Digital skills and ICT use in schoolwork in Mexico: A combined importance-performance map analysis

Habilidades digitales y uso de las TIC en el trabajo escolar en México: Un análisis del mapa combinado importancia-desempeño.

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ABSTRACT

This study explores the influence of five types of digital skills—operational, strategic, Communication and information social, and creative—on ICT use for schoolwork in Mexico. The research used data from a large-scale analysis of 4,990 records of individuals, mostly children and adolescents, who were frequent users of ICT and enrolled in different levels of education, as reported by the 2024 National Survey on Household Availability and Use of Information Technology (ENDUTIH). Data were analyzed using a multi-stage approach combining a validated Partial Least Squares Structural Equation Modeling (PLS-SEM) (R^2= 0.891), Importance-Performance Map Analysis (IPMA), and Necessary Condition Analysis (NCA). The results exhibit differences in the influence of the five digital skills on ICT use for schoolwork and, in particular, highlight the importance of operational competencies and irrelevance of social skills. The cIPMA results provide evidence to support the design of technology integration strategies in schools. This work concludes that while a solid foundation in operational skills is an essential prerequisite for academic ICT use in Mexico, a systemic failure to cultivate higher-order creative and strategic competencies is hindering students' potential. To this end, some future lines of inquiry are also suggested, including the effective integration of social networks into teaching practices in schools.

RESUMEN

Este estudio explora la influencia de cinco tipos de habilidades digitales—operativas, estratégicas, comunicación e información, sociales y creativas—en el uso de las TIC para el trabajo escolar en México. La investigación utilizó datos de una gran escala de 4,990 registros de individuos, en su mayoría niños y adolescentes, que son usuarios frecuentes de las TIC, inscritos en diferentes niveles educativos, según lo reportado por la Encuesta Nacional sobre Disponibilidad y Uso de Tecnologías de la Información en los Hogares (ENDUTIH) 2024. Los datos se analizaron utilizando un enfoque de múltiples etapas que combina un Modelo de Ecuaciones Estructurales de Mínimos Cuadrados Parciales validado (PLS-SEM) (R^2 = 0.891), Análisis de Mapas de Importancia-Desempeño (IPMA) y Análisis de Condiciones Necesarias (NCA). Los resultados muestran diferencias en la influencia de las cinco habilidades digitales en el uso de las TIC para el trabajo escolar y, en particular, resaltan la importancia de las competencias operativas y la irrelevancia de las habilidades sociales. Los resultados del cIPMA proporcionan evidencia para respaldar el diseño de estrategias de integración de la tecnología en las escuelas. Los hallazgos permiten concluir que, si bien una sólida base en habilidades operativas es un prerrequisito esencial para el uso académico de las TIC en México, la falta sistemática de desarrollo de competencias creativas y estratégicas de alto nivel está frenando el potencial de los estudiantes. Para ello, se sugieren también algunas líneas de investigación futuras, incluyendo la integración efectiva de las redes sociales en las prácticas docentes escolares.

1. Introduction

Emerging countries like Mexico have seen considerable integration of information and communication technology (ICT) in school environments over the last two decades, supported by liberal policies and a narrative of modernization of the teaching-learning process (Duarte et al., 2024; Dussel & Williams, 2023; Toudert, 2025). This integration process has made increasingly clear that appropriation of ICT depends on a repertoire of skills to support effective use in school settings (Le & Palsole, 2022; Youssef et al., 2022). As with other areas of interest in ICT use, the digital divide approach has evolved from basic internet connectivity and interaction with online content to a focus on developing multifaceted digital skills, including operational, strategic, communication, social, and creative skills (Le & Palsole, 2022; Toudert, 2025; Zorko, 2024).

This shift reflects a growing recognition of digital literacy as a key skill for academic achievement, as has been demonstrated with small and large samples, including in research based on data from the Programme for International Student Assessment (PISA) (Hori & Fujii, 2021; Suarez Enciso et al., 2024). In this regard, it should be noted that the provision of digital skills is viewed through mechanisms that appear to deepen preexisting socio-territorial inequities. Pending issues include an urgent need to discuss the effective use of digital technologies in education processes (Youssef et al., 2022; Diogo et al., 2018).

Research into digital skills has progressed from basic approaches centered on instrumental device use to complex, multifaceted frameworks that include operational, strategic, communication, social, and creative skills (López Jacobo et al., 2024; Scheerder et al., 2017; Youssef et al., 2022). Against the backdrop of this shifting conceptual framework, while students in basic education continue to receive little focus, evidence has shown effective use of ICT in education with skills that go beyond rudimentary technological literacy (González Grez, 2025; Ilomäki, 2023; Toudert, 2025). In the literature, greater attention has been given to the influence that school ICT use has on educational achievement than to the impact that skills have on said use of ICT, which has seen limited analysis despite the role played by ICT in achieving success in school (Hori & Fujii, 2021; Toudert, in press; Youssef et al., 2022). From this perspective, and with a view to both theoretical reflection and practical implementation, it is relevant to explore these causal relationships to understand how different skills impact the use of ICT in school and apply the findings to formulate strategies to optimize educational achievement (Baquerizo Álava et al., 2024).

