Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

https://doi.org/10.23913/ride.v14i28.1761

Scientific articles

Adoption of ICT as teaching tools in a public university derived from the covid-19 health contingency

Adoption of ICT as teaching tools in a public university derived from the COVID-19 health contingency

Adoption of ICT as educational tools in a person Public university derived from the COVID-19 health contingency

Julio César Macías Villarreal
Autonomous University of Tamaulipas, Mexico
jcmacias@docentes.uat.edu.mx
https://orcid.org/0000-0002-8636-0570

Hugo Isaías Molina-Montalvo
Autonomous University of Tamaulipas, Mexico
himolina@docentes.uat.edu.mx
https://orcid.org/0000-0003-0914-7597

José Refugio Castro López
Autonomous University of Tamaulipas, Mexico
jrcastro@docentes.uat.edu.mx
https://orcid.org/0000-0001-9085-2087

Resumen

El objetivo de esta investigación es explorar, desde la perspectiva de los estudiantes de una universidad pública estatal que utiliza el modelo por competencias, los desafíos y oportunidades claves derivados de la adopción de herramientas digitales en el contexto de un modelo educativo en línea surgido como respuesta a la pandemia por covid-19. Para ello, se implementó una metodología de enfoque cuantitativo con el fin de validar la hipótesis planteada. La población objeto de estudio comprendió a los estudiantes inscritos en las cuatro licenciaturas ofrecidas por la Facultad de Comercio y Administración Victoria. A partir de esta población, se

seleccionó una muestra aleatoria de 334 alumnos. La recopilación de datos se llevó a cabo mediante un cuestionario estructurados que consta de 35 ítems. El análisis de confiabilidad, evaluado a través del índice alfa de Cronbach, arrojó un valor de 0.739, lo que indica una alta confiabilidad en los resultados obtenidos. Este estudio consideró la percepción de los estudiantes universitarios en seis dimensiones clave, tomando en cuenta las condiciones de infraestructura, conectividad y conocimientos en diversas plataformas, las cuales influyen en el proceso de enseñanza-aprendizaje: i) participación académica, ii) calidad educativa, iii) incorporación tecnológica, iv) apoyo académico, v) habilidades digitales y vi) flexibilidad académica.

Palabras clave: covid-19, educación superior, modalidad virtual, tecnologías de la información, universitarios.

Abstract

The objective of this research is to explore, from the perspective of students at a state public university that uses the competency-based model, the key challenges and opportunities derived from the adoption of digital tools in the context of an online educational model, generated as response to the COVID-19 pandemic. The implications of this transition were also examined. To carry out this study, a quantitative approach methodology was implemented with the objective of validating our hypothesis. The population under study included students enrolled in the four bachelor's degrees offered by the Victoria Faculty of Commerce and Administration. From this population, a random sample of 334 students was selected. Data collection was carried out using a structured questionnaire consisting of 35 items. The reliability analysis, evaluated through Cronbach's alpha index, yielded a value of 0.739, indicating high reliability in the results obtained. This study considered the perception of university students in six key dimensions, taking into account the conditions of infrastructure, connectivity and knowledge on various platforms, which influence the teaching-learning process: i. academic participation, ii. educational quality, iii. technological incorporation, iv. academic support, v. digital skills and vi. academic flexibility.

Keywords: COVID-19, Higher Education, virtual modality, information technologies, university students.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Resumo

O objetivo desta pesquisa é explorar, na perspectiva de estudantes de uma universidade pública estadual que utiliza o modelo baseado em competências, os principais desafios e oportunidades derivados da adoção de ferramentas digitais no contexto de um modelo educacional online, gerado como resposta à pandemia de COVID-19. As implicações desta transição também foram examinadas. Para a realização deste estudo foi implementada uma metodologia de abordagem quantitativa com o objetivo de validar nossa hipótese. A população em estudo incluiu alunos matriculados nos quatro cursos de bacharelado oferecidos pela Faculdade de Comércio e Administração de Victoria. Desta população foi selecionada uma amostra aleatória de 334 estudantes. A coleta de dados foi realizada por meio de questionário estruturado composto por 35 itens. A análise de confiabilidade, avaliada através do índice alfa de Cronbach, obteve valor de 0,739, indicando alta confiabilidade nos resultados obtidos. Este estudo considerou a percepção dos estudantes universitários em seis dimensões principais, tendo em conta as condições de infraestrutura, conectividade e conhecimento nas diversas plataformas, que influenciam o processo de ensino-aprendizagem: i. participação acadêmica, ii. qualidade educacional, iii. incorporação tecnológica, iv. apoio acadêmico, v. competências digitais e vi. flexibilidade acadêmica.

Palavras-chave: COVID-19, Ensino Superior, modalidade virtual, tecnologias de informação, estudantes universitários.

Fecha Recepción: Mayo 2023 **Fecha Aceptación:** Enero 2024

Introduction

Given the widespread closure of educational establishments derived from the COVID-19 pandemic, and according to data provided by the United Nations Educational, Scientific and Cultural Organization (UNESCO), in April 2020 more than 90% of Students worldwide were affected by the suspension of all in-person educational activities. This unprecedented measure generated the need for all academic actors, including managers, teachers and students, to adapt to new alternatives to traditional teaching processes, which forced them to move towards a virtual modality supported by online education tools and platforms. distance, a transition that significantly impacted all educational systems (IESALC-UNESCO, 2020).

According to information provided by the United Nations (2020), suspensions in educational sectors impacted 94% of students worldwide, affecting developing countries more pronouncedly. In fact, the inability of some groups to access technologies intensified during the

contingency, which resulted in an irremediable loss of educational opportunities in populations with significant deficiencies and caused the abandonment of classrooms or the postponement of school activities.

The suspension of in-person classes in Spanish-speaking countries led to the development of distance learning alternatives. Thus, various technological options were used with the sole objective of providing continuity to the study plans and programs. To achieve this, the support and mobilization of educational personnel was essential, as well as prioritizing attention to the health and comprehensive well-being of students (ECLAC-UNESCO, 2020). According to the findings of Brown and Salmi (2020), it is revealed that, despite the aspiration of many institutions to integrate online learning, few manage to meet the standards necessary to carry out this transition safely. agile. This challenge has a significant impact on students from the most vulnerable groups, demonstrating the disparity in access to online education and highlighting the urgent need to address these gaps.

