



INFORMATION AND COMMUNICATION TECHNOLOGIES IN HIGHER EDUCATION: A Bibliometric Review

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ABSTRACT

Information and Communication Technologies (ICT) are increasingly being integrated into educational processes, including those at the university level, resulting in significant transformation. Using a literature review methodology, this study examines research indexed in Scopus that focuses on the use of ICT in higher education. Manual coding was applied to the bibliometric data obtained and was complemented by the use of artificial intelligence (AI) GPT-4 and VOSviewer software. The central research question guiding the study was: What research has been conducted on ICT in the university context, and how can it be characterised in terms of quantity, geographical origin and main thematic areas?

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1. Introduction

Before the COVID-19 pandemic, Information and Communication Technologies (ICT) were already deeply embedded in a range of contexts, professions, trades and everyday activities. These societal transformations, particularly in relation to traditional dynamics in the contemporary world, have been widely examined (Paredes Menéndez, et al., 2022). A central focus of this discussion is the complex set of challenges that ICT presents to human societies today.

The world is experiencing a profound transformation in terms of access to information and the utilisation of digital tools, which facilitate the acquisition, comprehension and generation of knowledge, which are essential components of the ongoing digital transformation. Considerable innovation has arisen from the proliferation of the Internet and the expansive circulation of information (Grajales Escobar & Osorno Mira, 2019, p. 3).

In Latin American, one of the most significant challenges regarding ICT has been the digital literacy gap, which is widely perceived as a considerable barrier. In Colombia, for example, efforts have been made to reduce this gap; nevertheless, deficiencies persist in terms of access, use and interactivity with ICT (Grajales Escobar & Osorno Mira, 2019). These shortcomings have limited the effective use of ICT tools, which have played a fundamental role in the transformation of economic, political and cultural paradigms (Grajales Escobar & Osorno Mira, 2019; Martínez-Heredia, 2020).

Within universities, the incorporation of ICT has been a driving force behind the significant evolution of teaching and learning dynamics. Teachers have integrated these tools into their educational practice, while students have also embraced them, employing them in presentations, assignments and other academic tasks. However, ICT is not always used effectively or to its full potential. García Flores (2019) notes that 70% of students in a professional degree programme connect to the Internet primarily to search for information related to university assignments, while the remainder do so less frequently or not at all. Interaction between educational actors, generating cognitive and social actions mediated by ICT, has been shown to be closely connected to learning dynamics (Pérez & Telleria, 2012).

2. ICT in Education

ICT encompasses the processing, synthesis, storage and retrieval of information, as summarised by Garza Coronado and Abreu (2022). It facilitates both synchronous and asynchronous collaboration among members of groups engaged in specific activities (González-Zamar et al., 2020). In the educational sphere, the primary role of ICT lies in the design, development and application of resources that support interaction in the transmission of information and communication. From different perspectives, ICT is closely connected to teaching and learning processes, particularly in relation to teachers, who require appropriate training at the instructional level in order to implement these technologies effectively. Their application will depend on the context, culture, region and age of the actors within the education system, as highlighted by Gündüz (2020). Nevertheless, it is the teacher who leads the educational process, including the integration of ICT.

Teachers face the challenge of guiding students who are increasingly connected to the Internet, familiar with technology and active participants in networks, contributing to the construction of digital culture. As a result, teachers have been compelled to organise activities that incorporate technological tools to enhance classroom performance. Embracing digital teaching and learning across the educational process therefore requires an initial understanding of students' digital skills [...] (García Flores, 2019, p. 116).

Today, ICT underpins human interaction, extending beyond the economic and social spheres to become firmly embedded in education (Lorduy & Naranjo, 2020). Its integration into classroom teaching and learning processes has been crucial in revitalising the relationship between teachers and students, particularly through the adoption of digital tools (Ccoa & Alvites-Huamaní, 2021). Acknowledging the availability of technological resources, several authors have observed that ICT has had a profound impact on the education system, to the extent of transforming it (Guaña-Moya et al., 2023).

Higher education is increasingly reliant on technology, as evidenced by universities' transition towards virtual education and e-learning (Suárez & Custodio, 2014). The expansion of ICT in education has led to its incorporation as a central component of educational strategies (Guaña-Moya et al., 2022). This suggests that platforms, tools and other technological resources can be deployed effectively in this context. In line with this perspective, ICT enables information to be harnessed not only as an educational resource in its own right but also as a medium for interaction between diverse audiences (Suárez & Custodio, 2014).

