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Effect of ICTs on customizing learning in the context of higher education

Efecto de las TIC en la personalización del aprendizaje en el contexto de la enseñanza superior

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Abstract

In today's world, ICTs have become essential for the daily activities of humanity. The challenges brought about by recent events, such as pandemics and armed conflicts, have further highlighted their importance, particularly within higher education institutions. ICTs have been integrated into these institutions with greater emphasis, enabling them to adapt dynamically to the evolving needs of students. However, examining the impact of ICTs on the personalization of university students' learning reveals both advantages and drawbacks, as noted in several prior studies. For this reason, this bibliographic article was developed to analyze these perspectives in depth, focusing on the positive and negative aspects of ICTs' influence on personalized learning for university students. Additionally, it explores the future challenges anticipated in the educational context, particularly concerning student learning and retention. This work offers a comprehensive overview, involving both teachers and higher education students as key participants in the modern digital era.

Keywords: Technologies for Information and Communication (ICTs); Tertiary Education; Customized Learning; Academic Challenges.

Resumen

En el mundo actual, las TIC se han vuelto esenciales para las actividades cotidianas de la humanidad. Los retos planteados por acontecimientos recientes, como las pandemias y los conflictos armados, han puesto aún más de relieve su importancia, sobre todo en las instituciones de enseñanza superior. Las TIC se han integrado en estas instituciones con mayor énfasis, permitiéndoles adaptarse dinámicamente a la evolución de las necesidades de los estudiantes. Sin embargo, examinar el impacto de las TIC en la personalización del aprendizaje de los estudiantes universitarios revela tanto ventajas como inconvenientes, como se ha señalado en varios estudios anteriores. Por este motivo, este artículo bibliográfico se ha desarrollado para analizar en profundidad estas perspectivas, centrándose en los aspectos positivos y negativos de la influencia de las TIC en el aprendizaje personalizado de los estudiantes universitarios. Además, explora los desafíos futuros que se anticipan en el contexto educativo, particularmente en lo que respecta al aprendizaje y la retención de los estudiantes. Este trabajo ofrece una visión de conjunto, implicando tanto a los profesores como a los estudiantes de educación superior como participantes clave en la era digital moderna.

Palabras clave: Tecnologías de la Información y la Comunicación (TIC); Educación Terciaria; Aprendizaje Personalizado; Retos Académicos.

1. INTRODUCTION

Information and Communication Technologies (ICT) transform multiple facets of human life, including the field of education. Within universities, these technologies facilitate the adoption of more adaptable learning methods designed to meet the unique needs of each student, a practice referred to as personalized learning. This approach involves customizing the educational experience to align with individual students' traits, interests, and learning speeds, fostering greater engagement and enhancing academic outcomes.

From the dawn of humanity, curiosity has been an inherent trait that has driven progress along the evolutionary journey. This innate quality has propelled humanity to consistently innovate, creating tools that simplify and enhance daily tasks. Human evolution represents a vast collection of pivotal events that have shaped the society we navigate today, marked by transformative changes that have ensured our survival and ability to adapt to an ever-changing world.

Historians assert that humanity has successfully overcome adverse situations, paving the way for the improved quality of life we experience today. However, significant change necessitates a period of adaptation, which can vary in duration depending on the accessibility and practicality of the new tool or method. Presently, the incorporation of information and communication technologies into higher education has raised considerable expectations. While these technologies bring convenience, they also require an adjustment phase, highlighting those capable of adapting. As the technological landscape expands rapidly, permeating every aspect of life—from education to work to daily living—adapting to the changes it brings remains the only viable approach.

In recent years, global events have significantly shifted the balance in favor of information and communication technologies (ICT). Individuals who previously operated within traditional routines were compelled to adapt their work and studies to digital tools. In light of this, this article explores various epistemological perspectives from authors who have analyzed the impact of ICT, particularly in the field of education, with a specific emphasis on the university setting.