In this context, information and communication technologies (ICT) continue to be the main support for the continuity of online classes, both synchronously and asynchronously (Cabero, 2008). These tools facilitate the creation of creative and flexible environments for the teaching-learning process, and open new information possibilities that allow overcoming time and space barriers, as well as promoting innovative educational models. In addition, they contribute to increased connectivity and interaction, among other benefits.

As highlighted by Coll (2008), the perspectives for the integration of ICT as part of a continuous improvement process are considerably broad, although reality has lagged significantly in this regard. The incorporation of ICT in classrooms, whether in traditional, distance or hybrid modalities, modifies the roles of both teachers and students. This change implies that students reach a significant level of self-sufficiency in their learning process, which means that the teacher is no longer the only source of knowledge for the academic and professional training of students (IESALC-UNESCO, 2020).

According to Tinio (2003), the appropriate use of tools and technologies, especially computers and internet connectivity, has the potential to shape innovative forms of education. Currently, ICT management has had an unprecedented impact, especially in the educational field, thanks to its accessibility and the emergence of easy-to-use applications for both teachers and students. During the pandemic, teachers found the need to train independently in various technological tools to maintain the continuity of their teaching work. This not only involved addressing the content, but also the development of technological skills to interact with the students. In a world that is experiencing constant modernization, especially in the technological

field, where digital news or updates emerge every day, Lloyd's (2020) findings highlight the need to be prepared to adapt to these changes.

Virtual education

During the pandemic, online education quickly replaced in-person learning classrooms, so students had to put aside their social activities to connect through various digital devices. However, in this new scenario, the connection between teachers and students has experienced notable inequalities in terms of educational participation due to the disparity of existing conditions. For this reason, Aguilar (2020) raises crucial questions such as the following: what type of teaching emerges from online education? And what are the social problems that originate in this type of virtual realities?

Lara (2002) conceptualizes virtual education as a teaching system that promotes educational quality and is mainly based on flexibility, which allows adaptation to variable times and spaces. This model reaches its maximum appreciation through technological inclusion with asynchronous, synchronous and autonomous modes.

Online teaching during the covid-19 pandemic became essential for the continuity of educational plans and programs. According to Molina-Montalvo *et al* . (2023), the virtual modality has historically been linked to higher level institutions and the business sector. Universities in England, the United States and New Zealand were pioneers in incorporating distance courses, and they later spread throughout Europe and Latin America. In response to the transformation of virtual education into an imperative need, these institutions have been forced to design new educational protocols in order to preserve the integrity of students' learning (Zuluaga-Gómez and Valencia-Ortiz, 2021).

The online modality during the pandemic was managed through digital media, which played a fundamental role in online teaching. This change, of course, required the effort of teachers to adapt programs, methodologies and evaluation instruments , which also demanded a constant process of reflection on the academic aspects and technological resources available in each context (García Aretio , 2021).

Likewise, the distance modality brings advantages for the academic community, since it promotes skills such as the systematization of knowledge, the introduction of new definitions and the expansion of language that encourages interconnection and dissemination. According to Tennuto *et al* . (2003), from the inclusion of virtual education “several units of information can be exchanged such as graphics, images, sound files, databases, among others” (p. 962),

which enables access beyond of the educational context. In this sense, the Internet has facilitated numerous connectivity alternatives and has given rise to empirical learning that is based on avant-garde methods adapted to the requirements of students.

Technological tools focused on education

The abrupt closure of businesses and isolation in homes led to a large part of daily activities being moved to digital platforms, although the delivery of classes was not interrupted thanks to the widespread use of mobile devices and computers. The consequences of these changes were reflected in the maintenance and even increase in online sales. In addition, the performance of government procedures and services became generalized (Cabero, 2008; Castro, 2022).

Several studies, including that of Alvarado *et al* . (2019), Aguilar (2020) and Castro *et al* . (2022) highlight that social networks, including popular platforms such as WhatsApp and Facebook, experienced a significant increase in their use. This phenomenon is attributed to the inability of people to physically attend meetings, which led to a general preference for holding virtual meetings through these platforms. The convenience and accessibility of these tools made them a predominant option for maintaining social connection in times when physical interactions were limited.

In the case of higher education institutions (HEIs), they chose to use digital platforms as an alternative to the suspension of in-person classes due to forced isolation. Among the challenges faced by the HEIs was the need to train their teachers in the use of these tools. This training was driven by the willingness of many academics, despite the fact that, before the pandemic, some showed resistance to this technological change. Teachers, therefore, had to update themselves to continue teaching their classes virtually.

The main challenge for HEIs, in order to avoid interruptions in the teaching-learning process during the transition to the virtual modality, was to face significant obstacles due to significant deficiencies in resources, infrastructure and connectivity . Thus, ICT emerged as essential elements to provide continuity to distance learning, which encouraged the development of various digital platforms designed specifically for the educational context. In this sense, the most demanded educational platforms are presented: Google Classroom , Microsoft Teams , Edixgal and Edmodo (Otero *et al* ., 2020), which have proven to be fundamental in the educational environment, as they have facilitated the interaction between teachers. and students, the distribution of educational materials and the carrying out of academic

activities virtually.

Materials and methods

This research aimed to highlight the perception of students at a state public university about the fundamental challenges and opportunities that have arisen with the implementation of digital tools in the context of an online educational model in response to the covid-19 pandemic, as well as examine its impact on higher education. The study followed a quantitative approach, aimed at understanding the variables and validating the dependency relationships between them, with a descriptive cross-sectional design that collects data at a single moment, analyzing the incidence of variables in a given population (Hernández -Sampieri *et al* ., 2014). Likewise, descriptive statistics, including frequencies and response percentages, were used to characterize the key informants in the study, according to the recommendations of Ritchey (2006). In addition, statistical analysis of the collected information was carried out using the Statistical statistical package. Package for the Social Sciences (SPSS), version 26.

