the differences in student learning outcomes has strongly focused on the role played by the student's economic, social and cultural status. The impetus for this research was partly provided by two important projects: the Coleman Report in the USA (Coleman et al., 1966) and the Plowden Report in Great Britain (Peaker, 1971). In broad terms, these reports concluded that the family context was more important than school-level factors in determining student achievement. Initially, the family context was restricted to economic and social status (measured by income, and the parents' education and occupation). However, this definition has become more complex over time. This is because research has found evidence to suggest that factors such as educational resources at home, as well as the family's social and cultural capital also influence student's educational outcomes (Buchmann, 2002; Sirin, 2005; Sullivan, 2007). Studies of performance in various subjects, particularly in mathematics and language, consistently show the relevance of these factors in explaining differences between students (Bradley Corwyn, 2002; Dahl & Lochner, 2005; OECD, 2013a, 2013b; Perry & McConney, 2013; Schulz, 2005; Sirin, 2005; Starkey & Klein, 2008).

Research into the role of economic, social and cultural status in explaining the digital divide among students has mostly been centered on how it affects student use of ICT (Hargittai, 2010; Peter & Valkenburg, 2006; Van Deursen & Van Dijk, 2014). So far, little research has been focused on student performance in a digital context, partly due to the difficulty of defining and measuring ICT or digital skills (Litt, 2013). Initially the concept of digital literacy referred to computer literacy, i.e. the ability to operate computers and their different programs (Norman, 1984). Subsequently, a broader concept appeared, transcending technical ICT skills and including skills linked to the capacity to solve information and communication problems in a digital environment. For example, searching, assessing, summarizing, analyzing, representing, or creating information; as well as sharing and collaborating with others (Claro et al., 2012; Ferrari, 2013; Fraillon, 2012; Fraillon, Schulz, & Ainley, 2013). The most reliable way to measure these skills is to use standardized tests in closed computational environments. However, due to the high cost involved in their design, measurements tend to rely on self-reporting by those being assessed (Van Dijk, 2006). Nevertheless, there are some studies that measure individual Internet skills (Hargittai, 2002; Van Deursen & Van Diepen, 2013; Van Deursen & Van Dijk, 2009) and digital reading skills (OECD, 2012). Furthermore, some countries such as Australia (ACARA, 2012) and Chile (Enlaces, 2011) have developed performance tests that are taken nationally and cover a range of objectives. Likewise, under the auspices of the IEA (International Association for the Evaluation of the Educational Assessment) the International Computer and Information Literacy Study (ICILS), an international evaluation, has been carried out with the participation of 21 countries (Fraillon et al., 2013). In general, the results of digital skills tests tend to show that, as within other fields of performance, family background measured using economic, social and cultural variables is a strong predictor of digital skills (Claro et al., 2012; Gui & Argentin, 2011; Hargittai, 2010; Hatlevic, Ottestad, & Throndsent, 2014; Litt, 2013; Van Deursen & Van Dijk, 2010).

In summary, academic research and discussion shows that the digital divide is more complex than simply the *haves* vs. the *have nots*. In the field of education, research is increasingly focused on the differences between students in terms of their digital skills. Furthermore, there is plenty of research on the importance of economic, social and cultural status to student performance in mathematics and language. Additionally, there is increasing evidence of this also being the case for digital skills. Nevertheless, there have been few studies as to whether the performance gap explained by student ESCS differs for print and digital tests in language or mathematics. One such study is PISA 2009. This study featured a print and digital reading test, and compared the effects of student attitudes and family background on both assessments. The results showed a very similar relationship between socio-economic background and student performance on both the print and digital tests (OECD, 2011:140). These types of studies are important for understanding whether there is anything new or different about the gap in student performance in the digital domain when compared with more traditional academic domains, such as print tests in language and mathematics. Consequently, the purpose of this study is to compare the effect of economic, social and cultural status in three performance domains —mathematics, language, and digital skills— in order to answer two questions:

1. Is the marginal effect of ESCS on students' digital skills equal to, greater than or less than the marginal effects on students' performance in language and mathematics?
2. Which factors of ESCS best explain student performance in the digital domain?

To do this, we will compare the effect of ESCS on student performance by a single group of Chilean students on a national standardized test in digital skills (sample test) against their performance on national standardized tests in mathematics and language (census tests).

