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Analysis and Visualization of Research on ICT Use in Higher Education Teaching Based on VOSviewer

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Abstract: The application of information and communication technologies (ICT) in the educational sector is promising because it represents a new transition towards modern education and digital technology. Thus, this research area attracts the attention of multiple scholars' and school administrators' attention. With the above in mind, a detailed analysis has been conducted through the methodology of bibliometrics. Our study selected 885 documents published between 2019 and 2023, and they all represent journal articles indexed in the Web of Science database. The retrieval words are ICT use or information and communication technologies, and higher education teaching. This study tries to examine the current development and major achievement of higher education teaching under the background of ICT. The research finds that while few new research and insights appear after 2022 some information we can still learned from Guillen-Gamez, Mayorga-Fernandez and Cabero-Almenara in Education Educational Research. Technology integration is an inevitable trend in the field of education now and then researchers need therefore put more efforts on it from divergent angles.

Keywords: ICT, higher education teaching, bibliometrics, knowledge graph, VOSviewer

1. Introduction

In the recent decades, the realm of education has witnessed a remarkable transformation, propelled by the integration of Information and Communication Technology (ICT). This metamorphosis has spurred an intricate web of scholarly discourse and pragmatic applications, notably accentuated in the digital era and further expedited by the educational exigencies brought forth by the COVID-19 pandemic. Scholars and practitioners alike have embarked on a journey to fathom the intricacies and potentialities encapsulated in the amalgamation of ICT and pedagogical practices, converging on the consensus that it harbors substantial promise in facilitating a profound evolution in the professional development of educators [1].

As we navigate through this dynamic landscape, this study aims to carve out a nuanced perspective on the utilization of ICT within the sphere of higher education teaching, grounding its inquiries in a robust bibliometric analysis. This analytical foray seeks to delineate the contours of ICT's potential utility in reshaping higher education teaching paradigms, serving as a beacon guiding future scholarly endeavors in this domain.

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To scaffold a comprehensive exploration, this manuscript is structured into four discerning sections, each contributing to building a cogent narrative. Initially, we embark on a critical appraisal of extant literature, laying the groundwork for the subsequent dissection of the methodological approach and research instruments employed in this study. This analytical journey culminates in a meticulous examination of the data accrued, fostering an in-depth discourse, illustrated through apt graphical representations. The final section contemplates the potential limitations inherent in the current research and envisages the trajectories that future inquiries might undertake, thereby adding a rich layer to the ongoing dialogue in this vibrant field of study.

2. Literature Review

2.1. Previous Works on ICT Use

Different schools of thought have tried to explain the definition of Information and Communication Technologies (ICT) because it has contributed to the development of our society and transformed the way. It is true that people can enjoy the convenience and efficiency of ICT in numerous sectors of society, such as telecommunication, transportation, medicine, health care, education, etc. Likewise, education is also closely correlated to ICT since it is a critical method to improve educational quality by using current technology systematically and innovatively.

A plethora of educational possibilities will be realized through implementing ICT into education. Ibujes Villacis and Franco [2] proposed that educators and school administrators seek equality and respect for all people, which means that it is nearly impossible without including technologies in education to realize the widespread use of new methods and forms. Also, educational technologies play a great role in special and urgent times, such as the lockdown of COVID-19 when students took classes with remote learning equipment such as Zoom or Tencent meeting. Distance education, e-learning, and online learning have become novel educational methods to address future challenges, which ICT supports. Thus, we can see technology's power in education, undoubtedly leading to educational reform.

Multiple benefits generated by ICT are far more than that, such as innovative courses and teaching methods. More freedom will be offered to students and teachers to learn and teach based on personal needs and schools will be able to keep up with technological innovation [3]. Useful and interesting courses would invite students to devote more time and effort. Students, therefore, could make more progress, leading to an increase in their interests.

2.2. Related Works on Higher Education Teaching

Higher education is an important part of a country's development since students are the masters of a country's future. To ensure the high-quality and sustainable development of higher education, teachers' professional development should combine well with digital technology to promote educational innovation and level of teaching. Higher education teaching has, therefore, been facing overwhelmingly unprecedented opportunities and challenges. The need for "well-trained, motivated and entrepreneurial" teachers is growing dramatically in quality education [4].