The population of interest was made up of 1,542 students enrolled in all degree programs offered by the Victoria Faculty of Commerce and Administration (FCAV), dependent on the Autonomous University of Tamaulipas. These programs include Public Accountant (CP), Bachelor of Administration (LA), Bachelor of Information Technology (LTI) and Bachelor of Economics and Sustainable Development (LEDS). The selected random sample consisted of 334 students, and efforts were made to ensure that all individuals in the population had the same opportunity to be included (Otzen and Manterola, 2017) (see table 1).

Table 1. Research technical sheet

Concept	Description
Field work	August-December 2022
Study focus	Quantitative of guy descriptive and transversal
Study population	Autonomous University of Tamaulipas (FCAV)
Application of the questionnaire	Electronics (Microsoft Forms)
Reliability test	Cronbach's alpha (α)
Research instrument	Likert scale questionnaire (5 points)
Statistical *software*	SPSS version 26
Type of sample	Simple random (334 respondents)

Source: self made

During the validation process using the IBM SPSS Statistics tool , the calculation of the Cronbach coefficient and the homogeneity and discrimination index were carried out. The results obtained indicate levels of reliability considered adequate, being above 0.70, in accordance with the guidelines established by Ruiz (2002). It is relevant to note that in this analysis no discrimination problems were identified, which increases the reliability of the data collected. This finding supports the internal consistency of the responses provided by the participants and grants validity to the measurement instrument used in the research.

Data collection was carried out using an adapted version of the instrument developed by Mirete Ruiz *et al* . (2015), adjusted to the specific needs of the present research. The result was a structured questionnaire consisting of a total of 35 items, organized into three sections. The first section collected general data from the respondent. The second evaluated the perception of ICT, and addressed two segments: a) attitude towards the use of ICT and b) training/knowledge. Finally, the third section explored the level of ICT use. To respond to the second and third sections, a 5-point Likert scale was implemented (from 1 = “totally disagree” to 5 = “totally agree”).

The application was carried out in the August-December 2022 academic semester. To digitize the questionnaire, the Microsoft electronic platform (Microsoft Forms) was used. It is worth mentioning that in no way was there any intervention in the possible responses by the respondents when expressing their free opinion by filling out the research instrument.

Study analysis categories

In the context of this period of confinement, university students faced various challenges, among which were tasks, activities, class presentations, tutorials, advice, thesis direction work, among others. To understand the perception of university students regarding aspects related to ICT integrated into academic practice and their learning processes, a statistical frequency analysis was carried out. The six categories used to organize and analyze the results are supported by a solid theoretical foundation:

Academic participation. This category refers to the degree of student involvement in virtual academic activities, so it considered aspects such as interaction in online classes, participation in discussions, and attendance at virtual tutorials.

Educational quality. This category evaluates students' perception of the general quality of the online education received. This includes aspects such as the clarity of content, the effectiveness of virtual teaching methods and the evaluation of learning.

Technological incorporation. Examines how technologies were integrated into academic practice. This ranges from the use of educational platforms to the implementation of technological tools to improve the learning experience.

Academic support. It refers to the support provided by the educational institution and teachers in terms of guidance, advice and support during virtual learning. It also includes the availability of educational resources.

Digital skills. Evaluation of students' digital competence. This ranges from the ability to use technological tools to skill in searching and managing information online.

Academic flexibility **.** It examines the extent to which online education allowed students to adapt to flexible schedules and manage their academic load more autonomously.

These categories provide a comprehensive framework to analyze the experience of university students during confinement and the transition to online education, which allowed us to identify areas of improvement and strength in the implementation of ICT in higher education.

Results

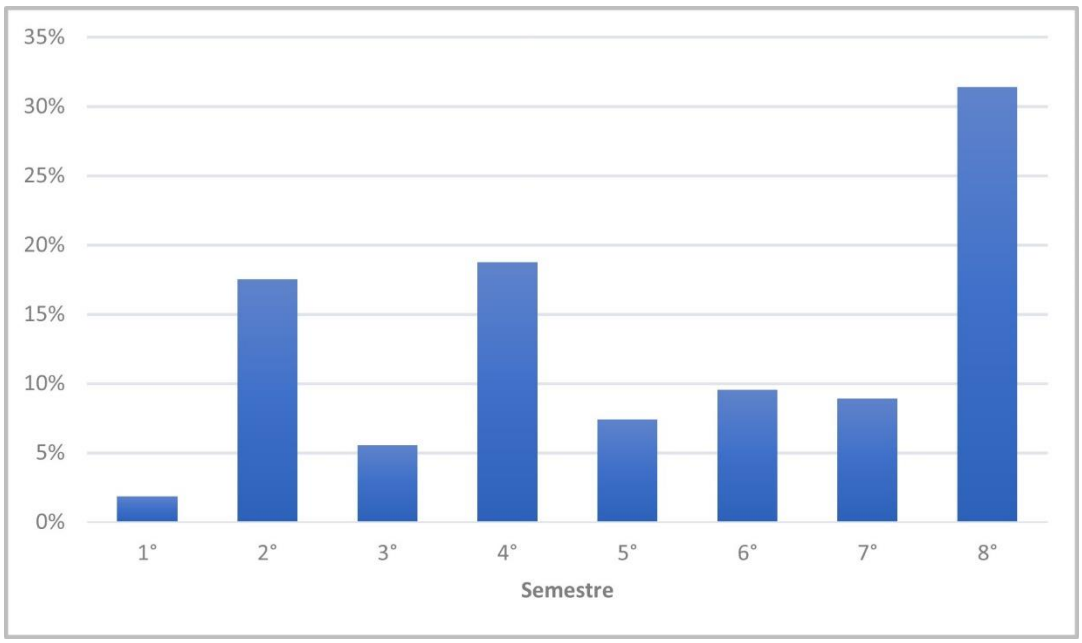
Of the 334 participants in this research, 37% are men and 63% women. Regarding the educational programs offered by the FCAV, 69% belong to the CP career, 21% to LA, 9% to LTI and 1% to LEDS (see table 2). In addition, it was observed that 32% of those surveyed are in their last semester (figure 1). Regarding technological equipment, 91% of students have cell phones, while 62% have a *laptop* (figure 2).

