

Usability and Satisfaction in Digital Environments with ICT for Distance Learning by University Students

Rubén A. More Valencia¹, María G. Albán Suárez¹, Mariela L. Córdova Espinoza¹ and Rosa D. Castro Tesen¹

¹ National University of Piura, Urb. Miraflores S/N, Castilla, Piura, Perú

Abstract

The research arises due to the impact on the teaching and learning processes in digital environments in university education, given that important impacts were generated, one of them being the provisional modality of distance education, given this situation a priori it can be mentioned that the higher the level of usability of information technologies, the higher the degree of satisfaction of those involved, such as teachers, students and authorities. There are key factors in the study that were analyzed as results in which 1057 students participated, so that the development and progress of their education at university level is not truncated, such as the level of use of new information and communication technologies that university students have, finding that 69.73% (737) have a high level, 29.80% (315) regular and only 0.47% (5) a low level. 47% (5) a low level, and the degree of satisfaction of the university students with regard to the new information and communication technologies was observed, finding that 54.49% (576) have a regular level, 35.57% (376) a high level and only 9.93% (105) have a low level of satisfaction. It can be affirmed that the majority of students have a regular level of satisfaction.

Keywords

Teaching and Learning, Virtual Environments, University Education, ICTs, Distance Learning, Distance Learning

1. Introduction

The deleterious impact of the pandemic has engendered a climate of uncertainty within the realm of university education. This situation has precipitated a shift from conventional, face-to-face pedagogical methods towards digital platforms, thereby presenting multifaceted challenges that implicate the continuity of students in their academic pursuits. Moreover, it has necessitated a profound reevaluation of pedagogical strategies by educators who have increasingly embraced digital tools and information and communication technologies (ICTs) characterized by features such as immediacy and hyper-connectivity.

This evolving educational landscape has introduced a salient area of inquiry: the utilization of electronic services for academic learning. Institutions are compelled to harness information technologies to facilitate learning, which invariably entails a comprehensive foray into the domain of e-learning. This shift entails careful consideration of factors including technical infrastructures, computing resources, and platform accessibility, all of which are now integral to students' educational experience. This shift also warrants an examination of the socio-cultural attitudes that influence productivity and convenience [1].

The current reality has underscored a stark digital divide, wherein disparities in access to connectivity, technological resources, and related services among university students have become manifest. Efforts have been made to ameliorate this inequity in the context of public university education in Peru. Initiatives aimed at enhancing pedagogy have included the

JINIS 2023: XXX International Conference on Systems Engineering, October 03–05, 2023, Arequipa, Peru
✉ rmorev@unp.edu.pe (R. More-Valencia); malbans@unp.edu.pe (M. Albán-Suarez); mcordovae@unp.edu.pe (M. Cordova-Espinoza); rcastrot@unp.edu.pe (R. Castro-Tesen)
ORCID 0000-0002-7496-3702 (R. More-Valencia); 0000-0001-8409-3301 (M. Albán-Suarez); 0000-0002-7205-461X (M. Cordova-Espinoza); 0000-0002-0396-2307 (R. Castro-Tesen)



© 2023 Copyright for this paper by its authors.
Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

CEUR Workshop Proceedings (CEUR-WS.org)

provision of physical devices such as computers and internet access to students and educators. However, the efficacy of such efforts has been constrained by administrative policies, which, regrettably, have fallen short of supporting those with limited financial means or residing in remote areas.

In the quest to bridge this divide, it is imperative to recognize that digital access alone is insufficient. The policies implemented at the national level and their execution by universities are fundamentally committed to fostering innovative modes of communication that can extend the reach of education to students, regardless of their geographical location. Additionally, the study of factors that influence the integration of information technologies into the pedagogical process is imperative. Such factors encompass the lifestyles of university students, the time they dedicate to employment and familial responsibilities, the dissonance in learning schedules within digital environments, the dedicated support offered by educators, the empathetic approaches adopted by certain academic disciplines in the realm of community service, and a broader sense of social responsibility. These considerations collectively underscore the imperative of adaptation as a foundational principle in the transition from traditional education to education in a digital milieu [2].

Leveraging information technologies within the framework of digital education introduces novel and intricate challenges. An exemplary case in point is the field of medical professional training, wherein the concept of "protected clinical simulations" or pedagogical exercises has been advocated. These pedagogical endeavors are designed not only to stimulate students' critical thinking but also to imbue them with the motivation to delve deeply into academic literature. Such exploration is oriented toward soliciting and implementing potential solutions through actions, all the while upholding a steadfast commitment to ethical considerations [3], [4].

