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Research Article

Demographic and school factors associated with digital competences in higher education students

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ABSTRACT

Nowadays, digital competencies encompass skills and attitudes with technical, informational, content, media, and communication aspects that are crucial for students and future professionals. Hence, there is a need to investigate the possible correlations between demographic and contextual variables and the development of digital competencies in higher education. This paper reports on several university-student demographic factors associated with digital competencies. The work used a quantitative approach with descriptive statistical techniques such as a means test and Pearson correlation analysis. The findings identified that (a) there are statistically significant differences between the mean obtained in the previous semester in digital competencies and the gender of the students, (b) there are no statistically significant differences in the final mean for digital competencies and the students' institution of origin, and (c) the variables included in the study are statistically significant. They also found that the mean attained by the university students in the previous semester had a strong predictive power of student performance; in contrast, the student's high school institution of origin variable was a weak predictor of their digital competency. This paper presents the findings and implications for practice and research.

Keywords: digital competencies, higher education, educational innovation, demographic factors, school factors, educational technology

INTRODUCTION

The accelerated growth of technology has impulse what is now known as the digital revolution, impacting all types of organizations and forcing them to transform their processes and operations (Falcó, 2019; López-Gracia et al., 2022; Uriarte & Acevedo, 2018). Expectantly, the digital revolution should increase the economy and the quality of people's lives; however, there is also a risk of job loss due to the obsolescence of people's knowledge and skills, bringing new challenges to human capital formation.

The digital revolution in education has penetrated slower than in the industrial sector. For higher education institutions, it has transformed the university paradigm from the 3.0 stage to 4.0. According to Dewar (2017), this change implies that universities should focus their processes on applying technology like in other sectors. However, digital transformation not only affects the internal and external use of technology in organizations but also requires broad structural and organizational changes such as the elimination of barriers between content delivery formats (face-to-face, online, and hybrid), implementation of essential

information services, and the creation of a digital university management service (Safiullin & Akhmetshin, 2019). These changes force higher education institutions to implement technological tools in their practices and advance their vision of the future digital world.

Universities' digital transformation has caused different resistances to change; achieving a profound transformation requires the collaboration of digital leaders from various organizations. These leaders are the agents who lead the management to achieve the required changes. A leader must have skills to integrate, propose innovative ideas and help others involved understand the magnitude of the changes (Škare & Porada-Rochon, 2021; Ruel et al., 2021). This requires a series of stages to achieve permanent change.

Achieving digital transformation in universities is a process that generates resistance both internally and externally. Regarding this, Llorens and Fernandez (2018) describe the five stages of maturation that institutions undergo to establish a new technological process. The first stage, digital resistance, is when the organization is not clear about its objectives and structure; there are individual efforts, but at the collective level, there is no understanding of the benefits that can be obtained.

In the second stage, institutions begin to have transformation initiatives that have been successful in the past and take them up again on an ad hoc basis. In the third stage, their medium-term objectives include digital initiatives, although the focus is not on transformation. In the fourth stage, the digital transformation efforts are accepted and incorporated into daily practice by the institution's members, and the outside world begins to recognize the potential for differentiation from the competition. Finally, in the fifth stage, the institution has potential in the market through disruptive technologies and new business models and even serves as a driver of change for other institutions in the initial stages of digital maturity.

The need for universities to move towards digital transformation also implies a change in institutional philosophy regarding the type of student they are training for today's society, which presents specific demands to address.

The digital transformation has significantly impacted educational processes, where, although a range of possibilities has opened, institutions must train citizens to be capable of inhabiting the digital society. Consequently, universities have integrated into their curricula the development of identified 21st century competencies necessary for this new society (Dede, 2010; United Nations Educational Scientific and Cultural Organization [UNESCO] 2017). In this learning series, citizens must be able to use information and communication technologies (ICT) critically and responsibly (Meshcheryakova et al., 2020). Therefore, digital competencies have acquired tremendous relevance in the curricula at various educational levels.

