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Digital Literacy among University Students in Mexico and Spain: Implications for Education 4.0

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Abstract

Digital literacy is crucial for attaining Sustainable Development Goals 4 and 9 and for education 4.0. For this purpose, university students must improve their digital skills—a fact adequately highlighted by the COVID-19 pandemic. To examine the perceptions of university students about their digital literacy in higher education, a descriptive, cross-national study was conducted with 378 university students from public universities in Mexico and Spain. Data was analyzed using Spearman's correlation and descriptive statistics in RStudio. The results show differences in digital literacy of university students between the two countries. However, gender has a much lower influence and is primarily linked to the use of online tools, such as Pinterest and Instagram. Prior training in Information and Communications Technology is also linked to several items evaluated at the level of literacy. Digital competencies are strongly influenced by a cultural component. These findings highlight the need to strengthen digital literacy programs in higher education to reduce cross-country disparities and promote inclusive digital competence aligned with SDG 4 and 9.

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Introduction

In 2020, humanity faced a major challenge: the COVID-19 pandemic, which led to a global emergency and triggered changes in how we live, work and study (Antonopoulou et al., 2021). Digital skills have become necessary for all students to continue their education from home. This need, which became urgent, was not new because universities were already required to help students develop skills necessary to fully adapt to social changes (Garrido et al., 2019). Consequently, digital literacy has emerged as a priority for educational systems worldwide, highlighting differences between existing pedagogical systems. The concept of digital literacy derives from UNESCO's definition of digital literacy as the combined set of skills (knowledge, abilities, and attitudes) necessary for life and work (Vuorikari et al., 2016) (Media and Information Literacy (MIL) program). According to Domingo-Coscollola et al. (2020), students and teachers must acquire digital literacy, which requires promoting collaborative learning through environments that facilitate the use of information and communication technology (ICT). The COVID-19 pandemic restricted classroom activities (Díaz, 2021). As the disease spread across the globe, most countries announced temporary school closures, which affected, As stated by United Nations Educational, Scientific and Cultural Organization (UNESCO, 2017), more than 91% of students worldwide. In April 2020, nearly 1.6 billion children and young people continued their studies through distance education, learning remotely, (Gámez, s. n.).

According to Akram et al. (2021), both teachers and students were compelled to switch from traditional face-to-face education to online education in response to the COVID-19 pandemic. This situation highlighted the importance of integrating technology into education and the need for teachers to maintain current digital skills. From a very early age, children and adolescents become familiar with digital tools. During the pandemic, our experience as higher education teachers made us notice that the students we would consider digital natives due to their age certainly had no problem navigating the internet, applications, and social networks. However, this did not guarantee that they would be able to effectively transfer these skills to an educational environment. Student digital skills must be enhanced in order to make effective use of the Internet during their studies (Miliou & Angeli, 2022).

Technology has now fully entered the educational space, fostering more accessible and flexible training (Ovejero et al., 2021), thereby promoting the evolution of professions (Humanante-Ramos et al., 2019). This shift has brought new challenges, demanding an additional effort from teachers (Garrido et al., 2019) and requiring both teachers and students to use new and diverse devices and platforms. Technology should accompany students throughout their academic training process (Roque et al., 2017), and universities should promote a technology-based culture to support regional development. In line with the above, García et al. (2021) state that professors must possess 'mastery of digital competences and skills in techniques in the computer area' to be competitive. Digital skills imply the 'critical and safe use of Information Society Technologies for work, leisure and communication' (Tourón et al., 2018).

To standardize criteria and concepts, the European Commission published the DigComp project as a proposal for a common framework of reference for digital skills. DigComp encompasses 21 competences divided into five

areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem solving (Vuorikari et al., 2022). Information and data literary integrate skills such as searching, evaluating, storing, and retrieving data. Communication and collaboration include interacting, participating, collaborating, and managing a digital identity through digital technologies. Digital content creation refers to developing and integrating digital content, copyright and licenses, and programming. Safety is related to protecting devices, personal data and privacy, health and wellbeing, and the environment. Problem-solving encompasses solving technical problems, identifying needs and technological responses, creatively using digital technologies, and identifying digital competence gaps (EU Science Hub-European Commission).

In 2015, the United Nations (UN) approved the 2030 Agenda for Sustainable Development, setting 17 sustainable development goals (hereinafter, the SDGs) to be achieved within 15 years for eradicating poverty and promoting environmental protection, education, equality for women, and design of sustainable cities (UNESCO 2017). This research relates to SDGs 4 (quality education) and 9 (industrial innovation and infrastructure) considering that developing open educational resources and using ICTs are key strategies for access to inclusive education. The SDG 4 aims at ensuring inclusive, equitable, and quality education and promoting lifelong learning opportunities for all. Education is key to eradicating poverty and enables citizens to become socio-economically independent. During the last decade, significant improvements have been made regarding access to education. However, this pandemic has exposed access inequality, which may be due to the lack of stable Internet access under conditions of restricted mobility.