Personalized learning through ICT leverages digital tools to create dynamic, accessible, and collaborative educational environments. These tools include online learning platforms, educational applications, simulations, social networks, and other technologies that enable students to access tailored educational resources, engage in interactive activities, and receive immediate feedback.

The integration of ICT in personalized learning also brings notable challenges, including the necessity for robust technological infrastructure, comprehensive teacher training, and equitable access to these tools. Addressing these factors is crucial to optimizing the benefits of ICT in university education.

This study aims to examine the impact of Information and Communication Technologies (ICT) on personalized learning within the university setting, focusing on the opportunities, challenges, and strategies that can foster educational development tailored to individual student needs. The central question driving this research is: How do Information and Communication Technologies (ICT) influence personalized learning in the university context, and what are the primary barriers and opportunities involved in this process?

2. METHODOLOGY

Information Collection

To carry out this bibliographic study, a thorough search for documented information was conducted within technological repositories of journals such as Scielo, Scopus, PubMed, and Web of Science. Keywords such as higher education, learning, technology, technological tools, perception of technologies, use of technologies, and information age were utilized to identify relevant documents. These sources were selected for their pertinence to the topic and their recent publication dates, making them significant for addressing the study's subject matter.

Information Extraction

To ensure clear and accurate information extraction, specific criteria were established to identify works directly relevant to the topic. A review matrix was designed and implemented to systematically record the necessary data for the article. Documents lacking reliable or precise information were excluded. The parameters for determining reliable sources included alignment between the objectives of this article and those cited, the methodologies employed, the effects observed, and, most importantly, the conclusions derived from prior research. A qualitative synthesis methodology was used to analyze sequences and trends in the gathered data, focusing on the influence of information and communication technologies on the personalization of learning, specifically among university students.

Synthesis of Results

To synthesize the findings obtained through the matrix comparison, the conclusions of the selected articles were integrated and cross-compared. This process facilitated the identification of key themes aligned with the study's focus while highlighting differences in the methodological approaches

employed by various authors. Special emphasis was placed on studies involving technological tools, including artificial intelligence, due to their relevance in advancing personalized learning.

Research Demarcation

To ensure the study's effectiveness, specific limitations were established to avoid an overly broad scope. The research considered the availability and accessibility of various information sources, databases, and prior studies, which allowed for the collection of substantial data. However, without defined boundaries, the quality of the results could have been compromised. As such, the study prioritized recently published works that provided cutting-edge insights into the educational field. Information from the last five years (2019 to the present) was selected, as this period included the most relevant developments. Studies unrelated to the influence of ICTs on personalized learning for university students were excluded, even if they addressed adjacent topics like telecommuting. Additionally, to maintain alignment with the study's objectives, the focus remained on the university student population, excluding information on other educational levels such as primary or secondary education. The demarcation also ensured that only documents adhering to similar methodologies were included, preserving the integrity and essence of the research.

Given that the study concentrated on a specific experimental unit, studies not aligned with this unit were excluded. While ICTs have influenced all educational levels (primary, secondary, and university), the information gathered encompassed these three areas. However, the primary focus of the study was on the university community. Finally, to preserve the study’s focus, the research boundary specifically targeted documents that did not include primary data and adhered to the same methodology.

3. RESULTS

To develop a comprehensive dissertation on the impact of implementing communication and information technologies in personalizing learning within the university setting, a documentary comparison matrix was created and utilized, incorporating the selected studies. A total of 15 articles addressing the topic were reviewed, providing substantial information aligned with the same objective. The influence of information and communication technologies on personalizing learning for university students is clear, as it undeniably offers an enhanced method for achieving higher levels of knowledge.

In order to draw these conclusions, the articles were thoroughly analyzed, highlighting crucial information that complemented the direction of the study, all facilitated by the matrix comparison presented below. The documentary

comparison matrix proved to be a valuable and flexible tool for conducting this type of research, allowing for a well-organized and evidence-based comparison of both objective and subjective perspectives from various authors. This method laid the solid groundwork for the current research. Below is the comparison matrix related to the topic under study:

Table 1:

Analysis of Documented Information Using a Matrix.

