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Artificial Intelligence in Accounting Education and its Trends in Scopus: A Bibliometric Analysis

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Abstract

Accounting education can greatly benefit from the incorporation of artificial intelligence, because it facilitates tasks and reduces the probability of human error. The aim of this study was to analyze the worldwide trends of scientific production in Scopus on artificial intelligence in accounting education during the period 2003-2023. It was a bibliometric analysis that defined the metrics of scientific production. The indicators were obtained from 110 documents chosen from the Scopus database using keywords in English ("artificial", "Intelligence", "Accounting", "Education"). The results show that between 2019 and 2022 there was a notable upturn in the number of papers published on the subject (62%). The highest scientific production rate is found in China (32.2%; n=38), and the highest publication rate is found in Ahlia University (n=4). The ACM International Conference Proceeding Series published 8 papers, while the most cited journal was Journal of Emerging Technologies in Accounting with 89 citations, with author Qasim, A. (n=2 papers) being the most cited (n=57). From the studies analyzed, it is concluded that the development of new technologies and the incorporation of these resources into a wide range of educational settings and pedagogical approaches, the field of AI in accounting education has grown, not only in terms of production and authorship, but also in terms of thematic diversity.

Keywords: *Artificial intelligence, education, accounting, scientific production.*

Introduction

Currently, we live in a society strongly committed to the technological revolution (Schwab, 2020). In that sense, depending on their level of development, all the sectors that compose it succumb periodically and with enormous advances in some cases or adapt in others to the developments of technology (Mejía & Acosta, 2023). This inescapable trend of adapting to new communities of technological connection is also occurring in the

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field of education (which is sensitive to changes in society as it advances with it); a method that considers emerging trends and profiles in light of recent suggestions for the industry (Torres-Rivera, 2023; Villarruel-Fuentes, 2019).

In that vein, due to the unique and transient nature of the parameter on which it is based, the development and applications of artificial intelligence (AI) are increasingly impactful, but so are the inevitable disagreements and fears that accompany them (Vera, 2023). Consequently, it should be a central point in discussions of transcendence in relation to novel educational initiatives, while presupposing to it the parameters that facilitate a more effective management of this crucial process, adapted to the requirements of the most representative institutions of society, with the end result of better conditions for citizenship in general (Fernandez & Gomes, 2022; Gonzalez & Martinez, 2020).

Coupled with this, the use by the education sector in training accounting professionals in cutting-edge technologies and applications such as artificial intelligence, ChatGPT, Bin Chat, etc. improves operational efficiency and has the potential to improve the quality of financial data used for reporting (Tamay et al., 2020; Araya, 2020).

On the other hand, AI is the ultimate expression of this capacity that accelerates the vertiginous arrival of the future (Morales, 2020). In the current era of information and communication, the fields that study it can look to the future with optimism (Murcio-Rodriguez et al., 2020; Nava & Naspleda, 2020). Since companies have used these innovations to speed up their processes, they need employees who are well versed in these tools and can use them to help the company achieve its goals (Diestra et al., 2021; Garay, 2022).

In this scenario, public accounting has also incorporated these pedagogical principles into its educational processes; however, the theoretical foundations of these principles are rarely or never discussed (Vargas-González, 2022). This type of language is also widely used in the classroom. It is clear that several themes have emerged in current studies on accounting education (Ocampo-Salazar, 2023). In that sense, it has been said that global accounting education standards, curricula and certifications, and new ones, such as critical thinking, come and go according to the development of the environment (Carmona & Muñoz, 2020).

Now, given that public accountants perform a wide variety of crucial responsibilities in modern businesses, it is essential to assess whether or not current public accounting courses are in line with industry standards (Perez et al., 2019; Villarreal et al., 2022). It is important to remember that, despite the rapid pace of technology development and its widespread appropriation, the obligations of auditors of the future remain unchanged when faced with applications involving the aforementioned technologies.Like statutory auditors, public accountants are obliged to carry out all the duties specified in their contracts and bylaws, as well as any additional duties that may be required by law (González-Acosta & Aparicio-Araque, 2020; Changmarín, 2021).