In turn, UNESCO, through the SDG 9, promotes the construction of resilient infrastructures by fostering sustainable industrialization and innovation. Universal access to information through open solutions is key to collaboration, research and knowledge acquisition for innovation. Along these lines, access to and use of ICTs must be promoted. As stated by UNESCO (2017, p. 4) data, 'It is estimated that in 2019, 96.5% were covered by at least a 2G network.' However, this coverage does not guarantee that this population can afford the cost of Internet connection and has access to services and information. Considering the above, and to assess the educational and technological contexts of Mexico and Spain using academic and technological indicators, Table 1 shows these countries' ranking for education and technology indicators in the Global Competitiveness Report 2019 of the World Economic Forum (WEF), alongside the country that leads each indicator globally.

Table 1. Education Indicators from the 2019 Global Competitiveness Report of the WEF

Indicator	**Mexico**	**Spain**	**Global**
Competitiveness	48	23	Singapore
Skillset of graduates	70	43	Switzerland
Digital skills among active population	99	61	Finland
Critical thinking in teaching	103	83	Finland
Research and Development (R&D) expenditures (%GDP)	64	32	Israel
ICT adoption	74	19	Korea
Fixed-broadband Internet subscriptions	62	24	Switzerland
Fibre Internet subscriptions	50	17	Korea

Indicator	Mexico	Spain	Global
Internet users (% adult population)	72	28	Qatar
Innovation capability	52	25	Germany
Source: The authors, based on the WEF data (2019)			

All indicators show that Spain has a higher level of development than Mexico. Accordingly, we can assume that the geographic context implies differences in the literacy level of university students. Based on the DigComp framework and the Sustainable Development Goals, this study aims to compare digital literacy perceptions among university students in Mexico and Spain. Therefore, this study presents the differences in the level of perception of literacy between university students in Mexico and Spain.

Method

Participants

A purposive non-probability sampling technique was employed. A sample of 378 university students was collected from two public universities (University of Tamaulipas, México; and University of Málaga, Spain), one from Mexico (N = 251) and the other one from Spain (N=127) by simple random cluster sampling. Students' average age was 21.78 years, with 65.96% women (39.2% Mexico and 26.7% Spain) and 34.1% men (27.2% Mexico and 6.9% Spain).

The sample was collected in October 2021, and the students were enrolled in Degree (98.9% of total of sample), MBS or Master (0.3%) and PhD Program (0.8%). Regarding academic disciplines, 68.5% of the participants were enrolled in Economics, 68.5% of the students belong to the area of Economics, 31.2% belong to the area of Heath and 0.3% belong to the area of Education. Most of the students study online/distance modality (66.4%), an important part studied face-to-face studies (32.8%) and a minority studied in hybrid modality (0.8%). The normality and homoscedasticity of the sample have been analyzed, fulfilling the second principle (Levene's test= 0.369; $p = .544$), but not the first (Kolmogorov-Smirnov = .770; $p < .001$). Regarding the size of the effect, we obtained $\delta \geq .5$, using the two-tailed criterion for detecting maximum type I = .05 errors. A sufficient sample size was considered.

Instruments

A two-part questionnaire was administered, containing both dichotomous and Likert-scale items. The first block included 14 questions on demographic information and general information on the existence, if any, of internet access difficulties, prior ICT training, and other prior training in higher education. Dimension 1 (Technological literacy and use) from the questionnaire for assessing the digital skills of teachers (Agreda et al. 2016) was used to measure technological literacy. Among the questions of this dimension, those related to social networks were eliminated, restricting the analysis to questions directly linked to the daily academic context.

To assess the students' perception of their technological literacy, the version by Agreda et al. (2016) has been

adapted to university students and administered. This instrument was originally created to assess the perception of teachers, having been used in many studies. For instance, Hinojo et al. (2017) used this instrument to analyze the training in ICT of the monitors of the day centers of the Andalusian Autonomous Community with a high reliability and internal consistency. To evaluate the reliability and validity of the instrument's adaptation to the student population must be analyzed. Cronbach's Alpha has been calculated, obtaining a value of α=0.935; so, we can say that it is a valid instrument. Exploratory factor analysis confirms the reliability of the instrument (KMO = .896; Bartlett´s Test of Sphericity ($\chi 2(45) = 3875$; $p < .001$)).

Procedure and Data Analysis

The two participating universities were selected through intentional cluster sampling, with a second phase of simple random sampling. The instrument was administered in October 2021 through Google Forms for online application, and all participants provided informed consent. Participation was voluntary, and no identifying data were recorded.

The results were analyzed using the statistical software RStudio. An exploratory analysis with contingency tables and a dependency analysis were performed to assess differences and relationships among the variables of sex, country, and prior ICT training through Fisher's exact test, chi-square test, and correlation matrix. These two statistics (Fisher's exact test and the chi-square test) are used in conjunction because in some cases, marginal sums may appear unequal. Therefore, both statistics are considered.

Results

Descriptive Analysis

Table 2 outlines the percentages and absolute values of internet access by gender and country, showing that most students did not experience access difficulties (52.9%), in contrast to 4.7% of students who did. Female students in Mexico (2.6%) faced the most difficulty accessing the internet, albeit with little variation, in contrast to male students in Spain (5.5%), who faced the least difficulty accessing the internet. The greatest difference between countries was found for students who indicated that they were facing internet access difficulties 'sometimes', with 37.1% of students in Mexico versus 5.3% in Spain.

