International Journal of Virtual and Personal Learning Environments
Volume 13 • Issue 1

Identifying the Cognitive and Digital Gap in Educational Institutions Using a Technology Characterization Software

Alexandra María Silva Monsalve, Universidad Santo Tomás, Colombia*
Duvan Andrés Garzón Garzón, Universidad Santo Tomás, Colombia

ABSTRACT

This research aims to identify the existing technological and cognitive gaps in educational institutions through the implementation of characterization software. To meet this objective, the study establishes a framework of digital competencies to validate the level of performance using the input of educational community members, which allows for establishing a diagnosis regarding the use and appropriation of technological resources. The study utilized an applied research methodology based on a validation approach using the technological acceptance method. The findings reveal educational institutions' lack of knowledge in identifying and appropriating technological resources. The research concludes that recognizing technology and technological resources can lead to the improvement of educational processes. It also provides a framework for researchers to present proposals that allow them to recognize technology's mediating role in the teaching-learning process.

KEYWORDS

Attitudinal, Axiological, Cognitive, Digital Gap, Instrumental, Software

INTRODUCTION

This article presents the aspects giving rise to the problem of limited access to technology in remote areas, which gave rise to the present investigation. The research aimed to address these difficulties through technological mediation. Therefore, the following question shaped the scope and approach to the research: In what way can technology contribute to the improvement of digital connectivity and be a facilitating medium in the teaching and learning process?

The paper also presents the literature supporting the study. These reports show the digital divide in Latin America regarding access to digital connectivity, use of platforms, and infrastructure. Several aspects of this divide became more evident with the emergence of the COVID-19 pandemic, as discussed below.

The so-called digital transformation—a consequence of the fourth industrial revolution—has integrated various disciplines, such as machine learning, artificial intelligence, nanotechnology,

DOI: 10.4018/IJVPLE.330130
*Corresponding Author

quantum computing, biotechnology, 3D printing, the Internet of Things, and autonomous vehicles (Florez et al., 2019). Despite this extensive technological development, the absence of digital connectivity in the 21st century is still evident in some regions of the world (Compaine, 2001). According to the internet connectivity map, approximately 60% of the world's population enjoys a digital connection. Regions such as North America, Western Europe, China, and some areas of South America have the greatest access, while Africa and Asia have the least access to the network (El Orden Mundial, 2021). However, studies by the Economic Commission for Latin America and the Caribbean (ECLAC) show that in Latin America, only 66.7% of the population has internet access (ECLAC, 2020). Similarly, the 2019 Latin American Telecommunications Congress (CLT19) revealed that despite technological advances in recent years, the internet has not reached everyone. Table 1 shows internet coverage in Latin America expressed in usage numbers and penetration levels.

During the COVID-19 pandemic, governments adopted mandatory quarantines to prevent the transmission of the virus, forcing educational institutions to adjust their training processes and use digital models. This situation revealed the digital divide, that is, the differences in connectivity between those who can widely access information and communications technology (ICT) and those with limited access (Compaine, 2001). One of the consequences of this phenomenon, particularly in Latin America, involved students dropping out of school due to their lack of connectivity and the appropriate technological tools.

Although governments have advanced various actions and strategies to mitigate this situation, many users still face an abysmal gap in accessing technology and connectivity. Herein lies the relevance of this project, which is oriented, first, toward proposing tools and strategies to estimate the technological resources possessed by educational institutions and, second, in allowing these institutions to join efforts to obtain new resources to strengthen their technological infrastructure.

Table 1. Internet coverage in Latin America

South America	Population	% Pop.	Internet Usage	% Population	% Users
	(2022 Est.)	Table	June 2022	(Penetration)	Table
Argentina	**45,873,172**	10.5%	**41,800,000**	91.1%	11.3%
Bolivia	**11,935,560**	2.7%	**8,817,749**	73.9%	2.4%
Brazil	**215,016,658**	49.2%	**178,100,000**	82.8%	48.3%
Chile	**19,383,887**	4.4%	**18,835,100**	97.2%	5.1%
Colombia	**51,771,495**	11.8%	**43,091,700**	83.2%	11.7%
Ecuador	**18,086,232**	4.1%	**15,618,700**	86.4%	4.2%
Falkland Islands	**3,653**	0.0%	**3,6**	98.5%	0.0%
French Guiana	**311,788**	0.1%	**162,8**	52.2%	0.0%
Guyana	**792,695**	0.2%	**574,5**	72.5%	0.2%
Paraguay	**7,276,583**	1.7%	**6,177,748**	84.9%	1.7%
Peru	**33,729,630**	7.7%	**29,359,300**	87.0%	8.0%
Suriname	**595,213**	0.1%	**428,2**	71.9%	0.1%
Uruguay	**3,493,160**	0.8%	**3,255,800**	93.2%	0.9%
Venezuela	**28,887,118**	6.6%	**22,735,000**	78.7%	6.2%
Total South America	**437,156,844**	**100.0%**	**368,960,197**	**84.4%**	**100.0%**