Digital platforms differ in purpose, functionality and mode of delivery. As part of their interaction strategies, teachers use them not only to transmit information and content but also to strengthen, develop and, in some cases, create innovative practices (Del Prete & Cabero, 2020; Llumiquinga et al., 2023). These platforms are also understood as digital spaces, particularly those designed for virtual training, which have become increasingly essential in the educational field (Del Prete & Cabero, 2019). Platforms dedicated specifically to education are primarily intended to provide academic and research support, whereas social platforms are oriented towards audio and multimedia. Social networks such as Facebook, Instagram and YouTube are generally employed to facilitate interaction between actors within the education system.

In general, ICT in education offers the following to those involved in the system:

- Multiple records of student activity on the platform (e.g., logins, time spent online, document access, participation in forums), which generate extensive data for decision-making.
- The possibility of creating online portfolios, monitoring the completion of activities and employing technological tools for collaborative work, including practical work in simulated or remote technology-mediated environments.
- Improved support for students with visual, hearing or motor disabilities through tools such as screen readers, magnifiers, text-to-speech and speech-to-text converters.
- The capacity to conduct numerous assessments, thereby facilitating access to substantially more individual and group data through learning analytics (García Aretio, 2021, p. 20).

2.1. Universities and ICT

Since the onset of the COVID-19 pandemic in 2020, universities have implemented remote learning modalities for both teaching and administrative management. Some institutions already had platforms designed for this purpose, offering virtually developed programmes, while others were compelled to migrate rapidly to new platforms in order to sustain large-scale interaction, particularly in classes.

Under these circumstances, universities were obliged to suspend face-to-face teaching and learning processes and continue in virtual formats. This abrupt transition, in addition to existing challenges, put universities to the test and exposed one of their structural deficits: inequities in both access to and progression through academic programmes (Ariño et al., 2019, in Pérez López et al., 2021, p. 332).

This situation brought into focus the experience and capacity of universities, as well as those of teachers, administrators, students and parents, in adapting to virtual learning. In this context, interaction within the educational environment is crucial for effective learning, provided it is embedded in a clear and coherent communication process. Moreover, external factors can influence the ways in which ICT-mediated learning is internalised, underscoring the importance of a well-structured communicative environment (Pure Chapis & Sánchez Trujillo, 2022). This concern links directly to a related issue: the development of digital skills in the university context.

There is widespread concern among governments, institutions and organisations to establish common criteria for the digital skills required of all citizens to participate fully in contemporary society. Universities cannot remain detached from this imperative, as digital skills represent a fundamental component that must be incorporated into higher education (Recio Muñoz et al., 2020, p. 128).

Teachers face the challenge of maintaining a common language with students in the use of ICT, as these technologies may be present in the daily lives of some but not others, or may be employed in different ways (Alonso López et al., 2022). Said Hung (2010) further emphasises that, in digital communication, ICT does not constitute an entirely new phenomenon but rather represents the migration of traditional media to the Internet, while simultaneously opening new possibilities through social networks, virtual communities and other technologies that facilitate digital interaction. In this context, a wide range of applications for ICT emerges, particularly through digital platforms and tools.

Literature reviews on the subject reveal diverse approaches to ICT in education. Although these perspectives are varied, they also expose gaps that support the findings of the present research. For instance, González-Zamar et al. (2020) and Tapia Cortes (2020), focusing respectively on university education and education more broadly, explore dimensions such as the sustainability of ICT in educational contexts; the former also integrates science, while the latter considers both teachers and students. Similarly, Borja Velezmoro and Carcausto (2020) highlight digital tools as a primary source of support for teachers and learners. Despite the significance of these contributions, important areas remain underexplored, including the identification of recent trends in the use of ICT in higher education and their connection to advanced analytical tools such as AI and bibliometrics.

This study addresses these gaps by highlighting the ways in which the COVID-19 pandemic has transformed the use of ICT in universities, and by analysing specific data drawn from the Scopus academic database. It also incorporates innovative methods, including VOSviewer and GPT-4, for data analysis. These elements not only underscore the relevance of this research but also provide a solid foundation for future inquiries into ICT as a strategic resource in higher education.

