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Application of Artificial Intelligence in Accounting Education: A Bibliometric Study

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APPLICATION OF ARTIFICIAL INTELLIGENCE IN TEACHING ACCOUNTING: BIBLIOMETRIC STUDY

1. INTRODUCTION

The remarkable evolution of technology demands a comprehensive understanding of its impact not only on industry, education, and society but also on labor relations and professions. Driven by the transition to a digitized economy, advances in robotics and artificial intelligence, and demographic changes (Tavares et al., 2023), this evolution brings challenges and opportunities. In the accounting context, digital transformation is drastically changing practices, automating functions, and making some obsolete, requiring graduates and professionals to prepare for new responsibilities (Al-Htaybat, von Alberti-Alhtaybat, and Alhatabat, 2018). Technological changes, such as automation, machine learning, AI, data analytics, and blockchain, reshape business processes and directly impact accountants (Aldredge, Rogers, & Smith, 2021; Moore & Felo, 2022).

Consequently, accounting education must adapt to prepare students for future job market challenges, an area often neglected by many academic institutions (Al-Hattami, 2021). The accounting profession must evolve, offering services that require a more diverse set of skills (Banasik & Jubb, 2021).

In Brazil, the Federal Accounting Council (CFC) Sufficiency Exam is essential for the professional practice of accountants. In recent years, despite the increase in the number of candidates, approval rates have declined, reaching just 13% in 2023, the lowest in recent years (Nader, 2023). This situation is worsened by significant disparities between states and difficulties in specific areas of accounting (Nader, 2023). Therefore, there is an urgent need for strategies that promote students' reflective learning, and artificial intelligence (AI) can be an essential tool in this process. AI is a potential solution to address these challenges, offering innovative tools and methodologies that can significantly improve Sufficiency Exam pass rates.

Recent studies highlight the growing impact of AI on accounting education, although its application is still in its early stages. AI has the potential to revolutionize teaching methods by personalizing learning experiences and automating administrative tasks, allowing educators to focus more on interacting with students (Meroto et al., 2024; Picão et al., 2023). However, challenges persist, including ethical concerns about privacy and data security (Meroto et al., 2024).

Accounting professionals recognize both the benefits and ethical dilemmas associated with the implementation of AI, seeking a balance between technological advancement and ethical responsibility (Leão De Souza et al., 2023). For accounting students, AI can be both beneficial and harmful, depending on how it is used (Holanda & Negreiros, 2024). Although AI offers advantages such as immediate feedback and access to quality content, it also presents challenges such as the need for constant system updates and the potential for algorithmic discrimination (Picão et al., 2023).

Recent studies have addressed the interaction between technology and accounting education. Birt, Safari, and Castro (2023) conducted a literature review to identify and systematize the impact of AI and other related technologies on accounting professionals. They highlighted the skills that accountants need to develop, such as technology knowledge, data analysis skills, and active participation in strategic management, I was highlighting the importance of continuing education and the redesign of educational programs in accounting. Handoyo (2024) investigated the evolving paradigms in accounting education, analyzing the impact of information technology and highlighting the need to integrate emerging technologies and advanced educational strategies into accounting curricula.

Tavares' research (2023) focused on the impacts of Era 5.0 on the accounting profession, identifying the need for adaptation and collaboration between educational institutions, professionals, and entities to ensure the adequate preparation of accountants. Agustí and Orta-Pérez (2023) carried out a bibliometric analysis on the use of big data and AI in the areas of accounting and auditing, identifying the most productive journals, influential authors, and emerging research trends, in addition to highlighting the need to update skills and CVs. Ballantine, Boyce, and Stoner (2024) critically examined the implications of generative AI in accounting academia and accounting education, proposing the integration of AI into teaching and learning practices with an emphasis on the human dimension of accounting.

Studies assess the critical reasoning level of accounting students also using AI algorithms and different teaching strategies. Cunha de Souza (2023) developed a method to classify students' critical reasoning in the History of Accounting course using access logs, natural language processing, and the Flesch-Kincaid readability index, achieving 86.20% accuracy compared to a teacher's assessment. Cornachione, Duncan, and Johnson (2007) evaluated critical reading, writing, and reasoning skills at the largest public university in Brazil, finding positive engagement and relevance to professional life. Figueiredo & Silva (2024) observed that multiple complementary teaching strategies are necessary for reflective learning, requiring effort from both teachers and students. Continuous in-service training helps teachers promote reflective learning.