Table 2. Internet Access Difficulties by Country and Gender

Country	**Gender**	**Internet access difficulties**							
		Yes		Sometimes		No		Total	
		%	N	%	N	%	N	%	N
Mexico	Women	2.6	10	22.8	86	13.8	52	39.2	148
	Men	1.9	7	14.3	54	11.1	42	27.3	103
Spain	Women	0.2	1	4.0	15	22.5	85	26.7	101
	Men	0.0	0	1.3	5	5.5	21	6.8	26
Total		4.7	19	42.4	160	52.9	200	100	378

Table 3 clearly shows differences in prior ICT training between students in Mexico (30.2%) and those in Spain (6.6%), albeit with similar percentages of women without prior ICT training in both Mexico and Spain (20.4% and 21.9%, respectively). The difference between male students in Mexico and those in Spain is evident when comparing those with prior ICT training (11.4% Mexico versus 1.8% Spain) and those without (15.9% Mexico versus 5.0% Spain).

Table 3. Prior ICT Training by Country and Gender

Country	**Gender**	**Prior ICT training**					
		Yes		No		Total	
		%	N	%	N	%	N
Mexico	Women	18.8	71	20.4	77	39.2	148
	Men	11.4	43	15.9	60	27.4	103
Spain	Women	4.8	18	21.9	83	26.7	101
	Men	1.8	7	5.0	19	6.8	26
Total		36.8	139	63.2	239	100	378

Dependence Analysis

Knowledge and Use of ICT Basic Components

The relationships of peripheral elements, external storage and digital whiteboards and projectors with the variables of country, gender and prior ICT training were analyzed, revealing that Ho cannot be negated regarding gender (peripheral elements: Fisher's exact test p= .7; $\chi 2$= 1.2, p= .7; external storage: Fisher's exact test p= .1; $\chi 2$ = 5.8, p= .1; digital whiteboards and projectors: Fisher's exact test p= .57; $\chi 2$= 1.97, p= .5); and prior ICT training (peripheral elements: Fisher's exact test p= .06; $\chi 2$ = 7.57, p= .05; external storage: Fisher's exact test p= .17; $\chi 2$= 4.88, p= .18). When analyzing the relationship between prior ICT training and digital whiteboards, Ha (3) is accepted (Fisher's exact test p= .02; $\chi 2$=9.32, p= .02). In turn, as shown in Table 4, knowledge and use of peripheral elements, external storage, and digital whiteboards and projectors are related to the country of origin. Therefore, Ha (3) is accepted.

Table 4. Knowledge and Use of ICT Basic Components by Country

Knowledge and use of ICT basic components by country	**Fisher's exact test**	**Chi-squared test**	**p value**
Peripheral elements (keyboard/screen/mouse/CPU/others)	.007*	12.187*	.006*
External storage	.000***	14.837***	.001**
Digital whiteboards and projectors	.001**	16.182**	.001**

* p <.05; **p<.01; ***p<.001.

Knowledge and Use of Operating Systems

Ho (1) is rejected for the three elements included in knowledge and use of operating systems (word processors,

images and presentations, and spreadsheets and databases) regarding the variable of country (Table 5). In relation to gender, Ho (2) cannot be negated (word processors: Fisher's exact test p= .78; $\chi 2$= 1.205, p= .75; images and presentations: Fisher's exact test p= .11; $\chi 2$= 5.83, p= .12; spreadsheets and databases: Fisher's exact test p= .57; $\chi 2$= 1.97, p= .57). The knowledge and use of spreadsheets and databases depended on prior ICT training (Fisher's exact test p= .02; $\chi 2$= 9.32, p= .02). In turn, Ho (3) between word processors and prior ICT training (Fisher's exact test p= .06; $\chi 2$= 7.57, p= .05) or between images and presentations and prior ICT training (Fisher's exact test p= .17; $\chi 2$=4.88, p= .18) cannot be negated. Spanish women more frequently reported knowledge of word processors (10.3%). The frequency of students who indicated less knowledge of images and presentations was found in the population of Mexico (3.1% women, 1.8% men), whereas the highest percentage was found in both Mexican (16.1%) and Spanish (14.8%) women. Of the total number of students, 52% indicated using spreadsheets and databases.

Table 5. Knowledge and Use of Operating Systems by Country

Knowledge and use of operating systems	Fisher's exact test	Chi-squared test	p value
Word processors	.007*	12.187*	.006*
Images and presentations	.000***	14.837**	.001**
Spreadsheets, databases	.001**	16.182**	.001**

* p <0.05; **p<0.01; ***p<0.001.

Web Use

Ho (3) is rejected for the variables of prior ICT training and country regarding web use (Table 6), albeit with a weak effect size in both cases (Cramer´s V< .3), but not for the variable of gender, which showed no relationship (gender and email and mailing lists: Fisher's exact test p= .6; $\chi 2$= 1.43, p= .6; gender and web browsers and search engines: Fisher's exact test p= .6; $\chi 2$= 1.76, p= .5; gender and file sharing tools: Fisher's exact test p= .2; $\chi 2$= 3.82; p= .2).