This study examines the impact of different types of digital skills on ICT use for schoolwork in Mexico, using a methodological approach that combines an importance-performance map analysis with a necessary condition analysis, both based on structural

equation modeling to identify the most relevant digital skills and the extent to which these skills are developed by Mexican students. Specifically, the research seeks to resolve two major unknowns in both the literature on ICT use for schoolwork and in practice. The first objective is to determine, in terms of importance and performance, the observed predictive power of each type of skill in explaining ICT use in school. Secondly, the analysis determines whether the skills constitute a necessary condition for ICT use for schoolwork and the extent of the impact of these skills in improving levels of ICT use. Lastly, some general guidelines are offered to increase the use of ICT in schools, and these could be developed in greater depth in subsequent work.

2. Literature review and hypotheses

2.1. Digital skills to support ICT use for schoolwork

Digital skills are often characterized as knowledge and behaviors that enable students to engage with ICT tools and content through private and public networks like the internet (Eyal & Te'eni-Harari, 2024; Ilomäki et al., 2023; Scheerder et al., 2017; Suarez Enciso et al., 2024; Youssef et al., 2022). These digital skills, recently addressed from more comprehensive frameworks that acknowledge their multidimensional nature, involve a set of individual competencies on which there is no clear consensus (van Deursen et al., 2016; Voda et al., 2022). These include, among others, operational skills for the use of digital tools; strategic skills for digital integration and planning; information and communication skills for interacting with content and other users; social skills to support the use of social networks, which are often necessary to promote collaborative engagement; and, lastly, creative skills, with a focus on digital innovation (Amnouychokanant, 2023; López Jacobo et al., 2024; Laar et al., 2020; Scheerder et al., 2017; Toudert, 2025; Youssef et al., 2022). These dimensions are generally presented within a framework of interrelated actions that collectively influence the breadth and quality of ICT use for schoolwork (González Grez, 2025; Kiryakova & Kozhuharova, 2024; Scheerder et al., 2017; Zorko, 2024).

Operational skills are seen as the keystone of digital skills and generally refer to the ability to use tools, programs, and online search engines, and browse different types of public and private sites (Ilomäki et al., 2023; van Deursen et al., 2016; Voda et al., 2022). In Mexico, as elsewhere, and despite increased prevalence across broader social and territorial contexts, these skills continue to exhibit disparities associated with intersecting components of intersectionality (gender, age, education, social stratum, etc.) (Colomo Magaña, et al., 2023; Scheerder et al., 2017; Toudert, 2025; van Deursen et al., 2016). However, these skills appears to foster certain beneficial uses of ICT, driven by family

support for children in school, and moderated by gender division in workplace ICT use and by changes in parenting patterns (Toudert, in press; Yuen et al., 2018).

Strategic skills, rarely addressed in the literature on ICT appropriation, are recognized as less widespread than operational skills (van Laar et al., 2020; Voda et al., 2022) and point to a more advanced level of interaction with ICT that is often associated with more productive use (Ilomäki et al., 2023; Toudert, 2025; van Deursen et al., 2016). Generally speaking, strategic skills refer to the ability to align ICT use with specific goals and use advanced problem-solving skills, and they include the ability to plan, monitor, and assess the use of digital tools and content based on specific educational goals (Toudert, 2025; van Deursen et al., 2016). In Mexico, López Jacobo et al. (2024) and Toudert (2024) have reported that ICT users – and in particular students with more highly developed strategic skills, who make up a relatively small share of the total – use technology more effectively for learning, independently of socioeconomic status.

Communication and information skills, include communication, information search, digital content interaction, and Internet of Things (IoT) skills, in isolation or in combination, and they constitute the most prevalent skill set among ICT users, together with social skills (Amnouychokanant, 2023; Toudert, 2025; van Deursen et al., 2016). In the context of education, Cojocariu and Boghian (2024) and Baquerizo Álava et al. (2024) have maintained that these skills facilitated collaborative learning and student participation in ICT-mediated educational activities. Zorko (2024) has noted that in addition to being associated with collaborative learning, these skills are also a relevant factor in boosting motivation to use ICT. Toudert (2025) has observed that the distribution of both communication and information skills and social skills is independent of users' socioeconomic status, using a scale validated by van Deursen et al. (2016). Communication and information skills, include the ability to interact with other users through various social networks and are typically stronger in students of higher socioeconomic strata to providing them with an advantage (Velasco & Gallegos, 2024). But Toudert (2025), with support from other studies, instead ascribes the differences that exist between strata in the productive impact of these skills to a primarily entertainment-oriented use of ICT by the lower strata. Meanwhile, the general social background of users from higher strata (occupation and social participation and representation) ultimately facilitates the productive use of digital activities originally intended for entertainment.