However, the implementation of these changes must be approached with a cognizant view of the need for uniform and consistent application, mindful of the nuanced distinctions that may arise between public and private universities. Considerations also extend to the nature of courses, whether they predominantly feature theoretical or practical components, as well as the indispensable transition of materials that were once confined to laboratory settings or the physical precincts of the university into the digital realm. These factors are inextricably tied to the socioeconomic profiles of both students and educators, thereby warranting a comprehensive analysis of usability and satisfaction.

In this context, the present study, conducted at the National University of Piura in Peru, endeavors to scrutinize the interplay between the extent of technological integration and the resultant level of satisfaction. This research aims to delineate the patterns of technology utilization, ascertain the degrees of contentment within the digital environment, and evaluate the utility of the various platforms and tools founded on information and communication technologies.

2. Research Study

The onset of "mandatory preventive isolation" precipitated a sweeping transformation in educational institutions across all tiers, compelling a shift toward remote modes of instruction, learning, and training. This rapid transition to an education model reliant on information and communication technologies posed a confluence of challenges, spanning infrastructure, pedagogical strategies, and the imperative evolution of mindsets, both among educators and students. As aptly articulated, this shift "demanded a paradigm shift" [5].

While the pandemic did not give rise to educational disparities, it unequivocally laid bare preexisting inequities, effectively exacerbating them. The imperative to secure livelihoods in the face of economic adversity overshadowed the academic pursuits of many university students. This exigency compelled them to defer crucial decisions, adopting a wait-and-see approach as they grappled with the novel realities of higher education.

The investment in technology access and utilization, although a commendable initiative for some students, proved to be a multi-faceted challenge. The experience, which unfolded in a highly

diverse environment, underscored the profound socio-economic disparities inherent in students' educational choices. Several studies illuminated the struggles of students who had limited connectivity, operated with modest hardware, grappled with subpar signal quality, and were compelled to share their devices with fellow residents, all within environments ill-suited for effective learning. These were the stark realities imposed by the pandemic [6].

2.1. Review of the literature

Facilitating the professional competence of university-level educators, particularly in the context of competence-based problem-solving teaching, presents a distinctive challenge. Such teaching inherently unfolds within specific environments. In many instances, it mandates students' physical presence within scenarios carefully crafted by their instructors. For instance, in fields like medicine, this means engaging with hospitalized patients or outpatient settings, with the guiding presence of their educators. This pedagogical approach hinges on strategies rooted in the university setting, encompassing methods for effective individual or collective work, rotating assignments, and assessment. However, these approaches, intricately linked to physical environments, became unfeasible during the mandatory isolation enforced in response to events like the pandemic. Practical experiences integral to professional training were disrupted due to the imperative of isolating students [7].

The utility of information technologies in the realm of distance learning is manifested through interactions involving both communication and the utilization of applications and programs. These technologies enable synchronous collaboration, with roles shared among educators, students, and the university, supported by technology services, networks, and software applications. However, the overarching objective is not limited to addressing the technical and technological challenges alone. Instead, it encompasses the broader educational and social dimensions, with an emphasis on understanding and addressing vulnerabilities that emerge due to abrupt shifts in the educational and social milieu. Adaptation is essential to well-being in this evolving academic landscape [8].

Information and communication technologies in higher education serve as a foundational framework for pedagogical innovation. They empower both educators and students to effect substantive changes in the teaching and learning processes. This transformation is facilitated by a spectrum of resources, including teaching materials, virtual environments, internet resources, audio tools, blogs, wikis, web quests, forums, chat platforms, messaging systems, videoconferencing, and a range of communication channels. These technologies are not merely tools; rather, they are harnessed to empower students to cultivate skills and competencies that serve as primary objectives within the educational process. Communication channels foster the exchange of ideas and information, resulting in the integration of knowledge through the utilization of information and communication tools [9].

The study of the usability of technological platforms, emerging from pedagogical research, revolves around assessing strategies through a synthesis of data. These strategies involve the modeling of roles, reflective processes, collaborative methods, feedback mechanisms, instructional designs, as well as experiential learning through cases and projects. These models serve as a credible foundation for integrating technology platforms into educational practices. Their viability is gauged in terms of acceptability and adoption levels among educators. Furthermore, the evaluation process extends to gauge the utility and usability of these platforms from the perspective of students [10].