Table 2. Characteristics of the respondents

Gender	Women	209	62.6
	Man	125	37.4
Careers	CP	229	68.6
	THE	69	20.6
	LTI	31	9.3
	LEDS	5	1.5
Whole		334	100.0

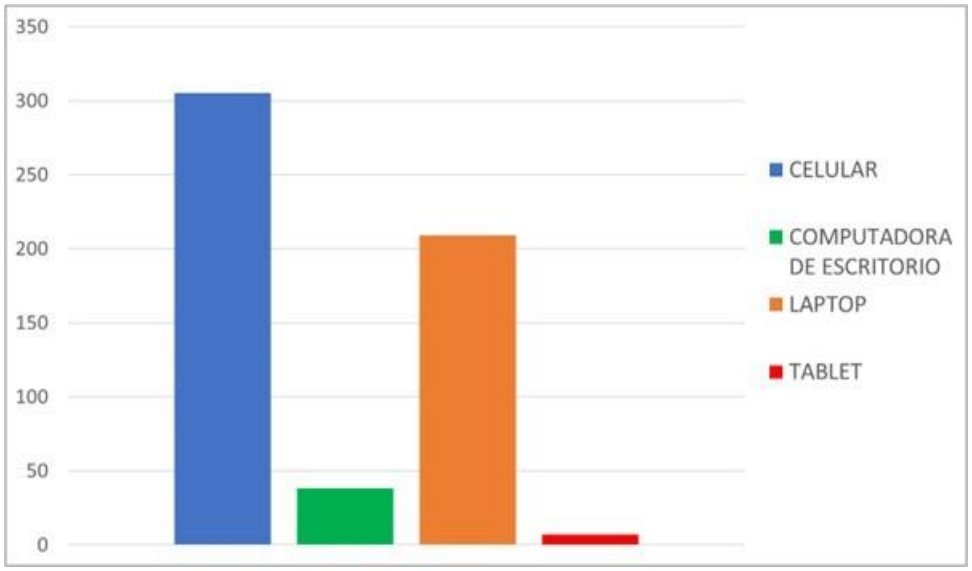
Source: self made

Figure 1. Enrollment by school period



Source: self made

Figure 2. Technological equipment



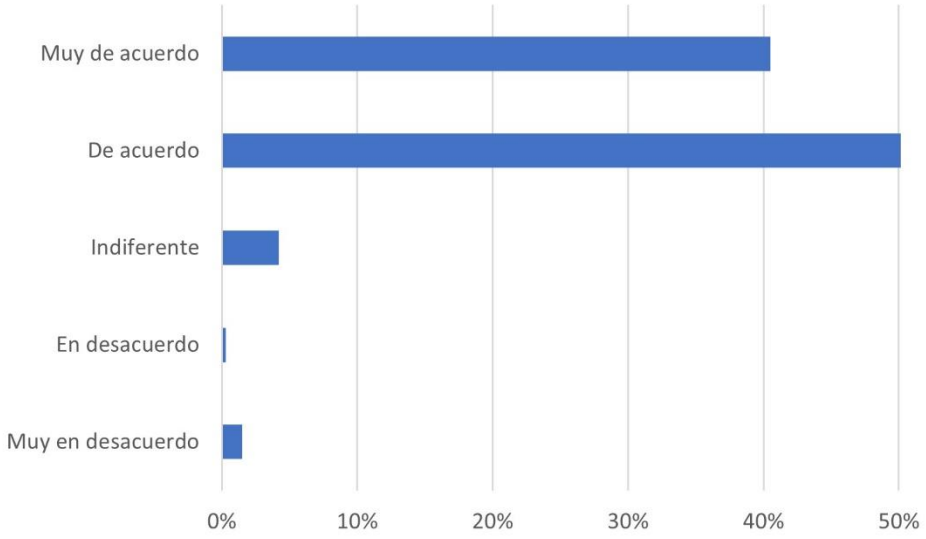
Source: self made

During this period of confinement, university students faced various challenges, which included tasks, activities, class presentations, tutorials, advice and thesis direction work, among others. Through a statistical frequency analysis, it was possible to identify the perception of university students in relation to aspects associated with ICT implemented in academic practice and in their learning processes. In order to carry out a more detailed analysis, the results were organized into the six categories already mentioned, that is, academic participation, educational quality, technological incorporation, academic support, digital skills and academic flexibility.

Academic participation

In light of the experience, a decrease in student participation in their teaching and learning processes could have been anticipated during the school period analyzed due to the change from face-to-face to distance learning. However, the results surprisingly revealed that 40.4% strongly agree and similarly 53.3% agree that technologies have stimulated their academic participation. When delving into the underlying causes of these results, it is attributed to the synchronous and asynchronous communication and connectivity that the students experienced through various technological educational tools and platforms made available to the university community (figure 3). This increase in participation can be understood as a direct result of the successful adaptation of technology to facilitate student interaction, which contributes to the success of the transition to distance education.

Figure 3. ICT encourages participation in educational processes



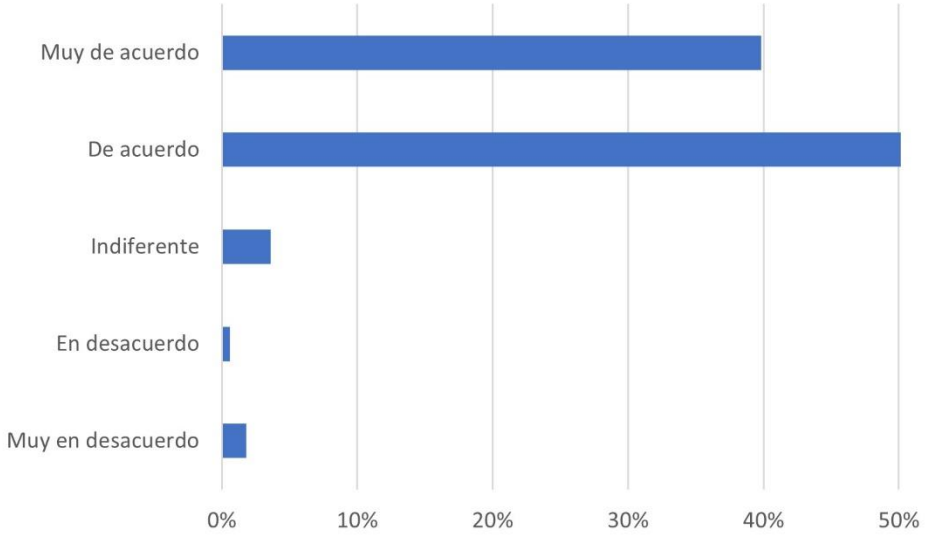
Source: self made

Educational quality

The emergence of the pandemic and its consequences in the educational field generated significant improvements in the quality of the teaching-learning processes thanks to the incorporation of technological tools. This improvement is perceived by 93.7% of the students surveyed (figure 4). The aspects in which these changes are most evident include the use of virtual databases and libraries, virtual platforms, online educational resources, as well as the creation of virtual materials and access to networked resources. These changes, identified by

students, suggest a radical and profound transformation in teaching practice, and highlight the effectiveness of technology as a catalyst for the continuous improvement of educational quality.

