Gender Digital Divide: The Complexity of Digital Media Literacy Among High School Students With Professional Technical Training in Mexico

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Abstract
Nowadays, society faces a new era of digitization and virtualization due to the Fourth Industrial Revolution. This era has influenced all the complex aspects of human life. Therefore, it is vital to promote the digital media literacy of students in all educational levels, but it is needed in high school as a step before higher education. On the other hand, the digital gender divide represents a digital fracture that causes a lower representation of women in the digital world and access to STEM careers, even affecting female students' learning due to factors such as technophobia or stereotypes associated with feminine and masculine roles. This study presents the perception of the complex level of digital media literacy of 124 students (men=73, women=44, and non-binary students=7) in a high school center with technical professional training in computer science in Mexico. The data collection employed an instrument that measured three dimensions of digital media literacy based on gender. The sample considered just male participants in all groups, highlighting a gender gap in technical and professional education. However, men had a lower level in all three dimensions: Access to Digital Information (ADI) (M=3.05), Interpretation of Digital Information (IDI) (M=3.05), and Production and Socialization of Digital Communication (PSDC) (M=3.02) compared to women (ADI: M=3.10; IDI: M=3.10; PSDC: M=3.21). Although the results indicate differences in media literacy among high school students with professional technical training, the interaction between men and women is highly similar.

Keywords: Gender Gap, Gender Digital Divide, Digital Media Literacy, Technical Professional Training, High School

Introduction

It is becoming increasingly apparent that Industry 4.0, also known as the fourth industrial revolution or 4IR, is impacting many aspects of people's lives nowadays (Muñoz et al., 2021). This involves incorporating advanced technologies into production processes to enhance efficiency, flexibility, and customization in product manufacturing (Rozo, 2020).

Industry 4.0 relies on digitalization, connecting objects and systems in production, automating processes, and utilizing advanced technologies to enhance production efficiency and quality (Cañas et al., 2021). This has opened up new opportunities and presents challenges regarding employment and skill requirements (Guillén et al., 2016). In order to keep up with Industry 4.0, it is necessary to have highly skilled professionals who can manage and utilize advanced technologies such as Artificial Intelligence, the Internet of Things, robotics, automation, Big Data analysis, and cybersecurity (Basco et al., 2018).

According to the United Nations (UN) (2022), the ongoing technological revolution can bring notable economic and social advantages but also presents significant challenges. As a result, the importance of digital literacy and skill development is highlighted, along with the need to create a favorable environment for innovation and entrepreneurship (UN, 2022).

In order to prepare individuals for the demands of Industry 4.0, it is crucial to possess optimal digital literacy skills (Sánchez, 2019). The abilities to utilize digital technologies effectively and adapt to the rapid changes in the job market are essential (Rosalina et al., 2021). The Inter-American Development Bank (BID) (2021) supports the idea that countries, including Mexico, must promote the education and training of professionals specialized in these technologies to harness the benefits of Industry 4.0. Therefore, digital literacy plays a fundamental role in the education of future professionals, who must acquire digital and technological skills to adapt to the constantly changing demands of the business environment (Coldwell & Cooper, 2019).

There are multiple definitions of digital literacy, and it constantly adapts to suit the demands of society and the digital landscape (Martínez et al., 2021). The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2018) offers digital literacy's most widely accepted definition. It refers to the capacity to securely and appropriately access, manage, understand, integrate, communicate, evaluate, and create information using technology for work and entrepreneurship. On the other hand, Martínez et al. (2021) and Sandoval (2021) describe digital literacy as the process of acquiring knowledge and developing the ability to properly employ technologies in the digital world in order to facilitate people's participation in work, educational, and citizen ecosystems increasingly mediated by the use of electronic systems.

For instance, Kipper et al. (2021) emphasize the importance of media and information literacy as a crucial aspect of digital literacy for Industry 4.0. This includes the ability of workers to locate, manage, analyze, and assess media and information using critical thinking skills, as well as making informed decisions to engage with ICT. Media literacy is a vital component of professional training in the era of Industry 4.0 and contributes to developing other essential competencies in this field (Jalik, 2018). Ozdamar et al. (2015) define media literacy as the capacity to communicate and collaborate effectively using digital media, consisting of three dimensions: access to digital information (ADI), interpretation of digital information (IDI), and production and socialization of digital communication (PSDC).