Mishra, Koehler and Henriksen [5] imply that increasing teachers' level of knowledge and integrating pedagogy and technology is necessary to optimize their professional performance. According to Bangemann, the European Union, since 1993, has been emphasizing education, training teachers in ICT literacy to be more efficient in the use of technology in the report "Europe and the World Information Society" [1]. ICT is widely used in blended learning and flipped classrooms in university classrooms as an innovative and efficient teaching tool to help teachers improve student engagement, teaching quality, and complete teaching tasks.

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3. Methodology

In this study, we employed a stringent bibliometric methodology to scrutinize the burgeoning field of Information and Communication Technology (ICT) utilization within higher education pedagogy. The foundational database for this investigation was sourced from the reputable Web of Science (WoS) core collection, a rich repository that enabled the retrieval of scholarly articles encompassing the terminologies "ICT use" and "higher education teaching".

To refine the scope and enhance the specificity of our research, a total of 885 documents spanning the years 2019 to 2023 were meticulously excluded from the analysis. These documents were subsequently exported in plain text formats, facilitating a streamlined data processing workflow. The data retrieval process reached completion on August 15, 2023.

Central to this research is the bibliometric analysis, a potent tool that delineates the evolving trends within the domain of ICT integration in higher education teaching. Utilizing the advanced capabilities of the VOS viewer – a proficient reference processing tool – we crafted visualized maps which distilled complex literature data into intuitive graphical representations, thereby aiding researchers in acquiring a nuanced comprehension of this specific area. As posited by Huang et al. [6], bibliometrics embodies a quantitative analytical approach, leveraging mathematical and statistical methodologies alongside innovative research concepts to facilitate a comprehensive evaluation of scholarly articles. Through this methodological lens, we aspire to shed illuminative insights into the multifaceted dynamics of ICT integration in higher education teaching, fostering a rich academic discourse in this rapidly evolving field.

4. Results

4.1. Source Distribution of Publications

885 publications were selected from the WoS core collection from 2019 to 2023. A total of 4631 times cited and 5.21 average per item, and the H index is 32. Analyzing published sources plays a dominant role in distinguishing relevant major journals, and it is necessary for researchers to look up related references and synthesize the information they need. As we can see from the retrieved results, 69 journals were published from 2019 to 2023. Figure 1 shows the top 10 active journals. Education Educational Research is the most constructive journal, followed by Environmental Sciences, Computer Science Interdisciplinary Applications, and Green Sustainable Science Technology.

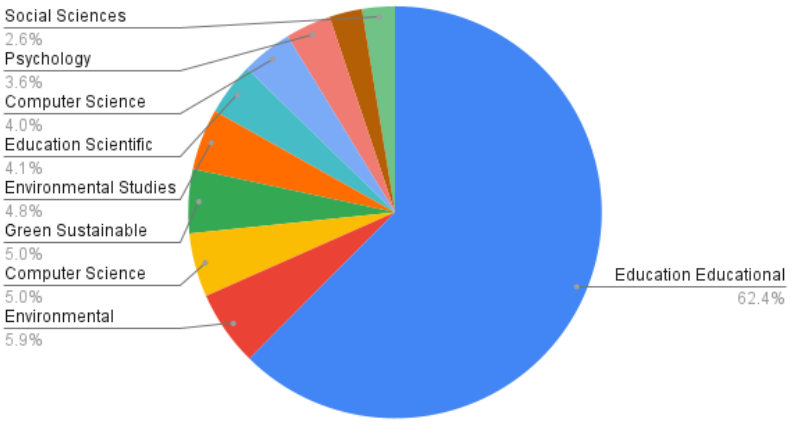

Figure 1: The top 10 categories of retrieved documents during 2019-2023.

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4.2. The Growth and Output Publications

From 2019 to 2023, the number of publications and citations on ICT use in higher education is seen in Figure 2. Overall, new ideas and publications in this area are decreasing, and most research is based on previous studies in the past five years. While the number of articles published on the WoS database mounted to 220 in 2019, it fell gradually in the following years. It is worth mentioning that a huge decrease of 100 articles can be seen between 2022 and 2023, and likewise, the number of citations appeared a sharp reduction simultaneously. As for the analysis of citations, the number of citations on ICT use dramatically increased from 2019 to 1800 citations by 2022, reaching a peak before declining sharply.