Given the importance of the topic, universities must equip their students with the necessary knowledge and skills not only to make the best use of technology (as is the use of AI), but also to protect themselves from the dangers of its misuse and the harm that could be caused to people's basic freedoms and to the moral and ethical foundations on which society rests (Moreno, 2019; Mayor-Ríos et al., 2019).

On the other hand, according to the relevance of the research, the use of AI in education has evolved positively to the accounting sector and thus research (Dai, 2022; Bastos et al., 2021). Consequently, bibliometrics as the study of quantifying information about documents and other forms of literature, helps researchers to track the evolution of scientific publications, draw conclusions about the importance of works and, more importantly, allocate resources efficiently (Caló, 2022; Leyva et al., 2022).

In that order of ideas, it is used for databases that store scientific background to provide accurate information on the results and methods of scientific research (Sanz, 2022). Consequently, bibliometric indicators (Hidalgo, 2022; Mohammed, 2022) are created to quantify the results of the metric analysis of scientific production related to this topic or to various fields of study.

According to Prahani et al. (2022), he expects more advanced AI models to arrive in the near future, capable of cross-referencing data and establishing reasoning links at a faster rate than the human brain. Just as various applications produce content with far-reaching effects on business and other spheres of life, the multimodal content generation processes themselves have profound implications in these domains (Sánchez, 2022; Villarreal & Terán, 2023). Consequently, AI creates challenges in the classroom when teaching future CPAs (Gaibazzi et al., 2021). One of them is learning how different companies use AI and what benefits they obtain from it (Orantes, 2020).

Therefore, in order to better explain and portray the academic community's understanding of artificial intelligence in accounting education, it is necessary to categorize and analyze the material according to different bibliometric indicators such as: year of publication, country, subject area, type of document, source and authorship. Based on this premise, the study aims to analyze the worldwide trends of scientific production in Scopus on artificial intelligence in accounting education, during the period 2003-2023.

Methodology

Bibliometric techniques were used to examine the academic literature on the topic of artificial intelligence in accounting education. Likewise, both qualitative and quantitative results were obtained through the application of bibliometrics in the research process (Salinas and Garcia, 2022). In addition, the Scopus database was consulted for its wide use and indexing of scientific production worldwide, and the search was conducted from 2003 to 2023.

As part of the search strategy (based on the abstract, title and keywords), Boolean terms were chosen that included the following terms: "artificial" AND "intelligence", "accounting" AND "education" (Wanden-Berghe, 2023; Arango et al., 2020). Using this strategy, 137 documents could be collected initially. However, filters were applied to the acquired data to obtain the final sample. As a result, it was possible to extract a sample of 110 documents that served as the unit of analysis. On the other hand, the filtering procedure or exclusion criteria established were: 1) research conducted before or after the study period (2003-2023), 2) duplicate documents and 3) studies that did not address the research topic.

Based on the 110 selected documents, a review of the academic literature was carried out according to a series of bibliometric indicators such as: production by year of publication, authorship trends, source or journal of origin, country of origin of the document, institutional affiliation, type of document and subject area (Florez-Fernández & Aguilera-Egua, 2020).

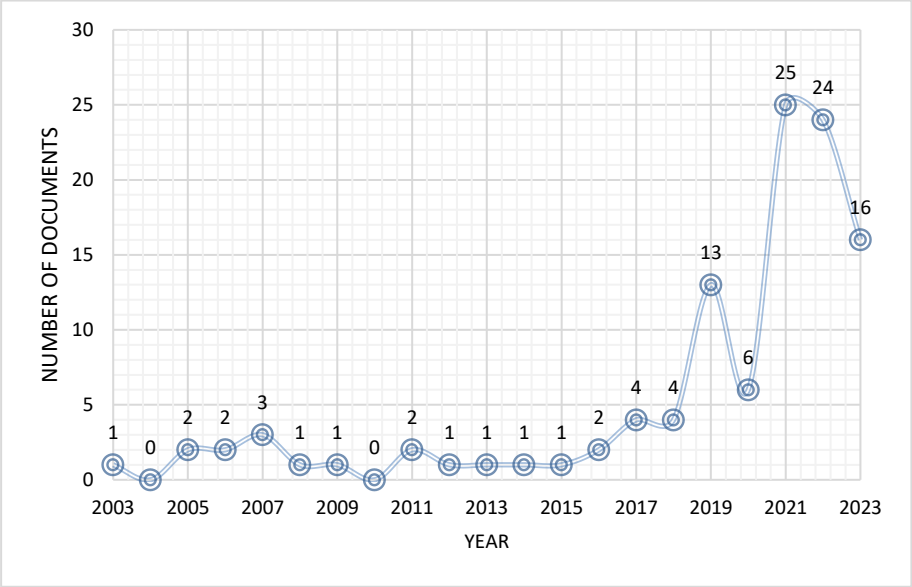
Finally, descriptive methods and frequency counts were used to analyze the data. Excel was used to compile and analyze the descriptive statistics of the large documentary sample, while VOSviewer V_1.6.19 was used to create keyword co-occurrence and source density maps.