Information and communication technologies, as integral products of the teaching and learning continuum, facilitate processes aligned with the advancement of science. They are harnessed to satisfy the innate human desire for knowledge acquisition, mastery, and results derived from the analysis of information and contextual realities. Their pervasive influence is propelled by the digital era, fundamentally altering the dynamics of how individuals connect, communicate, and manage activities. For contemporary generations, this digital realm has become a natural medium for interaction and communication [11].

The advent of information and communication technologies has catalyzed transformative shifts across various dimensions of human endeavors. These technologies have assumed a pivotal role in the educational landscape, serving as essential tools for the management of information and knowledge. Leveraging technological proficiency, computer platforms, hardware, as well as data, metadata, and information, these technologies permeate research, administrative functions, and academic activities, including shaping institutional directives and university policies. As a consequence, they give rise to novel requisites and responsibilities in the sphere of higher education and within diverse sectors constituting modern society. The ever-increasing dependence on technological tools necessitates adaptive responses to meet evolving demands [12].

Effective teaching with information and communication technologies hinges on core principles, including teacher-student interaction, student collaboration, active learning, prompt feedback, organized planning, positive expectations, and catering to diverse learning styles [13]. Evaluation of technology usage factors encompasses online class preference, real-time accessibility, recorded materials, curricular impacts, equipment availability, and internet access. It also considers students' psychological needs, equipment choices, shared access, study environments, and administrative challenges due to digital communication tools [6]. Learning consists of course activities and content accessibility. Smartphones enhance both, supporting a constructivist learning approach. They enable mobility, real-world engagement, and content interaction through various media while simplifying assessments via audio, video, and mobile-optimized modules [14].

2.2. Related Studies

Research on technology's role in education suggests that factors like performance, effort, and conditions positively influence students' use of digital learning systems. However, social aspects like companionship appear less significant in students' perceptions of these systems [15].

Expectations of performance don't significantly impact students' intentions in digital learning environments. Instead, usability matters greatly. Students see digital platforms as tools that aid academic performance. This involves access to information, effective time management, and economic benefits. To ensure usability, platforms should be user-friendly with simplicity and clarity, facilitating efficient co-educational learning experiences [1].

Integrating technology into education calls for a coherent shift from face-to-face to distance learning. This transition requires standardizing activities and reconfiguring the organizational structure. Technological enhancement is vital for information technologies' usability, fostering intuitive communication and efficient processes for student course outcomes [2].

Collaboration and teamwork in digital environments must prioritize quality, ethics, and transparency, regardless of students' geographical locations. Achieving this involves records of meetings, institutional emails, accessible information, performance tracking, and dialogic follow-ups. Critical reflection and autonomy in tasks and objectives play a significant role in enhancing the usability of information technologies [16].

The study in China explored the digital divide in online and distance learning, examining indicators such as family income, professional status, and equipment and network conditions. It revealed that adaptability in the new teaching and learning environment is influenced by economic advantages, but digital skills remain crucial. These findings emphasize the potential for information technologies to exacerbate existing inequalities in usability, skills, and geographical access [17].

The shift from face-to-face to digital education, especially during the pandemic, was assessed through an informetric study. It highlighted the benefits of information and communication technologies in education for socio-productive development and management indicators in higher education. This transition aims to extend technology beyond teaching, focusing on accessibility, visibility, and interoperability for a vulnerable educational environment [18].

The integration of ICT applications in education necessitates students' familiarity with these tools, given their future roles in the workforce and job market. Educators and students

collaboratively use ICT platforms for various learning activities, including analyzing academic materials and creating shared content. The use of computer applications contributes to the establishment and utilization of educational networks, particularly significant for higher education [14].

Studies examining the theoretical perspectives held by learning communities on virtual education and digital environments in universities shed light on the transformative impact of new information technologies. The research, employing web documents and interviews, highlights the societal need for structural changes to enhance quality of life. This shift toward a new academic reality introduces novel paradigms, revolutionizing educational systems, university teaching, and social governance [12].

Adapting clinical learning practices in professional fields like medicine necessitates the temporary integration of various digital tools. A review of full-text articles and hermeneutic reviews underscores the importance of considering past actions to address adverse situations such as confinement and limitations in accessing face-to-face learning. It signifies an ongoing process of adaptation to our evolving reality [19].

Presenting the current opportunities and challenges in the realm of distance education necessitates the development of solutions that facilitate traceability and effective use of digital environments at a Latin American scale. Academic studies in distance education demand methodological approaches encompassing bibliographic analysis, exploratory reviews of teaching experiences, and experimental trials of new tools and practices. Distance education holds relevance in both pandemic and post-pandemic scenarios, providing a secure means of continuing education without jeopardizing the safety of teachers and students in face-to-face settings [20].