2. Methodology

To answer the research questions, we will analyze the marginal effect of ESCS on the results of a group of Chilean students on three standardized tests. These tests are the Mathematics SIMCE, the Language SIMCE and the ICT or digital skills SIMCE. As will be described in more detail in Section 2.2, the ICT SIMCE measures students' digital skills. ESCS was measured using five variables that are typically used in international studies on education: parents' highest level of education, parents' highest occupational status, household income, educational resources at home, and cultural possessions at home (OECD, 2012).

The sample used in this study is presented in Section 2.1. The variables that comprise student ESCS, as well as the dependent variables, i.e. the national SIMCE tests, are described below in Section 2.2 and 2.3, respectively (Table 1).

2.1. Sample

Chile is an OECD member Country since 2010. Disposable household income in Chile is about 60% of the OECD average. The Country also has the highest level of income inequality and the 4th highest level of relative poverty in the OECD area (OECD, 2014a). Chile spent 6.9% of its GDP on educational institutions in 2011, above the OECD average of 6.1%, but has the highest share of private expenditure on all levels of

Table 1
Description of ESCS variables.

ESCS Variable	Source	Description
Highest educational level of parents	SIMCE ICT 2011 Parents or Tutors Questionnaire	Maximum including Mother and Father's years of schooling. Index based on PISA (OECD, 2012).
Highest occupational status of parents	SIMCE ICT 2011 Parents or Tutors Questionnaire	Maximum occupational level of Mother or Father Occupations recoded into four International Standard Classification of Occupations (ISCO) skill levels (ILO, 2012). Index based on PISA (OECD, 2012).
Household Income	SIMCE ICT 2011 Parents or Tutors Questionnaire	13 income segments from lower to higher
Home educational resources	SIMCE ICT 2011 Student Questionnaire	Index based on PISA (OECD, 2012), constructed with one-parameter Item Response Theory (IRT) scaling methodology for dichotomous items, that measures the possession of: A desk for studying A place for studying A computer that can be used for schoolwork Educational software Internet connection (this is not part of the original PISA (OECD, 2012) index, however, it is included due to increasing evidence of Internet use as a source of information for schoolwork (Claro et al., 2012; Hinostroza, Matamala, Labbé, Claro, & Cabello, 2014; OECD, 2011).
Cultural possessions	SIMCE ICT 2011 Student Questionnaire	Index based on PISA (OECD, 2012), constructed with one-parameter IRT scaling methodology for dichotomous items, that measures the possession of: Classical literature books Poetry books Works of art
ESCS Index	SIMCE ICT 2011 Student and Parents or Tutors Questionnaire	Index constructed with a Principal Component Analysis considering the five ESCS variables presented above: Highest educational level of parents Highest occupational status of parents Household Income Home educational resourcesCultural possessions

education with 40% of education expenditure coming from private sources (OECD, 2014b). In terms of educational results, in PISA 2012 Chile scored higher than any other Latin-American country but significantly below de OECD average. In terms of equity, Chile is one of the countries where the socioeconomic factors explain a greater percentage of the PISA results variance, way above the OECD average (OECD, 2013a, 2013b).

The SIMCE tests analyzed in this study were sat by the same group of students at two different moments in time: the Mathematics SIMCE and Language SIMCE in 2009, when the students were in 8th Grade; and the ICT SIMCE in 2011, when they were in 10th Grade. The Mathematics SIMCE and Language SIMCE were taken by 239,745 students; i.e. 92.5% of 8th Grade students in the country. The ICT SIMCE, on the other hand was taken two years later by a sample of 9462 students; i.e. 3.8% of the students who were in 8th grade in 2009. The decision to apply this test only to a sample of the student population was made by the Ministry of Education because of cost effective reasons.

The sample used in this study corresponded to students that sat all three SIMCE tests (7153) and for whom the necessary information on their ESCS was available, as reported by the student (4489) and by the parent or tutor (7391). This information was gathered using characterization questionnaires that were administered at the same time as the ICT SIMCE test in 2011. Considering the above conditions, the final sample consisted of 2933 students. In order to ensure national representation, weightings by type of school administration and region were used in all estimations.