Although these studies explore the interplay between technology and accounting education, there is still a significant gap in the specific understanding of the application of AI in accounting education. Research such as Cornachione, Duncan, and Johnson (2007), Birt, Safari, and Castro (2023), Handoyo (2024), Tavares (2023), Agustí and Orta-Pérez (2023), Cunha de Souza (2023) and Ballantine, Boyce, and Stoner (2024) address the necessary technological skills, educational paradigms emerging trends and big data and AI. However, there is a lack of detailed bibliometric analyses that use the Web of Science and Scopus databases to specifically map research trends, identify key authors and institutions, and examine the evolution of pedagogical methodologies in the context of accounting education. This work aims to fill this gap, providing a comprehensive and structured view of the state of the art on the application of AI in accounting teaching, to improve the preparation of candidates for the Federal Accounting Council (CFC) Sufficiency Exam in Brazil.

Given this scenario, the question arises: what are the trends and patterns of scientific publications on the application of AI in accounting teaching? This work set out to analyze the state of the art on the use of AI in accounting teaching, identifying research trends, main authors, institutions, and areas of focus over time. To this end, bibliometric techniques were applied to a set of documents from the Web of Science and Scopus databases.

The contributions of this research are substantial in both practical and theoretical terms, in addition to positively impacting society. From a practical point of view, research into advanced pedagogical methods and the integration of emerging technologies provides educators and educational institutions with an understanding of accounting teaching practices, enabling professionals to deal with contemporary challenges and implement innovative solutions. In theoretical terms, the research expands the understanding of accounting phenomena and encourages the development of new models and theories that can enhance the efficiency and precision of accounting practices.

Furthermore, the research has important social implications. Strengthening teaching programs with relevant discoveries and innovative methodologies contributes to the training of qualified professionals prepared to face the complex challenges of the contemporary economic environment. Indirectly, by promoting more effective accounting practices, research also promotes transparency and economic stability, benefiting organizations and society in general.

Therefore, this research has significant implications for the field of decision-making in the legal sphere, offers direction for future research, and presents a framework that highlights the interaction between different categories of analysis.

2. METHODOLOGY

This study investigates the literature on the use of artificial intelligence (AI) in accounting education, analyzing research trends, prominent authors, institutions, and areas of focus. To achieve this, a quantitative approach is used, organizing the evolution of literature through a bibliometric study.

2.1 Data collection

A graphical overview of the data sources and the collection process is illustrated in Figure 1. The first step involves defining the scope of the study, focusing on the relationship between Artificial Intelligence (AI) and Accounting Education. This focus was chosen because studying AI in accounting education is important, as it can revolutionize teaching methods, personalize learning, and automate administrative tasks, improving efficiency and educational interaction.

In the second stage, scientific documents were searched in the Scopus and Web of Science (WoS) databases between 07/06 and 07/08/2024, as they are leaders in citations and widely used in academic research, essential for evaluating scientific productivity through citation analysis (Zhu & Liu, 2020; Oliveira et al., 2013). Scopus offers better data management, while WoS provides more comprehensive information when exporting data (Suela et al., 2021). This competition benefits researchers, expanding the possibilities of analysis and access to global scientific production (Peixe & Pinto, 2021; Suela et al., 2021).

Relevant documents were searched in the Scopus and WoS databases using the following keywords: "artificial intelligence" and "Teaching in accounting". As shown in Table 1, we sought to include as many words related to Artificial Intelligence and Teaching in Accounting as possible. The term "Accounting train*" was initially included, resulting in 207 documents (excluding duplicates), including publications from sources such as journals and conference proceedings. However, when reading the titles of the works, the authors realized that the articles with this keyword did not adequately represent accounting education.

Therefore, this keyword was removed, and a new query was carried out in the databases using the strings presented in Table 1, resulting in 140 documents in Scopus and 51 in Web of Science, totaling 191 documents.