Alongside the skills discussed above, creative abilities are notable for their importance in fostering collaboration, critical thinking, and innovative learning environments (Zorko, 2024; Ilomäki et al., 2023; van Laar et al., 2020; Voda et al., 2022). These skills are generally characteristic of processes of educational digitalization and innovation associated with the creation and modification of digital content created for use both online and offline (González

Grez, 2025; Ilomäki et al., 2023; Toudert, 2025; van Deursen et al., 2016). Yet despite their importance for innovative educational practices and developing critical thinking (Baquerizo Álava et al., 2024; Ilomäki et al., 2023; Toudert, 2025; Voda et al., 2022), creative skills are rarely explored in the literature, perhaps due to the challenges involved in conceptualizing and operationalizing them in high-quality research.

2.2. Research model hypotheses

Based on the literature review and theoretical framework, the following research hypotheses were proposed:

H1: Operational skills have a significant positive effect on ICT use for schoolwork.

This hypothesis was based on studies that have shown consistent positive correlations between users' operational skills and effective ICT use, both in general and specifically in school settings (Ilomäki et al., 2023; Pezo, 2024; Scheerder et al., 2017; van Laar et al., 2020; van Deursen et al., 2016; Voda et al., 2022). However, these skills alone do not appear to guarantee a pedagogically meaningful use of ICT, underscoring the importance and necessity of more advanced skills.

H2: Strategic skills have a significant positive effect on ICT use for schoolwork.

Previous research has suggested that students with stronger strategic skills tend to use ICT effectively in learning processes (Colomo Magaña, et al., 2023; Ilomäki et al., 2023; López Jacobo et al., 2024; van Laar et al., 2020; van Deursen et al., 2016; Voda et al., 2022). This causal relationship, which has been supported by previous research and appears to align the use of technology with productive goals, has been proposed as key to achieving effective use of ICT both in general and, particularly, in education (Le & Palsole, 2022; Kiryakova & Kozhuharova, 2024; Scheerder et al., 2017; Youssef et al., 2022).

H3: Communication and information skills have a significant positive effect on ICT use for schoolwork.

This hypothesis is based on evidence suggesting that information and communication skills facilitate access to teaching and learning resources and participation in ICT-mediated collaborative educational activities (Amnouychokanant, 2023; van Deursen et al., 2016; Ilomäki et al., 2023). In the context of these causal relationships, it has been reported that entertainment-related activities that are associated with communication and information

processes may act both as distractors and as motivating factors in learning (Ilomäki et al., 2023; Toudert, in press). This may explain, at least in part, the above differences between higher and lower strata in the relationship between effective ICT use and ICT use for entertainment (Toudert, 2025; Velasco & Gallegos, 2024).

H4: Social skills have a significant positive effect on ICT use for schoolwork.

Findings on the impact of social skills on school ICT use, and on academic performance and achievement, have been mixed. Youssef et al. (2022) and Kumar (2024) have demonstrated a negative effect, fueled primarily by the use of ICT for entertainment purposes, which can even result in symptoms of social media addiction. On the other hand, Youssef et al. (2022) also report – in line with Romi (2024) – a significant, positive impact on ICT use for school, specifically for certain academic periods, socioeconomic contexts, and levels of intensity of ICT use.

H5: Creative skills have a significant positive effect on ICT use for schoolwork.

This last hypothesis is based on evidence suggesting that digital content creation skills support the development of higher-order skills and innovative use of ICT for learning (Cojocariu & Boghian, 2024; Ilomäki et al., 2023; Voda et al., 2022; Zorko, 2024). Yet despite the apparent importance of these skills in developing 21st-century competencies, there has been little research into their possible impact on achievement and performance.

3. Methodology and data

3.1. Instrument and sampling

This study used data from the 2024 National Survey on Household Availability and Use of Information Technology (ENDUTIH), for which the questionnaire, sampling techniques, and microdata are available at Instituto Nacional de Estadística y Geografía [INEGI] (2025). The survey sample consisted of 65,067 visited homes, selected using a three-stage, stratified cluster probability sampling process, resulting in a face-to-face interview completed in 87% of cases (57,053). INEGI (2025) reports a 90% confidence level for the sample, a design effect of 4 based on previous observations, a maximum expected relative error of 13.8%, a non-response rate of 15%, and an average of 1.02 households per home. This study focused on records for survey respondents aged 12 years or over, mostly children and adolescents, who were enrolled in school at the time of the survey and used the internet at least once a day. These selection criteria yielded a homogeneous population of 4,990