Results

For the bibliometric study, a total of 110 papers on the topic of artificial intelligence (AI) in accounting education from 2003 to 2023 were selected. Also, Figure 1 shows

information on the number and distribution of papers published on the topic worldwide, indexed in the Scopus database, during the last twenty years. Between 2019 and 2023, an annual increase in production of 76.4% is observed, i.e., 84 additional scientific papers. In addition, 2021 and 2022 were the years with the highest number of publications (25 and 24, respectively) worldwide.

Figure 1 *Documents published by year*



Source: Scopus data (2023)

Table 2 shows the distribution of authors among the different countries; the publications are represented by authors from 37 different countries, drawing attention to the countries where the most research papers have been published on this topic. The three most productive countries were China (32.2%; n=38), the United States (17.8%; n=21) and Australia (4.2%; n=5). In addition, English was the most common language of publication (88%), followed by Spanish (9%) and Portuguese (3%).

Table 1 *Publication of documents by country*

N°	Country	Number of documents	%	N°	Country	Number of documents	%
1	China	38	32.2%	18	Denmark	1	0.8%
2	United States	21	17.8%	19	Egypt	1	0.8%
3	Australia	5	4.2%	20	Ethiopia	1	0.8%
4	Bahrain	4	3.4%	21	Finland	1	0.8%
5	Russian Federation	4	3.4%	22	India	1	0.8%
6	United Arab Emirates	4	3.4%	23	Indonesia	1	0.8%
7	Japan	3	2.5%	24	Ireland	1	0.8%
8	Romania	3	2.5%	25	Jordan	1	0.8%
9	Bulgaria	2	1.7%	26	Lebanon	1	0.8%
10	Canada	2	1.7%	27	Mexico	1	0.8%
11	France	2	1.7%	28	New Zealand	1	0.8%
12	Germany	2	1.7%	29	Nigeria	1	0.8%
13	Italy	2	1.7%	30	Oman	1	0.8%
14	Singapore	2	1.7%	31	Philippines	1	0.8%
15	Taiwan	2	1.7%	32	Saudi Arabia	1	0.8%
16	Colombia	1	0.8%	33	Indefinite	5	4.2%
17	Cyprus	1	0.8%	Total countries		37	

Source: Scopus data (2023)

Data for this analysis were drawn from 49 academic sources. Table 2 shows the main journals of publication for the papers on this topic. It can be seen that: I ACM International Conference Proceeding Series published the highest number of papers (n=8), followed by Journal of Physics Conference Series and Lecture Notes in Computer Science, each with five papers, while Journal of Emerging Technologies in Accounting had a total of 4 publications. The journals are also among the highest impact journals globally, with rankings in the two highest impact factor categories or quartiles.