Table 1. Detailed Strings

	Strings
Artificial Intelligence	("artificial intelligence" "machine learning" "deep learning" "neural networks" "natural language processing" "computer vision" "expert systems" "automated reasoning" OR "data mining" OR "robotics" OR "fuzzy logic" OR "genetic algorithms" OR "autonomous systems" OR "predictive analytics" OR "intelligent agents" OR "speech recognition" OR "knowledge representation" OR "reinforcement learning" OR "cognitive computing" OR "intelligent automation" OR "algorithmic trading" OR "recommendation systems" OR "ethics of artificial intelligence" OR "governance of artificial intelligence" OR "applications of artificial intelligence" OR "technologies of artificial intelligence" OR "intelligent systems" OR "self-learning systems" OR "adaptive systems")
Teaching in Accounting	("accounting educ*" OR "teach* accounting" OR "accounting instruction" OR "accounting learning" OR "accounting pedagogy" OR "academic accounting" OR "accounting training" OR "accounting curriculum" OR "education in accounting" OR "instruction in accounting" OR "accounting teaching methods" OR "accounting classroom" OR "accounting course design" OR "accounting syllabus" OR "accounting educational strategies" OR "accounting professional development" OR "accounting certification" OR "accounting academic program*" OR "accounting learning outcomes" OR "accounting distance learning" OR "accounting online educ*" OR "accounting e-learning" OR "accounting instructional design" OR "accounting vocational education" OR "accounting higher education" OR "accounting undergraduate education" OR "accounting graduate education" OR "graduate accounting program" OR "accounting peer learning" OR "accounting student" OR "accounting faculty development")

The third stage involves filtering the scientific documents obtained in the second stage. Because the resulting documents come from a variety of sources, you need to ensure that they meet specific criteria. The filtering process is based on two parameters: 1) the type of journal and conference sources, and 2) the use of the English language. Only documents written exclusively in English are considered for analysis. Sources from journals and conference proceedings were chosen because they undergo peer review, ensuring that documents meet publication quality standards (Walker & Rocha da Silva, 2015).

English was chosen as the preferred language due to its widespread use in scientific communication on a global scale. After filtering, the dataset obtained contained 46 documents from WoS and 136 from Scopus. After joining the tables and removing duplicates in R Studio (bibliometrics), the final file resulted in 130 documents from 79 sources (journals and conferences), with the participation of 594 authors and 395 authors' keywords. Figure 1 below shows the data collection steps and a brief description of the documents

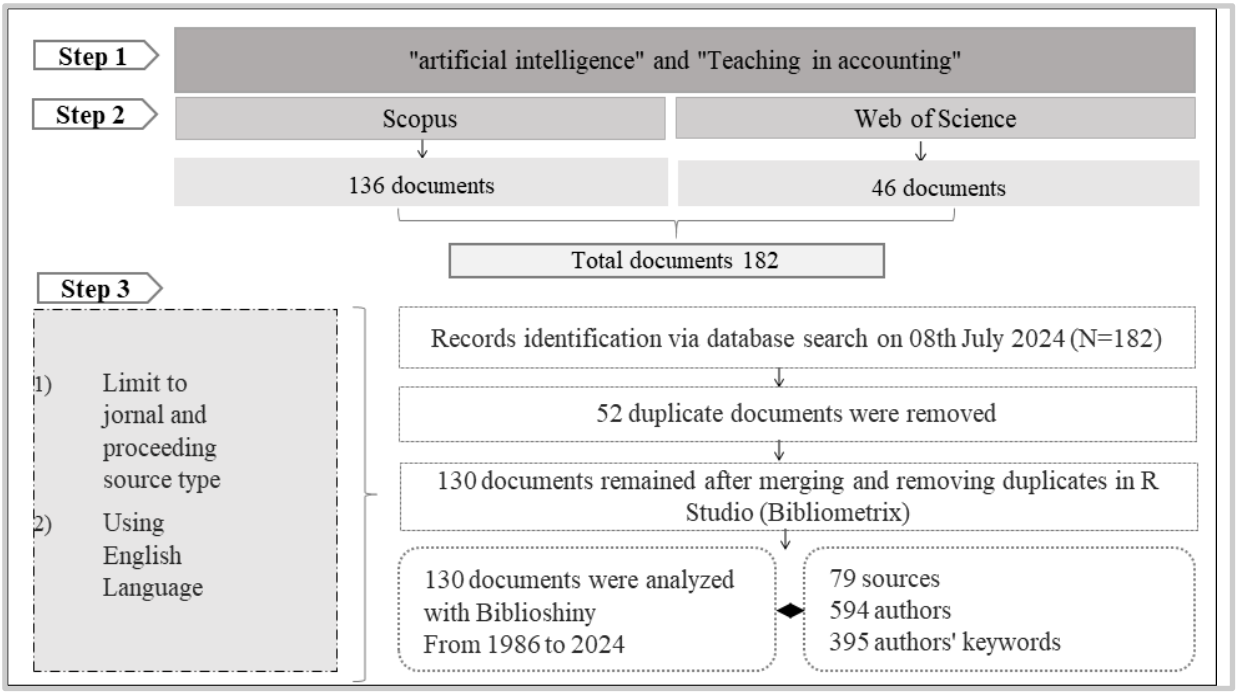


Figure 1. Data collection steps and brief description of documents

2.2 Data Analysis

The study utilized RStudio and Bibliometrics for bibliometric analyses. RStudio is an open-source IDE for R programming, widely used in data science and academic research (Giorgi et al., 2022). Bibliometrics, developed for RStudio, is a program for scientometric and bibliometric research, offering functionalities such as citation analysis, collaboration networks, and thematic analyses. The data were analyzed using Biblioshiny, a free web-based interface of the R operating system (R Core Team, 2021; Aria & Cuccurullo, 2017). In the Biblioshiny interface, the data were imported, selecting the raw data format.