records that constituted a highly significant sample, consistent with the recommendations of Hair et al. (2022) and Hauff et al. (2024), for the application of partial least squares structural equation modeling (PLS-SEM).
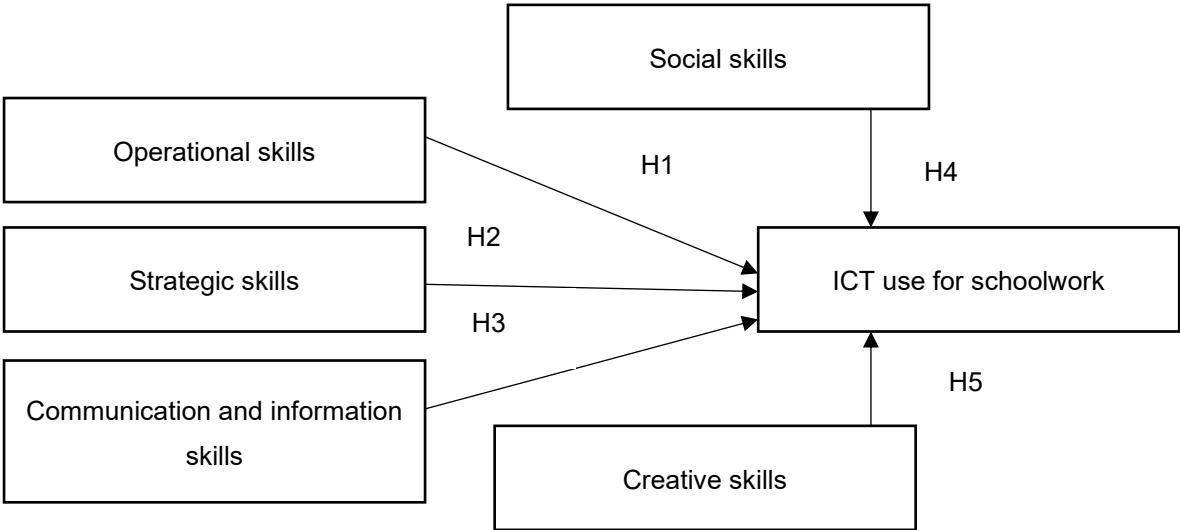
In conjunction with the PLS-SEM analysis, an importance-performance analysis (IPMA) was also conducted to rank the skills by relative impact. A necessary condition analysis (NCA) was performed to confirm and quantify the IPMA; this revealed the threshold levels for the influence of each of the skills examined on ICT use for schoolwork. The combination of the three methods involved in this study was recently proposed by Hauff et al. (2024) and referred to as combined importance-performance map analysis (cIPMA). In this research, cIPMA was employed with the goal of generating a new set of inputs to support the design of strategies to promote skills that influence ICT use and achievement in school, objectives described as emerging lines of inquiry by Duarte et al. (2024), Jacobo et al. (2024), Ilomäki et al. (2023), Romi (2024), and Zorko (2024).

3.2. Variables and scales of measurement

The theoretical model used for this research included 22 items assigned to six latent variables, in turn organized into five dimensions representing digital skills, which were modeled as formative constructs alongside a reflective component representing students' use of ICT for schoolwork (see Figure 1 and Table 2). The model's formative constructs characterize each type of skill under study: operational, strategic, communication and information, social, and creative. Both the reflective and the formative constructs were developed by summing the responses to binary questions (Yes = 1, No = 0) that were thematically and epistemologically similar to the item in question. By way of example, to characterize the construct "information and communication skills", three items representing basic information and communication skills were used and positive responses for basic proficiency in these two activities were summed, while the "combined information and communication" item counted responses that combined these two activities with others; lastly, "interaction with the IoT" sums the responses to questions on the use of smart devices like televisions, washing machines, etc. In order to homogenize the scale of measurement for all items (Hauff et al., 2024), the sum obtained for each variable was standardized in discrete values between 0 and 7, with 0 the lowest score and 7 the highest.

Figure 1

The proposed conceptual model and hypotheses.

Source: own elaboration.

The constructs shown in Table 2 were developed based on structural and nomological frameworks similar to those used in previous studies, both in Mexico by Toudert (2024, in press) and internationally in work by Deursen et al. (2016) and Nurlaela and Amiruddin (2023).

4. Results

The records that met the selection criteria for this research are primarily urban respondents (83.23%), with almost 50% living in cities of 100,000 or more inhabitants (see Table 1). The gender breakdown shows that 54.4% are female, while nearly 70% are between 12 and 17 years of age. In addition, 61% of individual records are from low or lower-middle socioeconomic strata, and half have completed secondary or higher education. Overall, the socioterritorial distribution of frequent ICT users highlights the predominantly urban and increasingly feminized nature of the sample, with a socioeconomic background that leans toward the lower-middle stratum and a level of education at the upper end of compulsory schooling. These sample characteristics reveal a social diffusion of ICT that has overcome gender limitations, but which remains constrained by territorial and socioeconomic disparities (Toudert, 2025).