Table 2 *Publication of documents by source or journal*

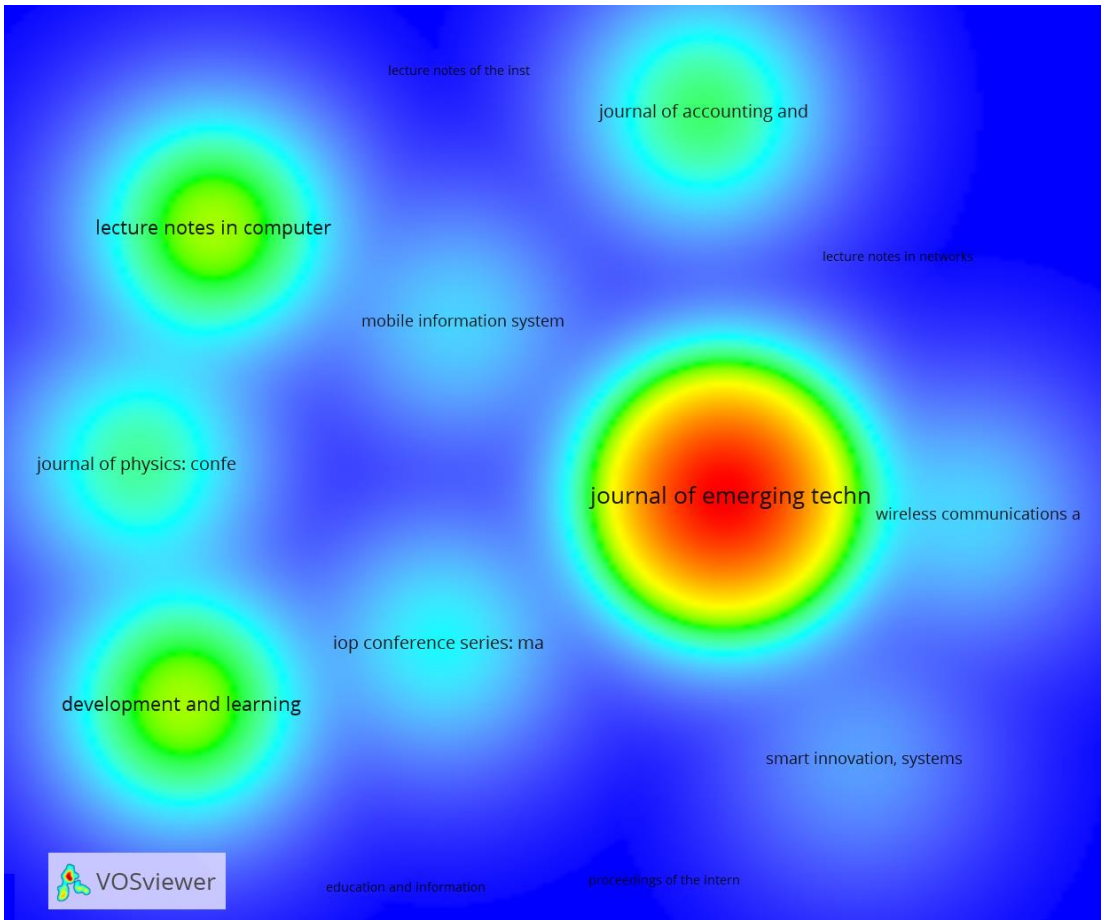
Source or Magazine	Number of documents	Source or Magazine	Number of documents	Source or Magazine	Number of documents
ACM International Conference Proceeding Series	8	Accounting Finance Sustainability Governance and Fraud	1	IEEE Access	1
Journal of Physics Conference Series	5	Advances in Developing Human Resources	1	Industry and Higher Education	1
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	5	Australasian Accounting Business and Finance Journal	1	International Journal of Engineering Education	1
Journal of Emerging Technologies in Accounting	4	Chinese Journal of Radiology China	1	International Journal of Information and Communication Technology Education	1
Lecture Notes in Networks and Systems	3	Computational Intelligence and Neuroscience	1	Issues in Accounting Education	1
Accounting Education	2	Computers and Education Artificial Intelligence	1	Journal of Advanced Computational Intelligence and Intelligent Informatics	1
Advances in Intelligent Systems and Computing	2	Development and Learning in Organizations	1	Journal of Chemical Information and Modeling	1
Education and Information Technologies	2	E3s Web of Conferences	1	Journal of Education for Business	1
Iop Conference Series Materials Science and Engineering	2	Educational Technology and Society	1	Journal of Higher Education Theory and Practice	1
Journal of Accounting and	2	Frontiers in Artificial	1	Journal of Neuroengineering	1