No.	Title	Author(s)	Year	Abstract	DOI
1	Artificial Intelligence and its Implications in Higher Education	Fernández, Yolvi Fernández, Luis Aburto, Luzmila	2019	This article discusses the new challenges universities must address due to the integration of technology and the advantages it offers for personalized learning.	10.2051 1/pyr20 19
2	Preparing Students for Generation Z: Considerations on 3D Printing Curriculum TT - Getting Ready for Generation Z Students - Considerations on 3D	Popescu, Diana Popa, Diana Cotet, Beatrice	2019	The authors indicate that personalized learning emphasizes the importance of teachers being part of Generation Z or digital natives, enabling education to be improved through feedback.	10.20511/pyr201 9
3	The Challenge of New Technologies: The Use of the Virtual Classroom and its Influence on Academic Performance	Gómez, Katherine	2019	Katherine Gómez states that the impact of technologies in the university setting motivates educators to stay more current with their knowledge and create more tailored teaching methods for students.	10.33936/rehuso. v4i3.2136
4	Problem Solving with Technology in a Collaborative Learning Environment using Wiki in Secondary Education	Calle-Álvarez, Gerzon Yair Agudelo-Correa, Iván Darío	2019	The study seeks to describe the process by which higher education students address problems using technology in a collaborative learning setting facilitated by a wiki.	10.22335/rlct.v11 i2.876
5	Technological Tools in the Teaching-Learning Process in Higher Education Students	Molinero, María del Carmen Chavez Morales, Ubaldo	2019	The aim of this study was to explore the technological tools most commonly used by university students in higher education institutions and to examine how these tools impact their educational experience.	10.23913/ride.v1 0i19

6	Higher Education in Blended Modality: Strengths and Weaknesses of its Implementation	Benítez González, MC	2019	This article examines the advantages and challenges of delivering higher education in a blended format through the use of ICT and the Internet.	10.18004/ucsa/2409-8752/2019
7	TPACK Model: A Means to Innovate the Educational Process Considering Data Science and Machine Learning?	Salas-Rueda, Ricardo Adán	2019	This study shows that the outcomes of machine learning (with 50%, 60%, and 70% training) support the conclusion that the use of information and communication technologies enhances the teaching and learning process.	10.22201/enesl.20078064e.2018.19.67511
8	Impact of technology use on the teaching-learning process of integral calculus	Villena Muñoz, M Rivas Maldonado, N.	2019	Villena Muñoz and Rivas Ronaldo highlighted that the teaching-learning process is ever-evolving, with the integration of information and communication technologies being a constant challenge for both teachers and students.	1990-8644
9	Integration of ICT to Improve EFL Students' Skills in Vulnerable Communities	Roys Romero, Nancy Rosa	2019	This article highlights the challenges and effects of incorporating information and communication technologies (ICT) in the classroom to enhance students' abilities.	10.18634/sophiaj.15v.2i.770
10	Evaluation of Student Perception Regarding the Use of the Moodle Platform from a TAM Perspective	Bedregal, Norka Cornejo, Víctor Tupacyupanqui, Doris Flores, Sidanelia	2019	The authors of this article concluded that, in recent years, the use of information and communication technologies in educational institutions has become widespread, highlighting the need to assess their impact on teaching processes.	N/A
11	Quantification of the Influence of Smartphone Use on Practical Learning in Chemical Engineering	Pratto Burgos, Martin	2019	It was noted that the majority of students who used smartphones managed to achieve scores ranging from 60% to 79%, exceeding the minimum passing requirement.	10.24215/18509959.24.e05
12	Science-technology-society education: a methodology for 21st-century teachers	Rodríguez Morales, Alina	2019	Rodríguez Alina shows that the integration of information and communication tools has a profound effect on students in the chemical sciences education program.	conrado.ucf.edu.cu/index.php/conrado