Integrating information and communication technologies (ICT) into higher education reveals that technology alone cannot fulfill academic purposes. It underscores the need for students and teachers to contribute their ideas, activities, research, and societal responsibility. Encouraging the use of ICT complements academic exercises, fostering comprehensive educational experiences [21].

The emergence of ICTs simplifies activities, saving time and enhancing information access in current teaching methods. It offers easy, self-directed, or collaborative experiences without physical mobilization and represents a valuable addition to curricula [22].

Information and communication technologies (ICTs) and learning and knowledge technologies (LKTs) play a crucial role in advancing online and distance education in higher education. Literature reviews and analysis of experiences are essential, especially in situations of isolation or immobility. To effectively implement such technologies, teacher training is critical, emphasizing balanced and active methodologies [23].

The strategy for promoting academic activities in digital environments encompasses five key aspects: security to mitigate pandemic-related risks, training, learning management, and comprehensive support for mental health. It involves the implementation of information repositories updated daily, accessible to students through online transmission platforms, digital classrooms, and regular updates [24].

Teachers establish tacit tools within communication platforms, such as Google Drive, individual and group emails, or WhatsApp chats. These tools organize didactic materials, and bibliographic resources, and facilitate academic innovation, driven by both academic and research directions [25].

Teachers' digital competencies in implementing distance education require activities like organizing digital information, sharing content through virtual media, editing digital materials, and safeguarding personal data. Student-focused competencies revolve around communication, collaboration, and problem-solving. While few teachers reach innovative competency levels, strategies must address prevention and feasibility to ensure the quality of educational services in a digital environment [26][27].

2.3. Methodology

The design of the research work is non-experimental, cross-sectional, and sectional correlational since the variables and indicators will not be manipulated at any time as study concepts, the use of deductive cognitive analysis allows the relationship to be schematized by association and is presented in a continuous situational phenomenon, i.e. given the pandemic situation, the use of technologies in the academic teaching processes is continued.

The techniques used in the research project are surveys and their corresponding instrument, the questionnaire. The duality manifested proposes that the questionnaire corresponds to evaluate the level of usability, usefulness, and degree of satisfaction of the new information and communication technologies, which was adapted for research purposes for each of the variables based on existing studies on the concepts as variables of study, applying to 1057 students, duly registered in enrollment and who are studying or have studied academic cycle during the year 2021 at the National University of Piura (UNP), and who agreed to participate in the study.

For their selection, a probability sample was taken into account; that is, the subjects that will make up the sample were selected randomly; likewise, it was considered to use stratified random sampling with proportional allocation to students enrolled in the second semester of the year 2021 of all professional schools of the National University of Piura, using the following formulation:

$$n = \frac{9\,693 * 1.96^2 * 0.5 * (1 - 0.5)}{(9\,693 - 1) * 0.5^2 + 1.96^2 * 0.5 * (1 - 0.5)}$$

Where Z is the value of the standard normal distribution table, at a confidence level of 95%, whose value is 1.96 (Z=1.96), P is the proportion of the degree of satisfaction with the new information and communication technologies, with the value of 50% (P = 0.5), E is the maximum accepted estimation error of 5% (E = 0.05) and N = 9 693 is the population of UNP students (N = 9 693). Therefore, the sample selected was n of 1057 enrolled students.

The reliability of the questionnaires was evaluated using Cronbach's Alpha method, in a pilot sample of 42 students, which resulted in a reliability of 0.843 for 12 questions of the questionnaire for the variable level of usability of information and communication technologies, and a reliability of 0.837 for the variable degree of satisfaction with ICT with respect to 08 questions of the questionnaire, thus indicating that both questionnaires according to the variables evaluated are reliable and are prepared to obtain the necessary information.

2.4. Results of the Research

Table 1 shows the level of use of new information and communication technologies by university students, showing that 69.73% (737) have a high level, 29.80% (315) a regular level and only 0.47% (5) a low level. In view of this, we can affirm that the majority of students at the University have a high level of ICT use. We observed the degree of satisfaction of the university students with regard to the new information and communication technologies, and found that 54.49% (576) have a regular level, 35.57% (376) a high level and only 9.93% (105) have a low level of satisfaction. Therefore, in view of the results obtained, it can be affirmed that the majority of students have a regular level of satisfaction.