In this study, citation, co-citation, co-author, and co-word analyses were conducted. According to Zupic & Čater (2015), citation analysis measures the influence of documents, authors, or journals by citation rates, answering questions about the most influential authors, the impact of journals and disciplines, specialists in specific fields, and recommended reading lists. Co-citation analysis connects documents, authors, or journals based on joint references, analyzing the intellectual structure, central and peripheral researchers, the diffusion of concepts, and the development of scientific communities. Co-author analysis connects authors who co-author articles, studying interdisciplinary collaborations, factors influencing co-authorship, the impact of collaboration, the citation frequency of co-authored articles, and the social structure of the field. Finally, co-word analysis connects keywords in titles, abstracts, or keyword lists, examining conceptual dynamics, conceptual blocks, research themes, and the evolution of concepts.

3. PRESENTATION OF RESULTS

3.1 Citation analysis

Citation Analysis, developed by Garfield, founder of the Institute for Scientific Information (ISI) in the 1960s, aims to compile, organize, and locate information to keep researchers up to date in scientific knowledge (Garfield, 1979). This analysis identifies the most influential documents, authors, and journals based on citation counts. It is assumed that authors cite important documents for their research (Zupic & Čater, 2015) and that connections in the literature are established when publications cite each other (Donthu et al., 2021).

Building on the principles of citation analysis, a performance analysis was conducted to examine the integration of AI into accounting education research. This analysis used productivity and impact indicators, including the number of annual articles, the most productive journals and authors, and the most cited articles, highlighting their influence on the scientific community (Merigó & Yang, 2017). The temporal

evolution of publications revealed three distinct phases. Between 1986 and 1995, publications were sparse and low in number, with a peak of 5 articles in 1995. From 1996 to 2008, there was stagnation, with years without publications and occasional peaks of up to 3 articles. From 2009 onwards, moderate and consistent growth was observed.

The accelerated growth phase begins in 2019, with a significant increase in the number of publications: 10 articles in 2019, 23 in 2021, and 19 in 2023. This increase can be attributed to technological advances, new areas of study, and increased funding. The COVID-19 pandemic may also have influenced the increase in publications in 2020 and 2021 (Alshurafat et al., 2021; Lockee, 2021). Regarding the year 2024, it was observed that, in both Scopus and WOS, there are articles on the topic studied in the press, that is, those were accepted for publication, but have not yet been published in print.

Furthermore, the concentration of these articles in specific journals is notable, with 10 journals representing 43% of the total articles published. Table 2 presents the ten most frequent journals in terms of the number of articles and local impact by H index.

Table 2. Top 10 – Most frequent periodicals.

Most relevant sources		**Source of local impact by H-index**	
Periodical	**Article**	**Periodical**	**h_index**
Accounting Education	21	Accounting Education	11
Journal of Emerging Technologies in Accounting	10	Issues in Accounting Education	4
ACM International Conference Proceeding Series	6	Journal of Emerging Technologies in Accounting	4
Issues in Accounting Education	6	Accounting and Business Research	2
E3s Web of Conferences	3	Accounting Research Journal	2
Accounting and Business Research	2	Asian Review of Accounting	2
Accounting Research Journal	2	Contemporary Accounting Research	2
Asian Review of Accounting	2	Expert Systems With Applications	2
Contemporary Accounting Research	2	International Journal of Phytoremediation	2
Critical Perspectives on Accounting	2	Journal of Physics: Conference Series	2
Total	**56**		

Accounting Education stands out as the most relevant source, with 21 articles and the highest H-index of 11, indicating both frequency and significant impact. Journal of Emerging Technologies in Accounting and Issues in Accounting Education follows with 10 and 6 articles, respectively, and an H-index of 4, showing a considerable impact. Other sources such as ACM International Conference Proceeding Series and E3s Web of Conferences also contribute a relevant number of articles, although with less impact. In total, 56 articles were analyzed. Sources with less impact, but still relevant, have an H-index of 2, including Accounting and Business Research, Accounting Research Journal, and Asian Review of Accounting. In summary, Accounting Education is the leader in terms of relevance and impact, with other journals also contributing significantly to the field of accounting. It is noted that among the journals that published the most, two journals originate technology conferences. However, among the 79 journals, 20 are in the accounting area and 3 are specifically in Accounting Education.