With these considerations in mind, this literature review addressed the following question: *What research has been conducted on ICT in the university context, and how can it be characterised in terms of quantity, geographical origin and main thematic areas?* The review focused on three dimensions: the volume of studies, their geographical origins and their principal themes. Of these, the thematic analysis was identified as the most significant objective.

3. Method

This study forms part of a bibliographic literature review.

The primary objective of a bibliographic review is to conduct documentary research, that is, to collect existing information on a topic or problem from journals, scientific articles, books, archived material and other academic sources. [...] Therefore, a bibliographic review within a research article should demonstrate that the existing literature on a given topic contains gaps or limitations that the present study seeks to address (University Education, 2020, p. 1).

The literature review allowed for the identification of studies related to ICT, not in a general sense, but specifically within the context of university education. Its purpose was to serve as a theoretical framework for further research requiring background information or conceptual precision in theoretical frameworks or other elements of the research corpus. The results are presented as percentages, reflecting the recurrence of the elements counted, while also being interpretative due to aspects forming part of the structure of a review article, including author, year, country, language, design, sample, objectives, technology and results (Gabarda et al., 2022).

For this study, the Scopus bibliometric index was employed, selected for its prominence and its coverage of recurring topics. The information collected focused on studies addressing the aforementioned topics. Search terms included: *information and communication technologies, education, university, universities* and *university student*. Corresponding operators for Spanish terms were: TITLE-ABS-KEY ("tecnologías de la información y comunicación") AND TITLE-ABS-KEY (educación). Searches were also conducted using English terms: TITLE-ABS-KEY ("information and communication technologies") AND TITLE-ABS-KEY (education) AND (TITLE-ABS-KEY("university") OR TITLE-ABS-KEY("universities") OR TITLE-ABS-KEY ("university student")) AND PUBYEAR > 2018 AND PUBYEAR < 2025 AND (LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ARTS")).

The inclusion criteria were as follows: a) documents filtered in the sub-areas *Arts and Humanities* and *Social Sciences*; b) documents in Spanish, Portuguese and English; c) documents published between 2020 and 2024, inclusive; d) Open Access documents; e) document types including article, book, book chapter, conference paper and review; and f) complete or in-progress articles.

The exclusion criteria were: a) documents published prior to 2020; b) documents in Croatian, French, German, Italian or Russian that appeared in the search results with English terms; c) documents not available through any form of open access; and d) document types including editorial, erratum, note and retracted.

Using the Scopus bibliometric database, filters were applied to refine the results. Six documents were obtained from the search in Spanish, all of which were included. From the search using English terms, 842

documents were initially retrieved. After discarding duplicates and documents in Portuguese or unrelated languages, 687 remained. Filtering by document type further reduced this number to 681, and applying the open access filter, excluding empty cells, resulted in a final dataset of 369 documents.

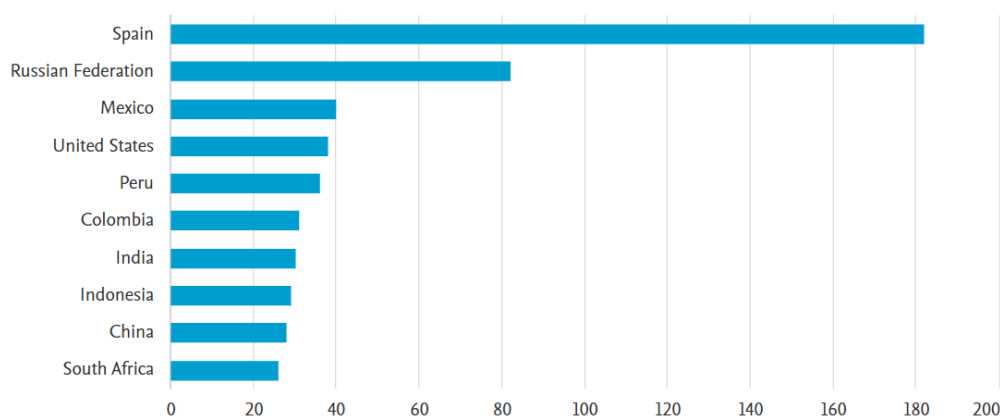
For bibliometric analysis, VOSviewer was employed, using the matrix exported from Scopus in the RIS (.ris) format. In addition, GPT-4, a state-of-the-art artificial intelligence model available on a premium basis, was utilised to support data analysis.