The definition of digital competency is complex because it is often used indiscriminately with other similar concepts, such as digital literacy. Digital competencies involve skills and attitudes encompassing technical, informational, content, media, communication and ethical and strategic decision-making for problem-solving (Díaz-Arce & Loyola-Illescas, 2021). According to different authors, digital competencies cannot be reduced only to the ability to use ICTs but also imply the acquisition of a critical and ethical stance in using technologies (Cabero-Almenara & Palacios-Rodríguez, 2020; Sánchez-Caballé et al., 2020; Spante et al., 2018) for social inclusion, active and conscious civic participation, and intelligent, competitive and sustainable growth of today's society (Lucas, 2019).

Digital skills training should be a priority issue for education systems for a significant contribution to the knowledge society. Digital skills training should include both teachers and students (Ascencio et al., 2019; Ben Youssef et al., 2022; Rodríguez-Hoyos et al., 2021; Rubach & Lazarides, 2021), incorporating five skill areas: information and data literacy; communication and collaboration; digital content creation; digital security; and problem-solving (González-Calatayud et al., 2018; Jiménez-Hernández et al., 2021).

Research on digital competencies has increased in recent years (Fernández-Batanero et al., 2022; Pettersson, 2018; Sánchez-Caballé et al., 2020; Zhao et al., 2021), particularly on factors associated with teachers' competency achievements (Cabero-Almenara et al., 2022; Cattaneo et al., 2022; George-Reyes & Glasserman-Morales, 2022; Hinojo-Lucena et al., 2019; Lucas et al., 2021). Research focused on university students has received less attention.

Research on students' digital competencies has examined personal, school and family factors. The relationship between personal factors and the achievement or acquisition of digital competency has received

the most attention in the literature, analyzing aspects such as gender, age, and socioeconomic status (He & Zhu, 2017; Silva-Quiroz & Morales-Morgado, 2022; Valdez-Asto et al., 2021; Zhao et al., 2021), and psychological variables such as attitude or willingness to learn through digital technology (Cabezas-González et al., 2022; Hatlevik et al., 2015; He & Zhu, 2017; Scheel et al., 2022).

To a lesser extent, aspects of the school context and the family have been found to influence the development of digital competencies in university students. Existing studies focus mainly on academic performance, the educational institution of origin, the academic level of the parents and the activities they perform at home (Cabero-Almenara & Palacios-Rodríguez, 2020; Cabezas-González et al., 2022; Hatlevik et al., 2015; Valdez-Asto et al., 2021). The evidence shows that the parents' academic performance and level positively affect digital competency, although the student's school origin has no effect.

The present study aims to report on university-student demographic and school factors and the correlation with their digital competencies. It addresses aspects of the individual and the school context. Although some studies explain how these factors are related to digital competency, more are needed to clarify the influence of these factors on digital competency in university students. Therefore, this paper analyses whether there are statistically significant differences in means compared to the previous semester and the final average in digital competency, also considering gender.

Similarly, the work analyzed whether there were differences in means between the final average in digital competency and the students' institutions of origin and, finally, the correlations between the variables for digital competency, including institution of origin, student status, average in the previous semester, type of subject under the educational model, delivery modality of the subject, and the course duration. The study was conducted in a private non-profit higher education institution in Mexico.

METHOD & MATERIALS

The methodology was a quantitative approach using a means test and Pearson's correlation based on Boslaugh (2012) proposal.

Data Collection

The data used in this study came from the Data Hub-Living Lab, Institute for the Future of Education at Tecnologico de Monterrey, which is the data repository for the academic community, students, and faculty. The dataset contained records of 508 undergraduate students from the school of humanities and education, of whom 194 (33.0%) were male and 314 (62.0%) were female. Ages ranged from 17 to 30 years (mean=18.60; standard deviation=1.08). The students came from seven different countries: Mexico (95.9%), the United States (2.4%), Ecuador (.4%), El Salvador (.6%), Spain (.4%), Costa Rica (.2%), and Honduras (.2%). **Table 1** shows the variables considered to respond to the research objectives.