According to UNESCO (2021), Technical and Vocational Education and Training (TVET) should prepare students with the necessary skills and competencies to enter the labor market and enhance their employability. Education, consequently, can play a significant role in promoting digital literacy and facilitating the growth of Industry 4.0 (Raman et al., 2019). TVET is thus regarded as a practical means of expanding access to education and learning opportunities and promoting social equity and inclusion in society (Muñoz, 2019).

TVET enrollment is divided between women and men in Latin American countries at 50.2% and 49.8%, respectively (UIS, 2018). Although women have greater access to TVET, they can still experience limitations and obstacles in their educational and professional process, including within TVET (Muñoz, 2019). Although policies and programs have been implemented to encourage women's involvement in technical and professional fields in Latin American countries such as Argentina, Brazil, Chile, Cuba, Peru, and Uruguay (UNESCO, 2022), gender-based career aspirations persist because of a complex mix of individual decisions, societal attitudes, and institutional structures that sustain social and work-related inequalities between men and women (Bloj, 2017; Sepúlveda, 2017). In this sense, gender segregation in technical and vocational education has been little studied and is still a potential source of social inequity (Sevilla et al., 2019).

Gender Gap

The gender gap refers to the situation in which women have fewer opportunities than men to develop equally in different areas (Davies, 2011). In the educational field, the gender gap has been observed for several decades, and differences in performance and learning styles between female and male students have been identified (Vantieghem et al., 2014). This phenomenon persists today due to traditional attitudes about gender roles transmitted by religion, parental education, and culture (Rivera, 2022). It limits women's progress and participation (Marchionni et al., 2018).

These days, multiple gender gaps restrict women in various spheres, such as education, work, society, or the digital world (Olarte, 2017). In the digital world, for example, the digital divide more profoundly restricts women than men due to gender roles and stereotypes established by society (Acosta et al., 2020).

The Gender Digital Divide

The Gender Digital Divide (GDD) reflects a digital inequality faced by women in accessing, using, and benefiting from Information and Communication Technologies (ICT) due to their societal role and social expectations regarding male and female use of ICT (Berrío et al., 2017; de Andrés et al., 2020). This gap is seen in different forms, such as ease of access to the Internet, possession of technological devices, training in digital skills, participation in technology-related fields, and equitable representation in the technology industry (Banerjee, 2019). This phenomenon can be magnified or diminished depending on nationality, social class, race, access to education, qualifications, age, and social position of women, who may face barriers or inequalities in accessing, using, and benefiting from ICT compared to men (de Andrés et al., 2020).

Additionally, the GDD is represented by the lack of educational materials with a gender perspective (Pedraza, 2021; Pérez et al., 2021; Wong & Kemp, 2018), the disinterest of girls and young women in the digital world (Yu, 2018), and the false identification of male-

dominated spaces such as computer labs (Gorlach & Agic, 2019). The GDD is also related to the absence of professional vocations in technology and engineering (Liu et al., 2022) due to exclusionary and self-exclusionary factors that limit women's interaction with technology, such as a pessimistic perception and technophobia (Rodríguez & Jiménez, 2020).

Several studies have highlighted the main differences and inequalities of the GDD in the educational field (Alozie & Akpan, 2017; Balay & Singhal, 2018; Bikos et al., 2018). In this regard, it is essential to identify the level of digital literacy among men and women in the current generations since limited research has measured the GDD. For example, a study compared differences in access, use, and ability to use ICT between male and female university students and showed a significant gender gap in ICT usage skills, with male students being more competent in software downloading and installation (Saha & Zaman, 2017). Another study demonstrated that men had better technology skills than women in higher education institutions in Mexico (Domínguez et al., 2020).