4. Results and Discussion

Of the documents retrieved using English search terms, as shown in Figure 1, the majority of results in this study, 840 in total before filtering, originated from Spain (182 articles), the Russian Federation (82), Mexico (40), the United States (38), Peru (36) and Colombia (31). These were followed by India (30), Indonesia (29), China (28) and South Africa (26). This distribution aligns with trends noted by Piñeiro-Naval and Morais (2021), who emphasise the expansion of ICT and social media across diverse cultural contexts, and the focus of research on countries with educational policies oriented towards digital innovation, highlighting Spain's output compared with Latin America (81.9% and 18.1%, respectively).

Spain's prominent contribution can be linked to its robust research tradition in pedagogical innovation and teacher training, a point also emphasised by Bernalés Guzmán (2023), who underscores the importance of ICT training for teachers and students. The significant output from Russia may reflect substantial investment in education and technology, consistent with state strategies aimed at modernising higher education. In Latin America, studies by Sosa Díaz and Valverde Berrocoso (2022) and Molina Loyola et al. (2020) highlight the need for teacher training and improvements in educational infrastructure, factors that may explain why countries such as Mexico, Peru and Colombia are producing scientific contributions on the topic. As Molina Loyola et al. (2020, p. 2) observe, in this new reality, teachers urgently need to attune to these emerging youth languages and modes of interaction.

Figure 1. List of the 12 countries with the most documents in the search



Source: Own elaboration, 2025

To classify topics based on the bibliometric matrix, the abstracts of each article were reviewed following CSV conversion to Excel. From this dataset, a thematic analysis was conducted, supported by the application of artificial intelligence (AI) GPT-4, using specific prompts designed to reduce and organise topics.

The AI prompt specified the following task:

You are writing a literature review article entitled: Information and Communication Technologies for Higher Education: A Literature Review. This study explores articles extracted from Scopus as an alternative for broader research, whether basic or applied, that mainly focus on ICT and higher education. For this purpose, a specific filter was applied in Scopus, yielding a database of 842 documents. Subsequently, only documents in English and Portuguese were retained, resulting in 687 entries. Filtering by document type reduced this to 681, and applying the open access filter, excluding empty cells, left 369 documents. Of these, an Excel file was created containing the authors,

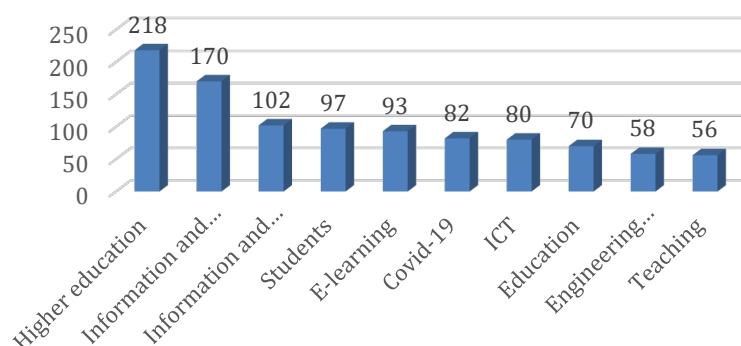
abstracts and other relevant data. You should then identify at least five, and up to eight, significant themes based on an analysis of the abstracts, highlighting the technologies used. Each paragraph should cite the authors referenced and should preferably not exceed ten lines. Ensure that all authors are listed in each citation used in the document (OpenAI, 2024).

After reviewing the original sources and structuring the texts using the resources described above, five main topics were identified, addressing the core objective set out in the literature review. A brief discussion of each topic is provided below, conducted independently of AI support.

As a preliminary step in identifying the five themes, the bibliometric analysis software VOSviewer was employed to extract the ten most frequently occurring terms, using a threshold of at least 56 occurrences per word. Of the 3,202 keywords analysed, ten met this criterion (Figure 2). When singular and plural occurrences are combined, *ICT* emerges as the most frequently cited term, surpassing even *higher education*. Other terms of quantitative significance include *student* and *e-learning*. The coexistence and association of these recurring words and phrases reflect an educational ecosystem with multiple elements and facets.

The bibliometric results indicate that these co-occurring terms capture the complexity of the educational ecosystem. *Higher education* (218 occurrences) and *information and communication technologies* (170 occurrences) dominate the list, illustrating a strong interest in the relationship between higher education and ICT. This aligns with research by Bernalés Guzmán (2023), who emphasises that the use of these technologies has a direct impact on pedagogical innovation and student engagement, although infrastructure limitations and gaps in teacher training persist. Similarly, the prominence of *e-learning* (93 occurrences) and *students* (97 occurrences) highlights the centrality of learners and online learning in the literature, supporting the findings of Sosa Díaz and Valverde Berrocoso (2022), who argue that teacher training and curriculum design are crucial for the successful integration of ICT.