Source: Internet World Stats (2022)

Table 2 summarizes the percentage of existing internet-related tools in educational institutions in Latin America and the Caribbean, including online applications for educational use, access to electronic devices for educational tasks, and educational software as a tool for teaching and learning processes.

According to the data in Table 2, educational institutions must first recognize their technological capabilities and then identify the actions and strategies they must implement to mitigate the absence of these resources. Incorporating technologies that can mediate or replace face-to-face attendance, made impossible by isolation due to the pandemic, is crucial. However, it is also necessary to recognize the educational institutions' existing technological capacity and to establish measures that allow widespread internet access with the support of government entities and the educational community. With this context in mind, this research aimed to characterize institutions' technological infrastructure versus installed capacity. The following objectives were proposed to fulfill this general goal: determine the relationship between the installed capacity and the number of students and build the technological characterization software.

This project's innovative component involves establishing educational institutions' installed capacity of their technological infrastructure versus their student population. Additionally, it allows students and teachers to identify their perception and critical use of technology and its implementation in the classroom. In this sense, in countries with limited internet connection, the isolation of COVID-19 generated disadvantages in implementing hybrid models, leading to a deterioration in learning and an increase in school dropouts. The research found that some educational institutions had technological resources but did not know how to use them. In other cases, the schools had no technological infrastructure or internet connectivity. Therefore, this research aimed to address these problems by generating a technological characterization software to compare an educational institution's installed capacity to its needs and use this information to determine future actions. The following research question was thus proposed: How can technology contribute to improving digital connectivity and be a facilitating medium in the teaching and learning process?

LITERATURE REVIEW

The literature review for the present investigation focuses on works related to methodologies, tools, and software for the assessment of the technological infrastructure of educational institutions. The results of this research are presented here.

Table 2. Overview of virtual education tools in Latin America

Country	Internet Connection	Computer	Educational Software
Brazil	91%	59%	30%
Chile	88%	82%	43%
Uruguay	87%	82%	41%
Costa Rica	83%	73%	39%
Argentina	83%	72%	33%
Dominican Republic	78%	44%	27%
Panama	68%	60%	29%
Mexico	68%	57%	28%
Colombia	67%	62%	29%
Peru	57%	53%	28%

Source: Solorzano (2020)

Manyoma et al. (2011) conducted a study to determine educational institutions' installed capacity compared to their number of students. They developed a methodology to measure the capacity of an academic unit in a training program of a higher education institution. The authors set out to determine a student's average resource consumption compared to the school's installed capacity and the relationship between these two elements. Although the study did not use software, it did propose formulas for estimating the mediation of categories (installed capacity versus number of students).

Sánchez et al. (2017) sought to determine the role of technological infrastructure concerning the digital divide and digital literacy by conducting surveys in 100 educational institutions in Bogotá, Colombia. The authors used two instruments to diagnose the institutions' technological and electrical infrastructure. Although the results indicate differences regarding technological infrastructure in different areas of the country, none stands out regarding technological development.

Torres et al. (2010) analyzed the availability of technological and computer infrastructure at Universidad Autónoma del Estado de Morelos (UAEM) in Mexico, as well as how the university's teachers appropriate and use information and communications technology (ICT). They surveyed 303 professors from different higher education units to collect the information. The results showed that the modernity of the infrastructure and technological equipment does not necessarily translate into the successful appropriation and use of ICT in complex university educational settings.