Figure 4. ICT improves the quality of teaching processes

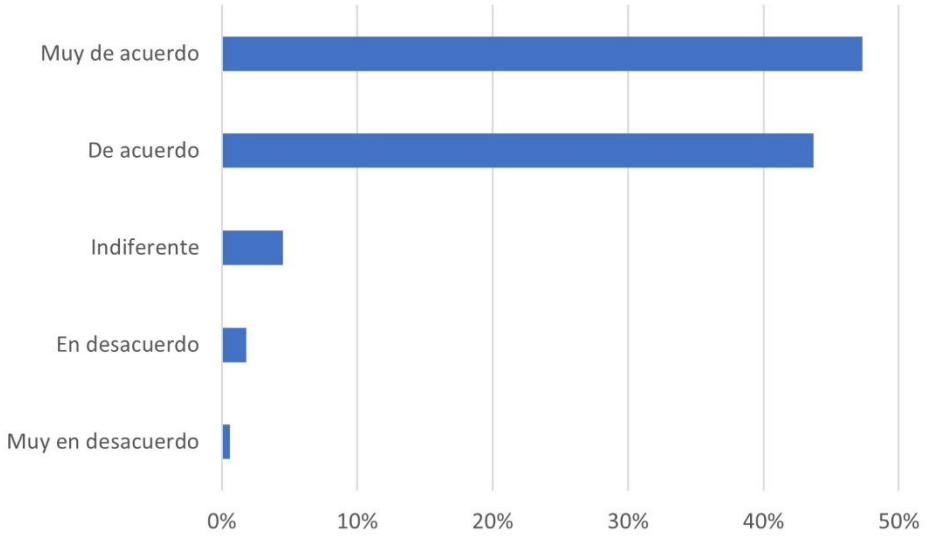


Source: self made

Technological incorporation

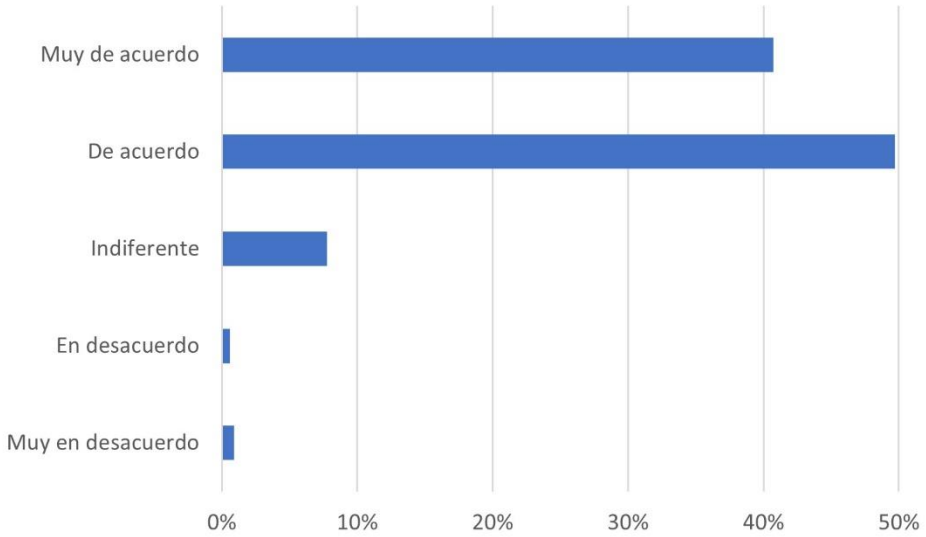
The students' perception about the importance of incorporating ICT in their academic activities reveals a clear inclination towards the acceptance and use of these tools. 44.6% of the participants expressed agreement, while a notable 47.6% indicated they strongly agreed, which shows the marked influence of the pandemic on the adoption of practices related to technology and educational innovation (figure 5). In line with these results, 90.4% of those surveyed stated that classes are favored as ICT is implemented (figure 6). These data underscore the perceived importance of technology as a vital resource to enhance and enrich the academic experience, highlighting its key role in the current educational environment.

Figure 5. The incorporation of ICT in the educational context: a key factor



Source: self made

Figure 6. The incorporation of ICT in classes as an improvement process



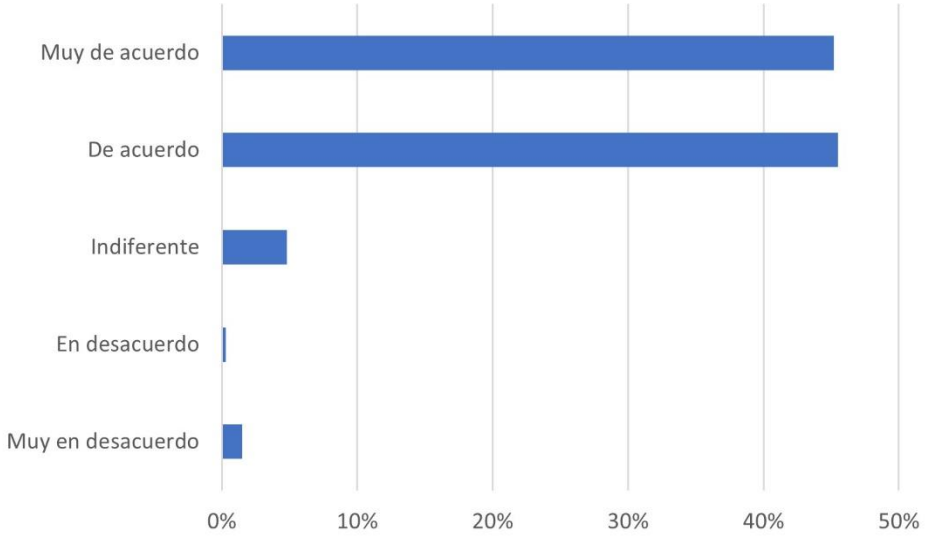
Source: self made

Academic support

The good acceptance of students towards the incorporation of digital tools during confinement is an aspect worth highlighting. A significant 46.7% expressed their agreement, while a considerable 46.4% indicated they strongly agreed that the inclusion of ICT facilitates the development of classes. This support accentuates the students' positive perception of the teaching effort to update their daily practice through the use of these tools (figure 7). The