2.2. ESCS covariates

The variables for measuring student ESCS were selected based on the information gathered in the characterization questionnaires administered together with the SIMCE tests. All ESCS variables, except for household income, are the variables used in the PISA socioeconomic index and were constructed using the PISA methodology (OECD, 2012: 280–287). Of the variables included in these questionnaires (parents' education, parents' occupation, household income, goods and services available at home) the ones selected were those that were considered more stable over time, i.e. those that had less chance of changing over a two-year period. Considering these criteria, goods and services available at home were not included. Table 1 describes the ESCS variables that were used.

It should also be mentioned that indices for Educational Resources at Home and Cultural Possessions are complex and were constructed using Item Response Theory, following the PISA methodology (OECD, 2012). Therefore, these indices were verified to see if the scores defining Educational Resources at Home and Cultural Possessions were monotonically related to the items used to construct each index. For the data under analysis, this was the case. In other words, as the Educational Resources at Home or Cultural Possessions indices increased, the amount of goods related to each index also increased.

2.3. National assessments used in the study

The SIMCE is a national system for assessing learning outcomes administered by the Chilean Ministry of Education. The system has been in place since 1988 (first version). The Mathematics SIMCE and Language SIMCE evaluate student achievement on the national curriculum and are administered once a year to all students enrolled in the grade levels under evaluation (MINEDUC, 2010). The ICT SIMCE evaluates students' digital skills and was applied to a sample of students in Secondary Education for the first time in 2011 and for a second time in

2013. A characterization questionnaire is also administered to students and their parents or tutors, with both types of assessment. The Ministry of Education ensures that the use of the results is strictly confidential and for academic purposes only.

The Language SIMCE for 8th Grade students in 2009 measured reading comprehension skills, especially extracting information, making inferences or interpretations and reflecting on the content and format of a text. Questions asked students to extract information located in different sections of a text, such as a footnote, or to make inferences and interpretations, such as inferring how a character might feel. It also asked participants to determine the relationship between images and verbal information. These skills were evaluated using questions related to different types of texts, both literary (e.g. stories, poems and plays) as well as non-literary (e.g. news articles, instructions, opinion pieces and posters). Non-literary texts generally included complementary elements such as tables, charts, boxes, footnotes or illustrations. The texts were either complete or excerpts, and referred to both real and imaginary situations (MINEDUC, 2010). The Mathematics SIMCE for 8th Grade students in 2009 evaluated four areas: numbers, geometry, algebra and data, and probability. Students had to demonstrate their knowledge by solving problems related to relevant mathematical concepts in each of these areas (MINEDUC, 2010).

The ICT SIMCE in 2011 measured the students' ability to solve information and communication problems, as well as ethical dilemmas in a digital context (Enlaces, 2011). The assessment was administered on a computer, using specific software that simulated a virtual environment (with chat, files, desktop, programs, tools and an instruction window). Here, tstudents were asked to perform tasks related to a cross-curricular topic, “the environment”. It measured 12 skills involving three dimensions: Information, Communication, and Ethics and Social Impact. The Information dimension evaluated skills related to the use and production of information. More specifically, Use of Information (information as a source) evaluated the students' ability to determine the information that was needed, search, select, evaluate and organize information. Production of Information (information as a product) evaluated the students' ability to integrate, analyze and present information as well as to generate new information. The Communication dimension evaluated the students' ability to transmit information by selecting the appropriate digital media based on a given context. The Ethics and Social Impact dimension evaluated the students' ability to recognize and reflect upon the ethical dilemmas generated by the use of new technologies in their personal lives and the lives of others, as well as their impact on society as a whole (Enlaces, 2011).

A generic example of the type of task included in the test is the following: students are presented with a statement that says “*In order to build a campaign together with your friends to protect animals in danger of extinction, prepare a presentation to quantify and explain this phenomenon, highlighting the consequences of human actions*”. Students were then asked to:

1. Determine the information that was needed
2. Search online and select valid and reliable information
3. Summarize and reorganize information
4. Analyze and represent information
5. Decide on the most appropriate method for presenting the information (text, charts, diagrams, photos, video, etc.)
6. Produce the presentation considering message and audience.

As the example shows, the test transcends the functional management of technology and requires students to solve information and communication problems. Although mastery of ICT applications is required, higher-order cognitive skills are also very important, such as the ability to analyze, synthesize and represent information.