13	Inverted learning as an approach to university educational quality in ecuador	Aycart Carrasco, Francesco	2019	This work contends that technologies have significantly transformed the world, creating new dynamics for communication and learning in education. In the 21st century, it continues to be both a challenge and an essential cultural shift for those who organize, facilitate, and shape the knowledge needed by academic programs and society.	conrado.ucf.edu.cu/index.php/conrado
14	Cognitive Load and Learning with ICT: An Empirical Study in Third-Level Chemistry and Physics Students	Salica, Marcelo Augusto	2019	Salica Marcelo emphasizes that the manner in which students acquire and process information is a crucial element for effectively incorporating Information and Communication Technologies (ICT) into the curriculum for science subjects, such as Physics and Chemistry.	10.24215/18509959.24.e08
15	Learning Histology Through Game-Based Learning Supported by Mobile Technology	Rojas-Mancilla, Edgardo Conei, Daniel Bernal, Yanara A Astudillo, Dan Contreras, Yuri	2019	This study has demonstrated that digital technology-based learning and the testing effect are effective in enhancing learning. The integration of information and communication technologies offers the opportunity to experiment with innovative learning strategies in the classroom.	903-907, 2019

Source: Own elaboration.

4. DISCUSSION

Once the matrix comparison of various approaches from previous reports was completed, it became clear that the influence of information and communication technologies (ICT) on personalized learning for university students has been an ongoing evolutionary process. In the past, outdated teaching methods resulted in poor education and learning outcomes (Roys Romero, 2019).

A particularly notable example came from the engineering field, where it was observed that students entering university for the first time showed a strong enthusiasm for learning. However, as their years of study progressed, their

interest and perseverance dwindled due to outdated teaching and learning strategies. This decline in engagement was not limited to engineering students but was seen across other disciplines as well. Prolonged exposure to teaching methods and tools that did not align with students' contemporary preferences led them to shift their focus towards merely maintaining mental well-being, preserving self-esteem, and avoiding failure (Moreno et al., 2019).

This reality is further supported by Ocaña-Fernández et al. (2019), who suggested that both the student body and the information age demanded a significant shift in paradigms, moving away from rigid standards toward more feasible approaches. To address this, the integration of ICT for personalized learning was proposed as a key strategy to improve or completely transform the current educational landscape, as proposed by Jiménez B. et al. (2023).

In their works, Salas Rueda (2019) and Ocaña-Fernández et al. (2019) argued that the integration of ICT would significantly enhance personalized learning. Researchers like Cunha & Hernández Vélez (2019), Villena Muñoz & Rivas Maldonado (2019), Rios Miranda & Portugal Durán (2019), and Baracaldo Guzmán (2019) observed in their studies that university students showed notable improvement in academically demanding subjects.

Not only did subjects such as calculus, physics, chemistry, English, and algebra become more widely accepted by university students, but even history became more engaging when personalized tools were developed to deliver new knowledge. Rojas-Mancilla et al. (2019) proposed that one personalized strategy could involve the use of 21st-century tutors, an idea supported by Galán Mireles & Moreno Tapia (2019), who confirmed that modern tutors would be the best option to ensure students feel understood when discussing technological tools.

However, despite the positive findings from previous studies, some opposition emerged regarding the application of a cognitive evaluation model for students in automation programs who were taught using technological tools. In his study, Salica (2019) pointed out that when an evaluation model was applied to students who had received personalized education through ICT, it became apparent that the speed at which they answered questions suggested blatant cheating (Pratto Burgos, 2019).

Benítez González (2019) agrees with Pratto's viewpoint, as his research also highlighted that, despite the positive impact of ICT in higher education, issues like plagiarism and the improper use of external academic content could arise.

The uncontrolled integration of ICT might lead to breaches in students' personal ethics, as it allows for the use of information without the authors' consent (Bedregal et al., 2019). Meanwhile, Gómez Vera (2019), in his work

"The Challenge of New Technologies," emphasized that the influence of ICT on personalized learning requires a reasonable adjustment period, which not all students are able to complete (Calle-Álvarez & Agudelo-Correa, 2019).