Table 3 presents the 10 most productive entities in the study area, both by the gross number of published articles and by the fractional count of articles.

Chen J and Jackling B are the most productive authors with 4 articles each. Everaert P, Natoli R, and Smith J follow with 3 articles each, while Beatson N, Boyce G, Cheng X, Dunn R, and Er M have 2 articles each. It is noteworthy that Natoli R. and Jackling B. are co-authors and have published numerous articles together.

In terms of fractional articles, Wu Y leads with 2.00, followed by Xu Y with 1.50 and Everaert P with 1.42, demonstrating the significant contribution of these authors in co-authorship. Er M and Fogarty T have 1.00 fractional articles each, indicating a notable impact on collaborative work. Goldwater P., Ng A, Abdolmohammadi M, Ardichvili A, and Auyeung P also contribute 1 fractional article each. The fractional

count better reflects the individual contributions of authors in collaborative works, highlighting the influence and significant participation of each one in academic production.

Table 3. Top 10 – Most productive authors.

Author	Number of articles	Author	Articles Fractionated
Chen J	4	Wu Y	2.00
Jackling B	4	Xu Y	1.50
Everaert P	3	Everaert P	1.42
Natoli R	3	Er M	1.00
Smith J	3	Fogarty T	1.00
Beatson N	2	Goldwater P	1,00
Boyce G	2	Ng A	1,00
Cheng X	2	Abdolmohammadi M	1,00
Dunn R	2	Ardichvili A	1,00
Er M	2	Auyeung P	1,00

In this sense, it can be inferred that Chen J and Jackling B stand out in terms of the total number of publications, while Wu Y is the main contributor in terms of fractional impact. Everaert P and Er M are notable for their presence in both metrics, showing a balance between total and collaborative productivity.

In terms of the most relevant affiliations based on the number of published articles, the University of North Carolina stands out as the most productive institution with 6 articles. Following closely, Fuzhou University Of International Studies And Trade, Ghent University, Universitatea Din Craiova, University System Of Georgia, and Victoria University are tied with 5 articles each. Bina Nusantara University and the University of Pretoria follow with 4 articles each, while Brigham Young University and Deakin University contribute with 3 articles each, indicating a significant but smaller participation in the analyzed set of publications.

The contributions of articles and their impact on the development of research trends can be evaluated by the number of citations. Thus, the most cited articles tend to be those that contributed most to the development of research trends, serving as references for other researchers. Table 4 lists the 10 highest-impact articles.

Table 4. Top 10 - Articles with the greatest impact.

Title	Authors	Periodical	Year of publication	Quote local	Quote Global
Blockchain Technology, Business Data Analytics, and Artificial Intelligence: Use in the Accounting Profession and Ideas for Inclusion into the Accounting Curriculum.	Amer Qasim, Faten F. Kharbat;	Journal of Emerging Technologies in Accounting	2020	6	54
The Experience of Deep Learning by Accounting Students.	Turner, M., & Baskerville, R.	Accounting Education	2013	3	37
Relationships between Vocational Interests and Learning Approaches to Advance the Quality of Student Learning in Accounting.	McDowall, T., Jackling, B., & Natoli, R.	Accounting Education	2015	2	13
The relationship between motivation, learning approaches, academic performance, and time spent.	Everaert, P., Opdecam, E., & Maussen, S.	Accounting Education	2017	2	81
Conceptions of Learning and Approaches to Learning—A Phenomenographic Study of a Group of Overseas Accounting Students from Sri Lanka	Abhayawansa, S., & Fonseca, L	Accounting Education	2010	1	37
Expanding the Horizons of Accounting Education: Incorporating Social and Critical Perspectives	Boyce, G., Greer, S., Blair, B., & Davids, C	Accounting Education	2012	1	58

Title	Authors	Periodical	Year of publication	Quote local	Quote Global
The impact of unstructured case studies on surface learners: a study of second-year accounting students.	Wynn-Williams, K., Beatson, N., & Anderson, C.	Accounting Education	2016	1	19
Factors influencing students' learning approaches in auditing	Barac, K., Kirstein, M., Kunz, R. and Beukes, B.	Meditari Accountancy Research	2016	1	11
Embracing Emerging Technologies and Artificial Intelligence into the Undergraduate Accounting Curriculum: Reflections from the UAE	Amer Qasim, Ghaleb A. El Refae, Shorouq Eletter;	Journal of Emerging Technologies in Accounting	2022	1	3
Implications for Education and Research.	Elliott, R. K.	California Management Review	1986	0	6

The data reveals a significant prevalence of studies on the integration of emerging technologies and artificial intelligence (AI) into the accounting curriculum. The article by Amer Qasim and Faten F. Kharbat, published in 2020, stands out with 6 local citations and 54 global citations, highlighting the substantial interest in this area. This high number of global citations suggests widespread recognition of the importance of incorporating these technologies into accounting education.