This phenomenon requires constant attention at all educational levels, as it was recognized in previous studies. It should include Technical and Vocational Education and Training (TVET), as it is an essential pillar for equity and can contribute to achieving the 5th Sustainable Development Goal (SDG) that aims for gender equality (UNESCO, 2022). Additionally, TVET has the potential to build a more inclusive society that balances the sustainable growth of men and women and the productive development of society (Rucci et al., 2015). Therefore, this study recognizes the importance of analyzing the complex media literacy level among TVET students and identifying if there are significant differences between male and female students. It is important to underline that this study is a component of a broader research endeavor focused on examining the progression of communicative literacy within Education 4.0.

Methodology

The research follows a descriptive and exploratory design with a quantitative approach (Creswell & Creswell, 2017) to collect data through a questionnaire measuring media literacy among students in TVET. The study aimed to analyze the complex level of media literacy among TVET students and identify if there are significant differences between male and female students.

To identify the level of media literacy among students, the three dimensions established by Ozdamar et al. (2015) were considered: a) Access to Digital Information (ADI), b) Interpretation of Digital Information (IDI), and c) Production and Socialization of Digital Communication (PSDC). The instrument used in the study was an adaptation of the instrument *e-complexity* (Vázquez et al., 2022). It consists of 18 items to evaluate the three dimensions, which was assessed through Cronbach's Alpha (p=.917), indicating a high internal consistency in the instrument's items and an acceptable internal consistency in each dimension: ADI (α=.820), IDI (α=.849), and PSDC (α=.735), (Viladrich et al., 2017).

Regarding the population, the sample consisted of students from the computer science technical program at a public TVET institution in the southern zone of Mexico City, Mexico during the August-December 2022 semester. An intentional and convenience sampling approach was used to select the participants, considering their availability and accessibility within the institutional context. Student participation was voluntary, and informed consent was obtained before including them in the study. Additionally, consent was obtained from the

participant's parents or legal guardians, as they were minors. The school also provided documented consent, ensuring that all parties involved were adequately informed and agreed to the study conducted in the school environment.

Results

The results of the study are described in two phases: a) descriptive analysis and b) inferential analysis. In the descriptive analysis, it was observed that the study population consisted of 124 participants, predominantly males (n=73, 58.9%), followed by females (n=44, 35.5%), and non-binary students (n=7, 5.6%). The age ranges were from 15 years (n=22, 17.7%) to 21 years (n=2, 1.6%), with a mode of 16 years among the participants (38.7%). The population was mainly in the third semester (n=57, 46%), (see Table 1).

		N	%
Gender	Male	73	58.9%
	Female	44	35.5%
	Non-binary	7	5.6%
Age	15	22	17.7%
	16	48	38.7%
	17	46	37.7%
	18	6	4.8%
	21	2	1.6%
Semester	First semester	24	19.4%
	Third semester	57	46%
	Fifth semester	43	34.7%
Total of participants		124	100%

Table 1: Study population by gender, age, and semester

The descriptive analysis of each dimension of media literacy shows differences between males and females in TVET. In terms of Access to Digital Information (ADI), it was recognized that males (*M*=3.21, *SD*=0.577) exhibit a lower level in this dimension compared to females (*M*=3.31, *SD*=0.569). When examining the different items that compose the ADI dimension, some interesting variations were found between males and females, as items 2, 3, and 6 show a higher level from female students. However, male students perceive themselves to have a better level in items 4 and 5. It is important to recognize that the most significant difference was found in item 1 regarding access to different digital media to obtain the same information. On the other hand, it is essential to mention that non-binary students perceive themselves to have a lower level than males and females in ADI (*M*=2.95, *SD*=0.458), (see Table 2).