2.4. Analytical approach

One possible approach for analyzing the relationship between ESCS and the different SIMCE test scores is to conduct separate analyses of the association between ESCS and each SIMCE test. However, this approach assumes that SIMCE scores are uncorrelated, which is not the case. A simple correlation analysis showed that the correlations between the students' performance on the tests are 0.65 between Language and Mathematics; 0.57 between ICT and Language; and 0.6 between ICT and Mathematics.

It is therefore necessary to fit a model that takes into account the correlation between the scores of each pupil. Multivariate linear models or Seemingly Unrelated Regressions (SUR) (Zellner, 1962) are therefore the most appropriate statistical tool.

SUR models are specified in the following way: for each pupil, the dependent variable corresponds to a 3-dimensional vector (the scores on the ICT, Language and Mathematics SIMCE tests). The explanatory factors are the same, but the vector of marginal effects, or linear regression coefficients, is specific to each coordinate of the dependent variable. Thus, it is possible to estimate the marginal effect of each explanatory factor on the ICT SIMCE test, as well as on the Language and Mathematics SIMCE tests. Finally, the residuals for each equation are assumed to be correlated, which is a consequence of the empirical correlation between the three test scores.

Two advantages of fitting SUR models should be highlighted:

1) It is possible to compare the marginal effects of the explanatory variables on, for instance, the ICT SIMCE with the marginal effects on the Language SIMCE. This comparison should be made using a hypothesis test.
2) It is possible to estimate the correlations between the three SIMCE test scores after controlling for the explanatory factors (the socio-economic and socio-cultural factors). When those correlations are not zero, we can say that correlations between the three SIMCE test scores are due to individual characteristics (those of the pupils), and not to the explanatory factors.

Using SUR or Multivariate linear models, two analyses were performed in order to answer the studies research questions:

1. In order to answer the first research question, related to the marginal effect of ESCS as a whole, a multivariate regression analysis was conducted using an ESCS index and the three SIMCE tests. The ESCS index was created using a principal component analysis of the five ESCS variables: parents' highest level of education, parents' highest occupational status, household income, educational resources at home and cultural possessions. The first component explained 56% of the variance.

2. In order to answer the second research question, related to the specific variables of ESCS that explain student performance on the ICT SIMCE, a multivariate regression analysis was conducted using the five ESCS covariates and the three SIMCE tests.

The analyses were performed using *manova* and *mvreg* commands, along with the test post-estimation command in STATA 12.

3. Descriptive analysis

Table 2 presents descriptive statistics for the model variables. It is worth noting that in order to achieve comparability between the marginal effects and facilitate interpretation of the model in terms of standard deviations, all ESCS covariates were standardized using a z-score.

The selected set of ESCS variables to be included in the model seeks to address different aspects of student ESCS. All correlations between the five ESCS variables are significant and positive (Table 3). However, correlations range from 0.21 to 0.72, which shows that none of the variables fully explain any of the others and that different aspects of student ESCS are being measured. It was therefore relevant to include all of the selected variables in the model. Furthermore, the correlations between the ESCS index and the variables that were used to create it were very high, which validates the construction of the index.

Likewise, it can be observed how the three SIMCE tests are positively correlated to the ESCS index, as well as to all of the ESCS variables. This indicates a positive association between a higher ESCS and student performance. The ESCS index is most closely correlated to the ICT SIMCE (0.49), then to Mathematics (0.45) and finally to Language (0.43). More specifically, three out of the five ESCS variables are most closely correlated to the ICT SIMCE (parents' highest level of education, parents' highest occupational status and educational resources at home). This suggests that the effect of ESCS is greater on students' digital skills than on the other two subjects. Nevertheless, these correlations do not account for the association between the three SIMCE tests. Therefore, multivariate regressions need to be used.