Ramirez et al. (2021) carried out a study to characterize the profiles of teachers in the framework of Education 4.0. The categories they included were digital literacy, critical thinking, and problem-solving in educational settings linked to real-world scenarios. The researchers proposed the following guiding question: "What are the characteristics that a teacher should have in terms of Education 4.0?" (Ramirez et al., xx). They carried out a descriptive-exploratory study with 337 undergraduate students in education programs, 313 graduates, 20 experts in education, and focus groups with the educational community in Mexico City. The results showed that a teacher's ideal characteristics should be oriented to skills such as facilitating, soft skills, human sense, and the use of technology.

Park (2009) conducted a study in Korea examining how university students adopt and use e-learning, applying the technology acceptance model (TAM) to 628 university students. The results demonstrated the effectiveness of TAM in understanding students' acceptance of e-learning; thus, it proved to be an appropriate methodology.

In addition, a methodology called Scrum, used in the construction of characterization software, stands out as a team support model that helps to deliver higher quality products and quickly adapt to changes in the project. The Scrum methodology is an agile approach to software project management that focuses on continuously delivering value to the customer. It has become extremely popular in recent years due to its ability to quickly adapt to changing project requirements and its focus on collaboration and effective communication among team members.

In addition to Scrum, TAM is also selected for the study, considering that it is a widely used model for validating technical requirements for software. TAM is based on two main factors: the perception of usefulness and ease of use. According to the model, users are more likely to adopt a particular technology if they perceive it as valuable and easy to use.

Based on the above literature review, educational institutions appear concerned with identifying their connectivity and technological infrastructure difficulties. Although various instruments have been applied, the review found no evidence of a tool used to generate detailed results regarding installed capacity, technological infrastructure, internet access, and knowledge related to ICT matters in educational institutions and their communities.

Previous studies have identified how technology can improve teaching and learning processes. However, without adequate infrastructure and connectivity, educational methods are hindered (Mejía, Silva, & Gómez, 2020). Likewise, in addition to the instrumental use of technology, the critical use of technology must be considered (Silva, 2022), generating in students the capacities and skills required to form competent citizens in Society 5.0.

METHODOLOGY

The project used an applied research methodology. The methodological design is split into three phases: in the first, the needs of the population under study were identified through self-perception surveys. In the second phase, the Scrum methodology was used to build the software, considering the needs identified in the first phase. In the third phase, the technical validation of the software was carried out using the technological acceptance model (TAM).

The research aimed to characterize the technological infrastructure in educational institutions compared to their installed capacity. Its purpose was to determine the existing technological gap in the institutions and propose ways to improve digital connectivity. To these ends, the following objectives were established: (1) determine the relationship between the installed capacity of technological infrastructure and the number of students, and (2) implement software that allows the technological characterization and appropriation of ICTs in educational institutions.

For the first objective, a theoretical framework related to the appropriation of ICT by students and teachers was built, and three instruments were applied to identify their perception of their use of ICT, which were incorporated into the software design. For the second objective, the Scrum methodology was implemented to develop the application to characterize the technological infrastructure. Scrum is a framework for addressing complex adaptive problems and creating and delivering products of maximum creative and productive value. The projects developed through Scrum are done iteratively and incrementally, and their development is structured in cycles called sprints (Lara, 2021).

Finally, the TAM was used to validate the technological characterization software in educational institutions. Using this method, the relevance of the technological tool was assessed against the proposed objective. Davis (1989) developed the TAM to measure organizations' acceptance of information systems. Its objective is to explain the factors that determine the use of ICTs, and it is applied to predict their use. It is based on two main characteristics: perceived utility (PU) and perceived ease of use (PEOU). PU refers to the degree to which a person believes that using a particular system will improve their job performance, and PEOU indicates the degree to which a person believes that by using a particular system, they will expend less effort in performing their tasks (Yong et al., 2010).

The investigation was carried out with the population of the official educational institution La Ribera, located in the urban area of the municipality of Montería (Córdoba, Colombia). This educational institution was selected due to its location in the northern municipalities of Colombia, which have a lower level of connectivity. On the one hand, secondary education teachers who teach grade 11 classes are enrolled in careers through the Ministry of National Education in Colombia and have the highest level of training at the master's level. On the other hand, the students in grade 11 comprise adolescents between the ages of 14 and 17 from low socioeconomic strata. The instruments on the perception and use of technologies in the classroom were applied to 25 students and 23 teachers. The software validation instrument was endorsed by three thematic experts, selected due to their knowledge and experience in technology at a master's degree level. A scale from 1 to 5 was used to measure the degree of agreement, with 1=very deficient, 2=deficient, 3=low, 4=medium, and 5=high.