Table 6. Web Use by Country and Prior ICT Training

Web use		Fisher's exact test	Chi-squared test	p value
Email and mailing lists (country)	Country	.000***	14.469**	.002**
	Prior ICT training	.05*	7.77*	.05*
Web browsers and search engines	Country	.013*	10.423*	.015*
	Prior ICT training	.001**	12.298**	.001**
File sharing tools	Country	.05*	7.629*	.05*
	Prior ICT training	.000***	20.335***	.000***

* p <0.05; **p<0.01; ***p<0.001.

Management and Distribution of Resources through Web 2.0 Applications

In relation to the management and distribution of resources through Web 2.0 applications, Ho is rejected for the

variable of country regarding the use of blogs and content syndication. In relation to Wikis, Fora, VideoBlogs, and Online Presentations, Ho (1) cannot be negated.

Table 7. Management and Distribution of Resources through Web 2.0 Applications by Country

Management and distribution of resources through Web 2.0 applications	**Fisher's exact test**	**Chi-squared test**	**p value**
Blogs	.008**	11.906**	.007**
Wikis	.853	0.8183	.845
Fora	.140	5.5598	.135
VideoBlogs	.407	2.7898	.425
Content Syndication (digital content distribution)	.015*	10.59*	.014*
Online Presentations	.124	6.0422	.109

* p <0.05; **p<0.01; ***p<0.001.

The variables of gender and prior ICT training (see Table 8) were related to VideoBlogs, but prior ICT training may also be related to blogs and content syndication.

Table 8. Management and Distribution of Resources through Web 2.0 Applications by Gender and Prior ICT Training

Management and distribution of resources through Web 2.0 applications		**Fisher's exact test**	**Chi-squared test**	**p value**
Blogs	Gender	.47	2.59	.45
	Prior ICT training	.05*	8.99*	.05*
Wikis	Gender	.08	6.722	.08
	Prior ICT training	.13	5.512	.13
For a	Gender	.24	4.14	.24
	Prior ICT training	.31	3.66	.31
VideoBlogs	Gender	.04*	8.309	.04*
	Prior ICT training	.01**	13.28**	.01**
Content Syndication (digital content distribution)	Gender	.09	6.631	.09
	Prior ICT training	.05*	8.870*	.05*
Online Presentations	Gender	.59	1.908	.59
	Prior ICT training	.19	4.850	.18

* p <0.05; **p<0.01; ***p<0.001.

The variable of country was related to the tools Google Drive, Dropbox, and iCloud, as shown in Table 9. In contrast, Office 365 and SkyDrive were not associated with this variable. The variables of gender and prior ICT training were not related to any variable linked to the use of cloud tools or storage (gender and Google Drive: Fisher's exact test p= .3; $\chi 2$=2.88, p= .4; gender and iCloud: Fisher's exact test p= .5; $\chi 2$=2.19, p= .5; gender and Office 365 and SkyDrive: Fisher's exact test p= .9; $\chi 2$=0.42, p= .9; prior ICT training and Google Drive: Fisher's

exact test p= .3; $\chi 2$= 3.64, p= .3; prior ICT training and iCloud: Fisher's exact test p= .3; $\chi 2$=3.5, p= .3; prior ICT training and Office 365 and SkyDrive: Fisher's exact test p= .3; $\chi 2$=3.14, p= .3), except for Dropbox (gender: Fisher's exact test p< .05; $\chi 2$=10.02, p< .05; prior ICT training: (Fisher's exact test p< .01; $\chi 2$=12.71, p< .01).

Table 9. Management and Use of Tools and Storage in Cloud Environments by Country

Management and use of tools and storage in cloud environments	**Fisher's exact test**	**Chi-squared test**	**p value**
Google Drive	.000***	14.469**	.002**
Dropbox	.007**	11.902**	.007**
iCloud	.001**	16.304***	.000***
Office 365 and SkyDrive	.063	7.1601	.066

* p <0.05; **p<0.01; ***p<0.001.

Therefore, Ho (1) is rejected for the relationship between country and Google Drive, Dropbox, or iCloud; for the relationship between gender and Dropbox; and for prior ICT training and Dropbox. Ho cannot be negated for the other relationships described above.

Knowledge and Use of Management Platforms

The variable of sex was not related to knowledge or use of management platforms (sex: Fisher's exact test p= .7; $\chi 2$=1.42, p= .7), whereas the variables of prior ICT training (Fisher's exact test p< .01; $\chi 2$=14.39, p< .01) and country of origin were related (Table 9). Therefore, Ho is rejected for the variable of gender but not for country or prior ICT training. The associations between country and Blackboard and WebTC and between country and MSTeams showed a medium effect size (Cramer's V> .3 for both cases).

Table 10. Knowledge and Use of Management Platforms by Country

Knowledge and use of management platforms	**Fisher's exact test**	**Chi-squared test**	**p value**
Moodle	.000***	27.581	.000
Blackboard, WebTC	.000***	34.04	.000***
MsTeams	.000***	43.261	.000***
Other virtual platforms	.533	2.1824	.535

* p <0.05; **p<0.01; ***p<0.001.