It is important to highlight that based on prior research which distinguished between operational, formal, information and strategic skills (Van Dijk, 2006; Van Deursen & Van Dijk, 2010; Van Deursen, Van Dijk, & Peters, 2012), we also explored whether it is possible to identify the probability of correctly answering operational questions vs. information and communication questions. Operational questions are those which require students to carry out tasks relating to the use of a computer, such as following instructions to edit and format a text. Information and communication questions are those that require students to perform tasks involving searching for, selecting, evaluating, understanding, analyzing and presenting information. We also looked at whether ESCS had different effects on these skills. However, a factor analysis using a polychoric correlation matrix (Holgado–Tello, Chacón–Moscoso, Barbero–García, & Vila–Abad, 2010) on all test items showed that it was not possible to differentiate between sub-dimensions on the ICT SIMCE test. There was therefore no point in continuing with this analysis.

4. Results

4.1. ESCS index

Table 4 shows the multivariate model results of the three SIMCE tests (components of the dependent variable) with the ESCS index. Residual correlations were 0.57 between Mathematics and Language; 0.45 between Language and ICT; and 0.49 between Mathematics and ICT. The Breusch–Pagan test of independence was statistically significant with a p-value < 0.001. In other words, after controlling for the ESCS index, the tests are not independent. The pertinence of adjusting the multivariate regression models is therefore confirmed.

Second, as can also be observed in Table 4, the model has an adequate fit (Wilks' Lambda of 0.71, with a $p < 0.01$). A hypothesis testing procedure was performed in order to compare the marginal effect of the ESCS index on the three SIMCE tests, and learn whether the differences reported by the model are statistically significant or not. The results, presented in Table 5, show that the ESCS index has a statistically greater marginal effect on the ICT SIMCE than on the Language SIMCE. However, the difference between the effect on the ICT SIMCE and on the Mathematics SIMCE is not statistically significant. It can therefore be concluded that the association between ESCS as a whole and the ICT SIMCE is greater than or equal to the other SIMCE tests.

4.2. ESCS variables

Table 6 shows the multivariate model results of the three SIMCE tests (components of the dependent variable), using the five ESCS variables as covariates. Residual correlations were 0.57 between Mathematics and Language; 0.46 between Language and ICT; and 0.5 between Mathematics and ICT. The Breusch–Pagan test of independence was statistically significant with a p-value < 0.001. In other words,

Table 2
Descriptive statistics of dependent and covariate variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
SIMCE Reading 2009	2933	253.49	47.66	111.84	378.08
SIMCE Mathematics 2009	2933	261.43	52.71	140.43	402.42
SIMCE ICT 2011	2933	256.06	47.55	107	384
Highest educational level of parents	2933	−0.13	0.97	−3.60	2.58
Highest occupational status of parents.	2933	−0.13	0.90	−1.09	1.61
Household income	2933	−0.17	0.87	−1.14	2.41
Home educational resources	2933	−0.13	1.01	−2.03	1.63
Cultural possessions	2933	−0.14	1.00	−1.62	1.24
ESCS index	2933	−0.18	0.91	−2.40	2.43

All ESCS covariates and ESCS index were standardized using z-score.

Table 3
Matrix of correlations among variables.

	Highest educational level of parents	Highest occupational status of parents.	Household income	Home educational resources	Cultural possessions	SIMCE Reading 2009	SIMCE Mathematics 2009	SIMCE ICT 2011
Highest occupational status of parents.	0.72	1						
Household income	0.60	0.64	1					
Home educational resources	0.45	0.40	0.43	1				
Cultural possessions	0.21	0.22	0.30	0.33	1			
SIMCE Reading 2009	0.35	0.35	0.34	0.29	0.29	1		
SIMCE Mathematics 2009	0.35	0.34	0.42	0.34	0.23	0.65	1	
SIMCE ICT 2011	0.45	0.38	0.39	0.35	0.22	0.57	0.60	1
ESCS index	0.84	0.85	0.83	0.68	0.46	0.43	0.45	0.49

All correlation coefficients have a p-value < 0.001.
All ESCS covariates and ESCS index were standardized using z-score.

Table 4
SIMCE test multivariate model with ESCS index.

	SIMCE ICT 2011		SIMCE Mathematics 2009		SIMCE Reading 2009	
	B	SE	B	SE	B	SE
ESCS index	13.842	(30.15)**	14.288	(27.51)**	12.328	(25.95)**
Constant	256.06	(333.73)**	261.428	(301.23)**	253.492	(319.35)**
Wilks' Lambda	0.71**					
N	2933					

**$p < 0.01$.

after controlling for the ESCS covariates, the tests are not independent. The pertinence of adjusting the multivariate regression models is therefore confirmed.