Table 1
Relationship between Satisfaction and Usability of ICTs

		Degree of satisfaction							
		Low		Regular		High		Total	
		N	%	N	%	N	%	N	%
Level: Usability of Information and Communication Technologies	Low	2	0.19%	3	0.28%	0	0.00%	5	0.47%
	Regular	43	4.07%	176	16.65%	96	9.08%	315	29.80%
	High	60	5.68%	397	37.56%	280	26.49%	737	69.73%
		105	9.93%	576	54.49%	376	35.57%	1057	100.00%

Spearman's coefficient as an inferential result of the study shows that the relationship is 0.115, a value that indicates that the relationship is low and positive, but given the p-value of 0.000 ($p < 0.05$), the relationship is significant. It is accepted that there is a significant relationship between the level of use and the degree of satisfaction with information and communication technologies at the National University of Piura and, likewise, it can be inferred that the greater the use of information technologies implemented at the university, the higher the level of satisfaction and vice versa.

In Table 2, usability and usefulness are significantly valued for the use of devices with 71.5% (756), and to a lesser extent for factors related to communication 37.8% (400), and its usefulness in academic activities not necessarily related to university content. The usefulness of a digital environment for searching for information is regularly 44.2% (467).

As tools, the most significant evaluation is the platform used by the University with 78.3% (828), followed by presentation activities at 51% (539), it is interesting to review the descriptive descriptions with low levels of usability, tools for the organization of information 10.6% (112), the storage of information 26.5% (280) and that it is used for cooperative work 31.3% (331).

Table 2
Usability of university students' ICT-enabled digital environment for distance learning.

Level: Usability of ICT	Never		Rarely		Sometimes		Almost always		Always	
	N	%	N	%	N	%	N	%	N	%
Devices	3	0,3%	4	0,4%	37	3,5%	257	24,3%	756	71,5%
Communication	2	0,2%	27	2,6%	148	14,0%	480	45,4%	400	37,8%
Digital environment classes	6	0,6%	18	1,7%	88	8,3%	291	27,5%	654	61,9%
Information search	3	0,3%	18	1,7%	132	12,5%	467	44,2%	437	41,3%
Non-University Courses	36	3,4%	97	9,2%	270	25,5%	390	36,9%	264	25,0%
Tools										
Social Networking	10	0,9%	63	6,0%	258	24,4%	384	36,3%	342	32,4%
Google Platform	3	0,3%	3	0,3%	29	2,7%	194	18,4%	828	78,3%
Tools other than UNP	219	20,7%	237	22,4%	332	31,4%	167	15,8%	102	9,6%
Information Organization	134	12,7%	266	25,2%	374	35,4%	171	16,2%	112	10,6%
Information Storage	18	1,7%	110	10,4%	308	29,1%	341	32,3%	280	26,5%
Presentation of information	3	0,3%	14	1,3%	112	10,6%	389	36,8%	539	51,0%
Collaborative work	15	1,4%	70	6,6%	277	26,2%	364	34,4%	331	31,3%

Table 3**Satisfaction with the ICT-enabled digital environment of university students for distance learning.**

Level of Satisfaction	Never		Rarely		Sometimes		Almost always		Always	
	N	%	N	%	N	%	N	%	N	%
Situation own problems	53	5,0%	17	1,6%	472	44,7%	54	5,1%	461	43,6%
Support with devices	116	11,0%	225	21,3%	542	51,3%	46	4,4%	128	12,1%
Support with accessibility	125	11,8%	218	20,6%	524	49,6%	57	5,4%	133	12,6%
Digital environment	98	9,3%	36	3,4%	411	38,9%	92	8,7%	420	39,7%
Academic performance	87	8,2%	26	2,5%	353	33,4%	73	6,9%	518	49,0%
Communicate verbally device	167	15,8%	42	4,0%	323	30,6%	92	8,7%	433	41,0%
Visually present device	228	21,6%	72	6,8%	341	32,3%	77	7,3%	339	32,1%
Understand interim environment	50	4,7%	25	2,4%	368	34,8%	81	7,7%	533	50,4%

In table 3, the satisfaction for affectation of the digital environment with ICT of university students for distance learning, for a little more than half of the students, there was a satisfaction recognizing that the situation is provisional 50.4% (533), that the academic performance and has a high positive affectation in 49% (518) students, while the support of the institution with devices.

As an affectation for satisfaction was regular in 51.3% (542), and for accessibility is 49.6% (524), this is relevant for correspondence are defined by accessibility and having devices.