Organizational Change		Intelligence and Applications		and Rehabilitation	
Mobile Information Systems	2	Frontiers in Digital Health	1	Kardiologie	1
Smart Innovation Systems and Technologies	2	Frontiers in Psychology	1	Undefined	12
Wireless Communications and Mobile Computing	2	Frontiers in Public Health	1	Total magazines	49

Source: Scopus data (2023)

Based on the information collected from the selected sources, a bibliographic clustering analysis was performed to classify the different groups of publications (Figure 2). Five major clusters emerge from this analysis: the first focuses on the source Journal of Emerging Technologies in Accounting (89 citations), the second on Lecture Notes in Computer Science (76 citations), the third on the source Development and Learning in Organizations (64 citations), the fourth on Journal of Accounting and Organizational Change (57 citations) and the fifth focus on the Journal of Physics Conference Series (49 citations). In other words, the analysis of bibliographic citations shows a strong connection between the main sources and the most cited papers published in the same journals.

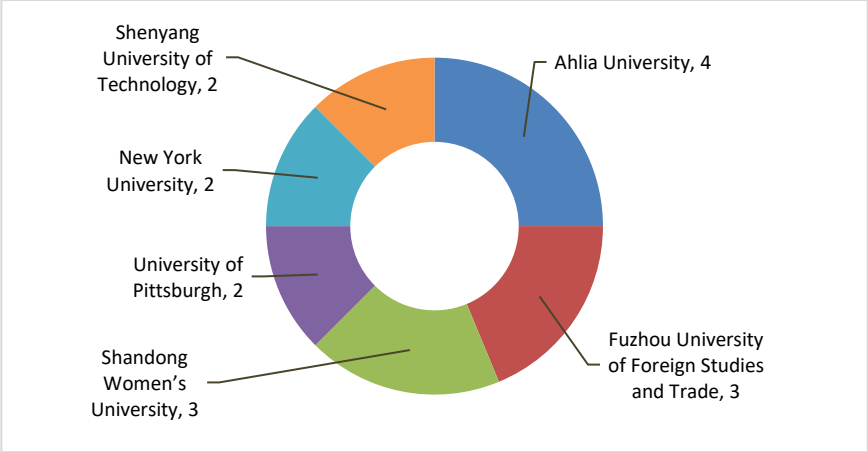
Figure 2 *Source or journal clustering density map*



Source: Results in VOSviewer (2023)

The 110 research papers were the result of collaboration among scholars from 160 institutions. Figure 3 shows that, during the specified study period, the highest number of research papers on artificial intelligence in accounting education was published by Ahlia University (n=4), followed by Fuzhou University of Foreign Studies and Trade and Shandong Women's University with 3 papers each. While University of Pittsburgh, New York University, Shenyang University of Technology and Al Ain University produced 2 scientific publications respectively.

Figure 3 *Documents published by institution*



Source: Scopus data (2023)

A total of 150 authors from 160 different institutions participated in the papers. Table 3 shows that Guomin, S. and Qasim, A. are the researchers with the most scientific publications (n=2 each). It also shows that Aben, J.P.D., Adiyarta, K., Akre, V., Al Amairi, J.S.S. and Al Ghatrifi, M.O.M. have one paper each.