undeniable contribution of ICT to improve the effectiveness of the learning process is reflected in the fact that these technologies make classes more interesting and interactive, which translates into a more enriching educational experience for students. This result highlights the vital importance of technology as academic support and its ability to improve the quality of teaching in a virtual environment.

Figure 7. ICT facilitates the teaching process

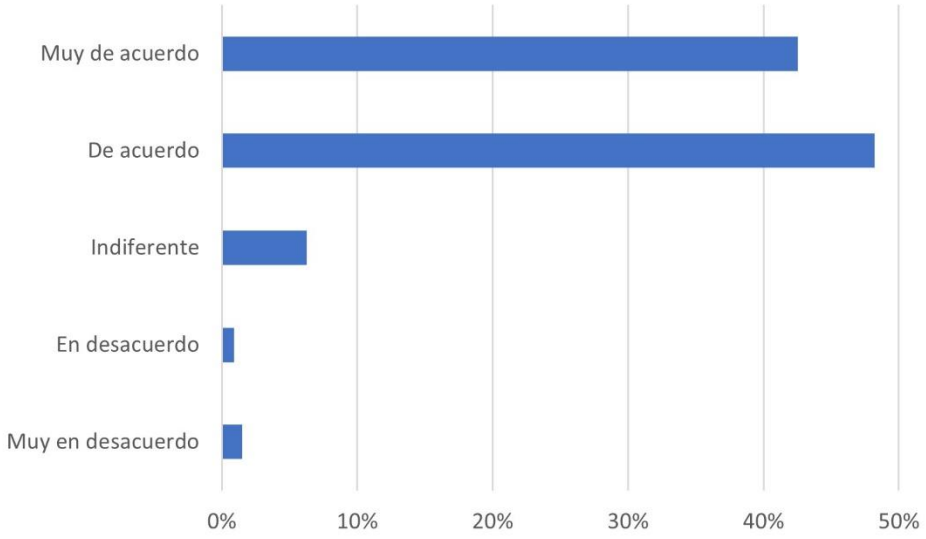


Source: self made

Digital skills

Regarding the role of the teacher in achieving the development of skills, abilities and knowledge in ICT during the transition to the online educational modality, the opinion of the students turns out to be very favorable. A solid 48.8% of the participants indicated that they agreed, while a notable 42.2% expressed that they strongly agreed that these tools are fundamental in the university training process, thus contributing to the acquisition of significant learning (figure 8). This support highlights the positive perception of students towards the essential role of the teacher as a facilitator of the acquisition of digital skills. The recognition of ICT as key elements in the training process underlines the importance of the effective integration of these technologies by educators to enhance the academic and professional development of students in a digital educational environment.

Figure 8. ICT contributes to developing skills and abilities

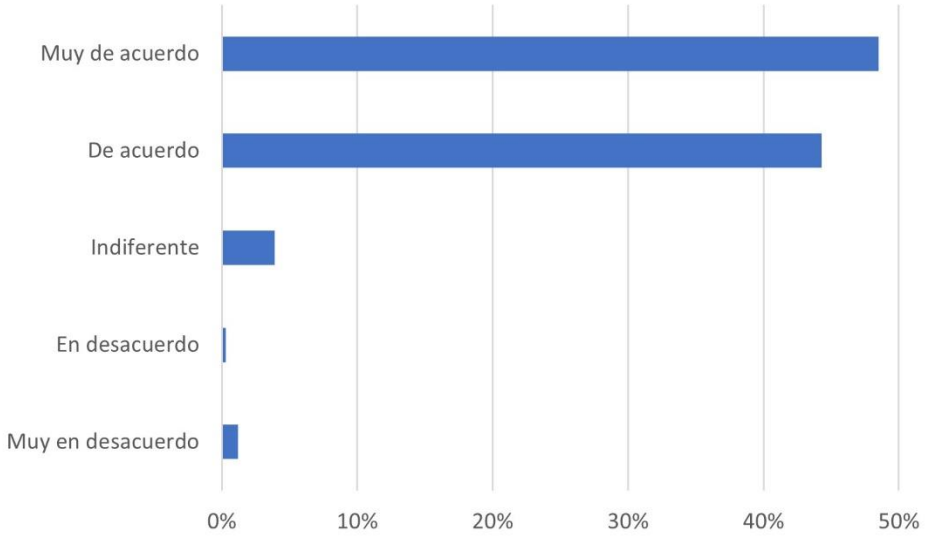


Source: self made

Academic flexibility

During the pandemic, an essential feature in academic activities was the flexibility provided by ICT in terms of space and time. Available and easily accessible, these tools allowed students to interact from the comfort of their homes, workplaces, and even in public spaces. This flexible approach received significant approval, as a solid 94.3% of participants expressed a positive attitude toward this adaptability (Figure 9). This high level of acceptance underlines the importance of the academic flexibility provided by ICT during the distance learning period, reflecting its ability to adjust to various contexts and individual needs. Flexibility in the delivery of content and participation in educational activities through digital platforms emerged as a key factor for the success of online education during the health crisis.

Figure 9. ICTs offer adaptability in space and time



Source: self made

Discussion

One of the most notable findings lies in the positive perception of students about how technologies boosted their academic participation, a result that is similar to the research carried out by Guàrdia *et al* . (2017). In both studies, it is evident that ICT plays a crucial role in promoting participation, commitment and self-regulation among students. This alignment of results reinforces the idea that the effective integration of ICT in educational environments can have a positive and consistent impact on the active involvement of students in their learning processes. The relationship between technology adoption and improved academic engagement underscores the importance of considering effective technological strategies to optimize the educational experience.