Items of Access to Digital Information (ADI)	Gender					
	Male		Female		Non-binary	
	M	*SD*	*M*	*SD*	*M*	*SD*
Average of dimension (ADI)	3.21	0.577	3.31	0.569	2.95	0.458
Item 1. I access different digital media to learn about the same information.	3.08	0.812	3.55	0.663	2.86	0.378
Item 2. I use search strategies to find updated information (last week/month/year).	3.14	0.694	3.20	0.668	3.14	0.690
Item 3. I protect the information stored in my digital devices with biometric passwords.	3.32	0.780	3.41	0.871	2.71	1.113
Item 4. I use information search strategies based on logical operators.	3.01	0.858	2.93	0.789	3.00	0.577
Item 5. I recover and store information in digital media like Google Drive, Dropbox, Box, etc.	3.23	0.874	3.18	0.922	2.86	0.690
Item 6. I protect my personal digital information using secure passwords.	3.52	0.709	3.64	0.650	3.14	1.069

Table 2: Descriptive Statistics of Access to Digital Information (ADI)

The Interpretation of Digital Information (IDI) results show similar levels among the three groups. Male students got lower level (*M*=3.05, *SD*=0.620) than female students (*M*=3.10, *SD*=0.616), and non-binary students (*M*=3.11, *SD*=0.427). Analyzing each item that composes the IDI dimension showed that males obtained a slightly lower level (*M*=3.00, *SD*=0.782) than females (*M*=3.14, *SD*=0.702) in item 7 that is related to judging a piece of information and contrast it with different sources. However, item 10 shows that males can use tools to validate information (*M*=3.05, *SD*=0.848) better than females (*M*=2.91, *SD*=0.910). It is important to recognize that the better level in this dimension was for non-binary students (*M*=3.11, *SD*=0.427), (see Table 3).

Items of Interpretation of Digital Information (IDI)	Gender					
	Male		Female		Non-binary	
	M	SD	M	SD	M	SD
Average of the dimension (IDI)	3.05	0.620	3.10	0.616	3.11	0.427
Item 7. To judge a piece of information, I contrast it with different sources.	3.00	0.782	3.14	0.702	2.71	0.756
Item 8. I know how to estimate the credibility of information by differentiating between that which comes from reliable media and that which comes from unverified media.	3.08	0.777	3.20	0.795	3.43	0.535
Item 9. Before using the information, I evaluate whether it is fake news.	3.11	0.843	3.14	0.765	3.14	0.690
Item 10. I know how to use checking tools to validate the information from web pages and social networks.	3.05	0.848	2.91	0.910	3.29	0.756
Item 11. I reference an official page or a recognized author to interpret the information.	2.95	0.911	3.16	0.805	3.00	0.816
Item 12. I organize the information I recover using strategies such as shared folders, web bookmarks, local folders, social networks, etc.	3.12	0.725	3.11	0.813	3.14	0.690

Table 3: Descriptive Statistics of Interpretation of Digital Information (IDI)

Finally, it was observed that females had a higher level in the dimension of Production and Socialization of Digital Communication (PSDC) (*M*=3.21, *SD*=0.537) than males (*M*=3.02, *SD*=0.587) and non-binary students (*M*=3.09, *SD*=0.302). It is important to highlight that females show a superior level in two items. First, females consider themselves better (*M*=3.36, *SD*=0. 892) at sharing information using various means than males (*M*=3.10, *SD*=0.900) in item 13. Another item that shows advantages for females over males is item 16, which focuses on identifying recipients before sending, where males had a median of 3.05 (*SD*=0.832), while females had a median of 3.41 (*SD*=0.583). It should be considered that non-binary students had the lowest average in item 16 (*M*=3.00, *SD*=0.816), (see Table 4).

Items of Production and Socialization of Digital Communication (PSDC)	Gender					
	Male		Female		Non-binary	
	M	*SD*	*M*	*SD*	*M*	*SD*
Average of the dimension (PSDC)	3.02	0.587	3.21	0.537	3.09	0.302
Item 13. I have shared information using various media such as web pages, social networks, videos, podcasts, etc.	3.10	0.900	3.36	0.892	2.86	0.690
Item 14. The information I share respects the rules of digital citizenship, such as equity, ethics, objectivity, non-discrimination, etc.	2.96	0.841	3.18	1.040	3.14	0.378
Item 15. I cite the sources from which I obtain information when producing and socializing digital content.	3.07	0.855	2.91	0.960	3.00	0.816
Item 16. Before sharing digital information, I identify the recipients.	3.05	0.832	3.41	0.583	3.00	0.816
Item 17. I use design strategies and techniques to elaborate digital information.	3.04	0.824	3.23	0.831	3.43	0.535
Item 18. I have built a digital identity to socialize the digital information I share.	2.93	0.855	3.18	0.896	3.14	0.690