Regarding learning methods, articles by Turner and Baskerville (2013) and Abhayawansa and Fonseca (2010) address deep learning experiences and phenomenographic studies, respectively. Both articles have a considerable impact, with 37 global citations each, indicating the relevance of innovative pedagogical methods in accounting training.

The relationship between motivation, learning approaches, and academic performance is another prominent topic. The study by Everaert, Opdecam, and Maussen (2017), which explores this relationship, received 81 global citations, the highest number in the table. This data highlights the importance of motivational factors in the educational success of accounting students.

Furthermore, the incorporation of social and critical perspectives in accounting education is also relevant. The article by Boyce et al. (2012) on this topic is highly cited globally (58 citations), indicating a growing recognition of the importance of an accounting curriculum that considers social and critical aspects.

The impact of unstructured case studies on surface learners is explored by Wynn-Williams, Beatson, and Anderson (2016), with 19 global citations. This article points to the effectiveness of case studies as an important pedagogical technique. The research by Barac et al. (2016) on factors influencing audit learning approaches, with 11 global citations, highlights the complexity of audit education and the need for adaptive pedagogical approaches. The integration of AI into the accounting curriculum is again addressed in the research by Amer Qasim, Ghaleb A. El Refae, and Shorouq Eletter (2022), which, despite being recent and with fewer citations (3 global and 1 local), highlights the importance of updating curricula with emerging technologies. Finally, Elliott's article (1986), despite being the oldest and having only 6 global citations and no local ones, serves as a historical starting point for the evolution of educational methodologies in accounting.

The analysis of scientific production among the most productive countries reveals that the United States leads with 133 articles, followed by China (33) and Australia (27). In terms of citations, Australia stands out with four hundred citations and an average of twenty-five per article, indicating high relevance. The United States registers 339 citations (average of 17.80), while the United Kingdom, with only 10 articles, has 138 citations (average of 27.60). Belgium, despite having only three articles, exhibits a remarkable average of eighty-one citations per article. In contrast, China, with thirty-three articles, has a lower average of 2.90 citations per article, suggesting lower individual impact.