Regarding the impact of the use of technological tools on improving the quality of teaching-learning processes, the students' perspective aligns with the findings of Naffi (2020). In his research, Naffi highlights the importance of building objectives, competencies and capacities in educational environments that are characterized by their quality. This parallelism between the results reinforces the notion that the effective integration of technological tools not only translates into a modernization of teaching methods, but also contributes significantly to the substantial improvement of educational quality. Attention to quality in these digital contexts becomes, according to the students' perception, a key factor for achieving academic objectives and developing relevant skills.

Regarding the dimension of technological incorporation, a marked acceptance by students

was observed, evidenced by the imperative need to integrate ICT into educational processes during the past confinement. This phenomenon finds support in the study by Parra (2012), who points out that one of the areas most influenced by technology is school. Specifically, in the context of higher education, there was a notable synergy between students and technologies. This phenomenon is largely attributed to the previous existence of educational platforms and the favorable age of university students, who are in the ideal range to get involved and practice with the technological tools necessary for their future professional development. This pre-existing link with educational platforms and familiarity with ICT contributed to a more fluid and successful adaptation during the distance teaching period.

Regarding the role of ICT as academic support, university students express a positive perspective towards these practices. In their perception, they recognize that, although technology in itself does not guarantee learning, its effectiveness is enhanced when it goes hand in hand with a trained and updated teacher. This approach coincides with the ideas presented by Moreno-Guerrero *et al* . (2020), who highlight the importance of teaching guidance to develop innovative teaching material using various digital platforms. Furthermore, the digital skills component acquires great relevance for students, since they consider it essential in the university training process. This recognition highlights the importance of cultivating digital competencies among students to make the most of the educational potential of ICT.

García Aretio's (2021) approach on the importance of adequate flexibility highlights the need for adaptability in terms of space and time in education. This flexible approach becomes crucial in the post-pandemic stage, where scenarios could arise that make physical presence difficult or even sporadic episodes of isolation. The proposal is to incorporate innovative methods that combine both traditional modalities and distance learning. This strategy seeks to offer solutions to diverse academic training needs and allows educational institutions to address changing challenges and provide a more adaptable and accessible learning environment.

Conclusions

In conclusion, some of the most relevant findings of this study are mentioned, where the main challenges and opportunities that arose with the adoption of digital tools in an online educational model were identified, as well as their repercussions on higher education.

It can be noted, as a first point, that the transition to the virtual modality derived from the pandemic has had a significant impact on academic participation and educational quality. The disparity in the conditions of equipment and knowledge on the different platforms, as well as

connectivity, have accentuated the development of the teaching-learning process.

It is also important to note that university students have experienced challenges in terms of academic flexibility and support due to the conditions imposed by the pandemic. The need to adapt to new tools and platforms required additional effort from students and educational staff.

The inability to access technologies has generated social and economic repercussions, especially in vulnerable groups. The economic crisis derived from the pandemic has led to the irreparable loss of learning for some students, which could result in abandoning classrooms or interrupting their studies, as various studies have already pointed out.

In addition, the pandemic has required training and adaptation by teachers in the use of technological tools for online teaching. The rapid transition to virtual education has required teachers to develop technological skills to interact effectively with students

Despite the challenges, ICT remains essential for online teaching, offering opportunities to enhance academic development, overcome impediments of time and space, and increase connectivity and interaction in education.

In summary, the adoption of ICT as teaching tools in a public university due to the Covid-19 health contingency has generated significant impacts on academic participation, educational quality, academic flexibility and student support. In addition, it has highlighted the importance of teacher training and adaptation, as well as the continued potential of ICT in education.

Future lines of research

Considering the findings and observations presented in the study on the adoption of ICT as teaching tools in a public university due to the health contingency of covid-19, various areas are identified that could be the subject of future research. These areas include the following:

- Explore the long-term impact of the transition to virtual modality on academic participation, educational quality, and support for university students. This could include tracking students throughout their academic journey to assess the ongoing impact of the adoption of digital tools in higher education.
- Investigate disparities in access to technologies and their impact on educational equity. This could include a detailed analysis of the social and economic repercussions of not being able to access technologies, especially for vulnerable groups, and how these disparities affect student learning and retention.
- Explore effective strategies for training and adapting teachers in the use of technological

tools for online teaching. This could include identifying specific training needs and best practices for developing technology skills among educational staff.

These areas of research offer opportunities to expand understanding of the effects of ICT adoption in higher education and to develop effective strategies that improve educational quality and equity in virtual environments.

References

Aguilar , FR (2020). From learning in face-to-face settings to virtual learning in times of pandemic. *Pedagogical Studies* , *46* (3), 213-223. http://dx.doi.org/10.4067/S0718-07052020000300213

Alvarado , ER, Ochoa Mendieta, MA, Ronquillo Murrieta, GV and Sánchez Soto, MA (2019). Importance and use of social networks in education. *Recimundo* , *3* (2), 882-893. https://doi.org/10.26820/recimundo/3.(2).abril.2019.882-893

Brown , C. and Salmi, J. (2020). Putting fairness at the heart of higher education. *University World News. The Global Window on Higher Education.* https://www.universityworldnews.com/post.php?story=20200417094523729

Cabero , J. (2008). Innovation in teacher training and professional development. In J. Salinas (coord.), *Educational innovation and use of ICT* (pp. 83-99) . International University of Andalusia . https://dspace.unia.es/bitstream/handle/10334/2524/innovacioneduc2008.pdf?sequence=1

Castro , JR, Macías Villarreal, JC and González Bandala, DA (2022). *The impact of the COVID-19 pandemic on higher education. Challenges and strategies* . Fontamara Publishing House . https://libros.uat.edu.mx/index.php/librosuat/catalog/view/272/246/899-1

ECLAC -UNESCO. (2020). *Education in times of the COVID-19 pandemic. COVID-19 ECLAC-UNESCO Report* . https://repositorio.cepal.org/bitstream/handle/11362/45904/1/S2000510_es.pdf

Coll , C. (2008). Learning and teaching with ICT: expectations, reality and potential. *Bulletin of the Free Institution of Education* , (72). https://www.educ.ar/recursos/70819/aprender-y-ensenar-con-las-tic-expectativas-realidad-y-potencialidades

García Aretio, L. (2021). COVID-19 and digital distance education: pre-confinement, confinement and post-confinement. *IRIED. Ibero-American Journal of Distance*

Education, 24 (1), 09-32. https://doi.org/10.5944/ried.24.1.28080

Guàrdia , L., Crisp, G. and Alsina, I. (2017). Trends and challenges of e-assessment to enhance student learning in higher education. *IGI Global* , 36-56. https://doi.org/10.4018/978-1-5225-0531-0.CH003

Hernández -Sampieri, R., Fernández-Collado, C. and Baptista, L. (2014). *Research methodology* (6th ed .). McGraw-Hill.

