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The impact of formal education on literacy and numeracy skills in Chilean adults: a comparative analysis with Latin American counterparts

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Chile and other Latin American countries consistently demonstrate the lowest scores in the international surveys of foundational information-processing skills. This paper examines the effect of formal education on the literacy and numeracy performance of Chilean adults and compares this effect with that observed in Latin American countries with similar information-processing skills. Using data from the Programme for the International Assessment of Adult Competencies (PIAAC), we conducted a comparative analysis of literacy and numeracy skills in the Chilean population relative to Mexico, Peru, and Ecuador. Our analysis revealed that, regardless of the years of formal education, the populations of these countries do not achieve a level 3 in literacy and numeracy skills (on PIAAC's five-level scale), which is considered the minimum requirement for effective participation in today's technologically-driven economy and society. We also observed that Chileans at higher levels of formal education (with a bachelor's or higher university degree) are on par with or exceed the literacy and numeracy skills of the best-performing Latin American country, Mexico. Less educated Chileans, however, lag behind education-matched groups of Mexicans and rank with the lowest-performing countries like Peru and Ecuador, in both skills. These findings highlight critical implications for educators and policy-makers in Latin America, particularly concerning educational system effectiveness in developing crucial competencies. The analysis shows the impact of past and ongoing reforms in the Chilean school system and underscores the importance of addressing skill development across all educational levels for personal and professional success in contemporary society.

KEYWORDS

literacy, numeracy, Chile, Latin America, formal education, PIAAC

Introduction

Literacy and numeracy are foundational information-processing skills in the present-day technological society. For adults, lacking adequate proficiency in these skills can hinder the achievement of professional and personal potential, jeopardizing employability, civic engagement, and health (e.g., Morrisroe, 2014). For a society, having a workforce that is under-qualified for technologically advanced occupations and tasks presents an obvious economic and social challenge and stymies national growth (Reder, 2010). Hence, understanding the distribution of literacy and numeracy skills in the adult population of a country – along with areas of vulnerability or success – is an important goal for economists, educators, and

policy-makers (e.g., Bynner, 2004; OECD and Statistics Canada, 2011; Grotlüschen et al., 2016).

In an effort to provide a comprehensive understanding of information-processing skills among adults, the Programme for the International Assessment of Adult Competencies (PIAAC) was initiated in 2011 under the direction of the Organization for Economic Cooperation and Development (OECD), producing one of the most comprehensive surveys for adult literacy, numeracy, and problem-solving skills (Hanushek et al., 2015). To date, the survey has compiled extensive cross-sectional datasets from adults aged 16 to 65 across 39 countries. One of the findings of the most recent PIAAC results from 2015 was the particularly poor performance of the Latin American countries relative to other regions. Indeed, Mexico, Chile, Peru, and Ecuador occupy the lowest ranks (in descending order) in the internationally aggregated data on information-processing skills. The literature shows that this low performance is persistent and prolonged (Bizzo and Mattos, 2009; Milford et al., 2010).

A recent comparative analysis (Kyröläinen and Kuperman, 2021) of 33 countries identified major predictors of the literacy scores represented in the 2015 release of PIAAC (for reviews see Schiefele et al., 2012; Suárez Fernández and Boto García, 2019). The most important predictor of literacy across all countries is formal education, followed by the number of books in the childhood household, practicing reading and numeracy at home, age, learning at work, readiness to learn, using numeracy and reading for work, mother's education, occupational status, and father's education. The prominent role of formal education is consistent with evidence that demonstrates a strong positive correlation between years of formal schooling and performance on standardized tests that measure literacy and numeracy skills (Gustafsson, 2016; Reder, 1998, 2000). In other words, the quality of education received appears to be central for the competencies with which individuals face their adult lives (see Council of Ministers of Education (Canada), 2016; Green and Riddell, 2003, 2013). Therefore, improving the quality and equity of education systems has become a priority for many countries seeking to strengthen the capabilities of their population (see Jones et al., 2009).

In Chile, this concern has been reflected in the implementation of multiple educational reforms in the last four decades. In 1981, during Pinochet's dictatorship, an important law that decentralized the administration of public schools to municipalities and introduced a system of vouchers or per-student subsidies was passed. This allowed the entry of private providers (subsidized private schools) that could receive the state subsidy per student, creating an educational quasi-market with competition between municipal, subsidized private, and paid private schools (Parry, 1997). In 1993, subsidized private schools were allowed to charge an additional copayment or shared financing to the state voucher, which increased socioeconomic segregation between schools. Instead of improving the quality of the Chilean educational system, these reforms had serious negative effects in terms of quality and equity. It was not until 2016, that decisive measures were taken to reduce the segregation and inequality that the voucher system had generated: Specifically, the School Inclusion Law that prohibited copayment, profit, and selection in schools that receive state contributions was approved (Cummings et al., 2023). Despite these reforms and the significant increase in educational spending in recent decades, the performance of various segments of the Chilean population, as measured by assessments like PISA and PIAAC, remains low (e.g., Bizzo and Mattos, 2009; Milford et al., 2010).

These concerns about educational quality and equity have also shaped reform trajectories in other Latin American countries, but through different paths. Mexico's educational system followed a distinctive trajectory characterized by a deeply rooted corporatist arrangement between the state and the National Union of Education Workers (SNTE). Through this arrangement, the government of the Institutional Revolutionary Party (PRI) ceded significant control of education to the union in exchange for electoral support and limited opposition to its education policies (Muñoz, 2008). The SNTE's involvement in education administration became institutionalized through mechanisms that allowed union officials to occupy important bureaucratic posts and carry out key administrative processes (Muñoz, 2008). Unlike Chile's market-oriented reforms of the 1980s, Mexico's major reforms of the 1990s focused on administrative decentralization. Thus, the 1992 National Agreement for the Modernization of Basic Education transferred the operation of basic education services to states while maintaining federal control over key aspects like curriculum and evaluation. The 1993 General Education Law consolidated this framework, maintaining a predominantly public system. This institutional configuration persisted until 2013, when a significant reform attempted to reconfigure state-teacher relations through new evaluation mechanisms and school-based decision making (Keck, 2015). Peru's educational system underwent significant transformations since the 1980s. During this decade, the system was severely weakened by hyperinflation, reduced funding, and internal conflict. The reforms of the 1990s attempted to address these challenges through various mechanisms. A key piece of legislation was the 1998 Legislative Decree 882, which promoted private investment in education through deregulation and tax incentives. This reform, combined with economic growth after 2004, resulted in significant changes to the educational landscape: enrollment in private education increased from 14 to 25% of overall enrollments in basic education between 1998 and 2012. However, these transformations occurred in a context of weak regulatory oversight, where even basic information about schools' operations were not systematically collected by authorities (Balarin, 2015). Ecuador's educational system has experienced substantial reforms since the late 1980s. Like other Latin American countries during this period, Ecuador faced the effects of structural adjustment policies and reduced public spending in education. However, a significant turning point came with the 2008 Constitution, which redefined education as a 'public good' and established tuition-free public higher education. This constitutional change was operationalized through two key pieces of legislation: the Organic Law of Intercultural Education (LOEI) in 2011 and the Law of Higher Education (LOES) in 2010. These reforms strengthened state control over education through various mechanisms, including new quality assurance systems, particularly through the creation of the Council for Evaluation, Accreditation, and Quality Assurance of Higher Education (CEAACES) as an evaluation and accreditation body, and the implementation of the National Examination for Higher Education (ENES).