Protection Software Use and Data Protection

Regarding protection software use and data protection, significant differences were found between countries (Fisher's exact test p< .001; $\chi 2$= 34.9, p< .001), with a medium effect size (Cramer's V< .5) on this variable. Significant differences in this variable were also found between genders (Fisher's exact test p< .02; $\chi 2$= 9.16, p< .02). Conversely, prior ICT training was not related to the country of origin (Fisher's exact test p= .15; $\chi 2$= 5.19, p= .15). Therefore, Ho is accepted for this variable.

Mastery of Databases and Thesauri in Searching for Information

When comparing the mastery of databases and thesauri in searching for information by country (Fisher's exact test p< .001; $\chi 2$= 29.6, p< .001) and gender (Fisher's exact test p< .02; $\chi 2$=14.75, p< .02), we found a relationship with the variables of country and prior ICT training but not with gender (Fisher's exact test p= .11; $\chi 2$= 5.92, p= .11). Ha is accepted for country and prior ICT training but rejected for gender.

Knowledge and Use of QR Code Generators

Significant differences were found for both country (Fisher's exact test p< .001; $\chi 2$= 36.53, p< .001) and prior ICT training (Fisher's exact test p< .001; $\chi 2$= 16.9, p< .001). In turn, the variable country had a medium effect (Cramer's V> .3) on knowledge and use of QR code generators. However, we found no relationship with sex (Fisher's exact test p= .11; $\chi 2$= 5.9, p= .11).

Knowledge of Personal Learning Environments

Ha is accepted for the variables of country and prior ICT training, with p< .001 (Fisher's exact test p< .001; $\chi 2$= 30.08, p< .001) and p=0.03 (Fisher's exact test p= .03; $\chi 2$=8.85, p= .03), respectively. The variable country had a medium effect size (Cramer's V> .3). Regarding gender, we found no significant differences between men and women in terms of knowledge of personal learning environments (Fisher's exact test p= .8; $\chi 2$= 0.64, p= .8). Therefore, Ho cannot be rejected for this variable. Regarding the implementation of technological resources, such as learning tools, Garrido et al. (2019) found that the use of interactive online exercises combined with feedback improves analysis and synthesis skills, in addition to increasing student satisfaction and improving learning.

Collaborative Use of ICT

Regarding collaborative ICT use, Ha is accepted for the variable country (Fisher's exact test p< .001; $\chi 2$= 14.9, p< .001) and rejected for the variables gender (Fisher's exact test p= .5; $\chi 2$=2.42, p= .4) and prior ICT training (Fisher's exact test p= .07; $\chi 2$=6.9, p= .07).

Table 11. Collaborative Use of ICT by Country

Country	**Gender**	**Collaborative use of ICT**									
		1		**2**		**3**		**4**		**Total**	
		%	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**
Mexico	Women	1.3	5	5.3	20	18.8	71	13.8	52	39.2	148
	Men	0.8	3	4.0	15	13.8	52	8.7	33	27.3	103
Spain	Women	2.1	8	7.7	29	8.7	33	8.2	31	26.6	101
	Men	0.3	1	1.3	5	2.6	10	2.6	10	6.9	26
Total		4.5	17	18.3	69	43.9	112	33.3	61	100	378

Knowledge of Copyright and Intellectual Property

Knowledge of copyright and intellectual property is directly related to the variables of country and prior ICT training (Fisher's exact test $p < .001$; $\chi2 = 19.56$, $p < .001$ and Fisher's exact test $p = .1$; $\chi2 = 11.22$, $p = .1$, respectively) but not to gender (Fisher's exact test $p = .4$; $\chi2 = 3.05$, $p = .4$), as the highest percentage of responses was found for Mexican women (see Table 12).

Table 12. Knowledge of Copyright and Intellectual Property by Country and Gender

Country	Gender	Knowledge of copyright and intellectual property									
		1		2		3		4		Total	
		%	N	%	N	%	N	%	N	%	N
Mexico	Women	1.6	6	8.2	31	14.9	56	14.6	55	39.3	148
	Men	1.1	4	6.3	24	13.0	49	6.9	26	27.3	103
Spain	Women	3.4	13	9.3	35	8.7	33	5.3	20	26.7	101
	Men	0.5	2	2.6	10	1.8	7	1.8	7	6.7	26
Total		6.6	25	26.4	100	38.4	145	28.6	108	100	378

Use of Reference Management Software (Zotero, Mendeley, Refworks)

The use of reference management software was not related to any study variable (country: Fisher's exact test $p = .3$; $\chi2 = 3.62$, $p = .3$; gender: Fisher's exact test $p = .5$; $\chi2 = 2.49$, $p = .5$; and prior ICT training: Fisher's exact test $p = .5$; $\chi2 = 2.06$, $p = .6$). Therefore, Ha is rejected. Table 13 outlines the frequencies and percentages by country and sex.