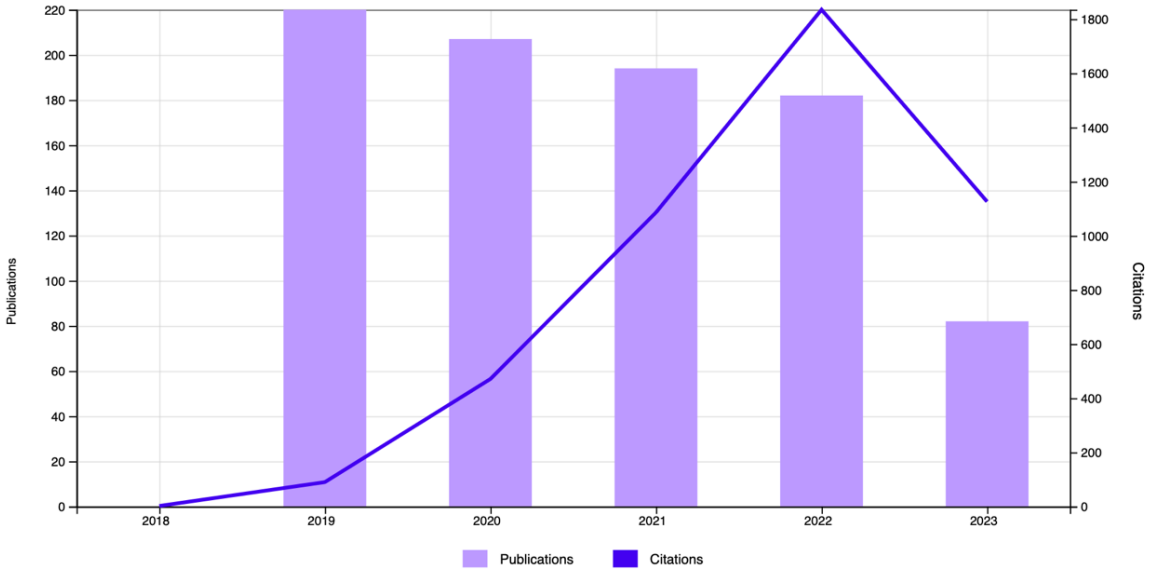

Figure 2: Times Cited and Publications Over time.

4.3. Collaboration Networks of Authorship

According to database analysis and statistics on the quantity and distribution trends of authors in major journals, it is feasible to evaluate their research groups' innovative and productive skills in the area, as well as their cooperative status [7]. Based on the authors' statistics in the WoS database for ICT usage in higher education teaching, 885 papers with 2551 authors may be downloaded, and the VOSviewer was used to cluster the authors and create the cooperation network of authors with more than two documents. As shown in Figure 3, the circles indicate the authors, the size of the circles is positively connected with the strength of the authors' connections, the authors with the same color in the view belong to the same cooperative network groups, and connection strength between different authors is represented by lines. Five major author clusters can be identified in the collaboration network. The blue cluster, which includes Guillen-Gamez and Mayorga-Fernandez, has the most collaborators, followed by the red and green groups. Guillen-Gamez, Mayorga-Fernandez, Cabero-Almenara, Palacios-Rodriguez, and Maria Fernandez-Batanero are the network's key researchers. Other researchers are tied to one of these primary investigators.

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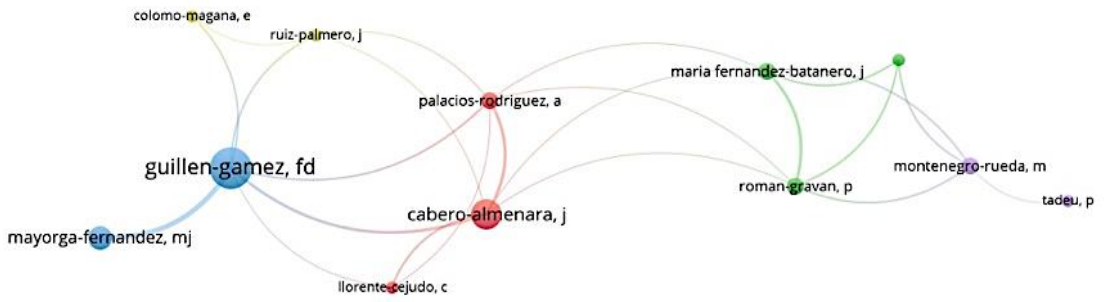

Figure 3: Map of the authors and collaboration network.