As can be observed, the model has an adequate fit (Wilks' Lambda of 0.67, with a $p < 0.01$). As with the multivariate model using the ESCS index presented in Section 4.1, there are differences between the marginal effects of each ESCS factor on the three SIMCE tests (Table 6). A hypothesis testing procedure was therefore used to test whether or not these differences are statistically equal (Table 7). The hypothesis test results comparing the marginal effects of ESCS variables over Mathematics and Language SIMCE tests (or between them) are presented in the Appendix.

The results (Table 7) show that after controlling for the remaining covariates, the parents' level of education is more strongly associated to the ICT SIMCE than to the Language and Mathematics SIMCE.

With regards to household income, the hypothesis test showed that its marginal effect is significantly different between ICT and Mathematics and not between ICT and Language (Table 7). The conclusion can therefore be made that household income is less associated to the Digital or ICT SIMCE than to Mathematics SIMCE, and that its association with ICT and Language is not different.

The parents' occupational status does not have a statistically significant marginal effect on the ICT SIMCE neither on the Mathematics SIMCE (Table 6). For this reason, no hypothesis test was performed. It could therefore be suggested that, after controlling for the remaining covariates, the parents' occupational status does not add any new significant information on explaining ICT SIMCE results, and it is only relevant in explaining performance on the Language SIMCE.

There is a statistically significant difference in the marginal effect of educational resources at home on student performance between the ICT SIMCE and Language SIMCE. However, this is not the case for the ICT and Mathematics SIMCE (Table 7). It could therefore be suggested that having educational resources at home is more closely correlated to performance in the ICT test than in the language test. There is also a statistically significant difference in the effect of having cultural possessions at home on student performance between the ICT SIMCE and

Table 5
Hypotheses tests of differences among marginal effects of ESCS Index.

Tests	Test F (1, 2931)	p-value	Conclusion
ICT – Reading	9.61	0.0019	Reject null hypothesis. Marginal effect is greater in ICT.
ICT – Mathematics	0.8	0.37	No statistically significant difference.

Table 6
SIMCE test multivariate model with ESCS variables.

	SIMCE ICT 2011		SIMCE Mathematics 2009		SIMCE Reading 2009	
	B	SE	B	SE	B	SE
Highest educational level of parents	13.960	(1.201)**	4.369	(1.358)**	6.849	(1.243)**
Household income	6.548	(1.227)**	15.302	(1.387)**	5.262	(1.271)**
Highest occupational status of parents.	1.436	(1.333)	2.799	(1.507)	5.907	(1.380)**
Home educational resources	6.133	(0.896)**	7.583	(1.012)**	4.159	(0.927)**
Cultural possessions	3.600	(0.823)**	4.306	(0.930)**	8.366	(0.852)**
Constant	260.577	(0.781)**	266.634	(0.883)**	257.848	(0.808)**
Wilks' Lambda	0.67**					
N	2933					

**$p < 0.01$.

Table 7
Hypotheses tests of differences among marginal effects of the ESCS factors between SIMCE ICT and other SIMCE tests.

Variable	Tests	Test F (1, 2927)	*p*-value	Conclusion
Highest educational level of parents	Reading – ICT	31.26	0.000	Reject null hypothesis. Marginal effect is greater in ICT.
	Mathematics – ICT	55.18	0.000	Reject null hypothesis. Marginal effect is greater in ICT.
Household income	Reading – ICT	0.98	0.323	No statistically significant difference
	Mathematics – ICT	44.01	0.000	Reject null hypothesis. Marginal effect is greater in Mathematics.
Home educational resources	Reading – ICT	4.33	0.038	Reject null hypothesis. Marginal effect is greater in ICT.
	Mathematics – ICT	2.27	0.132	No statistically significant difference.
Cultural possessions	Reading – ICT	29.90	0.000	Reject null hypothesis. Marginal effect is greater in Reading.
	Mathematics – ICT	0.64	0.425	No statistically significant difference.

Table 8
Hypotheses tests for differences among marginal effects on SIMCE ICT.