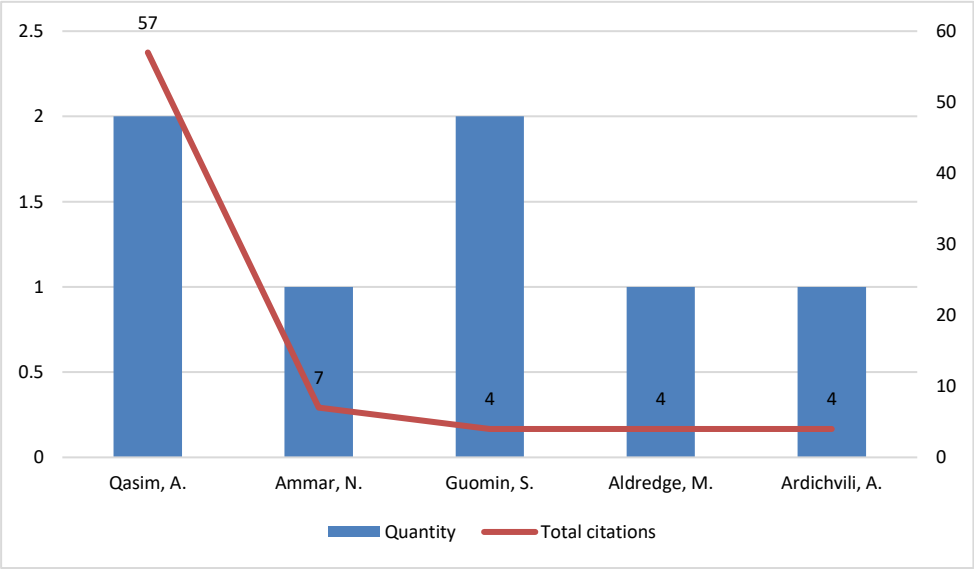
Table 3 *Documents published by author*

By author	Quantity	Total citations	By author	Quantity	Total citations
Guomin, S.	2	4	Al-Mekhlafi, M.	1	0
Qasim, A.	2	57	Al-Sartawi, A.	1	0
Aben, J.P.D.	1	0	Albu, A.	1	1
Adiyarta, K.	1	0	Aldredge, M.	1	4
Akre, V.	1	0	Ali, S.M.	1	0
Al Amairi, J.S.S.	1	0	Ammar, N.	1	7
Al Ghatrifi, M.O.M.	1	0	Ardichvili, A.	1	4
Al Shehab, N.A.	1	0	Ariza Ruiz, E.D.	1	1

Source: Scopus data (2023)

In addition to the study of publications by author, Figure 4 shows the most cited authors in the field of artificial intelligence in accounting education: Qasim, A. tops the list with 57 citations, followed by Ammar, N. (n=7). While, Guomin, S., Aldredge, M. and Ardichvili, A., occupy the third place with 4 citations respectively. Finally, in fourth place are Albu, A. and Ariza Ruiz, E.D. with one citation each.

Figure 4 *Most cited documents by author*



Source: Scopus data (2023)

Table 4, categorized by area and type of publication, shows all the papers published over the study period (2003-2023) that address the use of artificial intelligence in accounting education. The results show that, out of a total of 19 subject categories, the production of bibliographic works in the areas of computer science and social sciences represents 47% of the overall total.

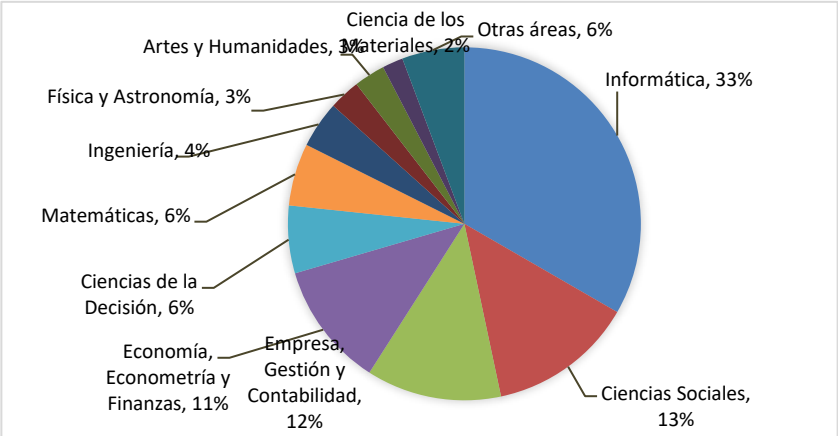
Table 4 *Publication of documents by subject area and type*

By area	Quantity	%
Computing	70	33%
Social Sciences	28	13%
Business, Management and Accounting	26	12%
Economics, Econometrics and Finance	24	11%
Decision Sciences	13	6%
Mathematics	12	6%
Engineering	9	4%
Physics and Astronomy	6	3%
Arts and Humanities	6	3%
Materials Science	4	2%
Other areas	12	6%
Total	210	100%
By type	Quantity	%
Article	105	95%
Book chapter	4	4%
Book	1	1%
Total	110	100%

Source: Scopus data (2023)

raph 5 also shows the proportion of scientific production by subject area: computer science accounts for 33%, social sciences 13%, business, management and accounting 12% and economics, econometrics and finance 11%. On the other hand, when analyzing the production according to the different types of documents, it can be seen that scientific articles account for most of the production (95%), followed by book chapters (4%) and books (1%).