Table 13. Use of Reference Management Software by Country and Sex

Country	Gender	Use of reference management software (Zotero, Mendeley, Refworks)									
		1		2		3		4		Total	
		%	N	%	N	%	N	%	N	%	N
Mexico	Women	8.0	30	13.0	49	11.6	44	6.6	25	39.2	148
	Men	5.0	19	10.9	41	8.2	31	3.2	12	27.3	103
Spain	Women	6.3	24	7.9	30	7.1	27	5.3	20	26.6	101
	Men	1.9	7	1.3	5	2.6	10	1.1	4	6.9	26
Total		21.2	80	33.1	125	29.5	112	16.2	61	100	378

Efficient Search and Discrimination of Relevant Information on the Web

The hypothesis is rejected for efficient searches and discrimination against relevant information on the Web, with no evidence of significant differences between countries, genders, or prior ICT training (country: Fisher's exact test $p = .3$; $\chi2 = 3.62$, $p = .3$; gender: Fisher's exact test $p = .5$; $\chi2 = 2.49$, $p = .5$; prior ICT training: Fisher's exact test $p = .5$; $\chi2 = 2.05$, $p = .6$). As shown in Table 14, most students in Spain and Mexico scored high in terms of searching

for and discriminating against relevant information on the Web.

Table 14. Efficient Search and Discrimination of Relevant Information on the Web by Country

Country	Gender	Efficient search and discrimination of relevant information on the Web									
		1		2		3		4		Total	
		%	N	%	N	%	N	%	N	%	N
Mexico	Women	2.6	10	7.1	27	16.4	62	13.0	49	39.1	148
	Men	1.1	4	6.9	26	13.5	51	5.8	22	27.3	103
Spain	Women	2.1	8	7.4	28	11.6	44	5.6	21	26.7	101
	Men	0.5	2	1.1	4	3.2	12	2.1	8	6.9	26
Total		6.3	24	22.5	85	44.7	169	23.5	100	100	378

Correlational Analysis

The country variable correlated significantly and positively with the variables for previous higher education (Spearman's rho= .137; p= .008) and with item 1 (Spearman's rho= .137; p= .007). This finding implies that previous higher education is linked to Spanish students, as is a perception of greater knowledge and use of basic ICT components. However, negative correlations were detected between country and the variables difficulty in accessing the internet (Spearman's rho= .433; p< .001), previous ICT training (Spearman's rho= .252; p< .001), Item 8 (Spearman's rho= .130; p= .012), Item 9 (Spearman's rho= .196; p< .001), Item 10 (Spearman's rho= .249; p< .001), Item 11 (Spearman's rho= .236; p< .001), Item 12 (Spearman's rho= .273; p< .001), Item 13 (Spearman's rho= .110; p= .033), and Item 15 (Spearman's rho= .205; p< .001). Thus, it is evident that although Mexican students have greater difficulty accessing the internet, they also have more previous training in ICT than Spanish students. In turn, they have a perception of their own knowledge and use of management platforms, of the use of device protection software and care in data protection, of their mastery of databases and thesauri in the search for information, of their knowledge and use of tools for the creation of QR codes, of their knowledge of personal learning environments, of their collaborative use of ICT, and of their knowledge of copyrights and intellectual property.

For Items 2, 3, 5, 6, 16 and 17, there is no significant correlation with the country variable. In the case of Item 1, if we evaluate each of the elements that compose it, we find that the country variable correlates positively with the perception of knowledge about peripheral elements (Spearman's rho= .197; p< .001) and this perception about whiteboards and digital projectors (Spearman's rho= .156; p= .002). Item 2, despite not showing significance as a whole with the country variable, does show significance in some of its specific items. Thus, the perceptions of knowledge of word processors, as well as of images and presentations, were positively correlated; Mexican students had the lowest perceptions of mastery of these elements, while Spanish students had a greater perception of mastery of spreadsheets (see Table 15).

In relation to item 3, only one of the subitems shows significant correlations with the country variable. In this case, Spanish students showed greater perceptions of mastery of e-mail and distribution lists than did Mexican

students (see Table 15). Item 5, linked to the perception of the management and distribution of resources through Web 2.0 applications and content syndication, showed a significant correlation with the country variable. In this sense, Mexican students showed a greater perception of this item than Spanish students did (see Table 15).

Two of the subitems of Item 6, linked to the perception of the management and use of tools and storage within cloud environments, presented significant correlations with the country variable. Specifically, the perception of mastery of Google Drive was greater for Spanish students, and the perception of mastery of iCloud was greater for Mexican students (see Table 15). If we focus on Item 8, there is a positive correlation with the knowledge and use of Moodle, so that there is a greater perception of knowledge and use by Mexican students. The variable "previous training in ICT" was significantly correlated with all three variables, and all of them were positively correlated with the following item: "Item 10. Knowledge and management of tools for the creation of QR codes", "Item 12. knowledge about personal learning environments"; "Item 13. Collaborative use of ICT", "Item 15. Knowledge about copyright and intellectual property" and "Item 17. Effective search and discrimination of relevant information on the web" (Table 2). This implies that a large part of the students' perception of ICT proficiency will be limited by their previous ICT training, so that the greater the previous ICT training is, the greater the perception of ICT proficiency. Previous higher education has less influence, establishing positive correlations with "Item 9. Handling of device protection software and care in data protection", "Item 13. Collaborative use of ICT", and "Item 16. Use of bibliographic managers (Zotero, Mendeley, Refworks)" (Table 15). This finding implies, as in previous studies, that higher education is associated with greater perceptions of ICT mastery.