Tests	Test F (1, 2927)	*p*-value	Conclusion
Education – Household income	15.46	0.000	Reject null hypothesis. Highest educational level of parents has a greater marginal effect.
Education – Home educational resources	22.89	0.000	
Education – Cultural possessions	51.46	0.000	
Household income – Home educational resources	0.06	0.799	No statistically significant difference.
Household income – Cultural possessions	3.48	0.062	No statistically significant difference.
Home educational resources – Cultural possessions	3.55	0.059	No statistically significant difference.

Language SIMCE. However, this is not the case for the Mathematics and ICT SIMCE. It could therefore be suggested that, after controlling for the remaining covariates, cultural possessions at home have less of an effect on student performance in ICT than in Language.

Finally, in relation to the ESCS variables that specifically have the strongest marginal effect on the ICT SIMCE, after controlling for the remaining covariates, the parents' highest level of education is the most relevant variable (Table 9). The marginal effect between educational resources at home, household income and cultural possessions at home show no statistically significant difference. The parents' highest occupational status has no significant marginal effect.

5. Discussion and conclusions

This article presents empirical evidence that helps understand the second digital divide in education. This is done by comparing the effect of economic, social and cultural status (ESCS) on the performance by Chilean students on a digital skills test with their performance on standardized language and mathematics tests. The marginal effect of a group of variables measuring student ESCS as a whole and separately were compared using multivariate linear regression analysis.

First, we found that variables of ESCS that are commonly measured to explain results on standardized tests (OECD, 2010; Schulz, 2005; Sirin, 2005) are relevant when explaining performance on the Chilean national standardized ICT or digital test.

Second, the ESCS index was equally relevant in explaining performance on the digital skills and mathematics test, while less relevant on the language test (see Table 5). This finding is particularly important since it provides evidence contrary to the belief that the digital environment, especially the Internet, would have the potential to provide equal opportunities and reduce ESCS differences among new generations of students. On the contrary, it indicates that the gap based on ESCS tends to perpetuate or even widen when moving from the areas of language and mathematics to the digital domain. These results provide empirical evidence for the idea put forward by some authors that being effective in solving problems involving information and communication is more demanding in a digital context (Castells, 2001; Di Maggio et al., 2004; Hargittai, 2008; Warschauer, 2012). The results also support the so-called Amplification Theory, which claims that instead of leveling the playing field, technologies tend to amplify existing inequalities (Toyama, 2011).

In addition, there were two relevant findings in relation to the ESCS factors that best explain Chilean students' performance on the ICT or digital test. The first is that achievement on the ICT test was best explained by the parents' highest level of education (Table 8). The second is that the parents' level of education was more strongly associated with the ICT test than with the other two tests (Table 7). These results are interesting since previous studies have shown that the parents' education is the most stable indicator of ESCS in the sense that it is established when the student is young and tends to persist over time. Income, occupation, or education and cultural possessions, on the other hand, may change more over the 12 years of the student's schooling (Sirin, 2005). Research also shows that the parents' education is significantly associated with and generally the best predictor of their children's intellectual outcomes (Mercy & Steelman, 1982). This is even the case after controlling for other indicators of socioeconomic status such as income (Dubow, Boxer, & Huesmann, 2009; Duncan & Brooks-Gunn, 1997). It also has long-term effects on outcomes for middle adulthood, such as education and occupation (Dubow et al., 2009). The fact that one of the strongest and most stable indicators of ESCS has a more significant effect on student performance in a digital context adds further support to the concern that performance differences may be widening in the digital domain in Chile. This in turn presents educational policymakers with the challenge to develop students' digital literacy skills starting from an early age.

To further understand the marginal effect of each of the ESCS variables in students' performance in each of the domains, qualitative studies should be performed. In addition, these findings pose the question of whether existing attitudes, practices and strategies normally associated with high ESCS families can explain the relevance of ECSC in digital context. For example, previous research shows that parents engaging in more and richer conversations with their children, reading to them more and providing more teaching experiences are characteristic of high ESCS families (Bradley & Corwyn, 2002; Hoff-Ginsberg, 1991; Shonkoff & Phillips, 2000). Alternatively, these families could be developing new strategies to deal with the demands of the digital world. This also calls for future qualitative research in order to have a more in-depth understanding of how specific ESCS-related characteristics may be affecting student performance in a digital context.