Figure 5 *Publication of documents by subject area*



Source: Scopus information (2023)

The data presented in Figure 6 were obtained by filtering the keywords that appear more than three times in the title, keywords and abstract of the analyzed documents. Depending on the degree of connectivity estimated by VOSviewer between each keyword, each color was assigned to a different set of words.

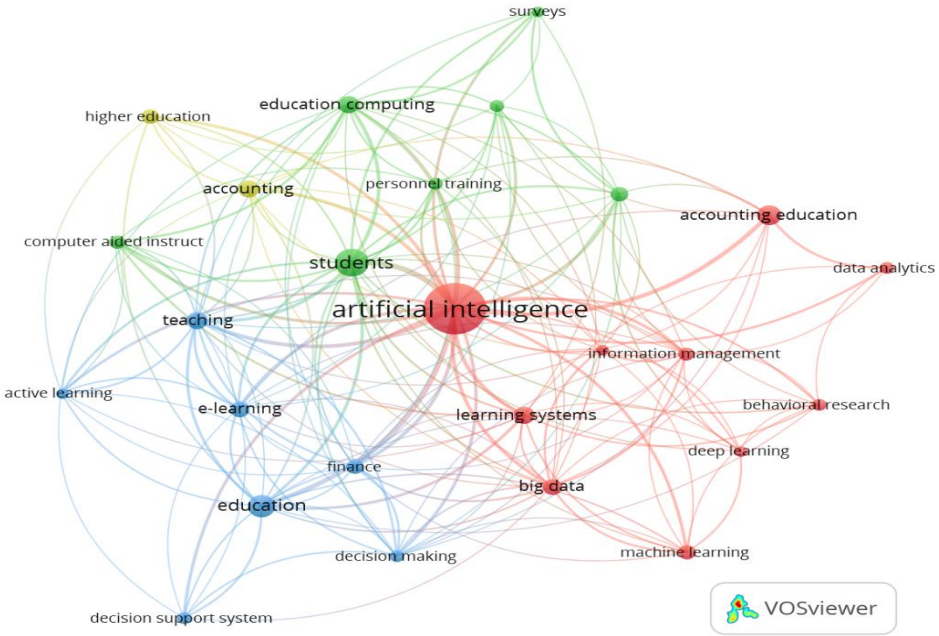
- Red cluster. "artificial intelligence" (n=89 occurrences), groups the following words: accounting education, data analytics, information management, behavioral research, learning systems, big data, machine learning, deep learning.

- Blue cluster. "education" (n=63 occurrences), is associated with the words: finance, teaching, active learning, e-learning, decision making, decision support system.

- Green-yellow cluster. "students" (n=45 occurrences), refers to a cluster of related words including: educational computing, personnel training, computer-assisted instruction, accounting, higher education.

The grouping shows that the most frequently used terms are directly related to the topic of the study.

Figure 6 *Keyword co-occurrence map*



Source: Results in VOSviewer (2023).

Discussion

The results demonstrate a growing interest and activity in the upward trend of scientific production on artificial intelligence in accounting education, during the period from 2019 to 2023 and especially the years 2021 and 2022 (n=49; 45%), with the highest total number of publications for the production in the chosen study period. According to Goodell et al. (2021), more and more academic papers have been published on this topic in recent years. This is due to the fact that AI is already part of the lives of millions of people around the world, playing an integral role in transforming economies and markets, as well as in the field of education (Qin et al., 2023; Mohammed et al., 2023). Thus, the adoption by the business sector of new technologies (such as artificial intelligence) and applications improves operational efficiency, which can facilitate better financial information useful for generating more reliable financial statements (Noordin et al., 2022; Ossandón, 2020).