Table 15. Correlation Matrix

		Gender	**Country**	**Difficulty in accessing the Internet**	**Previous ICT training**	**previous higher education**	**Item 9.**	**Item 10.**	**Item 11.**	**Item 12.**	**Item 13.**	**Item 15.**	**Item 16.**
Gender	Spearman's rho	—											
	p-value	—											
Country	Spearman's rho	-0.205***	—										
	p-value	< .001	—										
Difficulty in accessing the Internet	Spearman's rho	0.059	-0.433***	—									
	p-value	0.250	< .001	—									
Previous ICT training	Spearman's rho	0.030	-0.252***	0.038	—								
	p-value	0.565	< .001	0.458	—								
Previous higher education	Spearman's rho	0.117*	0.137**	-0.034	0.046	—							
	p-value	0.023	0.008	0.515	0.372	—							
Item 9.	Spearman's rho	0.131*	-0.196***	-0.002	0.094	0.115*	—						
	p-value	0.011	< .001	0.964	0.069	0.025	—						

		Gender	Country	Difficulty in accessing the Internet	Previous ICT training	previous higher education	Item 9.	Item 10.	Item 11.	Item 12.	Item 13.	Item 15.	Item 16.
Item 10.	Spearman's rho	0.115**	-0.249***	0.055	0.175***	0.084	0.579***	—					
	p-value	0.026	< .001	0.283	< .001	0.104	< .001	—					
Item 11.	Spearman's rho	0.061	-0.236***	0.048	0.116*	0.032	0.521***	0.552***	—				
	p-value	0.233	< .001	0.351	0.025	0.536	< .001	< .001	—				
Item 12.	Spearman's rho	0.001	-0.273***	0.059	0.143**	-0.011	0.536***	0.575***	0.640***	—			
	p-value	0.983	< .001	0.254	0.005	0.831	< .001	< .001	< .001	—			
Item 13.	Spearman's rho	0.039	-0.110*	-0.066	0.121*	0.107*	0.564***	0.473***	0.511***	0.633***	—		
	p-value	0.454	0.033	0.201	0.019	0.038	< .001	< .001	< .001	< .001	—		
Item 15.	Spearman's rho	-0.000	-0.205***	0.002	0.167**	-0.004	0.428***	0.460***	0.488***	0.569***	0.526***	—	
	p-value	0.997	< .001	0.966	0.001	0.945	< .001	< .001	< .001	< .001	< .001	—	
Item 16.	Spearman's rho	-0.028	0.012	-0.038	0.069	0.121*	0.414***	0.430***	0.522***	0.470***	0.437***	0.468***	—
	p-value	0.588	0.819	0.464	0.183	0.018	< .001	< .001	< .001	< .001	< .001	< .001	—
Item 17.	Spearman's rho	-0.015	-0.077	-0.076	0.123*	0.078	0.405***	0.367***	0.394***	0.461***	0.539***	0.545***	0.543***
	p-value	0.765	0.135	0.139	0.017	0.130	< .001	< .001	< .001	< .001	< .001	< .001	< .001

Note. *** p < .05, ** p < .01, *** p < .001**

Discussion

Regarding the study hypotheses, significant differences were found between university students by country of origin (Mexico vs Spain) for most variables analyzed in this study. Therefore, Ha (1) is confirmed. Most variables indicate a relationship between literacy and country of origin. This relationship implies the existence of inequalities between students, which should be urgently addressed by schools (Bergdahl et al., 2020). In line with these results, after conducting a comparative study on university students from Spain, Italy, and Ecuador, Tejedor et al. (2020) indicated that the university education system is not providing students with the required level of digital literacy.

In this study population, this line of investigation must be expanded to include attitudes toward the use of ICT and the possible influence, if any, of prior training on its acceptance. No gender differences were found regarding university students' digital literacy; therefore, the starting question was not confirmed (Ha (2)). Prior ICT training does have a greater weight than gender, but we cannot confirm Ha (3) because this question is fulfilled in 17 of the 32 digital literacy variables analyzed in this study.

In line with previous findings, as in the study by Hernández et al. (2018), students who had previous experience

using technologies and who also received advice or technical support on the use of the platforms felt less stressed and had a positive attitude toward online education. According to Díaz (2021), the tutoring service provided through Microsoft Teams at a university in Mexico helped students achieve favorable results. Gómez-Galan et al. (2021) reported that university students adequately handle essential tools, such as office automation software or internet searches and navigation, email, or social media. However, they show limitations in the use of Wikis and fora, creation of blogs, and working on academic platforms, among others—that is, activities with greater potential for their university studies.

Prior ICT training significantly affects students' digital literacy levels. This approach is essential for students because their level of prior knowledge when entering university influences their subsequent studies. Accordingly, Verhoeven et al., (2016) indicate that many university students access higher education without digital skills. In a similar study, Siddiquah and Salim (2017) reported that most university students experienced internet access difficulties because of slow internet speeds or poor conditions on their computers. Romero et al. reported that improved internet access conditions were related to increased ICT. knowledge and an improved attitude toward using ICT, which enabled an 'increased adaptation to virtual teaching' (2021, 14). According to Gomez-Galan et al. (2021), students are primarily interested in using ICT and the internet for social networking, collecting information, and leisure activities, in addition to their use for academic purposes. Similarly, Siddiquah et al. (2017) reported that university students, such as MS Word, MS PowerPoint, internet search and navigation, social networks, email, attachments, and computer games, have expertise in simple skills but possess poor skills regarding the use of digital libraries, forums, and blogs.