These contrasting reform trajectories provide a valuable comparative framework. The period during which these systems evolved (1980s-1990s) is particularly relevant as it corresponds to the formative years of the adult population whose numeracy and literacy skills were assessed in PIAAC. This variation in institutional arrangements and reform paths makes these countries especially suitable for examining our research questions: What is the effect of

formal education on the numeracy and literacy performance of Chilean adults, and how does this effect compare to that observed in Mexico, Peru, and Ecuador? To what extent does this effect vary based on the number of years of formal education across these different national and institutional systems? How do the distinct reform trajectories we have described help explain similarities and differences in the relationship between formal education and information-processing skills in these countries?

To address these questions, this study analyzes the results obtained by the Chilean adult population in the literacy and numeracy tests of the International Adult Skills Survey (PIAAC) (OECD, 2013), conducted by the OECD in 2015. In addition to characterizing the skill levels of the Chilean population, this paper compares them with the skills distribution of Ecuador, Peru, and Mexico, i.e., other geographically, demographically, culturally, and linguistically similar Latin American countries. This comparative approach provides a valuable benchmark for gauging Chile's progress and challenges from a more global perspective. The approach we take considers literacy and numeracy within and across countries as a function of select factors that prior literature identified as major predictors of information-processing skills (Kyröläinen and Kuperman, 2021), including education, age, the use of reading and numeracy at home and work, and others. This analysis makes use of regression modeling with population-based sample weights and thus its results are generalizable to adult populations of respective countries. The expected outcome of this exploratory study is a detailed understanding of the current status of information-processing skills among Chilean adults and of the specific areas that account for either advantages or shortcomings that this country shows relative to the comparator countries.

The findings of this analysis will not only contribute to the academic discussion on the determinants of cognitive skills in the adult population but will also provide guidance for targeting public policy efforts. It is by observing the outcomes obtained by adults after their passage through the educational system that one can evaluate the effectiveness of the reforms and policies implemented from a longer-term perspective. In turn, this perspective can point to solutions that ensure that education fulfills its promise of developing in all citizens the key competencies for their full personal and professional realization.

Method

We used publicly available files[1] to obtain PIAAC survey data for the countries of interest: Chile ($N = 5{,}212$), Ecuador ($N = 5{,}702$), Mexico ($N = 6{,}306$), and Peru ($N = 7{,}289$). The survey was administered in Chile in 2014–15, and the remaining countries conducted the survey in 2017. These data sets (combined $N = 24{,}509$) were further trimmed for a better alignment with the goals of this study. Thus, we only considered individuals who were born in the country of test administration and were native speakers of the language in which the test was taken (Spanish): These criteria excluded 1,519 observations. We further removed individuals between 16 and 20 y.o. (2,470 data points), since the majority of this group has not yet completed their high school education and for the entire group it is not yet certain what their highest educational achievement would have been (which is a key factor for our study).

We removed data from individuals with missing values for education and other major predictors (645 observations). After these trimming steps, data sets consisted of an average of 83% of original data ($N = 20{,}189$). Table 1 reports resulting sample sizes per country and education level (defined below), among other variables.

Samples of the PIAAC surveys are weighted and can be used to make inferences about populations of entire countries. This is achieved with the help of weights that enable each observed respondent to stand for a larger segment of the population (see Analytical approach below for details). For instance, the first line of Table 1 shows that there are 1,359 adults with education level 1 (lower secondary or lower). This group accounts for 28.7% (SE = 0.01%) of the Chilean sample. Applying the weights indicates that this group in the sample corresponds to 2.98 million (SE = 0.118 million) individuals in the total population of Chile.

Dependent variables

The dependent variables of this study are the literacy and numeracy scores, labeled in the analyses below as LIT and NUM, respectively. We discuss these variables in turn below.

Literacy

PIAAC defines literacy as "the ability to understand and use information from written texts in a variety of contexts to achieve goals and develop knowledge and potential".[2] This survey assesses literacy in the tasks that test comprehension, evaluation and integration of words, sentences and texts in authentic information-processing contexts (for details see Jones et al., 2009; Trawick, 2017). The majority of participants across countries took the digital version of the literacy test. A printed version was also available to individuals uncomfortable with using computer technology (Sabatini, 2015).

Literacy is estimated on a scale from 0 to 500 points and is divided into the following levels of proficiency. Scores between 0 and 175 points are below level 1 ("Only basic vocabulary knowledge is required, and the reader is not required to understand the structure of sentences or paragraphs or make use of other text features"). A score between 176 and 225 points corresponds to level 1 ("The respondent is expected to have knowledge and skill in recognizing basic vocabulary, determining the meaning of sentences, and reading paragraphs of text."), a score of 226–275 to level 2 ("respondents [need] to make matches between the text and information and [do] paraphrasing or low-level inferences"), a score of 276–325 to level 3 ("the respondent [needs] to identify, interpret, or evaluate one or more pieces of information and often [demonstrate] varying levels of inference"), a score of 326–375 to level 4 ("respondents [need] to perform multi-step operations to integrate, interpret, or synthesize information from complex or lengthy continuous, noncontinuous, mixed, or multiple-type texts"), and a score of 376–500 to level 5 ("the respondent [needs] to search for and integrate information across

1 https://www.oecd.org/skills/piaac/data/

2 https://www.oecd.org/skills/piaac/piaacdesign/

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TABLE 1 Descriptive statistics for each country and educational level (ED) include sample size (N), proportion of the total observations (including standard error of the mean, SE), estimated number of individuals in the national population represented by the sample (including SE), as well as mean literacy and numeracy scores per each education level (and standard deviations, SD).