Table 1. Dataset variables & definitions

Variable	Definition	Values
Gender	Gender of student	Male (1) & female (2)
Age	Age of student	12-30 years
Academic average of previous semester	GPA obtained in previous semester	48-100
Final grade	Reflects grade obtained in evaluated competency	59-100
High school institution of origin	School, where student attended high school	Not Tecnologico de Monterrey student (non-TEC student) (0) & Tecnologico de Monterrey student (TEC student) (1)
Student's academic status	Student's current academic status	Regular student (1), conditioned student (2), & academic drop/fail (3)
Type of material (TEC 21 educational model)	Type of course that student can enroll in TEC 21 model	Academic block (1), subject (2), & Tec 21 (3)
Modality of subject	Modality in which subject was delivered	Project (1), theoretical (2), & TEC week (practical) (3)
Duration of subject	Duration of course in weeks	5 weeks (1), 10 weeks (2), & 15 weeks (3)

Data Analysis

The data analysis comprised descriptive statistical methods, mean comparisons, correlations, and logistic regression analysis. First, the normal distribution of the data was analyzed. Subsequently, tests of mean comparisons between the variables of analysis were performed, and the effect size of the tests was also calculated to avoid incurring type 1 errors since values equal to or less than 0.2 suggest a weak effect size (Cohen, 1998). Subsequently, for the linear regression analysis, a correlation analysis was performed between the variables to avoid multicollinearity that would affect the regression analysis. For the regression analysis, the significance of the variables included in the model and the adjusted R2 were evaluated; the closer to 0.1, the better the model's explanation of the variance.

RESULTS

Average in Digital Competency & Gender

A test of differences of means determined if there were statistically significant differences between the average attained in the previous semester and the final semester, considering the digital competency and gender of the students. The results indicated statistically significant differences, with females attaining a higher digital competency mean than males in both the previous semester and the final average (**Table 2**).

Table 2. Comparison of means attained in previous semester in digital competency by gender of participants

	Male		Female		*t*	Cohen's *d*
	Mean	Standard deviation	Mean	Standard deviation		
Academic average in previous semester	90.2	7.2	92.6	5.3	-4.34	.18
Final grade point average in digital competency	89.5	11.7	93.3	8.7	-4.77	.20

Institution of Origin & Mean in Digital Citizenship Competency

To verify if there were statistically significant differences between the students' final digital competency average attained in the semester and their high school institutions of origin, we analyzed the means using the tests, which affirmed that there were no statistically significant differences (**Table 3**).

Table 3. Comparison of final means attained in digital competency & students' institution of origin

	TEC student		Non-TEC student		*t*	Cohen's *d*
	Mean	Standard deviation	Mean	Standard deviation		
Final grade point average in digital competency	91.7	8.6	91.5	12.2	0.22	.00

School Demographic Factors & Digital Competency

A Pearson correlation test analyzed the variables of interest in the study, where statistically significant relationships of moderate-to-strong intensity were found. The student's institution of origin variable negatively correlated with digital competency development, while the subject type and delivery modality were statistically significant (**Table 4**).

Table 4. Pearson's correlations among study variables

Variables	Digital competency	Student's institution of origin	Type of subject TEC 21 model	Modality of subject
Digital competency	-			
Student's institution of origin	.394**	-		
Type of subject TEC 21 model	.222**	-.169**	-	
Modality of subject	.217**	-.166**	.959**	-

School Demographic Factors Predictive of Digital Competency

A multiple linear regression was performed to determine the predictor variables of digital competency achievement in college students. The results show that the variables included in the study are statistically significant. The finding was that the mean attained in the previous semester had a strong predictive power; conversely, the student's institution of origin was a weak predictor of competency achievement. The model integrated by the studied variables explained 60.0% of the variance (**Table 5**).