A comparison of the results of the present study with the findings of Cabero-Almenara et al. (2018) showed that neither university students' prior training in the teaching platform Moodle nor their gender predicts their acceptance of the use of Moodle. The difference between the samples from both countries is considerable, so the data could vary by increasing the Spanish sample and obtaining more homogeneous groups between countries. Simultaneously, differences between study areas or universities (public or private) have been overlooked. Future studies should increase the sample size by collecting data on students from private universities and by using a larger sample to compare the results between different study programs.

The results of this study reveal significant differences in university students' perceptions of digital literacy between Mexico and Spain. These findings align with prior research that highlights the influence of sociocultural and contextual factors on the development of digital competencies (Garrido et al., 2019; Domingo-Coscollola et al., 2020; Vuorikari et al., 2022). The data show that Mexican students report higher levels of ICT training and self-perceived mastery of various digital tools, despite greater difficulties in accessing stable internet connections. This paradox suggests that exposure to resource-constrained environments may promote a more proactive and self-regulated use of technology, as previously noted by Humanante-Ramos et al. (2019) in contexts of educational innovation and professional adaptability.

Furthermore, the findings reinforce the argument that digital literacy is not merely a technical skill but a multidimensional construct shaped by access, prior training, and cultural factors (Ovejero et al., 2021). The

differences observed between countries can be partially explained by disparities in educational and technological infrastructure, as reflected in the Global Competitiveness Report (World Economic Forum, 2019). Spain's higher technological index and educational development correspond to a more structured institutional integration of digital tools; however, Mexican students' higher self-perceived competence suggests that individual motivation and informal learning environments play a crucial role in digital literacy acquisition.

Gender differences were minimal, consistent with recent studies indicating that gender gaps in digital competence are narrowing among younger populations (Miliou & Angeli, 2022). The limited gender influence observed here, mainly related to the use of social platforms such as Pinterest and Instagram, supports the notion that digital literacy is increasingly determined by functional and contextual factors rather than demographic ones. This is particularly relevant in the framework of Education 4.0, where digital ecosystems encourage universal participation and inclusivity (García et al., 2021).

Prior ICT training emerged as a decisive variable in students' perception of digital competence. This is consistent with previous findings by Agreda et al. (2016) and Hinojo et al. (2017), who emphasized that structured technological training enhances self-efficacy and facilitates the development of higher-order digital skills. The strong positive correlations between prior ICT training and items related to information management, collaborative use of ICT, and intellectual property awareness demonstrate the importance of formal instruction for fostering comprehensive digital competence.

The integration of the DigComp framework (Vuorikari et al., 2022) helps interpret these results more systematically. Students' responses indicate relatively higher competence in the areas of communication and collaboration, but lower proficiency in information and data literacy and safety. This pattern suggests that while social and interactive uses of technology are well integrated into students' routines, critical evaluation, data protection, and problem-solving skills still require reinforcement. These gaps point to the need for universities to adopt pedagogical strategies that foster not only instrumental but also critical and ethical dimensions of digital literacy, as recommended by UNESCO's Media and Information Literacy programme (Vuorikari et al., 2016).
In the broader framework of the Sustainable Development Goals, particularly SDG 4 (quality education) and SDG 9 (industry, innovation and infrastructure), the promotion of digital literacy emerges as a key component for achieving equitable and inclusive education (UNESCO, 2017). The COVID-19 pandemic accelerated the digital transformation of higher education (Akram et al., 2021; Díaz, 2021), exposing both the potential and the weaknesses of current educational systems in ensuring access and competency in ICT. In this sense, the findings of this study contribute empirical evidence to support policy efforts aimed at enhancing digital training programs in universities, especially in developing contexts.

Ultimately, the results underline that digital literacy development cannot be reduced to technological access alone; rather, it must be understood as an educational and cultural process requiring continuous adaptation, institutional support, and pedagogical innovation. As noted by Roque et al. (2017) and Tourón et al. (2018), the integration of ICT throughout students' academic trajectories should not only equip them with technical skills but also empower them to participate critically and safely in digital environments. From a teacher education perspective, universities

must integrate digital competence frameworks into curricula to prepare educators capable of fostering digital inclusion and innovation.

Conclusion

The results obtained show that the magnitude of the correlations is much lower in the case of previous higher education than in the case of previous ICT training; thus, the influence of these correlations on the perception of ICT mastery is much lower. Considering both aspects, it is understandable that Mexican students are the ones with the highest ICT proficiency. In the context of Education 4.0, these findings suggest that, the findings indicate that a good command of ICT implies specific training. Future research should include comparisons between digital competence and academic achievement. As part of this research, we are currently analyzing the relationship between the use of digital literacy and addiction to social networks.

This study was limited in its analysis of sociocultural contexts due to the context of the COVID-19 pandemic. This context was very specific and exceptional, which implies that the results obtained may be strongly influenced by the circumstances of that moment. As a result, it would be pertinent to consider other factors that are associated with digital literacy, such as the methodology used by each university. Due to a lack of adequate information, the management of the pandemic at different institutions could not be included.

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