Country	*N*	ED	Proportion	Proportion_ se	Total	Total_ se	LIT_ Mean	LIT_SD	NUM_ Mean	NUM_ SD
Chile	1,359	1	0.287	0.01	2,984,437	118,163	178.26	42.6	205.84	59.61
Chile	1973	2	0.437	0.012	4,548,536	158,879	223.94	44.37	185.36	54.48
Chile	701	4	0.161	0.009	1,677,095	100,371	244.59	42.4	212.61	49.78
Chile	431	5	0.098	0.007	1,017,918	77,495	267.89	40.51	185.49	61.78
Chile	54	6	0.016	0.003	169,231	31,466	277.96	39.71	205.84	59.61
Ecuador	2,366	1	0.441	0.008	3,710,043	82,044	175.06	46.65	185.36	54.48
Ecuador	1,444	2	0.274	0.007	2,307,454	65,982	206	45.97	212.61	49.78
Ecuador	220	4	0.042	0.003	354,158	26,860	211.75	47.54	185.49	61.78
Ecuador	517	5	0.218	0.009	1,831,873	88,708	218.61	47.74	205.84	59.61
Ecuador	63	6	0.026	0.004	216,989	31,108	222.74	45.14	185.36	54.48
Mexico	3,183	1	0.579	0.008	37,728,343	750,872	206.72	43.55	212.61	49.78
Mexico	1,253	2	0.253	0.007	16,472,016	527,685	239.77	38.43	185.49	61.78
Mexico	70	4	0.016	0.002	1,011,165	136,696	237.68	39.37	205.84	59.61
Mexico	592	5	0.135	0.006	8,826,561	419,953	258.61	39	185.36	54.48
Mexico	80	6	0.017	0.002	1,133,876	145,471	263.82	38.66	212.61	49.78
Peru	1,524	1	0.319	0.008	4,993,267	162,365	165.46	43.91	185.49	61.78
Peru	2,432	2	0.446	0.008	6,990,701	166,102	207.06	44.14	205.84	59.61
Peru	999	4	0.113	0.004	1,774,396	65,717	214.78	42.81	185.36	54.48
Peru	818	5	0.104	0.004	1,631,909	66,963	240.22	44.41	212.61	49.78
Peru	110	6	0.018	0.002	285,703	31,813	250.25	45.99	185.49	61.78

multiple, dense texts; construct syntheses of similar and contrasting ideas or points of view; or evaluate evidence-based arguments"). Level 3 or higher in literacy is considered sufficient to operate as a skilled worker and engage in social and cultural life in the modern information-based economies (Jones et al., 2009).

Numeracy

In parallel to literacy, numeracy is defined as "the ability to use, apply, interpret, and communicate mathematical information and ideas" (PIAAC Numeracy Expert Group, 2009). It is tested through problems that mimic the real-world working environment and typical cognitive challenges that this environment presents. The numeracy scale also ranges from 0 to 500 points and can be divided into several levels of proficiency. A score in the 0–175 point range is regarded as below level 1 ("Tasks at this level require the respondents to carry out simple processes such as counting, sorting, performing basic arithmetic operations with whole numbers or money[„„]") A score of 176–225 corresponds to level 1 ("Tasks at this level require the respondent to carry out basic mathematical processes in common, concrete contexts where the mathematical content is explicit with little text and minimal distractors.[…]), a score of 226–275 to level 2 ("Tasks at this level require the respondent to identify and act on mathematical information and ideas embedded in a range of common contexts where the mathematical content is fairly explicit or visual with relatively few distractors.[…]"), a score of 276–325 to level 3 ("Tasks at this level require the respondent to understand mathematical information that may be less explicit, embedded in contexts that are not always familiar, and represented in more complex ways.[…]"), a score of 326–375 to level 4 ("Tasks at this level require the respondent to understand a broad range of mathematical information that may be complex, abstract, or embedded in unfamiliar contexts. These tasks involve undertaking multiple steps and choosing relevant problem-solving strategies and processes.[…]), and a score of 376–500 to level 5 ("Tasks at this level require the respondent to understand complex representations and abstract and formal mathematical and statistical ideas, possibly embedded in complex texts.[…]"). As with literacy, the digital information-based economy of today requires Level 3 or higher in numeracy for operating as a skilled worker and engaging in social and cultural life (Jones et al., 2009).

Independent variables

Since our focus is on the impact of formal education on literacy and numeracy achievements in Latin American countries, we consider two critical independent variables. One such variable is *COUNTRY*, a categorical variable with four levels (Chile, Ecuador, Mexico, and Peru). Another critical predictor is *formal education* (labeled ED), which demonstrably correlates with literacy and numeracy levels (see Council of Ministers of Education (Canada), 2016; Green and Riddell, 2003, 2013; Tout et al., 2017). In this study, we use the PIAAC's 6-level International Standard Classification of Education (ISCED) classification of formal education levels: education level 1 corresponds

to "Lower secondary education or less," level 2 to "Upper secondary," level 3 to "Post-secondary, non-tertiary," level 4 to "Tertiary, professional degree," level 5 to "Tertiary, bachelor degree," and level 6 to "Tertiary, master/research degree." Since level 3 was under-represented in several of the countries under comparison, we merged it with level 4.Both literacy and numeracy are multifaceted skills that are known to be affected by a variety of demographic and socio-economic factors. A recent study (Kyröläinen and Kuperman, 2021) identified the relative importance of multiple variables that were proposed as major predictors of literacy scores (for reviews see Schiefele et al., 2012; Suárez Fernández and Boto García, 2019). In the present analyses, we selected several of the most influential predictors of literacy for close consideration as control variables.

Age is a control variable that has a complex but strong relation to literacy and numeracy. On the one hand, aging comes with a continuous lifelong accumulation of knowledge as seen in vocabulary growth, see for example Brysbaert et al. (2016), Keuleers et al. (2015), Ramscar et al. (2014), and Verhaeghen (2003). Yet age is often found to have a negative effect on literacy and other information-processing skills, with younger adults showing higher scores than older ones, possibly due to overall improvements in educational practices (Hannon and Daneman, 2009; Johnson, 2003; Paccagnella, 2016). In this study, we made use of the age variable that was discretized into nine 5-year bins, ranging from 21 to 65 y.o (labeled AGE).

Two additional control variables, both identified as strong predictors of literacy and numeracy skills (Gallik, 1999; Kyröläinen and Kuperman, 2021) are the use of reading at home and the use of numeracy at home. Reading for pleasure is a key driver of reading development throughout the lifespan (see, e.g., reviews by Sullivan and Brown, 2015). Recreational reading results in robust and accumulating advantage in literacy and numeracy skills (e.g., Gallik, 1999). Similarly, engaging with numeracy-related activities at home promotes numeracy skills across all ages and is strongly correlated with success in math and career choices in STEM disciplines (Reder, 2008). To quantify the effects of these variables, we consider derived PIAAC estimates of the amount and habits of reading done at home (variable READHOME) as well as the use of numeracy at home (NUMHOME). Each of these variables is represented by six levels: level 0 stands for zero use of reading or numeracy at home, and levels 1 to 5 stand for quintiles of the respective distributions.