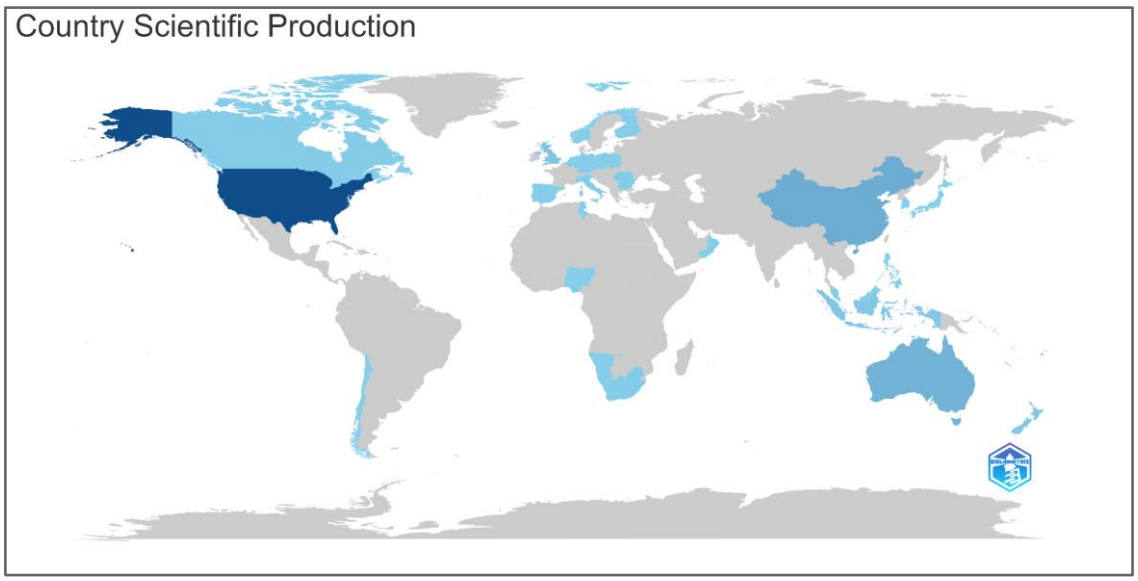


Figure 2. Country Scientific Production

The world map of scientific production visually illustrates this distribution, highlighting the United States, China, and Australia with more intense colors, corresponding to high production. However, scientific relevance, measured by the number of citations per article, places Australia, the United Kingdom, and Belgium in a prominent position due to the significant impact of their works (see Figure 2).

Table 5 contains the most cited references and shows the growing importance of artificial intelligence (AI) in accounting teaching.

Table 5. Top 10 – Most cited references.

References cited	Quotes
1) Kokina J, 2017, J Emerg Technol Acco, v14, p115, Doi 10.2308/jeta-51730	10
2) Booth P., Luckett P., Mladenovic R., The quality of learning in accounting education: the impact of approaches to learning on academic performance, accounting education: an international journal, 8, 4, pp. 277-300, (1999)	7
3) Gow L., Kember D., Cooper B., The teaching context and approaches to study of accountancy students, issues in accounting education, 9, 1, pp. 118-130, (1994)	7
4) Issa H, 2016, J Emerg Technol Acco, v13, p1, doi 10.2308/jeta-10511	6
5) Qasim a, 2020, J Emerg Technol Acco, v17, p107, doi 10.2308/jeta-52649	6
6) Ramsden P., Learning to teach in higher education, (1992)	6
7) Sledgianowski d., 2017, journal of Accounting Education, v38, p81, doi 10.1016/j.jaccedu.2016.12.008, doi 10.1016/j.jaccedu.2016.12.008	6
8) Dzuranin ac., 2018, Journal of Accounting Education, v43, p24, doi 10.1016/j.jaccedu.2018.03.004, doi 10.1016/j.jaccedu.2018.03.004	5
9) Entwistle n.j., ramsden p., understanding student learning, (1983)	5
10) Lucas U., Deep and surface approaches to learning within introductory accounting: a phenomenographic study, accounting education, 10, 2, pp. 161-184, (2001)	5

Kokina's (2017) article in the Journal of Emerging Technologies in Accounting (JETA) is the most referenced, with 10 citations, highlighting the influence of emerging technologies on accounting. This suggests that AI is increasingly becoming integrated into accounting practices and educational curricula, preparing students for a digital future.

Studies such as those by Booth, Luckett, and Mladenovic (1999) and Gow, Kember, and Cooper (1994), both with 7 citations, focus on the quality of learning and educational approaches. Including AI in teaching can improve the quality of learning by providing advanced tools for data analysis and automation of accounting tasks. Articles by Issa (2016) and Qasim (2020), both also published in JETA and with six citations each, reinforce the relevance of emerging technologies in accounting. AI is becoming an essential tool in the educational curriculum, training accountants proficient in advanced technologies.

Ramsden's (1992) book on higher education, with 6 citations, highlights the importance of effective teaching practices. AI can be used to personalize learning, offering content tailored to student's individual needs and improving the effectiveness of accounting education.

Studies by Sledgianowski (2017) and Dzuranin (2018), with 6 and 5 citations respectively, discuss educational aspects of accounting and suggest that AI can transform accounting education. It can provide practical simulations and predictive analysis, helping students better understand accounting concepts.

Finally, the works of Entwistle and Ramsden (1983) and Lucas (2001), both with 5 citations, investigate learning approaches. AI can support deep learning approaches, helping students better understand complex concepts through data analysis and real-time feedback.

Local citations measure how many times an author included in this collection has been cited by other authors also in the collection. In this sense, the frequency of the most cited authors locally is presented in Table 6.

Table 6. Top 10 – Most cited authors.

Author	Local citation
Qasim A	7
Kharbat F	6
Baskerville R	3
Turner M	3
Everaert P	2
Jackling B	2
Maussen S	2
Mcdowall T	2
Natoli R	2
Opdecam E	2

The table of most cited authors shows that Qasim A and Kharbat F are the most referenced, with 7 and 6 local citations, respectively, significantly standing out from the others. Baskerville R and Turner M follow, both with 3 citations. Another six authors (Everaert P, Jackling B, Maussen S, Mcdowall T, Natoli R, and Opdecam E) have 2 citations each, indicating an even distribution among them. The large differences in citations suggest that Qasim A and Kharbat F have greater influence or relevance in the analyzed context.