RESULTS

The results are presented according to the proposed objectives. For the first objective, a theoretical framework was built to identify the digital skills of the educational community and how they appropriate and use ICT in their educational contexts. The skills are oriented in four dimensions: instrumental, cognitive, attitudinal, and axiological, as described in Table 3.

UNESCO established the theoretical basis of the technology characterization software in the framework of competencies for teachers in knowledge, application, and innovation of ICT (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2019). Regarding the appropriation of ICT by teachers and students, the technological, pedagogical, communicative,

Table 3. Digital skills for the appropriation and use of ICT

Dimension	Description
Instrumental	Teach how to use the different technological resources' hardware and software and those related to internet access.
Cognitive	Develop skills for the critical use of information and communication.
Attitudinal	Promote rational attitudes towards technology, as well as social attitudes that foster empathy.
Axiological	Propose criteria related to ICT awareness for the critical analysis of information and its relationship with the cultural environment of society.

Source: Adapted from Marta-Lazo and Gabelas (2016).

managerial, and investigative dimensions were also included (Ministry of National Education, 2013). For this reason, the ICT competency framework of necessary knowledge for teachers and students proposed by Marta-Lazo and Gabelas (2016) was considered. Its competency framework integrates the operationalization of technologies and their critical use. Along these lines, the characterization software was implemented through two instruments that allowed for an understanding of the perception of teachers and students about their use and appropriation of ICT. The previous ones complemented the sessions that integrated the characterization software.

For the second objective, the technological characterization software was implemented. This software is made up of several sections, described below. At the top, a menu is displayed, where the user can find the start, register, query, and calculate options (Figure 1).

To start, an individual must click the registration button and create a user name to access the application. Depending on the role selected by the user (IT manager, teacher, or student), the following options are displayed:

- ICT appropriation instrument for students.
- ICT appropriation instrument for teachers.
- Characterization of the technological infrastructure.

Figure 1. Access to the technological characterization software (Source: http://www.plataformaasincronicainteligente.info/SoftwareCaracterizacion/public_software/)