Another control variable of influence for literacy and numeracy skills is the number of books in the household where the respondent grew up (Cheng and Furnham, 2019; Law et al., 2013; Sikora et al., 2019). Book-oriented environments are argued to communicate scholarly culture of the family and its orientation towards academic, professional and cultural goals (Sikora et al., 2019): These factors foster the development of information-processing skills. Respondents answered the following question: "About how many books were there in your home when you were 16 years old? Do not include magazines, newspapers or schoolbooks. To give an estimation, 1 m of shelving is about 40 books." Responses are organized into the following levels: 1 (10 books or less), 2 (11–25 books), 3 (26–100), 4 (101–200), 5 (200–500), 6 (over 500), and 9 (do not know or not stated). We label this variable NUMBOOKS.

A final set of control variables considered here due to their demonstrated influence on literacy and numeracy (Kyröläinen and Kuperman, 2021)includes Health status (HEALTH), ranging from 1 "excellent" to 5 "poor"; the highest level of education attained by the mother (MOTHER_ED); and, separately, by the father (FATHER_ED), with levels 0 for non-valid response, 1 for complete or incomplete secondary education, 2 for professional or bachelor's tertiary degree, and 3 for master's or PhD degree.

Analytical approach

In large-scale multi-item assessments such as PIAAC, each participant only responds to a subset of test items. Thus, a set of plausible values were derived to estimate the individual's overall proficiency, including on the items they did not respond to (Yamamoto et al., 2013). The matrix sampling method of PIAAC determines that the sets of items that each participant encounters and responds to are not identical. To enable an accurate estimation of the measurement error, an individual score in each cognitive skill test is represented as 10 plausible estimates of what that person's performance would be. Each plausible value is defined on the test scale from 0 to 500 points. When estimating a participant's performance in, say, a literacy or numeracy task, plausible values are sampled through a bootstrapping procedure to produce both a point-wise estimate and an estimate of variability incurred by the non-identical test items that each participant encounters.

Moreover, each participant in the PIAAC survey is associated with a weight, allowing the tested person to represent a larger segment of the population. The weights are based on census data and determined by the combination of the participant's age, gender, education, place of residence and additional factors (for details see Mohadjer et al., 2013). Specifically, the PIAAC data use Jackknife Repeated Replication weights that correct for the complex designs of the samples which vary from country to country (Mohadjer et al., 2013). Computational procedures have been developed which process the individual plausible values and apply the appropriate weighting to derive estimates of means and variances that are representative of a given participant sample in the given country (Yamamoto et al., 2013).

The analysis below makes use of ordinary least squares regressions with Jackknife Repeated Replication weights that correct for the complex designs of PIAAC samples which vary from country to country (OECD, 2013). The appropriate regression functions are implemented in the package intsvy that is designed specifically for the PIAAC data (Caro and Biecek, 2017) and is provided in the statistical platform R 4.2.2 (R Core Team, 2022). Specifically, the function piaac.reg.pv implements a procedure where a regression model for each national sample uses weights to estimate literacy or numeracy scores for the entire population of the country, based on plausible values of literacy or numeracy. Sampling weights, reported for each observed individual, are designed to allow for unbiased population-level estimates by compensating for the possible disproportionate sampling or non-coverage of various subgroups in the population, as well as reducing sampling errors by relying on demographic characteristics known with a high degree of accuracy (e.g., Bartsch et al., 2017).

The structure of the weighted regression model for literacy scores was as follows: LIT ~ COUNTRY + ED + AGE + READHOME + NUMHOME + NUMBOOKS + HEALTH + MOTHER_ED + FATHER_ED. The regression model fitted to numeracy scores had NUM as the dependent variable and the same set of predictors. All the predictors were sum-coded prior to the analysis. For each country, the fitted values were averaged while their variance was corrected due to

imputation (OECD, 2013). Inferential estimates are reported with the *t*-value. The absolute value of *t* greater than 1.96 roughly corresponds to the *p*-value <0.05. R^2 estimates of explained variance which are given as proportions.

At present, weighted regression models designed to work with plausible values of surveys like PIAAC do not allow for estimation of interactions between independent variables. Since such an interaction (country by education level) is key for answering our research question, we resorted to a simplified modeling procedure and used multiple linear regression models and ANOVA, implemented as functions lm() and anova(), respectively in the R platform. Specifically, we averaged all plausible values recorded for each individual to produce one literacy and one numeracy score per individual. We also omitted sampling weights associated with each individual. The structure of those models included the critical interaction: LIT ~ COUNTRY * ED + AGE + READHOME + NUMHOME + NUMBOOKS + HEALTH + MOTHER_ED + FATHER_ED. The regression model fitted to numeracy scores had NUM as the dependent variable and the same set of predictors and an interaction.

While this approach gives an advantage of using the full analytical toolkit associated with regression models and treatment of interactions, it may introduce minor biases in the regression estimates. The comparison of non-interacting terms between weighted regression using plausible values and unweighted linear regression using aggregated scores showed that the biases were truly minor, within 1–2 points on the PIAAC literacy or numeracy scale, i.e., less than 0.5% of the effective scale. Interactions were further analyzed using cell-means coding and post-hoc comparisons using the glht function in the multcomp package (Hothorn et al., 2008, 2015).

Results and discussion

The analyses below are performed on the combined sample of 20,189 individuals from four Latin American countries: Exclusion criteria are discussed in the Methods section and sample sizes are reported in full in Table 1. Below we present the descriptive statistics of literacy and numeracy scores across countries as well as inferential cross-country comparisons, obtained via regression modeling of literacy and numeracy skills.

Descriptive statistics

Mean literacy and numeracy scores, estimated on the basis of plausible values for each country and education level, are reported in Table 1. Among Latin American countries, Chile and Mexico are showing the highest average scores, which are nearly identical (literacy = 220 and 222, and numeracy = 207 and 210, respectively). These two countries show an overall advantage over Ecuador and Peru (literacy = 196 and 195, numeracy = 185 and 178) of more than one-half of the standard deviation. This difference of nearly 25 points in literacy and 20 points in numeracy also corresponds to one-half of the level in information-processing skills as defined on the psychometrically validated PIAAC scale. Yet, all the four countries show very low mean levels of literacy and numeracy relative to other participant countries in the PIAAC survey. Namely, Mexico, Chile, Peru, and Ecuador occupy the lowest ranks (in this order) in the internationally aggregated data on both information-processing skills (e.g., Hanushek et al., 2015).

Regression models

Tables 2, 3 report outcomes of regression models fitted to literacy and numeracy scores, respectively. The structure of regression models fitted to literacy and numeracy scores is reported in the Analytical Approach section above. Overall, weighted regression models explained a substantial proportion of variance in both information-processing skills and in each country, between 21 and 41% in literacy and 25 and 51% in numeracy, see Tables 2, 3. In all country-specific models, higher literacy and numeracy scores are observed in individuals with higher educational levels, with a greater number of books in their households when growing up (i.e., greater scholarly capital in the family), better health, greater use of reading and numeracy at home, and younger individuals. The highest attained education of the mother and father did not produce significant effects (at the 5% level).