Moreover, compared to other universities, Ahlia University has produced four scientific papers. As for the countries of origin, China accounts for the largest share (32.2%; n=38) of the world's production in this field; moreover, approximately eight out of ten (88%) of the papers published on this topic were written in English. In turn, Qasim, A. was the most cited author (n=57), while Guomin, S. and Qasim, A. were the most relevant writers by publication (each with two publications). In addition, it was observed that the most published source was ACM International Conference Proceeding Series (n=8). In terms of citations, however, articles from the Journal of Emerging Technologies in Accounting were the best performers (89 citations).

According to Agustí & Orta-Pérez (2022), they state that advancing academic promotion is difficult without international cooperation. Consequently, globally, institutions have taken advantage of these technologies to rapidly expand their operations, which requires the employment of qualified and highly capable personnel who can contribute to the achievement of the institution's objectives (Ocaña-Fernández et al., 2019; Erazo-Castillo & De la A-Muñoz, 2023). In that sense, CPAs play a wide variety of crucial roles within an organization, which calls for a closer examination of the accounting curriculum and its relevance to real-world needs (Gaibazzi et al., 2021; Vargas-González, 2022). Consequently, the role of accountants in the business world is evolving as a result of the incorporation of AI into accounting education (Lardo et al., 2022; Morán, 2020). As accounting processes become automated, accountants could move to act as controllers or strategic consultants, analyzing accounting data along with other departments to find ways to increase productivity and revenue (Toledo et al., 2022).

Likewise, the keywords around artificial intelligence in accounting education in the selected research papers suggest an interdisciplinary approach in the fields of mathematics, engineering, economics, econometrics and finance, among others. However, the papers studied here stand out in the fields of computer science, social sciences and business, management and accounting (59%). In addition, 95% of all the papers produced were scientific articles. Also, the most used keyword in this study is "artificial intelligence"; however, other keywords such as "education" and "students" are not too far away from what was explored by the authors. Consequently, the co-occurrence network provides a graphical representation of the central ideas shared by all relevant publications and disciplines in the form of clusters.

Therefore, AI demonstrates the benefits that modern technology can bring to the field of accounting education (Tsiligiris & Bowyer, 2021). Importantly, CPAs have access to a wide variety of useful tools facilitated by AI that can make their work easier and more efficient (Damerji & Salimi, 2021; Maturana et al., 2021). Overall, incorporating AI into accounting education will help accountants in many ways, including automating and making accounting tasks more accurate, driving more informed decision making,

contributing to business growth and profitability, and detecting fraud (Mackay-Castro et al., 2023; Porporato, 2023).

Conclusion

According to the objective of the study, bibliometric analysis of papers indexed in Scopus from 2003 to 2023 globally found that research on artificial intelligence in accounting education increased rapidly between 2019 and 2022 (accounting for 62%, or n=68). In addition, China accounts for 32.2% (38 publications) of all scientific output from 37 countries.

In addition, ACM International Conference Proceeding Series has published more articles than any other journal (n=8). Ahlia University, for its part, has contributed a total of four academic publications to this field. In addition, Guomin, S. and Qasim, A. are the authors with the most scientific publications on artificial intelligence in accounting education (n=2 each), while the latter was the most referenced (57 citations). It was also observed that most of the papers were scientific articles (95%), distributed in the main areas of knowledge: computer science (33%), social sciences (13%) and business, management and accounting (12%). In addition, a keyword analysis performed with the VOSviewer program revealed that the most frequent term was "artificial intelligence", with 89 occurrences.

From the analysis of the 110 documents that make up the study's sample, it is stated that as AI technology develops further, accountants must adapt and learn new skills, making ongoing education and training essential. In that sense, accounting professionals must stay abreast of the latest AI trends and tools to take full advantage of the opportunities this technology presents in the accounting industry. Finally, it is concluded that the field of AI in accounting education has expanded, not only in terms of production and authorship, but also in terms of thematic diversity, which tends to change along with technological advancement and the incorporation of these resources into a variety of educational settings and pedagogical approaches.

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