Figure 2. Number of occurrences per word found in the articles



Source: Own elaboration, 2025

The topics found, which are the focus of the analysis, are summarised and discussed below.

4.1. The Impact of COVID-19 on Higher Education

The COVID-19 pandemic has had a profound impact on higher education, compelling universities to adapt rapidly to new teaching methods. Several studies emphasise the need for teachers to develop digital skills to teach effectively in online or hybrid environments (Botero-Gómez, 2024; Rivera-Mamani et al., 2024). The swift integration of ICT in higher education has also presented challenges, including the digital divide among students and limited access to adequate technological resources. Additional research has explored the pandemic's effects on the mental health of both students and teachers, underlining the importance of implementing strategies to support psychosocial well-being in the current educational context (Dermentzi, 2024; Latorre-Coscolluela, 2024).

These challenges have not been confined to higher education; they have been experienced across all educational levels, including schools, as widely documented. In Peru, for example, the impact of COVID-19 on school education has been examined from several perspectives: national policy responses to mitigate the crisis through ICT (Alarcón-Llontop & Carrasco, 2023), common problems encountered by twelve

schools in Lambayeque (Centurión Larrea, 2021), and the social response of a rural district community in Lambayeque to the effects of the pandemic on schooling (Mateus & Bussalleu, 2023).

4.2. Digital Skills Training in Higher Education

Some studies have focused on the development of digital skills in teacher training, emphasising the importance of future teachers acquiring a comprehensive understanding of ICT and its effective application in the classroom (Eva et al., 2024; Nettey et al., 2024). In parallel, the need for a paradigm shift in teacher training has been highlighted, centred on the enhancement of digital competencies (Blanco et al., 2024). Research has also examined the role of ICT in inclusive education, demonstrating its potential to create more accessible learning environments for students with disabilities (Alquraan & Adouse, 2024).

The digital skills of university students have likewise been analysed, identifying key areas such as the effective use of ICT for communication, collaboration, research and learning (Sanders et al., 2024). Villarreal-Torres et al. (2024) advocate for the integration of gamification as a tool for developing digital skills in higher education, while López-Sánchez et al. (2024) examines the impact of ICT on the training of students and professionals within the context of the digital economy.

Even before the COVID-19 pandemic, supranational bodies in education, such as UNESCO, had addressed the need to develop ICT skills among key actors in the education system, including teachers and students at all levels (UNESCO, 2019). The onset of the pandemic further underscored this concern (UNESCO, 2021). In the post-pandemic era, independent researchers have also proposed sector-specific recommendations, such as those outlined by Mateus et al. (2022) for four Latin American countries within the framework of media education, which emphasise the active role of ICT.

4.3. ICT for Inclusion and Accessibility in Higher Education

ICT can serve as a catalyst for inclusion and accessibility in higher education, enabling students with diverse needs and abilities to engage fully with educational opportunities. Research on digital democracy, focusing on the promotion of values and the role of teachers in shaping ethical frameworks, explores how ICT can foster more inclusive educational environments for students with disabilities (Alquraan & Adouse, 2024; Van Stekelenburg et al., 2024). Additional studies examine the use of ICT for inclusive education in the context of health emergencies (Ancaya-Martínez et al., 2024).

Inclusive education is grounded in the recognition of equality, dignity and rights, respect for differences, and the value of all individuals. It calls for a rethinking of educational spaces to ensure that they welcome everyone, regardless of personal characteristics or conditions (Ministry of Education, 2023). The approach advocates that every individual should have genuine access to education and the full enjoyment of academic opportunities. Achieving this requires reforms across curricula, including the provision of adequate facilities, teacher training, and the availability of appropriate teaching materials (Escalante Puma et al., 2022). In this context, ICT plays a pivotal role by supporting the design and development of dedicated and alternative tools tailored to diverse audiences.