We further examined the critical country x education level interaction using non-weighted multiple regression models, see justification in the Analytical Approach. Analysis of variance for the models fitted to both literacy and numeracy scores (Tables 4, 5) demonstrated statistical significance of the COUNTRY x ED interaction, as well as the significance of main effects of COUNTRY and ED (all *p*s < 0.001).

Figure 1 visualizes partial effects of formal education on literacy (left panel) and numeracy (skills) presented by country. In general, all Latin American countries – across all educational levels–fail to reach level 3 of literacy or numeracy (276–325 points) that is deemed as the minimum sufficient for fully engaging in the modern-day digital economy and society. This is true even of the average scores for the highest education level 6 (master or research degree). This observation strongly suggests that a widespread improvement in literacy and numeracy skills is essential for Chile, Ecuador, Mexico and Peru to facilitate the ability of these countries to maintain a qualified, skillful workforce and participate in the competitive world economy.

Figure 1 also draws a comparative picture of the skill distribution across countries. Specifically, Figure 1 reveals a characteristic profile of Chilean adults with higher levels of education that stands out compared to other Latin American comparator countries. The visual inspection suggests that average literacy and numeracy performance of Chileans is on par with Mexico, see above. Yet, Chileans with lower levels of education (levels 1 and 2 that jointly cover secondary education) lag behind in literacy and numeracy skills among Mexicans at the same education level and match the performance of Ecuador and Peru (i.e., countries with the lower mean scores). We used the post-hoc comparison of estimated regression coefficients for specific cell-means to quantify these observed cross-national differences in distributions of literacy and numeracy skills. At level 1, the difference in estimated literacy scores between Chile (198 points) and Mexico (221) is close to one-half of standard deviation and thus is close to one-half of the PIAAC literacy level ($\beta = -23$, SE = 1.276, $t = -20{,}84$, $p < 0.001$). At level 2, the difference between Chileans and Mexicans (224 vs. 236) in literacy scores is reduced by one-half, to 13 points or one-quarter of standard deviation ($\beta = -13$, SE = 1.423, $t = 8.944$, $p < 0.001$). It is only at post-secondary educational levels 4–6 that

TABLE 2 Regression models fitted to literacy scores of Chile, Ecuador, Mexico, and Peru.

Estimate	Chile_β	Chile_SE	Chile_t	Ecuador_β	Ecuador_SE	Ecuador_t	Mexico_β	Mexico_SE	Mexico_t	Peru_β	Peru_SE	Peru_t
Intercept	233.08	2.62	88.88	214.81	4.97	43.18	236.98	3.36	70.61	219.89	3.13	70.26
ED2	−36.38	2.76	−13.19	−17.79	2.58	−6.89	−15.98	1.97	−8.13	−32.02	2.29	−14
ED4	−9.5	2.13	−4.46	1.27	2.22	0.57	−1.41	1.8	−0.78	−6.2	1.76	−3.53
ED5	1.46	2.56	0.57	3.19	3.49	0.91	−7.74	4.81	−1.61	−1.7	2.35	−0.72
ED6	18.94	2.79	6.79	7.54	2.97	2.54	11.04	2.59	4.26	15.56	2.24	6.95
NUMBOOKS2	−7.39	3.74	−1.98	−8.59	4.88	−1.76	−7.2	2.85	−2.53	−10.94	2.77	−3.95
NUMBOOKS3	−6.13	2.52	−2.43	−8.29	4.64	−1.78	−3.52	3.01	−1.17	−4.09	2.99	−1.37
NUMBOOKS4	−1.15	2.86	−0.4	0.79	5.15	0.15	−2.46	2.57	−0.96	−1.01	3.6	−0.28
NUMBOOKS5	2.74	4.34	0.63	17.99	7.28	2.47	−8.57	4.75	−1.8	8.82	3.87	2.28
NUMBOOKS6	5.3	3.44	1.54	−5.32	8.64	−0.62	7.28	5.13	1.42	12.74	7.09	1.8
AGE26	8.48	3.06	2.77	1.29	2.64	0.49	6.58	1.92	3.43	7.05	2.39	2.95
AGE31	4.24	1.92	2.21	3.29	2.63	1.25	5.68	2.03	2.79	4.41	2.1	2.1
AGE36	7.64	2.49	3.06	3.11	2.26	1.38	3.08	1.83	1.68	−1.25	2.02	−0.62
AGE41	−0.7	4.3	−0.16	−2.36	2.22	−1.06	2.23	1.88	1.19	1.44	2.15	0.67
AGE46	−1.19	2.63	−0.45	−1.42	2.64	−0.54	4.63	2.15	2.15	−6.28	2.6	−2.41
AGE51	−1.37	2.73	−0.5	2.85	3.02	0.94	−1.39	2.12	−0.66	0.08	2.3	0.03
AGE56	−4.93	3.17	−1.55	−3.33	2.79	−1.19	−3.51	2.14	−1.64	−2.52	2.74	−0.92
AGE61+	−3.44	3.16	−1.09	1.36	3.61	0.38	−4.28	2.44	−1.76	−2.25	2.91	−0.77
READHOME_Q1	−18.24	3.98	−4.58	−12.4	2.97	−4.17	−24.43	2.52	−9.69	−9.46	3.15	−3
READHOME_Q2	−3.94	1.86	−2.12	−4.51	1.85	−2.44	−2.28	1.42	−1.6	−0.2	1.47	−0.14
READHOME_Q3	−0.22	1.92	−0.12	−0.36	1.91	−0.19	6.03	1.57	3.85	−0.6	2.03	−0.3
READHOME_Q4	3.03	2.42	1.25	3.71	2.62	1.41	6.42	1.85	3.47	2.34	2.06	1.14
READHOME_Q5	7.27	2.33	3.12	6.36	2.7	2.36	6.63	2.07	3.2	1.74	2.18	0.8

(Continued)

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TABLE 2 (Continued)