4.4. Keywords Hotness Analysis

Keywords reflect the main idea of authors, and the analysis of keywords in a given field can quickly identify "research hotspots and frontiers" [6]. 885 publications taken from the WoS database were imported into VOSviewer, and 112 keywords were used. For VOSviewer to provide a network of keyword occurrences that can be visually evaluated and examined, the smallest number of times a keyword appears has been "adjusted to 10 in VOSviewer", thus limiting the number of occurrences of keywords with more than 10 occurrence [8].

Keywords were examined by clustering and visualizing the similarity of keywords in university IT use, as illustrated in Figure 4.

Before forming the map, some meaningless words need to be removed to avoid affecting the quality of the visualization. The deleted words are assessment, instruction, competence, usage, experiences, perspectives, perception, system, strategies, skills, framework, etc al.

As can be seen, the size of the circles indicates the occurrence of terms. The connecting lines show where the terms appear together. Figure 4 depicts five separate term clusters: cluster one (red color network), cluster two (green color network), cluster three (blue color network), cluster four (yellow color network), and cluster five (purple color network).

The red cluster (cluster 1) includes 25 items, among which "education", "information", "integration" and "model" are the most fluently used keywords. To fully contextualize cluster 1, it spreads out around the "ict" and "higher education".

The green cluster (cluster 2) is mainly about the item "impact", whose links are 64 and occurrences are 38. The green cluster's additional noteworthy keywords include performance, motivation, classroom, flipped learning, and blended learning. Therefore, we can find that the green cluster focuses on personalized learning and learning outcomes of students.

The blue cluster (cluster 3) include 22 keywords. The most cooperative terms are ict, higher education, students, covid-19, and e-learning. According to our analysis, this cluster focuses on online digital and distance education with the use of active methodologies during the period of the pandemic.

The yellow cluster (cluster 4) includes 14 keywords surrounded by technology. Data science, design, literacy, educational technology, and innovation are the main branches. These keywords show that technology integration (TI) is the trend of modern education and specifically, data analysis and model design are the heated issue.

Lastly, the purple cluster (cluster 5) is divided into 8 branches: digital competence, digital divide, efficacy, information technology, internet, teacher training, teachers, and training. The most frequently used keywords are "teachers" and "digital competence". Accordingly, the theme in cluster 5 is about teachers' professional development and digital teaching.

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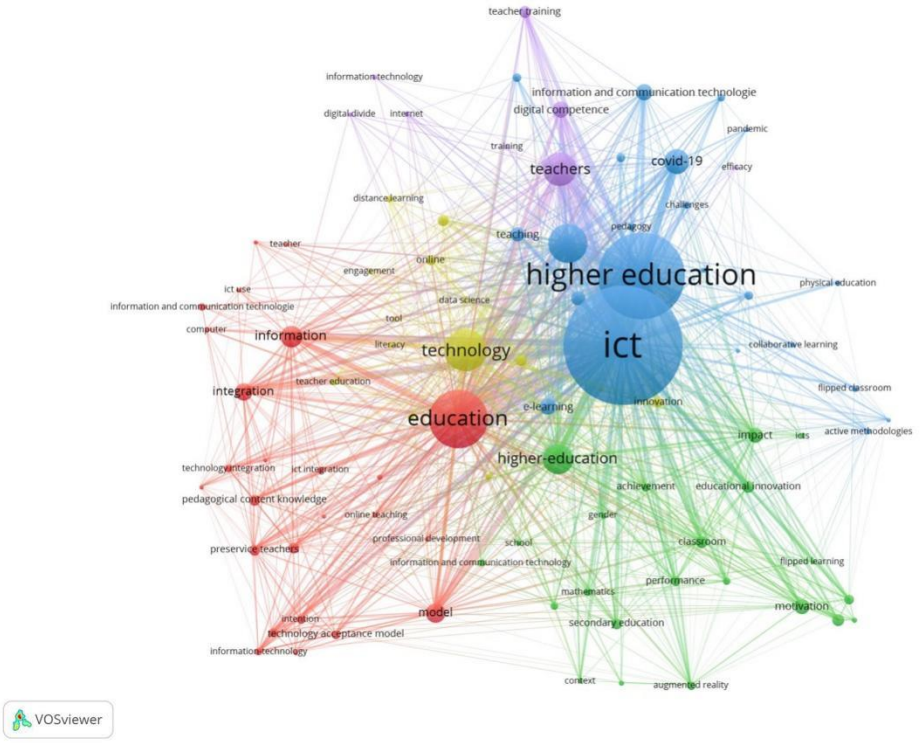

Figure 4: The overlay visualization of keywords.