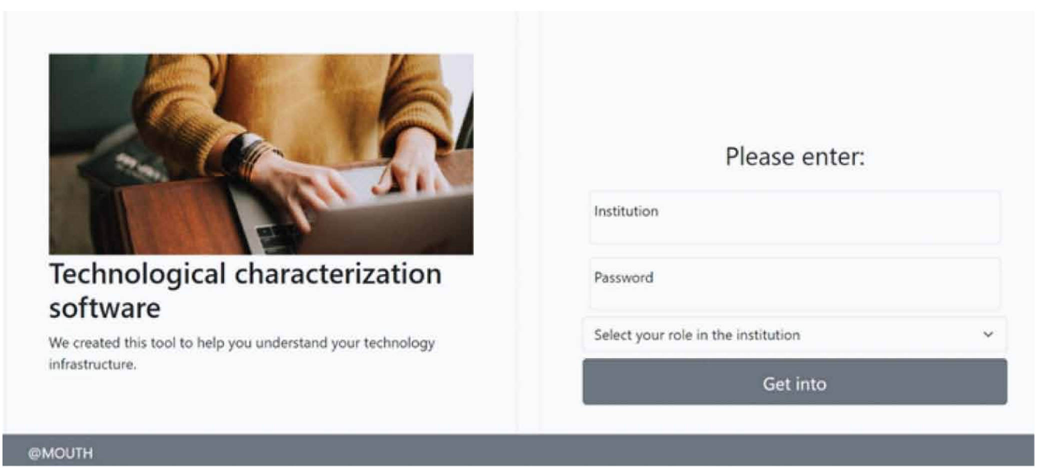


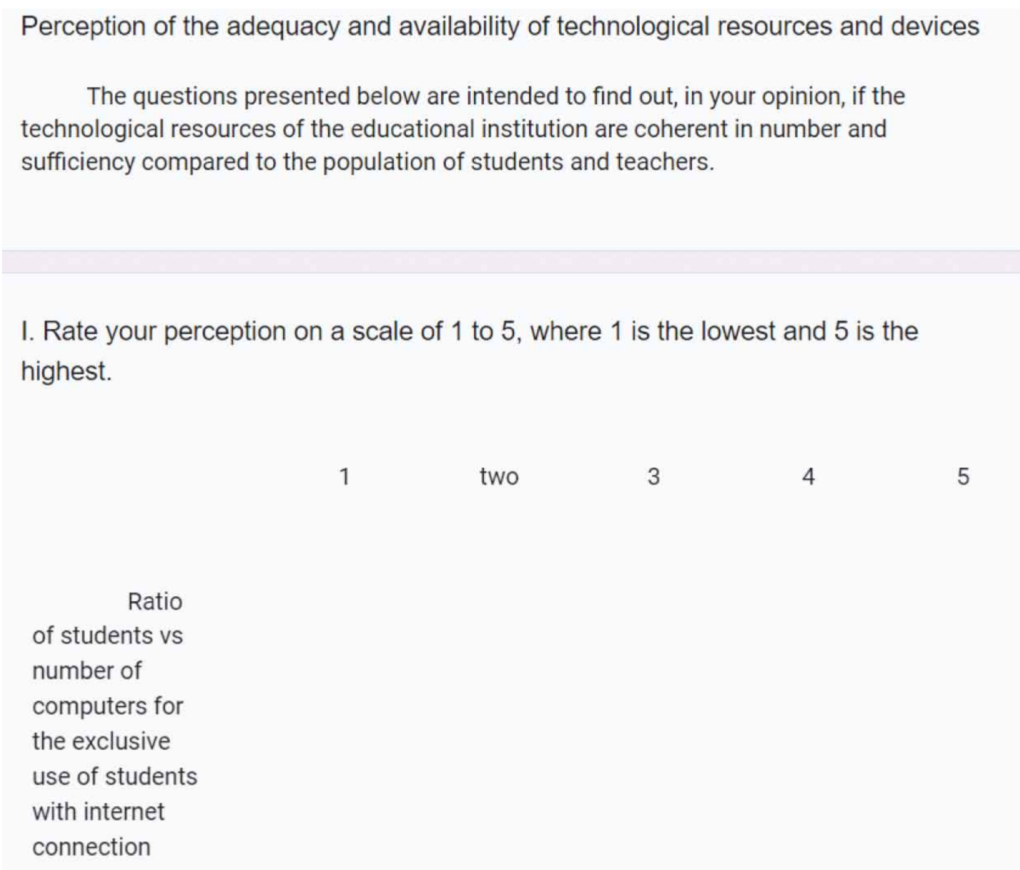
Figure 2 shows the menu in which the instrument for ICT appropriation can be selected, either for teachers or students. The information must be selected and filled out.

In the results consultation module, each educational institution can obtain a consolidated report by role (IT managers, teachers, and students). Finally, to attain the installed capacity, there is a section in which the number of students belonging to each group must be filled out. Subsequently, the installed capacity is calculated by generating a report of the technological resources required against the number of students, and it is presented against the existing technological resources. Figure 3 shows the module that calculates the installed capacity in terms of technological infrastructure.

The application was developed using the agile Scrum methodology in different phases: first, team members were identified, and responsibilities were assigned. Second, the *how* was defined—that is, the tools used by the Scrum team. In this phase, the user stories—which refer to the requirements of the application to be developed—and the task panel indicating what each member is doing were presented. Finally, the sprints were defined to indicate the time in which each functionality would be developed and delivered. Regarding the implementation, the sprints are defined in Table 4.

The technologies applied in the development of the application were HTML5, used for the structure of the application; CCS3 for the design; the Bootstrap framework for development, based on PHP in communication with JavaScript; and MySQL database manager. The FIGMA online tool was used to design each component of the application, as it allows for the generation of previews of the software being developed.

Figure 2. ICTs appropriation form



Perception of the adequacy and availability of technological resources and devices

The questions presented below are intended to find out, in your opinion, if the technological resources of the educational institution are coherent in number and sufficiency compared to the population of students and teachers.