In summary, the results of this study indicate that the effect of ESCS on Chilean students' performance on a digital test tends to be equal to or greater than the effect on other, more traditional tests. This therefore offers empirical evidence to suggest that instead of being more equal, the digital world tends to perpetuate and even widen the gap that is evident in other skills. In this sense, it also highlights the importance of public policy in education. In addition to being concerned about providing access and promoting the use of technology in schools, policies should also work on strategies to develop digital skills related to working critically and creatively with information in digital environments. As research is starting to show, these skills do not develop spontaneously in students as a result of having access to and using ICT. In fact, for example, research on information-problem solving shows that while students may have the ability to find information using digital technology, they have difficulty in defining information problems, specifying proper search queries and evaluating the information that they find (Brand-Gruwel, Wopereis, & Walraven, 2009; Van Deursen & Van Diepen, 2013; Walraven, Brand-Gruwel, & Boshuizen, 2008). Consequently, as in other performance areas, information problem-solving requires formal education activities if it is to be properly developed as a skill.

Finally, there were some limitations to this study. First, the digital test had very few items that only involved computer operation tasks without also involving information and communication tasks. In fact, analysis of the psychometric characteristics of the test indicated a strong correlation between the probability of correctly answering the information items and the operational items. Although this responds to the test construct that sought to measure the ability to jointly solve information, communication and technical tasks, it also represents a limitation since it does not allow these two types of skills to be differentiated for comparison and deeper analysis. It would therefore be recommendable to give separate scores to technical tasks when designing digital skills tests in the future. This would allow for important hypotheses to be tested, such as whether operational skills are more even among students than information or communication skills. It would also provide educational policymakers with evidence of which skills to support more intensively in formal schooling. Second, the results are only representative of the Chilean student population and therefore future work should consider performing international studies to compare the effect of ESCS on student performance in these three performance areas across different countries.

Appendix

Table 9
Hypotheses test results on differences of ESCS index marginal effects between SIMCE Reading and SIMCE Mathematics.

Variable	Tests	Test F (1, 2931)	*p*-value	Conclusion
ESCS index	Mathematics – Reading	17.58	0.000	Reject null hypothesis. Marginal effect is greater in Mathematics.

Table 10
Hypotheses test results on differences of ESCS factors marginal effects between SIMCE Reading and SIMCE Mathematics.

Variable	Test F (1, 2927)	*p*-value	Conclusion
Highest educational level of parents	4.18	0.041	Reject null hypothesis. Marginal effect is greater in Reading.
Household income	65.55	0.000	Reject null hypothesis. Marginal effect is greater in Mathematics.
Home educational resources	14.31	0.001	Reject null hypothesis. Marginal effect is greater in Mathematics
Cultural possessions	23.84	0.000	Reject null hypothesis. Marginal effect is greater in Reading.

Table 11
Hypotheses tests for differences among marginal effects on SIMCE Mathematics.

Tests	Test F (1, 2927)	*p*-value	Conclusion
Education – Household income	26.32	0.000	Reject null hypothesis. Household income has a greater marginal effect.
Education – Home educational resources	3.02	0.082	No statistically significant difference.
Education – Cultural possessions	0.00	0.969	
Household income – Home educational resources	17.55	0.000	Reject null hypothesis. Household income has a greater marginal effect.
Household income – Cultural possessions	37.91	0.000	
Home educational resources – Cultural possessions	4.64	0.031	Reject null hypothesis. Home educational resources has a greater marginal effect.

Table 12
Hypotheses tests for differences among marginal effects on SIMCE Reading

Tests	Test F (1, 2927)	*p*-value	Conclusion
Education – Household income	0.66	0.412	No statistically significant difference.
Education – Home educational resources	2.52	0.112	
Education – Cultural possessions	1.03	0.315	
Education – Occupation	0.17	0.681	
Household income – Home educational resources	0.43	0.514	No statistically significant difference.
Household income – Cultural possessions	3.6	0.057	
Household income – Occupation	0.09	0.768	
Occupation – Home educational resources	1.07	0.301	
Occupation – Cultural possessions	2.29	0.131	
Home educational resources – Cultural possessions	9.12	0.025	Reject null hypothesis. Cultural possessions has a greater marginal effect.

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