Table 4: Descriptive Statistics of Production and Socialization of Digital Communication (PSDC)

A Mann-Whitney U test for independent samples was conducted to identify if these differences were significant between men and women in the sample. However, the obtained p-value shows that the differences were not statistically significant in the three dimensions: a) Access to Digital Information (ADI) (z = -1.275, p = .202), b) Interpretation of Digital Information (IDI) (z = -.311, p = .756), and c) Production and Socialization of Digital Communication (PSDC) (z = -1.727, p = .084). After analyzing the previous results, it has been observed that there are variations in media literacy levels between genders in technical and professional education (TVET), although these results may not be statistically significant. It is crucial to acknowledge that these findings are based on a particular sample, and the conclusions may differ in different educational and cultural settings.

Discussion

The results revealed gender differences in the three dimensions of media literacy analyzed. Although men had a higher average in specific items, it is acknowledged that women displayed a superior level across all dimensions: ADI, IDI, and PSDC. Based on these findings, it is likely that public policies and programs promoting equity in Latin American countries, as described by UNESCO (2022), are yielding effects among the current generations of technical and professional students and that future generations of technical professionals will have a similar level of digital literacy. This suggests that there may not be a gender digital divide regarding digital literacy, as described by Domínguez Castillo et al. (2020).

Despite female students in TVET demonstrating higher levels of media literacy across all dimensions, it is crucial to emphasize a specific dimension. Women exhibited a higher level in the dimension of Production and Socialization of Digital Communication (PSDC)

(M=3.21, SD=0.537) compared to men (M=3.02, SD=0.587). At this point, it is relevant to highlight that this population of technical students showed increased engagement in the digital world, a skill essential for future professionals in Industry 4.0, as women need to actively participate in digital ecosystems for digital literacy in the current era (Sandoval, 2021). Moreover, these results might suggest that female students in technical and professional environments could perceive a better environment in their digital ecosystems. Consequently, various digital scenarios for women could be proposed since, as de Andrés et al. (2020) mentioned, the gender digital divide may either be exacerbated or diminished depending on each woman's specific environment.

It is essential to mention that the results obtained in this study may not apply to all Latin American scenarios, as gender inequalities in education are complex and involve multiple factors, including exclusion and self-exclusion, as mentioned by Rodríguez & Jiménez (2020). From this perspective, it is crucial to acknowledge that the study exhibits a lower representation of women, with only 44 female students out of the five groups that agreed to participate. This lower women representation could highlight the assumption put forth by Banerjee (2019) that women continue to be underrepresented in the technology industry.

Conclusions

In summary, the study revealed that women have a slightly higher level in the three dimensions of media literacy. Therefore, conducting a more detailed analysis of the context is suggested to identify the factors contributing to narrowing the gender digital gap in this technical-professional school. However, a higher representation of males in TVET was evident, where, despite intentional and convenience sampling, the participating groups reflected the typical situation in technical-professional schools, where women show less interest in technology-related professional vocations, as indicated by Liu et al. (2022).

From this perspective, it is relevant to implement actions that promote women's participation in technical and professional areas, as advocated in several Latin American countries (UNESCO, 2022), to close the gender gap and foster equity and access for women in technical-professional schools (Sevilla et al., 2019). Therefore, providing equal opportunities and empowering women to face the challenges of the digital world and build a successful future is crucial, as only through access to these spaces can the gender digital divide be reduced. This approach is supported by Sepulveda (2017), who recognizes that the education system perpetuates gender stereotypes in career choices; therefore, it is necessary to promote public policies that support reducing the gender gap.

Finally, it is essential to consider some limitations of this study when interpreting the results. Firstly, the sample was limited to TVET students in a specific institution in Mexico City, which limits the generalization of the findings to other populations and educational contexts. Additionally, the sample was predominantly composed of men, which may bias the results and not fully reflect the reality of women in TVET. Furthermore, a quantitative approach was used, which may have limited a deeper understanding of participants' experiences and perceptions.

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