4.4. Integration of ICT in Teaching Practices

Research in this area focuses on understanding how teachers integrate ICT into their teaching practices. Teachers' perspectives on the use of ICT in the classroom have been analysed (Jamil & Muschert, 2024), while the influence of learning contexts on the integration of ICT in teaching practices has also been explored (Rodríguez-Sabiote, 2024). The importance of developing pedagogical technology skills has been emphasised in studies such as those by Pan (2020), Alfadda and Mahdi (2021) and Sumuer (2018) (as cited in Al Arif et al., 2024).

The role of educational institutions in supporting ICT use during the pandemic has been examined in terms of creating virtual learning environments and providing training for teachers and students in times of crisis (Cueva, 2020; Medina Marín, 2021). This collective experience, with its associated adaptation challenges, is framed within the concept of digital interconnection, highlighting how ICT enables relationships between teachers, students and parents to be integrated into the classroom, thereby facilitating more interactive teaching and learning resources (Arias & Merino, 2016; VASS, 2018).

4.5. Technological Innovation and Emerging Practices in Higher Education

Higher education continues to evolve in its pursuit of new approaches to teaching and learning. ICT plays a central role in this evolution, enabling the development of innovative educational tools and strategies. Some authors investigate the use of gamification as a learning tool (Procopio et al., 2024; Román-Graván et al., 2024), while others examine emerging technologies and methodologies for fostering digital skills in the university context (Layton Jaramillo et al., 2024; Villarreal-Torres et al., 2024).

Research has also explored the impact of digital transformations on higher education, highlighting how these innovations have facilitated more efficient and creative teaching practices. This includes both general studies and specific case analyses, such as the examination of the Open University of Catalonia (UOC) by Romero Carbonell et al. (2023).

The topics and their corresponding interpretative summaries are presented in Figure 3.

Figure 3. ICT topics in university higher education identified after analysis

Impact of COVID-19	•Universities quickly adopted new online and hybrid teaching methods.
Inclusion and accesibility	•ICT allows for students with different needs to access education.
Technological innovation	•Exploration of new technologies and methodologies for the development of digital skills.
Practical integration	•ICT in teaching practices (teaching-learning) and the development of techno-pedagogical skills.
Digital competences	•The importance of training teachers in the use of ICT and the need for a paradigm shift.

Source: Own elaboration, 2025

5. Conclusions

The literature review provides a comprehensive overview of current research on ICT and higher education, particularly at the university level, highlighting thematic avenues for further study and robust sources for related research. It demonstrates that the effective integration of ICT not only supports learning but also fosters a virtual environment that can be both democratic and inclusive. The adoption of innovative teaching strategies and the development of digital skills are central to contemporary educational success.

The volume of research on ICT and university education is substantial within the Scopus database, with Spain leading the ranking even among publications in English, ahead of the United States, thereby driving the dissemination of research in this field. The predominant themes encompass multiple interrelated sub-themes. A key focus, particularly given the timing of the studies, is the impact of COVID-19 and the ways in which it accelerated the integration of ICT in higher education, exposing gaps that remain to be addressed. Another major thematic line centres on digital skills for students, the professional development of teachers, and the strategic role of educators in fostering interaction within academic spaces. This line of inquiry illustrates how ICT capitalised on a historic moment in which education not only relied on these technologies to continue but also highlighted their enduring value as tools for teaching and learning.

Other topics identified include the benefits for students with disabilities, particularly as learning environments become more inclusive and responsive to emergency contexts; the pedagogical integration of ICT, which extends beyond teacher training to the optimal application of acquired tools; and the use of online virtual spaces and diverse platforms, which enhance gamification as a means of improving classroom dynamics, supporting learning and skill development, and demonstrating the versatility of ICT in higher education. These findings reaffirm the potential of ICT in higher education and, indeed, beyond the university context, positioning ICT at the centre of multiple mediations while also highlighting areas

within educational environments that remain underexplored, limited only by human creativity and experimentation.

The primary strength of this research lies in its focus on the enduringly important topic of ICT in higher education, examined from novel perspectives. Its originality is reflected in the literature review methodology, which focused on documents from one of the leading scientific databases, Scopus, and combined search strategies with bibliometric analysis using VOSviewer and AI-assisted summarisation via GPT-4. This approach integrates advanced ICT tools into the study of ICT itself, with all outputs critically reviewed and interpreted through human judgment. Limitations of the study are acknowledged, including its reliance on a single database, the restriction to three primary languages, and the focus on one specific aspect of the variables examined, namely thematic content. Future research should build on these findings, critically evaluate them, and propose methodological refinements for subsequent studies along this line of inquiry.

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