2.5. Discussions and Conclusions

Adaptations were found in communication methods, including synchronous and asynchronous connectivity, which the university had to adjust, manage and organize. These adaptations extended to aspects such as examinations, use of laboratories, social engagement, access to books and collaborative work, encouraging interactions between students and teachers. These interactions were designed not only to elucidate the purpose and effects of socio-productive development but also to stimulate experimentation and knowledge generation through synergy. The evaluation of information technology usability reveals the successful accomplishment of various roles, including managing and providing feedback on results, all in alignment with the university's curriculum matrix. Furthermore, this extends to non-university academic activities across different learning domains, effectively achieving the goal of usability. The university's strategic planning, coupled with support from social networking media, significantly contributed to the success of the distance learning system [1], [8], [16].

Teamwork serves as a pivotal behavioral intention in the digital environment, allowing students to leverage their digital skills and expand their competencies in information access. Proficiency in organizing and storing information significantly enhances academic feedback, extending beyond a single course per semester. Students accumulate iterative and incremental material, fostering new knowledge and critical problem-solving in case-based and project-oriented scenarios. This iterative process not only facilitates academic feedback but also provides an institutional advantage.

However, challenges persist, primarily related to limited access and geographical constraints caused by internet connectivity issues. These challenges have been partially addressed through asynchronous access [15][17]. To ensure sustained usability and adaptation, formal communication is vital. It's noteworthy that educators have explored non-formal digital media, such as Facebook, WhatsApp, and Gmail, to complement the institution's proposed platform. They've created social network groups for direct communication, tracking course progress, and addressing student queries.

Nonetheless, the formal and direct use of information technologies for adaptation remains somewhat limited. Its primary function has been providing scientific information to support teachers' content discussions. Students have also made use of information organizers, with limited additional activities, mainly in specialized fields like engineering and social sciences [14][18].

Technology alone is not enough to fulfill educational purposes. Both students and teachers must actively contribute and feel comfortable expressing their ideas, which can be influenced by the quality of technology components such as microphones and cameras used for digital communication in classes. Half of the students' understanding of the digital environment reflects a provisional nature, which is reflected in their regularly expressed satisfaction levels. Teachers play a crucial role in adapting, modifying, and providing feedback on methodologies, extending beyond content availability to collaborative tools such as the Google platform.

The analysis covers the challenges that students face in adapting to various platforms and applications, which can require significant time and effort to fully participate in university course activities. Technology also affects other aspects of daily life, such as its relevance to employment, which limits overall satisfaction, particularly for students and their families. Devices with applications, including computer use, become increasingly important, especially for students seeking employment during a pandemic. The study suggests that the learning environment is crucial for students, as it aligns with societal and individual needs. This leads to social development through the utilization and satisfaction with information technologies, even though these technologies are artificial constructs containing content. While students engage with these materials through reading, practice, and application, the need for teacher guidance and consultation remains integral, signifying a shift in the education paradigm with the integration of information technologies.

The study emphasizes the importance of using and learning from information technology platforms for academic activities while addressing information security concerns, including assessment communications, data references, and information management. This urgency to use technology was driven by the need to reduce the risk of contagion. Teacher training, the learning management of educators, and university actions have evolved to adapt to this new digital environment, necessitating comprehensive care and a review of course contents.

The study's findings suggest that the pandemic has led to an increase in the use of information technologies in universities. The university's pedagogical models have helped most students become proficient in using these technologies. This, in turn, has facilitated the transition to the digital environment for various professional careers. The models have also encouraged responsibility and collaborative group experiences in the teaching-learning process. Additionally, both synchronous and asynchronous communications have proven to be useful. Effective information and knowledge management have the potential to address scientific research within the university environment and influence the degree of satisfaction among university students regarding new information and communication technologies. The satisfaction levels were generally regular, reflecting the diverse aims and purposes of achieving competencies required by the university. The process of adaptation with technological tools allowed for social appropriation, promoting institutionalized spaces.

In order to improve satisfaction levels and overcome limitations, it is crucial to maintain digital platforms that are easily accessible and offer diverse tools and functionality. These platforms should include forums, written debates, audio and video options, and teacher-led video conferences, which can positively impact students as active participants in societal changes. The challenges faced by teachers and students, such as limited access and resource constraints, have resulted in limitations in technology usage that have affected satisfaction levels. However, the study highlights the significant efforts made by academic authorities and university support in realizing the potential of information technologies. To sustain the use of digital communication and information tools, continuous work is necessary, with a focus on the practical application of technology as knowledge to enhance the quality of the teaching-learning process in the university context.