Estimate	Chile_β	Chile_SE	Chile_t	Ecuador_β	Ecuador_SE	Ecuador_t	Mexico_β	Mexico_SE	Mexico_t	Peru_β	Peru_SE	Peru_t
NUMHOME_Q1	−6.52	2.51	−2.59	−7.15	2.46	−2.9	−10.63	2.08	−5.1	−6.99	2.4	−2.91
NUMHOME_Q2	−1.35	1.77	−0.76	−3.25	1.87	−1.74	−2.65	1.38	−1.92	−1.57	1.9	−0.82
NUMHOME_Q3	−0.69	2.47	−0.28	0.49	2.02	0.24	0.67	1.53	0.44	0.66	1.82	0.36
NUMHOME_Q4	0.26	2.79	0.09	−0.21	2.56	−0.08	3.24	1.58	2.05	0.29	1.91	0.15
NUMHOME_Q5	4.11	2.41	1.71	1.71	2.48	0.69	2.65	1.77	1.5	0.35	1.93	0.18
HEALTH2	3.94	3.5	1.12	−0.42	2.65	−0.16	0.89	1.81	0.49	−2.12	3.25	−0.65
HEALTH3	8.75	2.33	3.75	5.8	2.33	2.49	7.12	1.83	3.89	4.5	2.4	1.88
HEALTH4	2.88	1.72	1.67	0.88	1.8	0.49	5.28	1.41	3.75	6.21	1.87	3.31
HEALTH5	−8.65	1.83	−4.71	1.79	2.2	0.81	−4.6	1.67	−2.76	−3.91	1.47	−2.66
MOTHER_ED1	−8.16	5.18	−1.58	−0.32	4.3	−0.07	−10.68	3.61	−2.96	−2.26	4.27	−0.53
MOTHER_ED2	0.36	3.1	0.11	−4.73	2.53	−1.87	−0.89	1.81	−0.49	−4.55	1.79	−2.55
MOTHER_ED3	4.28	2.56	1.67	−0.02	2.6	−0.01	8.16	2.32	3.52	4.4	1.89	2.32
FATHER_ED1	−3.91	3.54	−1.1	0.55	2.97	0.18	−4.14	2.73	−1.52	−1.62	3.61	−0.45
FATHER_ED2	−1.12	2.42	−0.46	−3.71	2.4	−1.55	−3.02	1.65	−1.83	−2.71	1.76	−1.54
FATHER_ED3	1.8	1.86	0.97	−1.69	2.33	−0.73	0.79	2.08	0.38	0.04	1.97	0.02
R-squared	0.42	0.02	17.43	0.21	0.01	14.83	0.34	0.02	19.65	0.33	0.02	18.21

β stands for the estimated regression coefficient, SE for the standard error of the mean, and *t* for the *t*-value. $|t| > 1.96$ corresponds to $p < 0.05$. AGE levels show the lower age bound of the 5-year interval; other values are explained in Methods. Reference levels are ED = 1 (lower secondary), NUMBOOKS = 1 (10 books of less), AGE 21–25 y.o., READHOME = 0 (non-valid responses), NUMHOME = 0 (non-valid responses), HEALTH = 1(excellent), MOTHER_ED = 0 (non-valid responses), FATHER_ED = 0 (non-valid responses).

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TABLE 3 Regression models fitted to numeracy scores of Chile, Ecuador, Mexico, and Peru.

Estimate	Chile_β	Chile_SE	Chile_t	Ecuador_β	Ecuador_SE	Ecuador_t	Mexico_β	Mexico_SE	Mexico_t	Peru_β	Peru_SE	Peru_t
Intercept	221.38	3.06	72.33	202.94	5.48	37.04	228.2	3.41	66.92	206.22	3.58	57.6
ED2	−44.2	2.56	−17.29	−24.37	2.81	−8.67	−22	2.38	−9.24	−40.75	2.58	−15.77
ED4	−10.51	2.72	−3.87	−0.36	2.52	−0.14	−0.56	1.84	−0.3	−3.61	2.09	−1.73
ED5	3.67	2.98	1.23	−0.25	3.41	−0.07	−6.8	5.17	−1.31	4.24	2.59	1.64
ED6	25.71	3.37	7.62	8	3.01	2.66	9.07	2.48	3.66	18.06	2.29	7.89
NUMBOOKS2	−8.58	3.59	−2.39	−8.48	4.96	−1.71	−5.46	3.17	−1.72	−14.47	2.84	−5.1
NUMBOOKS3	−8.67	2.55	−3.41	−8.28	4.81	−1.72	−2.35	3.31	−0.71	−4.33	2.81	−1.54
NUMBOOKS4	−0.13	2.5	−0.05	−0.12	5.82	−0.02	0.99	3.21	0.31	−0.18	2.98	−0.06
NUMBOOKS5	6.47	4.17	1.55	16.3	7.34	2.22	−0.65	5.85	−0.11	−2.97	4.69	−0.63
NUMBOOKS6	6.03	3.93	1.54	−6.39	9.41	−0.68	12.85	5.8	2.21	10.65	7.65	1.39
AGE26	4.81	3.8	1.27	−6.03	2.61	−2.31	3.29	1.69	1.94	−1.98	2.86	−0.69
AGE31	−0.51	2.84	−0.18	−2.83	2.6	−1.09	−0.41	2.08	−0.2	2.14	2.59	0.83
AGE36	8.68	2.28	3.82	5.08	2.55	1.99	7.34	1.83	4.02	−1.23	2.56	−0.48
AGE41	2.8	4.14	0.68	4.9	2.23	2.2	3.81	2.06	1.85	−0.57	2.59	−0.22
AGE46	5.04	2.69	1.87	2.21	2.37	0.93	3.24	2.56	1.27	−1.53	2.64	−0.58
AGE51	2.9	2.79	1.04	5.02	2.94	1.71	−0.75	2.37	−0.31	3.63	2.86	1.27
AGE56	−5.33	3.38	−1.58	3.5	3.19	1.1	−1.53	2.53	−0.61	0.26	3.13	0.08
AGE61+	−6	3.17	−1.89	2.71	3.2	0.85	−6.65	2.29	−2.91	0.54	3.63	0.15
READHOME_Q1	−15.77	4.47	−3.53	−10.68	3.06	−3.48	−23.62	2.57	−9.19	−16.36	3.79	−4.32
READHOME_Q2	−4.53	2.14	−2.12	−2.38	1.93	−1.23	−2.22	1.21	−1.83	0.47	2.01	0.23
READHOME_Q3	−1.76	1.84	−0.96	0.63	1.9	0.33	5.4	1.67	3.24	0.7	2.33	0.3
READHOME_Q4	4.73	2.71	1.74	4.28	2.75	1.56	6.56	1.84	3.57	4.32	2.35	1.84
READHOME_Q5	5.57	2.57	2.17	3.11	2.78	1.12	7.74	2.25	3.44	2.54	2.72	0.93
NUMHOME_Q1	−12.43	2.09	−5.93	−10.74	2.31	−4.66	−9.93	2.06	−4.83	−14.47	2.68	−5.4

(Continued)

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TABLE 3 (Continued)