Table 1

Summary statistics for overall sample (N = 4,990)

Urban/rural	%	Highest level of education attained	%
Urban	83.23	Preschool and primary	50
Rural	16.77	Lower secondary	30.7
Agglomeration type		High school	18.92
1: 100,000 inhab. or more	49.98	Bachelor's degree	.24
2: 15,000 to 99,999 inhab.	15.95	Graduate degree	.14
3: 2,500 to 14,999 inhab.	15.8	**Age (years)**	
4: less than 2,500 inhab.	18.2		
Socioeconomic stratum		12-14	36.69
Low	12.36	15-17	32.4
Lower middle	48.78	18-25	28.84
Upper middle	25.87	26 and over	2.06
High	12.99		
Gender			
Male	45.61		
Female	54.39		

4.1. Model validity and robustness

Validating the research model involved assessing the conditions for applying the cIPMA while also ensuring rigorous compliance of both the measurement and structural models (Hauff et al., 2024; Hair et al., 2022).

Following the cIPMA validation guidelines proposed by Hauff et al. (2024), the outer weights shown in Table 2 are all positive and the variance inflation factor (VIF) values are all below 5, indicating that all items can be retained.

The standardized root mean square residual (SRMR) was used to evaluate goodness-of-fit and yielded a value of .069, below the acceptable upper bound of .08 (Hair et al., 2022). Similarly, the measurement model shows adequate factor loadings for the reflective construct and adequate weights for the formative constructs. The single reflective construct

in the model showed acceptable internal consistency reliability as measured by composite reliability, convergent validity assessed using average variance extracted (AVE), and Cronbach's alpha. Discriminant validity for the reflective construct was reflected in heterotrait-monotrait ratio (HTMT) and VIF values consistent with the recommendations of Hair et al. (2022).

Table 2

Measurement and structural model assessment

Reflective latent variables	α1	VIF	CR	AVE	Cα	HTMT	R²	SRMR
ICT use for schoolwork		2.33	.868	.780	.859	.83	.891	.069
V13: General school uses	.361*	.878						
V14: Direct support for school uses	.353*	.857						
V15: Indirect support for school uses	.417*	.914						
Formative latent variables	**α2**							
Operational skills		2.05						
V1: Operating ICT devices	.690*	2.266						
V2: Operating online search engines	.348*	4.232						
V3: Navigating formal sites	.039*	4.684						
Strategic skills		2.65						
V4: Goal orientation	.855*	3.086						
V5: Advanced strategic skills	.171*	3.086						
Communication and information skills		2.38						
V6: Basic comm. and info. skills	.607*	1.391						
V7: Combined comm. and info. skills	.482*	1.51						
V8: Interaction with the IoT	.107*	1.238						
Social skills		2.26						
V9: General social networking	.706*	2.018						
V10: Private networking	.367*	2.018						
Creative skills		2.75						
V11: Creative skills for virtual activities	.732*	1.55						
V12: Creative skills for real-world activities	.373*	1.55						

α1: Loadings; α2: Weights; VIF: Variance inflation factor; CR: Composite reliability (ρa); AVE: Average variance extracted; Cα: Cronbach's alpha; HTMT: Heterotrait-monotrait ratio of correlations; R2: Variance explained by the exogenous variables; SRMR: Standardized root square residual; *Significant at p < .05.

The validation of the structural model showed a high predictive power of the endogenous construct "ICT use for schoolwork" by the exogenous variables, with an R^2 value indicating 81.9% explained variance. Table 3 also shows that the five proposed hypotheses, assessed with 5000 bootstrap resamples, were all found to be significant at *p* < *.05*. The causal relationships were all found to be positive, except for H4, which exhibited a negative relationship, meaning that greater social skills were associated with less ICT use for schoolwork.

Table 3

Hypothesis and necessity effect size significance

Significance of the structural model relationships		Necessity effect sizes	
Model hypothesis	**β**	**Latent variable scores**	**Effect sizes**
H1: Operational skills -> ICT use for schoolwork	.496*	Operational skills	.26*
H2: Strategic skills -> ICT use for schoolwork	.125*	Strategic skills	.184*
H3: Comm. and info. skills -> ICT use for schoolwork	.130*	Comm. and info. skills	.152*
H4: Social skills -> ICT use for schoolwork	-.03*	Social skills	.16*
H5: Creative skills -> ICT use for schoolwork	.264*	Creative skills	.158*