I. Rate your perception on a scale of 1 to 5, where 1 is the lowest and 5 is the highest.

	1	two	3	4	5
Ratio of students vs number of computers for the exclusive use of students with internet connection					

Figure 3. Module for calculating installed capacity

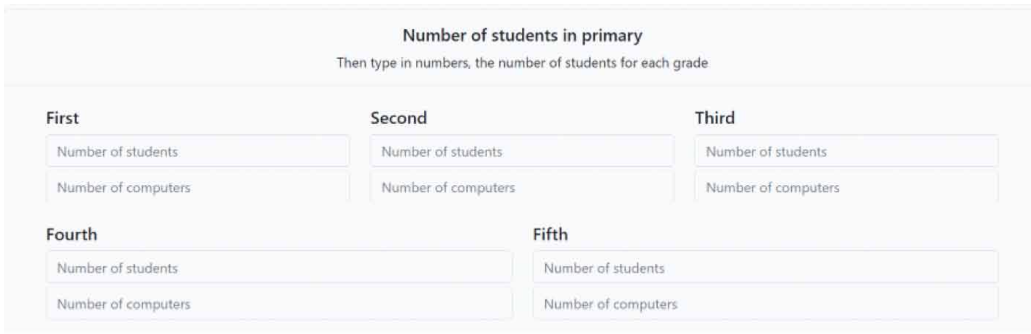


Table 4. Sprint of software features

Sprint 1	Design and implementation of the database to storage the registries.
Sprint 2	Registry and log in webpage connected to the database to storage the registries.
Sprint 3	Characterization page for students, teachers, and IT managers.
Sprint 4	Page to calculate the technological infrastructure, and log in page for the IT manager.
Sprint 5	Page for the IT manager to view the answers given by the members of the institution.

The TAM model was used to validate the technological characterization software in educational institutions. This model makes it possible to assess the technology's perceived utility and ease of use. Using the TAM instrument, three experts evaluated the technology. To measure the degree to which the experts agreed, a scale of 1 to 5 was used, in which 1 = very poor, 2 = poor, 3 = low, 4 = medium, and 5 = high. Regarding perceived usefulness, the experts gave an average score between 4.0 and 4.7. Their results are presented in Table 5.

As seen in Table 5, the experts strongly agree with carrying out technology characterization processes in educational institutions. They moderately agree that interaction with the software gives greater control over the technological infrastructure information and that the implementation of technological characterization software in educational institutions will generate an improvement in digital connectivity, as it will provide a consolidated report of the existing technological resources in educational institutions, helping to establish improvement plans. The results of ease of use perceived by the experts are presented in Table 6.

Table 6 shows that the average score given by the three experts for ease of use is between 3.7 and 4.3. This is relatively low compared to the average score given for perceived utility, which is between 4.0 and 4.7. The previous results show that the experts perceived that the software had a degree of usability between high and medium. This means that the software can be used by individuals who have a basic understanding of using technology.

The average score for the question, "To what extent do you agree that the software is intuitive enough?" was 3.7, indicating that the software has an acceptable degree of usability. Therefore, users are advised to refer to the manuals. This is confirmed by the average score of 4.0 given to "actions requested by the software are easy to perform." Regarding "learning to operate the software, its interaction and understanding for users," the experts gave an average score of 4.3 (Table 7).

Figure 4 shows that the software is at a high-to-medium level of technological acceptance, which is considered a positive result for incorporating technological characterization software in educational institutions.

Table 5. Utility perceived by the experts

Question	Average	Standard Deviation	Expert Classification According to the Degree to Which They Agree		
			High	Medium	Low
To what degree would you agree with carrying out technology characterization processes in educational institutions?	4.7	0.58	2	1	
To what degree do you agree that the implementation of technological characterization software in educational institutions allows for an improvement in digital connectivity?	4.3	0.58	1	2	
To what degree do you agree that interaction with the software gives greater control over the technological infrastructure information of educational institutions?	4.0	0.00		3	
To what extent do you agree that the software allows educational institutions to respond in terms of recognizing their technological capabilities to establish the reality of their digital divide and thus initiate actions and strategies for mitigating the absence or lack of these resources?	4.0	1.00	1	1	1
To what degree do you agree that the software provides enough useful information to educational institutions?	4.0	1.00		1	2
To what degree do you agree that the perceived utility positively influences the intention to use the software?	4.3	0.58	1	2	
Total			5	10	3
Percentage			28%	56%	17%