3. References

- [1] Y. H. S. Al-Mamary, «Understanding the use of learning management systems by undergraduate university students using the UTAUT model: Credible evidence from Saudi Arabia», *International Journal of Information Management Data Insights*, vol. 2, n.o 2, p. 100092, nov. 2022, doi: 10.1016/j.jjime.2022.100092.
- [2] E. A. Rosario Pacahuala, A. R. Medina Gamero, y J. I. Sánchez Pimentel, «Desafíos de la educación universitaria de la salud ante la covid-19», *Educación Médica*, vol. 22, p. S30, may 2021, doi: 10.1016/j.edumed.2020.09.007.
- [3] H. Peña-Martínez y M. López, «La pandemia de la COVID-19: el cataclismo del 2020 para la educación médica tradicional», *Educación Médica*, vol. 22, p. S39, may 2021, doi: 10.1016/j.edumed.2020.11.006.
- [4] R. F. Beltrán Gómez, «¿Cuál será el mayor legado de la pandemia por COVID-19 en materia de educación?», *Educación Médica*, vol. 22, pp. S34-S35, may 2021, doi: 10.1016/j.edumed.2020.09.017.
- [5] D. Vásquez, «Ventajas, desventajas y ocho recomendaciones para la educación médica virtual en tiempos del COVID-19: Revisión de Tema», *CES Medicina*, vol. 34, pp. 14-27, jun. 2020, doi: 10.21615/cesmedicina.34.COVID-19.3.
- [6] A. Pires y A. Pires, «COVID-19 y la educación superior en Brasil: usos diferenciados de las tecnologías de la comunicación virtual y las desigualdades educativas», *Educación*, vol. 30, n.o 58, pp. 83-103, ene. 2021, doi: 10.18800/educacion.202101.004.
- [7] J. Millán Núñez-Cortés, «COVID-19 por SARS-Cov2 también ha afectado a la Educación Médica», *Educación Médica*, vol. 21, n.o 4, pp. 261-264, jul. 2020, doi: 10.1016/j.edumed.2020.06.001.
- [8] B. Klusmann, M. Trippenzee, M. Fokkens-Bruinsma, R. Sanderman, y M. J. Schroevers, «Providing emergency remote teaching: What are teachers' needs and what could have helped them to deal with the impact of the COVID-19 pandemic? », *Teaching and Teacher Education*, vol. 118, p. 103815, oct. 2022, doi: 10.1016/j.tate.2022.103815.
- [9] M. R. Q. Arteaga, G. A. S. Gonzales, K. M. Zúñiga, y F. J. T. Arias, «Impacto De Las Tics En La Educación Superior En El Ecuador», *UNESUM-Ciencias. Revista Científica Multidisciplinaria*. ISSN 2602-8166, vol. 5, n.o 1, Art. n.o 1, 2021, doi: 10.47230/unesciencias.v5.n1.2021.238.
- [10] G. Knezek, R. Christensen, A. Smits, J. Tondeur, y J. Voogt, «Strategies for developing digital competencies in teachers: Towards a multidimensional Synthesis of Qualitative Data (SQD) survey instrument», *Computers & Education*, p. 104674, nov. 2022, doi: 10.1016/j.compedu.2022.104674.
- [11] J. L. C. Delgado, A. G. Chávez, y O. A. M. Molina, «El conectivismo y las TIC: Un paradigma que impacta el proceso enseñanza aprendizaje», *Revista Scientific*, vol. 4, n.o 14, pp. 205-227, 2019.
- [12] M. Morales Torres et al., «Entornos virtuales desde la ontología de los nuevos saberes de la educación superior en tiempos de pandemia covid-19», *Revista Universidad y Sociedad*, vol. 13, n.o 3, pp. 301-307, jun. 2021.
- [13] S. Alonso-García, I. Aznar-Díaz, M.-P. Cáceres-Reche, J.-M. Trujillo-Torres, y J.-M. Romero-Rodríguez, «Systematic Review of Good Teaching Practices with ICT in Spanish Higher Education. Trends and Challenges for Sustainability», *Sustainability*, vol. 11, n.o 24, Art. n.o 24, ene. 2019, doi: 10.3390/su11247150.
- [14] J. C. Yturalde Villagómez, J. E. Trejo Alarcón, D. A. Chiquito Peñaranda, y W. A. Rodríguez López, «El empleo de las aplicaciones de las tecnologías de la información y las comunicaciones en el proceso enseñanza-aprendizaje en la educación superior.», *Dilemas contemporáneos: Educación, Política y Valores*, mar. 2020, doi: 10.46377/dilemas.v34i1.2218.