*Significant at *p* < .05
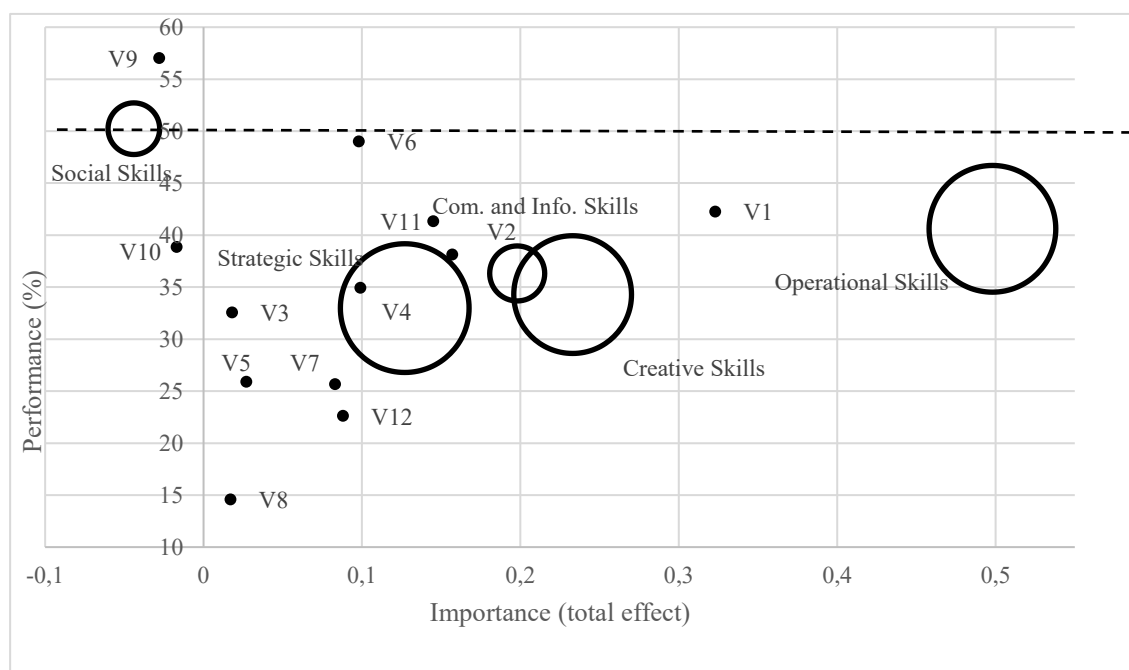
4.2. Importance and performance of skills

The importance-performance results presented in Figure 2 reveal contrasts between the different skills. The importance of skills is power to predict of ICT use for schoolwork, while performance indicates how well the predictor achieves the desired results (Hauff et al., 2024). The size of the circle for each skill in Figure 2 reflects the percentage of cases that did not achieve the desired result (a value of 7). A review of the importance-performance values of all the skills studied suggests that only operational skills appear to offer reasonable potential to bring about an increase in the prediction of ICT use for schoolwork. The other skills appear only marginally important for ICT use for schoolwork and cannot therefore be considered relevant factors for policymaking. It is important to note that the inverse effect of social skills on ICT use for schoolwork found a substantial proportion of users with these skills (88.77%).

Operational skills exhibit both the highest level of importance and the highest performance. This indicates that actions aimed at improving operational skills offer the greatest potential to support ICT use for schoolwork. It is estimated that a one-percentage point increase in performance in operational skills (from 40.612% at present to 41.612%)

would translate into an increase from 48.792% to 49.228% in performance in ICT use for schoolwork. This could be achieved through actions aimed at improving the operational skills of the 61.042% of ICT users in the study who have not achieved the desired performance in ICT use for schoolwork (that is, the maximum score of 7).

Figure 2

Combined IPMA (cIPMA)

Notes: The bubble sizes represent the percentage of cases that have not achieved the desired level of ICT use for schoolwork.

Source: own elaboration.

4.3. Necessity of skills for ICT use for schoolwork

The effect sizes, all significant at p < .05, showed that all skills were necessary for ICT use for schoolwork, regardless of importance-performance level (see Table 4). However, these skills did not all exhibit the same level of necessity to achieve a specific desired level of ICT use for schoolwork (a 100% score corresponding to a value of 7). Indeed, as shown in Table 4, to achieve a 30% score in ICT use for schoolwork, a level of operational skills of 1.316 is needed, whereas all other skills are not necessary. Similarly, if any proposed measures intend to achieve 50% of the maximum score in use for schoolwork (a value of 4), the required level is 2.332 for operational skills, 2 for strategic skills, and 1.496 for communication and information skills. In this specific scenario, as shown in Table 4, social and creative skills are not necessary to achieve the desired target. Viewed another way, a 50% target level requires at least 24.16% of users with operational skills, 19.4% with

strategic skills, and 1.80% with communication and information skills. In practical terms, the cIPMA method appears to provide relevant and original information on the cost-benefit ratio facilitating the planning initiatives aimed at achieving target levels of ICT use for schoolwork.