Table 6. Perceived ease of use

Question	Average	Standard Deviation	Expert Classification According to the Degree to Which They Agree		
			High	Medium	Low
To what degree do you agree that the actions requested by the software are easy to execute?	4.0	1.00	1	1	1
To what extent do you agree that learning to operate the software is easy?	4.3	0.58	1	2	
To what degree do you agree that interaction with the software is clear and understandable?	4.3	1.15	2		1
To what degree do you agree that the software is sufficiently intuitive, and it is not necessary to refer to the user manual frequently?	3.7	0.58		2	1
To what degree do you agree that the software and technological characterization instruments presented within it are easy to understand for users?	4.3	1.15	2		1
Total			6	5	4
Percentage			40%	33%	27%

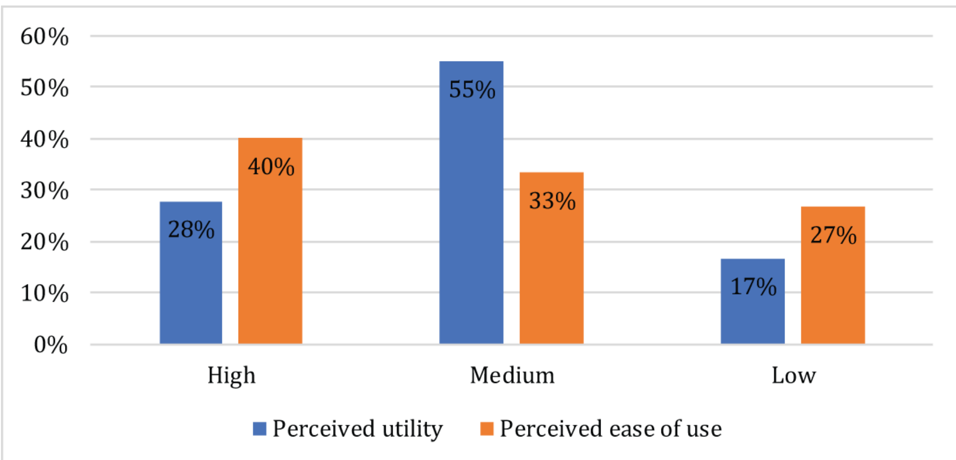
CONCLUSION

Some conclusions can be drawn regarding the scope and the proposed research question on how technology can improve digital connectivity and be a facilitating medium in the teaching and learning processes. First, the technological characterization software allowed the institutions to identify the capacity of their technological resources compared to the installed capacity. Likewise, it helped the members of the institutions (information technology managers, teachers, and students) to diagnose the

Table 7. Summary of the utility and ease perceived by the experts

Degree	Perceived Utility		Perceived Ease of Use		Total	
	Amount	%	Amount	%	Amount	%
High	5	28%	6	40%	11	33%
Medium	10	55%	5	33%	15	46%
Low	3	17%	4	27%	7	21%
Total	18	100%	15	100%	33	100%

Figure 4. Summary of the utility and ease perceived by experts about the software



ways in which they appropriate and use the technologies. For this, the software has different sections that diagnose the capacities of the actors to take advantage of the technologies.

Regarding the proposed objectives, it can be concluded that the tool supports the characterization of existing technological resources, identifying them against the installed capacity. Similarly, the software offers options that allow educational community members to recognize their strengths and weaknesses regarding the technological skills considered in the instrumental, cognitive, attitudinal, and axiological dimensions. In this sense, in addition to the instrumental dimension, the tool incorporates elements to diagnose technological appropriation, which makes it possible to identify a cognitive gap in the use of technologies. However, the software also recognizes digital appropriation, understanding that the technological gap is perceived in two dimensions: cognitive and digital. This is based on the theoretical understanding that technology cannot be seen as an instrumental tool and that the use of technology can contribute to significant learning theories framed in the constructivist context.

In short, based on the problem exposed here, this study highlighted the importance of the members of educational institutions identifying their digital capabilities. With their input, the actual dimension of their technological gap can be determined. In this way, using the proposed software, they can make decisions that help them improve connectivity, design strategies to mitigate their lack of resources or optimize the ones they already have.