- [15] A. Alharbi et al., «Identification of critical factors affecting the students' acceptance of Learning Management System (LMS) in Saudi Arabia», *International Journal of Innovation*, vol. 9, n.o 2, Art. n.o 2, ago. 2021, doi: 10.5585/iji.v9i2.19652.
- [16] M. A. Barros-del Río, C. López Nozal, y B. Mediavilla-Martínez, «Practicum management and enhancement through an online tool in foreign language teacher education», *Social Sciences & Humanities Open*, vol. 6, n.o 1, p. 100273, ene. 2022, doi: 10.1016/j.ssaho.2022.100273.
- [17] C. Guo y B. Wan, «The digital divide in online learning in China during the COVID-19 pandemic», *Technology in Society*, vol. 71, p. 102122, nov. 2022, doi: 10.1016/j.techsoc.2022.102122.
- [18] A. J. Paredes Chacín, A. Inciarte González, y D. Walles Peñaloza, «Educación superior e investigación en Latinoamérica: transición al uso de tecnologías digitales por Covid-19», *Revista de ciencias sociales*, vol. 26, n.o 3, pp. 98-117, 2020.
- [19] E. Vergara de la Rosa et al., «Educación médica a distancia en tiempos de COVID-19», *Educación Médica Superior*, vol. 34, n.o 2, jun. 2020, Accedido: 15 de enero de 2022. [En línea]. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_abstract&pid=S0864-21412020000200025&lng=es&nrm=iso&tlng=en
- [20] A. C. Umaña-Mata, «Educación Superior en Tiempos de COVID-19: oportunidades y retos de la educación a distancia», *Innovaciones Educativas*, vol. 22, n.o Especial, Art. n.o Especial, oct. 2020, doi: 10.22458/ie.v22iEspecial.3199.
- [21] D. F. Poveda-Pineda, J. E. Cifuentes-Medina, D. F. Poveda-Pineda, y J. E. Cifuentes-Medina, «Incorporación de las tecnologías de información y comunicación (TIC) durante el proceso de aprendizaje en la educación superior», *Formación universitaria*, vol. 13, n.o 6, pp. 95-104, dic. 2020, doi: 10.4067/S0718-50062020000600095.
- [22] M. R. Padilla Vargas, E. del C. Mullo Romero, M. R. Padilla Vargas, y E. del C. Mullo Romero, «Las tecnologías de la información y la comunicación a través de la educación superior. Su incorporación en las investigaciones turísticas», *Revista Universidad y Sociedad*, vol. 12, n.o 2, pp. 281-286, jun. 2020.
- [23] J. R. Guerrero Jirón, H. A. Vite Cevallos, J. M. Feijoo Valarezo, J. R. Guerrero Jirón, H. A. Vite Cevallos, y J. M. Feijoo Valarezo, «Uso de la tecnología de información y comunicación y las tecnologías de aprendizaje y conocimiento en tiempos de Covid-19 en la Educación Superior», *Conrado*, vol. 16, n.o 77, pp. 338-345, dic. 2020.
- [24] R. A. More Valencia, J. M. Tume Ruíz, A. T. Rangel Vega, y T. R. Correa Calle, «Evaluation of consequences and perceived solutions for academic stress due to non-face-to-face teaching with remote communication in regular basic education students», presentado en CISCi 2022 - Vigésima Primera Conferencia Iberoamericana en Sistemas, Cibernética e Informática, Decimo Noveno Simposium Iberoamericano en Educacion, Cibernética e Informática - Memorias, 2022, pp. 86-91. doi: 10.54808/CISCi2022.01.86.
- [25] J. N. Reynés Manzur et al., «Gestión del aprendizaje en tiempos de covid-19», *Acta Pediátrica de México*, vol. 41, n.o 4S1, Art. n.o 4S1, jun. 2020, doi: 10.18233/APM41No4S1ppS137-S1432074.
- [26] R. A. M. Valencia y R. C. Morocho, «Professional updating based on design thinking and technological capabilities for innovation in graduates of engineering schools of Piura in 2019», presentado en CICiC 2020 - Decima Conferencia Iberoamericana de Complejidad, Informática y Cibernética, Memorias, 2020, vol. 1, pp. 158-163.
- [27] J. Martínez-Garcés y J. Garcés-Fuenmayor, «Competencias digitales docentes y el reto de la educación virtual derivado de la covid-19», *EDUCACION*, vol. 22, n.o 39, Art. n.o 39, jul. 2020, doi: 10.17081/eduhum.22.39.4114.