Table 4

Bottleneck table based on the ceiling envelopment—free disposal hull values (CE-FDH)

A: % scores	A: values	B: values	B: % cases	C: values	C: % cases	D: values	D: % cases	E: values	E: % cases	F: values	F: % cases
0%	1	NN	0	NN	0	NN	0	NN	0	NN	0
10%	1.6	NN	0	NN	0	NN	0	NN	0	NN	0
20%	2.2	NN	0	NN	0	NN	0	NN	0	NN	0
30%	2.8	1.316	3.267	NN	0	NN	0	NN	0	NN	0
40%	3.4	1.963	11.483	1.217	10	1.418	1.102	NN	0	NN	0
50%	4	2.332	24.168	2.000	19.399	1.496	1.804	NN	0	NN	0
60%	4.6	2.684	34.609	2.000	19.399	1.993	6.413	2.626	4.589	1.623	17.916
70%	5.2	3.000	39.519	2.783	37.675	2.411	12.605	2.626	4.589	2.246	29.218
80%	5.8	3.963	61.042	3.217	62.926	2.411	12.605	3.252	11.222	3.000	53.006
90%	6.4	4.963	83.928	4.000	79.96	3.822	75.351	3.252	11.222	4.492	77.615
100%	7	5.648	93.707	4.783	88.818	4.326	89.078	4.000	43.427	5.246	88.457

A: Desired outcome level of ICT use for schoolwork; B: Operational skills; C: Strategic skills; D: Communication and information skills; E: Social skills; F: Creative skills; NN: Not necessary.

5. Discussion

The findings of this research suggest that while operational skills are non-negotiable for ICT use for schoolwork, the education system fails to promote strategic and creative skills that support consistent, advanced learning, as outlined in Cojocariu and Boghian (2024), Voda et al. (2022), and Zorko (2024). Of all the proposed hypotheses, operational skills exhibit the highest impact (H1, β = .496), nearly twice that of the next strongest relationship, creative skills (H5, β = .264), and therefore constitute the main predictor of ICT use for schoolwork. This predictive power is supported by the cIPMA, which identifies operational skills as the most important bottleneck in achieving adequate academic use of ICT,– for students with little or no operational ability to use ICT devices, software, and the internet. This finding suggests that despite two decades of integration policies, achieving functional, universal digital literacy remains a challenge. The scale of the task ahead is reflected in the fact that only 39% of frequent ICT users achieve a desired score of close to 7 for ICT use for schoolwork.

These persistent deficiencies may be the a reflection of ICT use that is confined to basic, repetitive tasks like writing reports, creating simple presentations, or performing targeted online searches instead of comprehensive, project-based learning. This use of ICT in teaching-learning environments has been described in the literature, which reports a persistent gap between integration discourse and the reality of ICT appropriation in Mexico, where material deprivation poses a major limitation, and family support, teacher training, and pedagogical models appear to fall short of expectations (Colomo Magaña, et al., 2023; Dussel & Williams, 2023; Gayosso Mexia, 2024; López Jacobo et al., 2024; Toudert, in press).

The second relevant aspect of this study involves the significant impact of creative skills (H5, β = .264) and strategic skills (H2, β = .125), which confirms that although academic ICT use does have a strong functional component, it also involves creating new content and making strategic digital decisions. The fact that creative skills emerge as the second predictor takes on crucial importance in the context of modern educational frameworks like DigComp, which highlight content creation as a core competency in today's world (Casadomet, 2024; Le & Palsole, 2022; Ilomäki et al., 2023; van Deursen et al., 2016). Yet Figure 2 reveals that it is precisely these vital, higher-order skills that exhibit low student performance, along with low importance for ICT use for schoolwork. This finding suggests that, while creativity and strategy are implicitly recognized and required in discourse, these skills are not being taught effectively. This may point to a systemic inefficiency, where skills with the greatest potential to elevate learning from basic use to genuine appropriation of ICT are also the most neglected. In fact, only 37% of all users in this study with strategic skills, and 47% of those with creative skills, are in a position to make optimal use of ICT for schoolwork.

Perhaps the most surprising but revealing finding is the low, negative relationship indicating that greater social skills are associated with a lower level of ICT use for schoolwork (H4, β = -.030). The corresponding IPMA result is also surprising, as social skills show the highest level of performance but the lowest level of importance for predicting ICT use for schoolwork (see Figure 2). Similar behavior has also been described by Kumar (2024), Romi (2024), and Youssef et al. (2022), who have stressed the dual nature of social skills, which can result in positive outcomes in some contexts and negative ones in others. This research finds a high level of proficiency in social networks, in a context marked by a failure to harness this skill as a positive resource to develop ICT use in schools. Given that only 11.22% of users displaying social skills are associated with optimal ICT use for schoolwork, this clear deficiency also appears to reveal an opportunity for educators to identify teaching approaches that can redirect these skills to strengthen academic use of ICT.