Table 5. Multiple linear regression between study variables

	B	ES B	β	t	p-value
Student's institution of origin	-2.23	0.76	-.11	-2.91	.004
Student status	-19.30	.26	-.16	-4.69	.000
Average in previous semester	1.09	.06	-.63	17.30	.000
Type of TEC 21 material	10.90	.81	.38	3.89	.000
Modality of subject	-0.66	.13	-.20	-5.06	.000
Duration of course	0.59	.32	.18	1.85	.064

DISCUSSION

Digital competencies represent one of the leading 21st century competencies of significant relevance for society, particularly for higher education students worldwide. This study analyzed whether there were statistically significant differences in means between the average in the previous semester and the final average in digital competency, also considering gender. The results showed that female students had a higher GPA in digital competency than male peers. Our findings differed from other studies, where females had lower digital competencies than males (Ahmad et al., 2019; Kamberidou et al., 2019; Perifanou & Economides, 2020). These discrepancies in the findings with the existing literature show that it is necessary to continue analyzing gender differences and digital competency; however, our results reflect that woman obtained and maintained a higher GPA than men in digital competency. This implies that female students developed greater awareness and responsibility about information and data access, had better collaboration and effective communication in networks, and were more accustomed to generating content for digital networks, implying good skills to maintain their digital security.

Also, as part of the objectives, the correlation between school contextual variables such as the student's institution of origin and the type and modality of the subject studied vis a vis digital competency was analyzed. The study found that the students' high school institutions of origin, the type of subject, and the modality in which the subject was taught correlated with their digital competency. The results aligned with those reported in the literature, which indicate that socioeconomic factors, social and cultural capital, and pedagogical strategies using Internet technology help students improve their academic performance and acquire competencies for their professional development.

Finally, grades or marks have been the standard in formal education to measure learning in different academic programs worldwide. In this study, the linear regression found that the average students attained in the previous semester was a strong predictor of digital competency, showing the value or importance of the students' school trajectories to predict their success in developing competencies. According to González-Calatayud et al. (2018) and Jiménez-Hernández et al. (2021), digital competencies develop in five dimensions:

(a) information and data literacy;

(b) communication and collaboration,

(c) digital content creation,

(d) digital security, and

(e) problem-solving, and there are different ways to validate development or appropriation of such competency.

Therefore, it is essential to analyze other variables of the students' school trajectory to determine their success in developing the competencies aligned with the objectives of the educational model. The value of these findings lies in the possibility of making decisions for students' potential success.

Limitations

The results from analyzing historical data of university students indicate that the data treatment allows us to find correlations between students' demographic and contextual variables for better understanding.

A study limitation was the availability of information from student records, which in this case was provided by the Data Hub-Living Lab, who agreed to respond.

Recommendations for Future Studies

Future lines of research could include data analysis with other methodological approaches, such as mixed studies, so that, once quantitative data have been obtained, qualitative approaches can provide a better understanding of the phenomena and units of analysis. The results of this study must be viewed with caution because they involve a sample of university students from an educational institution in Mexico with a very particular educational model, which does not reflect the standard of educational models in the country or the region. Finally, future research could consider other factors influencing students' digital competencies, such as access to technology, previous training in digital tools, and other possible determinants not addressed in this study.

CONCLUSIONS

Concerning determining the correlation of university student demographic factors with their digital competencies, our study identified statistically significant differences between the grade average obtained in a previous academic semester in digital competency and the students' gender. Likewise, it found no statistically significant differences in the final average of digital competency and the student's institution of origin and that the variables included in the study are statistically significant. Finally, it found that the average attained in the student's previous semester in the institution had a strong predictive power, while the student's high school of origin was a weak predictor of digital competency achievement.

Author contributions: LDG-M: writing & supervision of methodology; **CA-N:** methodology & data analysis; & **MIS:** conclusions & writing supervision. All authors approved the final version of the article.

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Ethics declaration: The authors declared that the study did not require approval from an ethics committee since data from participants was provided from the Data Hub of Tecnologico de Monterrey. This implies that students gave their consent to use their anonymous data for further analysis as it is stated in the Data Hub Privacy Policy: https://ifelldh.tec.mx/en/datahub.

Declaration of interest: The authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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