IESALC -UNESCO. (2020). *COVID-19 and higher education. From the immediate effects to the day after. Impact analysis, policy responses and recommendations* . Work documents . https://www.iesalc.unesco.org/wp-content/uploads/2020/04/COVID-19-070420-ES-2-1.pdf

Lara , L. (2002). Analysis of interactive resources in virtual classrooms. *Integration without Barriers in the 21st Century* . http://www.quadernsdigitals.net/datos/hemeroteca/r_43/nr_479/a_6424/6424.pdf

Lloyd , M. (2020). Educational inequalities and the digital divide. In J. Girón (ed.), *Education and pandemic. An academic view* (pp. 115-121). UNAM. https://www.iisue.unam.mx/investigacion/textos/educacion_pandemia.pdf

Mirete Ruiz, A., García-Sanchez, F., and Hernandez Pina, F. (2015). Questionnaire for the study of attitude, knowledge and use of ICT (ACUTIC) in Higher Education. Reliability and validity study. *University Journal of Teacher Training, 29* (2), 75-89. https://www.redalyc.org/pdf/274/27443659006.pdf

Molina -Montalvo, HI, Macías Villarreal, JC and Hernández Fonseca, M. del R. (2023). Evaluating the use of the Microsoft Teams platform in teaching and learning processes during the COVID-19 pandemic at a public university. A student perspective. *IE Journal of Educational Research of the REDIECH* , 14, e1633. https://doi.org/10.33010/ie_rie_rediech.v14i0.1633

Moreno -Guerrero, AJ, López, J., Pozo, S. and Fuentes, A. (2020). Influence of the context on the use of ICT devices in Basic Vocational Training. *EDMETIC, Journal of Media Education and ICT, 9* (1), 149-169. https://doi.org/10.21071/edmetic.v9i1.12195

Naffi , N. (2020). Disruption in and by Centers for Teaching and Learning During the COVID-19 Pandemic: Leading the Future of Higher. *L'Observatoire Internationale sur les Impacts Sociétaux de l'IA et du Numerique and the Government of Québec* . https://cutt.ly/6fQZibh

United Nations Organization (UN) (2020). *Policy Brief: Education during COVID-19 and beyond*. United Nations . https://www.un.org/development/desa/dspd/wp-

content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf

Otero , LC (2020). Digital tools for communication, tele-teaching and educational tele-guidance in times of COVID-19. *AOSMA, 1* , 92-111. http://aosma.es/wordpress/wp-content/uploads/2020/04/00_AOSMA_ESPECIAL.pdf

Otzen , T. and Manterola, C. (2017). Sampling techniques on a study population. *International Journal of Morphology, 35* (1), 227-232. https://dx.doi.org/10.4067/S0717-95022017000100037

Parra , C. (2012). ICT, knowledge, education and technological skills in teacher training. *Nomads, 36* , 145-159.

Ritchey , F. (2006). *Statistics for the social sciences* (2nd ed .). McGrawHill .

Ruiz , C. (2002). *Educational research instruments. Procedures for its design and validation* . CIDEG .

Tennuto , A., Klinoff, M., & Boan, A. (2003). *School for teachers. Encyclopedia of practical pedagogy* . Southern Latin Circle. Lexus.

Tinio , V.L. (2003). ICT in education. *E-Primers for information economy, society and policy* . https://digitallibrary.un.org/record/524544

Zuluaga -Gómez, M. and Valencia-Ortiz, NL (2021). Education in medical schools around the world during the contingency period due to SARS-COV-2. *MedUNAB* , *24* (1), 92-99. https://doi.org/10.29375/01237047.3942

Contribution Role	Author(s)
Conceptualization	Julio César Macías Villarreal (principal) Hugo Isaías Molina-Montalvo (supports)
Methodology	Julio César Macías Villarreal (supports) Hugo Isaías Molina-Montalvo (principal) José Refugio Castro López (supports)
Software	N/A
Validation	Julio César Macías Villarreal (same) Hugo Isaías Molina-Montalvo (same) José Refugio Castro López (same)
Formal Analysis	Julio César Macías Villarreal (principal) Hugo Isaías Molina-Montalvo (supports) José Refugio Castro López (supports)
Investigation	Julio César Macías Villarreal (same) Hugo Isaías Molina-Montalvo (same) José Refugio Castro López (same)
Resources	N/A
Data curation	Julio César Macías Villarreal (same) Hugo Isaías Molina-Montalvo (same) José Refugio Castro López (principal)
Writing - Preparation of the original draft	Julio César Macías Villarreal (principal) Hugo Isaías Molina-Montalvo (supports) José Refugio Castro López (supports)
Writing - Review and editing	Julio César Macías Villarreal (supports) Hugo Isaías Molina-Montalvo (supports) José Refugio Castro López (principal)
Display	Julio César Macías Villarreal (supports) Hugo Isaías Molina-Montalvo (principal) José Refugio Castro López (supports)
Supervision	Julio César Macías Villarreal (principal) Hugo Isaías Molina-Montalvo (supports) José Refugio Castro López (supports)
Project management	Julio César Macías Villarreal (principal) Hugo Isaías Molina-Montalvo (supports) José Refugio Castro López (supports)
Fund acquisition	Julio César Macías Villarreal (same) Hugo Isaías Molina-Montalvo (same) José Refugio Castro López (same)

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467