4.5. Co-citation Hotness Analysis of Cited Reference

When an article cites two other articles simultaneously, the two cited articles must be considered to have a co-citation relationship [8]. An overview of the framework and development of a given research area can be learned by analyzing the co-citation. The vitality of the link in the co-reference network is visually indicated by its dimensions and shade of depth is relative to the articles most closely related to higher education teaching in ICT. It is perceivable from Figure 5 that the most significant nodes are Mishra, Venkatesh, Davis, and Hair et al.

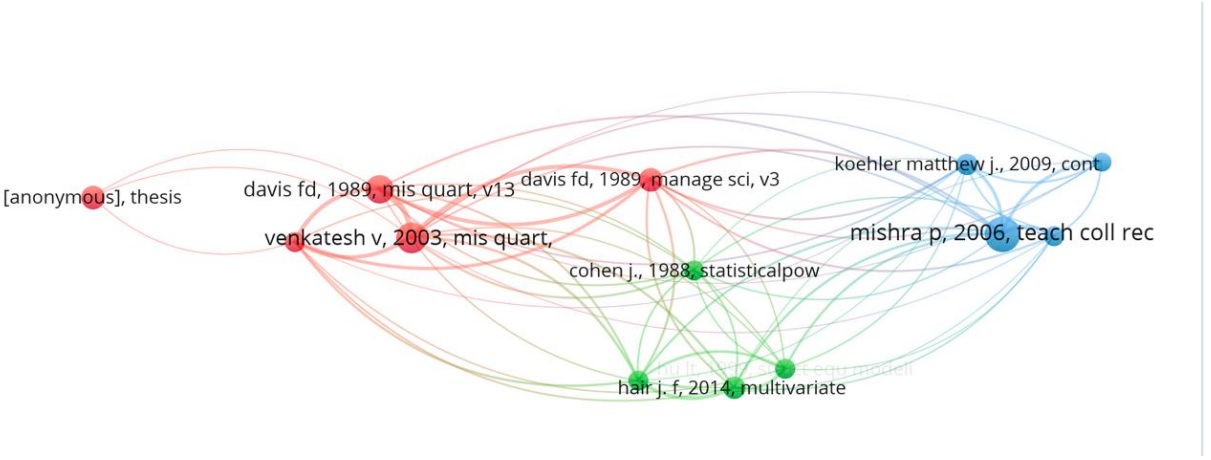

Figure 5: The reference co-citation network of higher education teaching-related publications in ICT.

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5. Conclusion

This paper has presented a theoretical study of the bibliometric analysis of the exploration of information and communication technology (ICT) in higher education teaching. This research casts a new light on this research topic's present status and trend. From the above discussion, the conclusion can be reached that Education Educational Research is the most productive journal, contributing 62.4%, and the number of publications and citations has declined since 2022. The main researchers in the network are Guillen-Gamez, Mayorga-Fernandez, Cabero-Almenara, Palacios-Rodriguez, and Maria Fernandez-Batanero. Furthermore, educational integration and higher education are the most frequently used keywords, which is followed by the impact, classroom and innovation et al. Finally, Mishra, Venkatesh, Davis, and Hair are the authors who are often co-cited between 2019 and 2023.

Nonetheless, these results must be interpreted cautiously, and several limitations should be considered. First, the study focuses on the WoS database as the source of information without considering other resources such as Scopus. Second, we only selected 885 papers in the retrieved documents due to the limitation of keywords, themes, and period. These papers are all journal articles, meaning several interesting insights about this topic appearing in books and dissertations will be largely overlooked. Therefore, future investigations should attempt to widen the bibliometric analysis's reach or use other novel research methodologies to make up new sources of information and produce more useful outcomes.

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