REFERENCES

Banco Mundial. (2019). *Personas que usan Internet (% de la población)* [People who use the internet (% of population)]. https://datos.bancomundial.org/indicator/IT.NET.USER.ZS

Compaine, B. (Ed.). (2001). *The digital divide*. MIT Press. doi:10.7551/mitpress/2419.001.0001

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *Management Information Systems Quarterly*, *13*(3), 319. Advance online publication. doi:10.2307/249008

Development Bank of Latin America. (2019, July 5). *Closing the digital divide in Latin America and the Caribbean critically depends on the transformation of Universal Service Funds*. CAF. http://bit.ly/2Nkbil2

Economic Commission for Latin America and the Caribbean. (2020, August 26). *Universalizar el acceso a las tecnologías digitales para enfrentar los efectos del COVID-19* [Informe especial COVID-19 No. 7]. ECLAC. https://repositorio.cepal.org/bitstream/handle/11362/45938/4/S2000550_es.pdf

El orden Mundial. (2022). *El mundo en 2021* [The world in 2021]. https://elordenmundial.com/el-mundo-en-2021/

Flórez, J., Aguilera, M., & Salcedo, O. (2019). Industry 4.0: Trends in recent academic literature. *Journal Espacios*, *40*(30), 27–44. https://www.revistaespacios.com/a19v40n30/a19v40n30p27.pdf

Lara, W. [@waltwr.lara.37]. (2015). How does the Scrum methodology work? What it is and its 5 phases. *Platzi*. https://platzi.com/blog/metodologia-scrum-fases/

Manyoma, P. C., Orejuela, J. P., & Gil, C. (2011). Methodology to determine the installed capacity of an academic program. *Estudios Gerenciales*, *27*(121), 143–158. doi:10.1016/S0123-5923(11)70185-1

Marta-Lazo, C., & Gabelas, J. A. (2016). Comunicación digital. Un modelo basado en el factor R-elacional [Digital communication. A model based on the R-relational factor]. Editorial UOC. *Revista de Estudios de Ciencias Sociales Y Humanidades, 36*, 117–121.

Mejía, C., Silva, A., & Gómez, S. (2020). *Tecnologías e Innovación en Educación Virtual*. EAN.

Park, S. Y. (2009). An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning. *Journal of Educational Technology & Society*, *12*(3), 150–162. https://www.jstor.org/stable/jeductechsoci.12.3.150

Ramírez, M. S., Loaiza, M. I., Zúñiga, A., & Portuguez, M. (2021). Characterization of the teacher profile in the framework of education 4.0. *Future Internet, 13*(4), 91. . https://doi.org/10.3390/fi13040091

Sánchez, L., Reyes, A., Ortiz, D., & Olarte, F. (2017). The role of technological infrastructure in relation to the digital divide and digital literacy in 100 educational institutions in Colombia. *Calidad en la Educación*, *47*, 112–144. doi:10.4067/S0718-45652017000200112

Silva, A. (2022). Propuesta neurocurricular para la enseñanza de las matemáticas en programas de ingeniería. In C. Daza-Orozco, A. Luque-Forero, & E. Padilla-Murcia (Eds.), *Educación superior: sustentabilidad y prácticas innovadoras*. Editorial Politécnico Internacional.

Solórzano, S. (2020, August 25). This is how the digital divide has affected students in Latin America and the Caribbean. *La República*. http://bit.ly/2LJEBNq

Statista. (2018, May 28). How many Internet users are there in Latin America? *Statista*. https://es.statista.com/grafico/13903/cuantos-usuarios-de-internet-hay-en-america-latina/

The World Order. (2021, May 25). *La población de Internet en el mundo. Y proporción de población con acceso a la red* [Internet population in the world. And proportion of population with web access]. https://elordenmundial.com/mapas-y-graficos/mapa-acceso-internet-mundo/

Torres, S., Barona, C., & García, O. (2010). Technological infrastructure and appropriation of ICT at the Autonomous University of the State of Morelos. Estudio de caso. *Perfiles Educativos*, *32*(127), 105–127. https://www.scielo.org.mx/pdf/peredu/v32n127/v32n127a6.pdf

United Nations Educational, Scientific and Cultural Organization. (2019). ICT competencies framework for teachers [Report]. UNESCO.

Yong, L., Rivas, L., & Chaparro, J. (2010). Technology acceptance model (TAM): A study of the influence of national culture and user profile on ICT use. *Innovar (Universidad Nacional de Colombia)*, *20*(36), 187–203. http://www.scielo.org.co/pdf/inno/v20n36/20n36a14.pdf