5.1. Theoretical and practical implications

The various findings of this study provide a glimpse of both theoretical and practical implications for educational policy-making and classroom management in Mexico and other similar contexts. From a theoretical perspective, the validation of a research model that shows high explanatory power with clear differentiation in the predictive power of skills reinforces the multidimensional conceptualization of digital skills, providing an argument against treating "digital literacy" as a single, uniform construct. In addition, an empirical assessment of the research findings supports the hierarchical nature of digital skills, in line with theoretical assumptions that regard basic literacy as a prerequisite for knowledge creation (Eyal & Te'eni-Harari, 2024; Ilomäki et al., 2023; Suarez Enciso et al., 2024). In this regard, the role of these skills as necessary conditions provides a quantifiable basis to demonstrate that higher-order skills are not merely a continuation of lower-order ones, but are interwoven across different levels. This disparity, reflected in the contrast between high performance and low importance, and vice versa, provides an empirical basis for conceptualizing the gap between formal and informal learning that appears to characterize social skills in particular.

In terms of the practical implications, the findings appear to support the adoption of a two-pronged strategy in national education policy that ensures basic proficiency and prioritizes higher-order skills. First, efforts should be directed at bridging the remaining gaps in creative skills, including the provision of basic and effective instruction and infrastructure for all students and creative and strategic skills should be incorporated into the official curriculum at all levels of education (Baquerizo Álava et al., 2024; Ilomäki et al., 2023; Toudert, 2025; Voda et al., 2022). Similarly, it is important that school administrations carry out competency reviews to diagnose specific gaps in student and teacher skills, thus enabling targeted interventions. This can be carried out in conjunction with efforts to implement comprehensive, project-based methods that link informal skills (social networks) with formal schoolwork (video creation, collaborative documents, podcasts) (González Grez, 2025; Kumar, 2024; Romi, 2024; Youssef et al., 2022). Lastly, there is a pressing need to begin to reverse the current trend by progressively shifting from consumption to creation of digital content, as part of a process that would requiring both creative skills and an increased commitment to learning.

6. Conclusions

This study provided empirical evidence on the multidimensional impact of digital skills on ICT use for schoolwork in Mexico, confirming the validity of the proposed theoretical model and revealing specific patterns of importance and performance, with implications for both educational theory and practice.

The confirmation of the five proposed hypotheses indicates that operational, strategic, communication and information, and creative skills constitute distinct dimensions that have different influences on ICT use in education. The model's high explanatory power (R^2 = 0.891) demonstrates that these dimensions adequately capture the main determinants of ICT use for schoolwork, exceeding the explained variance in previous studies.

The importance-performance analysis revealed critical patterns that challenge previous assumptions on the development of digital skills in education. The predominance of operational skills for ICT use for schoolwork suggests gaps in other skills that are often viewed as basic. Amid these paradoxes, one distinctive characteristic of Mexican students is their strong social skills, and this can be strategically leveraged to support the development of other higher-order skills. The underused potential of creative skills reveals further opportunities for pedagogical innovation to align digital skills with genuine educational objectives.

This study has shown that effective integration of ICT in Mexican education requires a nuanced and multidimensional understanding of students' digital skills. These findings challenge simplistic assumptions about the "digital generation" and cast light on the need for specific, targeted teaching interventions to support the development of digital skills for education.

6.1 Limitations and future lines of inquiry

While this study has provided some robust findings, it is important to acknowledge its limitations, which also suggest avenues for future research. Although the study sample is the largest and most representative in Mexico, the diverse socioterritorial contexts included in the sample call for further breakdowns along thematic and epistemological lines to permit a targeted exploration of more narrowly defined samples. Furthermore, the cross-sectional nature of the annual data examined does not capture dynamics or trajectories of development. For this, longitudinal studies are needed to monitor skill development over time and the impact of any policy measure. At this initial stage, this research is based on items drawn up from self-reported data. Future studies can be made more robust by including objective assessments to support these self-reported findings. Lastly, as previously mentioned, there remains a lack of consensus in terms of the approaches used to explore digital skills, making findings difficult to compare and reproduce. Exploring shared methodological approaches offers a promising direction for future research.

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Contributions

The manuscript is a unique authorship. The author is responsible for the totality of the work without collaboration.

Data Availability Statement

The data used is published publicly and can be downloaded from the web of the broadcasting organization at the URL: https://www.inegi.org.mx/programas/endutih/2024/#datos_abiertos.

Ethics approval

This investigation does not involve experiments with humans and animals.

Conflicts of interest

The author declared the non-existence of any conflict of financial interests, personal or other types that could influence the results of the study.

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