Estimate	Chile_β	Chile_SE	Chile_t	Ecuador_β	Ecuador_SE	Ecuador_t	Mexico_β	Mexico_SE	Mexico_t	Peru_β	Peru_SE	Peru_t
NUMHOME_Q2	−8.8	2.1	−4.19	−5.65	1.76	−3.21	−4.08	1.46	−2.79	−4.35	2.2	−1.97
NUMHOME_Q3	−3.9	2.39	−1.64	−1.14	2.07	−0.55	0	1.66	0	−0.22	2.17	−0.1
NUMHOME_Q4	1.42	2.68	0.53	1.31	2.66	0.49	3.38	1.67	2.03	3.14	2.19	1.44
NUMHOME_Q5	7.92	2.45	3.23	5.2	2.44	2.13	3.49	1.9	1.83	4.24	2.17	1.95
HEALTH2	10.29	3.92	2.63	2.38	2.97	0.8	0.6	2.02	0.3	0.14	4.07	0.03
HEALTH3	11.4	2.5	4.57	8.44	2.58	3.27	8.87	2.26	3.91	7.91	3.06	2.59
HEALTH4	5.18	1.62	3.2	1.6	1.93	0.83	5.09	1.52	3.36	6.93	2.13	3.26
HEALTH5	−8.38	1.84	−4.55	−0.42	2.02	−0.21	−4.3	1.6	−2.69	−1.29	2.06	−0.63
MOTHER_ED1	−10.37	4.63	−2.24	−6.9	4.61	−1.5	−5.76	4.05	−1.42	−9.48	4.98	−1.9
MOTHER_ED2	2.75	3.24	0.85	−1.74	2.51	−0.69	−0.74	1.78	−0.41	−2.09	2.05	−1.02
MOTHER_ED3	1.36	1.94	0.7	4.01	2.89	1.38	7.18	3.05	2.35	7.42	2.43	3.05
FATHER_ED1	−3.49	2.92	−1.19	−4.74	3.28	−1.44	−3.2	3.14	−1.02	−6.63	4.58	−1.45
FATHER_ED2	−1.48	2.55	−0.58	−1.26	1.95	−0.65	−3.63	1.62	−2.24	−1.64	2.14	−0.77
FATHER_ED3	1.24	1.94	0.64	1.04	2.32	0.45	0.98	2.52	0.39	2.11	2.18	0.97
R-squared	0.51	0.02	21.89	0.25	0.02	16.57	0.32	0.01	24.95	0.37	0.02	22.62

β stands for the estimated regression coefficient, SE for the standard error of the mean, and t for the t-value. $|t| > 1.96$ corresponds to $p < 0.05$. Reference levels are ED = 1 (lower secondary), NUMBOOKS = 1 (10 books of less), AGE 21–25 y.o., READHOME = 0 (non-valid responses), NUMHOME = 0 (non-valid responses), HEALTH = 1 (excellent), MOTHER_ED = 0 (non-valid responses), FATHER_ED = 0 (non-valid responses).

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TABLE 4 Analysis of variance of the regression model fitted to literacy scores.

Predictor	Degrees of freedom	Sum of squares	Mean square	*F* value	*p*
COUNTRY	3	2,689,017	896,339	659	<0.001
ED	4	9,887,704	2,471,926	1819	<0.001
AGE	8	1,117,309	139,663	102	<0.001
READHOME	5	1,600,910	320,182	235	<0.001
NUMHOME	5	277,884	55,576	40	<0.001
NUMBOOKS	5	479,509	95,901	70	<0.001
HEALTH	4	431,502	107,875	79	<0.001
FATHER_ED	3	173,451	57,817	42	<0.001
MOTHER_ED	3	89,637	29,879	21	<0.001
COUNTRY × ED	12	359,016	29,918	22	<0.001
Residuals	20,136	27,360,398	1,358	NA	NA

TABLE 5 Analysis of variance of the regression model fitted to numeracy scores.

Predictor	Degrees of freedom	Sum squares	Mean square	*F* value	*p*
COUNTRY	3	2,393,096	797,698	483	<0.001
ED	4	15,007,805	3,751,951	2,276	<0.001
AGE	8	1,144,062	143,007	86	<0.001
READHOME	5	2,198,546	439,709	266	<0.001
NUMHOME	5	634,030	126,806	76	<0.001
NUMBOOKS	5	598,230	119,646	72	<0.001
HEALTH	4	642,885	160,721	97	<0.001
FATHER_ED	3	215,812	71,937	43	<0.001
MOTHER_ED	3	93,278	31,092	18	<0.001
COUNTRY × ED	12	727,390	60,615	36	<0.001
Residuals	20,136	33,189,166	1,648	NA	NA

Chileans show equal or somewhat higher scores than Mexicans, and much higher scores than participants from other countries. For instance, the difference in literacy scores between Chile and Mexico is not significant at education level 4 (professional degree): $\beta = 8$, SE = 4.937, $t = 1.66$, $p = 0.09$. At level 5 (bachelor's and master's or PhD) Chileans show significantly higher literacy scores than their Mexican counterparts ($\beta = 7$, SE = 2.494, $t = 2.827$, $p = 0.005$ for level 5 and $\beta = 17$, SE = 6.937, $t = 2.383$, $p = 0.017$).

The contrasts between lower and higher educational levels across countries are similar in numeracy analyses as well. To focus on the comparison of Chile and Mexico, the numeracy score of the former country is 38 points (or two-thirds of the PIAAC level) lower than the latter country at the lower education level of incomplete secondary education ($\beta = -38$, SE = 1.413, $t = -26.86$, $p < 0.001$). This deficit is somewhat reduced to roughly one-half of the PIAAC numeracy level when drawing comparisons between individuals who completed secondary school ($\beta = -20$, SE = 1.575, $t = -1{,}298$, $p < 0.001$). The comparison of individuals with a professional degree (level 4) detects no significant difference in numeracy between Chileans and Mexicans ($\beta = 6$, SE = 5.466, $t = 1.029$, $p = 0.303$). And Chileans with a completed bachelor's or master's university degree show higher numeracy scores than their Mexican counterparts ($\beta = 14$, SE = 2.761, $t = 5.211$, $p < 0.001$ for level 5 and $\beta = 14$, SE = 7.68, $t = 1.812$, $p = 0.07$).

This pattern strongly suggests a specific deficit in the Chilean system of education and skill development. Lower levels of education (incomplete and complete secondary school) confer literacy and numeracy skills that disproportionately lag behind those conferred by the same levels of education in other countries in the region. In the General Discussion, we elaborate on possible causes of this deficit.