Although ICTs are presented as tools that benefit all students' learning, Bedregal et al. (2019) y Bernate et al. (2023) noted that not all university students have the necessary resources to fully engage in the educational environment, as access to quality information often comes at a significant cost.

They also argued that, despite the autonomy and personalized learning enabled by ICT, the role of the teacher must not be overlooked (Molinero & Chavez Morales, 2019). This perspective was supported by Kraus et al. (2019), who highlighted that the influence of ICT on personalized learning also encourages teachers to evolve into 21st-century educators. As members of Generation Z themselves, they would be better equipped to personalize learning. Ñáñez-Rodríguez et al. (2019) also agreed with Molinero and Kraus, emphasizing that ICT in university education requires teachers to be trained in computer skills from the outset, which demands considerable resources, including time.

While Kraus, Molinero, and Ñáñez advocated for the idea that the impact of ICT on the personalization of university education requires preparation and commitment from both teachers and students, Aycart Carrasco (2019) contended that there is no comprehensive guide to aid in the preparation of teachers and, consequently, students who, not being part of Generation Z, face difficulties in adapting to education in a globalized context. Rodríguez Morales (2019) also shared this opinion, suggesting that the absence of guiding methodologies and basic tools for those outside of Generation Z could negatively affect the community, turning the influence of ICT into a challenging and discouraging experience.

Despite the drawbacks, parents generally have a positive view of the influence of ICT on the personalization of university students' learning. Angulo Armenta et al. (2019) y Larrañaga et al. (2023) mentioned that parents of university students expressed surprise and satisfaction with the well-rounded education their children are receiving, noting that they had faced greater educational challenges in their own time.

5. CONCLUSION

The analysis reveals that ICTs provide university students with access to a wide range of educational resources, including e-books, online platforms, and educational videos. This supports personalized learning by allowing students to select materials that align with their learning preferences and specific

needs. E-learning platforms and online courses enable students to learn at their own pace, allowing them to review and revisit content as required. This is particularly helpful for students who need extra time to understand certain concepts or for those who wish to progress faster in their studies. ICTs also offer interactive features like simulations, educational games, and online assessments, which enhance engagement and provide immediate feedback. This feedback helps students quickly identify areas that need improvement and adjust their study methods accordingly. The incorporation of ICTs in university education enables students to access learning from anywhere, anytime, removing geographic and time constraints. This flexibility is especially important for students with work or personal commitments that make attending in-person classes difficult.

Another important aspect is that online communication tools, such as forums, chats, and video conferences, promote collaboration between students and professors, as well as among students themselves. This collaborative environment encourages a more dynamic exchange of ideas and helps develop teamwork and communication skills. ICTs enable the creation of content in various formats (text, audio, video, interactive), making it easier to accommodate different learning styles (visual, auditory, kinesthetic, etc.). This variety in presenting information ensures that each student can learn in the most suitable way for them. ICT-based learning platforms also gather data on student performance and behavior. By analyzing this data, educators can tailor content and activities to match each student's strengths and weaknesses, enhancing the overall effectiveness of the educational process.

The integration of ICTs in education also helps students develop digital skills, which are crucial in today's world. Gaining proficiency with technological tools and digital learning platforms equips students for the modern workplace. The use of ICTs in university education encourages innovation in teaching methods, enabling educators to explore new ways of delivering knowledge, such as project-based learning, gamification, and augmented reality, thus enhancing the overall educational experience.

The impact of ICTs on personalized learning in the university setting is significant and multifaceted. By offering tools and resources tailored to the individual needs of students, ICTs not only improve the quality of learning but also support more inclusive and accessible education. However, it is essential for educational institutions and educators to stay current with technological advancements and adopt teaching strategies that fully leverage these tools for the benefit of all students.

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Conflicto de Intereses: Los autores declaran que no tienen conflictos de intereses relacionados con este estudio y que todos los procedimientos seguidos cumplen con los estándares éticos establecidos por la revista. Asimismo, confirman que este trabajo es inédito y no ha sido publicado, ni parcial ni totalmente, en ninguna otra publicación.