General discussion

The goal of this study was to examine the effect of formal education on the literacy and numeracy skills of Chilean adults and compare this effect with that observed in Latin American countries with comparable information-processing skills represented in the PIAAC international survey. Our results confirmed findings known from existing literature and uncovered new insights about information-processing skills in Latin American countries. Our first key finding confirmed that literacy and numeracy scores across all Latin American countries in our study fell below the minimum

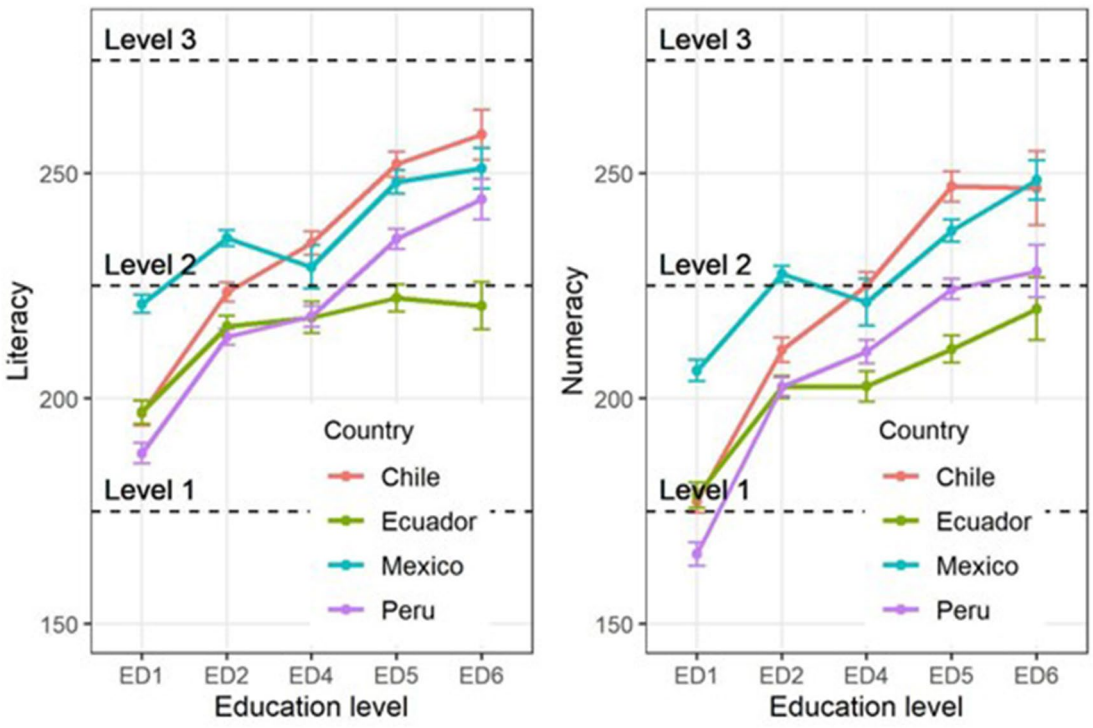

FIGURE 1
Partial effects of education levels on literacy **(left)** and numeracy **(right)** scores in Chile (chl), Ecuador (ecu), Mexico (mex), and Peru (per). Error bars stand for ±1 SE.

threshold deemed necessary for effective participation in today's digital economy (level 3). Notably, this deficit persisted across all educational levels, including among holders of advanced university degrees. Based on these findings, it is evident that improving literacy and numeracy instruction is necessary throughout the educational system, from primary to tertiary levels, across all studied countries, as representatives of developing and underdeveloped nations.

Our second finding revealed significant inequities within the region. Chile and Mexico emerged as higher-performing countries, demonstrating a substantial advantage—approximately one-half standard deviation in both literacy and numeracy—over Ecuador and Peru. While all four countries show concerning performance levels, Peru and Ecuador's notably lower scores suggest their populations may face greater challenges in engaging with modern technological demands and participating effectively in knowledge-based economies. The variation in performance levels appears linked to differences in educational administration approaches: Peru's weakly regulated privatization and Ecuador's delayed implementation of comprehensive educational legislation contrast with the more established centralized control mechanisms in Chile and Mexico. This highlights how historical educational policy decisions can have long-lasting effects on a country's human capital development and, consequently, its economic competitiveness in the modern technological era.

Our third and perhaps most striking finding revealed a particular imbalance in Chile's educational system regarding its ability to confer literacy and numeracy skills across the population. While Chilean graduates of post-secondary education perform comparably or slightly better than their Mexican counterparts, individuals with lower educational attainment (incomplete or complete secondary education) show substantial performance gaps relative to their Mexican peers. This disparity is most pronounced at educational level 1 (Lower secondary education or less), where Chileans perform on par with samples from Ecuador and Peru, significantly behind their Mexican counterparts—a deficit of approximately one-half standard deviation. This finding suggests that Chilean formal educational institutions at primary and secondary level may be underserving the country's most vulnerable population groups, potentially limiting their ability to participate fully in the modern economy. This impact is particularly significant given that 72.4% of Chileans (28.7% at level 1 and 43.7% at level 2) fall into these lower educational categories.

Several factors may contribute to these observed patterns in Chilean education. One potential explanation, which warrants further investigation, relates to the series of educational reforms implemented over the past four decades, particularly those promoting privatization. The neoliberal reforms of the 1980s introduced a massive voucher system and led to the emergence of state-subsidized private schools (SP schools) that now dominate the education market (Carrasco and Gunter, 2019). While these reforms aimed to improve educational quality through market mechanisms, this shift towards privatization negatively affected the quality of education at the primary and secondary levels (Cummings et al., 2023), as the focus on profitability and market competition could have overshadowed the importance of providing high-quality education to all students, regardless of their socio-economic background. More in-depth studies could illuminate the specific mechanisms through which privatization might influence educational quality, such as resource allocation, teacher recruitment, and pedagogical practices.

Another factor – directly related to the previous one – that may affect educational quality is Primary School teacher preparation. Recent evaluations suggest concerning gaps in teacher readiness at educational level 1: the 2011 Inicia Test indicated that approximately 60% of evaluated

pre-service teachers lacked basic teaching competencies (Rodríguez Garcés and Castillo Riquelme, 2014). Similarly, the 2017 National Diagnostic Evaluation revealed weaknesses in teachers' subject-specific knowledge, particularly in mathematics (Bastías-Bastías and Iturra-Herrera, 2022).

In contrast to the challenges observed in primary and secondary education, Chilean higher education shows stronger performance. Chilean universities consistently rank among the top institutions in Latin America according to the QS Ranking, which evaluates factors including academic reputation, research output, and employment outcomes. This may help explain why Chileans with higher education levels (4, 5, and 6) demonstrate stronger information-processing skills compared to their regional counterparts. However, it is crucial to note that even these highest-performing groups still fall short of the minimum threshold (level 3) for successful functioning in the modern digital world.

These findings collectively point to several strategic priorities for improving educational outcomes in Chile. A primary focus should be targeted investment in primary and secondary education, with particular attention to enhanced teacher training programs, improved educational resources and infrastructure, evidence-based instructional methods for literacy and numeracy, and support systems for underachieving students. The development of complementary educational opportunities is also crucial, including adult literacy and numeracy programs, informal learning opportunities, and extra-curricular educational activities.

The path forward requires systematic evaluation of educational reforms through regular assessment of policy impacts, monitoring of educational outcomes across different school types, and comparative analysis with other Latin American countries. Future research should focus on identifying the most effective interventions and understanding the complex interplay between educational policies, institutional structures, and student outcomes

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: https://survey.oecd.org/index.php?r=survey/index&sid=424913&lang=en.

Author contributions

FM: Conceptualization, Writing – original draft, Writing – review & editing. RI: Conceptualization, Writing – original draft, Writing – review & editing. VK: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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