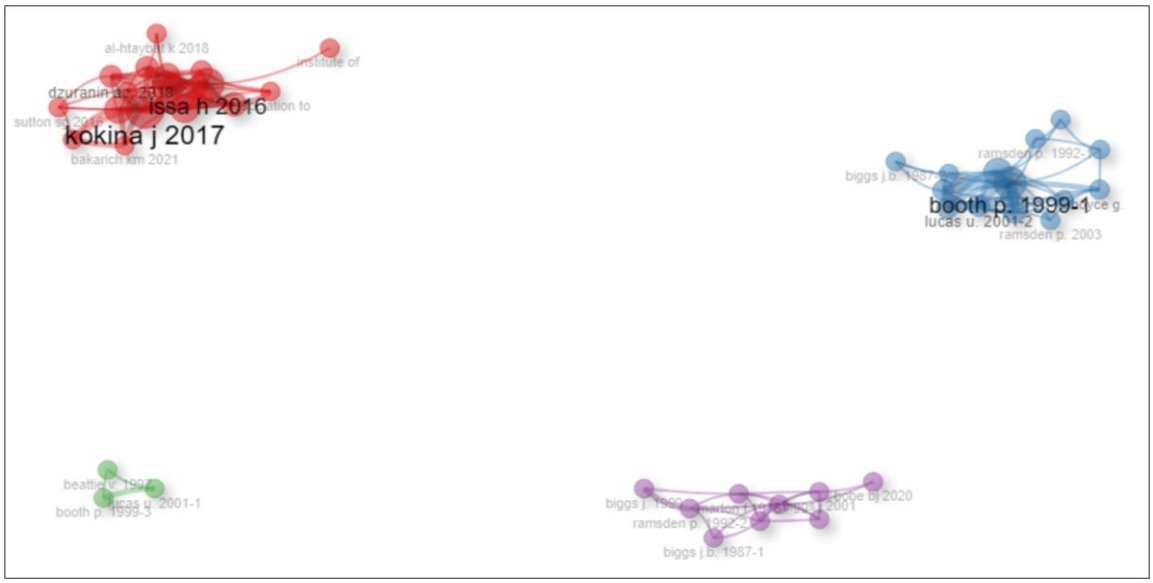
3.2 Co-citation Analysis

Co-citation analysis shows the structure and relationships within a research field, highlighting how often authors are cited together. This makes it possible to identify research clusters and understand the centrality and influence of authors (Small, 1973). The data provides information about authors, their clusters, and metrics such as betweenness, closeness, and PageRank, which help determine the importance of authors in the citation network (Table 7). Figure 3 presents the Co-citation analysis.

In terms of the Red Cluster, there are authors such as Kokina J. (2017), Issa H. (2016), Sledgianowski D. (2017) and Qasim A. (2020). These authors present relatively high betweenness and PageRank values. For example, Issa H. (2016) has a betweenness of 20.963 and a PageRank of 0.039, while Kokina J. (2017) has a betweenness of 18.262 and a PageRank of 0.037. These values indicate that these authors are important connectors and have a high influence on the citation network. This cluster appears to represent a recent and active area of research, with many authors publishing in recent years. The high betweenness and PageRank of several authors suggest that they are influential and frequently cited together, possibly on emerging and interdisciplinary topics.

Regarding the Blue Cluster, authors such as Booth P. (1999), Gow L. (1994), and Hall M. (2004), present high betweenness and PageRank. Booth P. (1999), for example, has a betweenness of 30.392 and a PageRank of 0.05, indicating a highly central and influential position in the network. Other authors, such as Entwistle NJ (1983) and Lucas U. (2001), are also relevant, although with slightly lower metrics. This cluster appears to represent a more established area of research, with influential authors who have been consistently

cited over time. The presence of older works suggests that these are seminal and continue to influence subsequent studies.



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In terms of the Red Cluster, there are authors such as Kokina J. (2017), Issa H. (2016), Sledgianowski D. (2017) and Qasim A. (2020). These authors present relatively high betweenness and PageRank values. For example, Issa H. (2016) has a betweenness of 20.963 and a PageRank of 0.039, while Kokina J. (2017) has a betweenness of 18.262 and a PageRank of 0.037. These values indicate that these authors are important connectors and have a high influence on the citation network. This cluster appears to represent a recent and active area of research, with many authors publishing in recent years. The high betweenness and PageRank of several authors suggest that they are influential and frequently cited together, possibly on emerging and interdisciplinary topics.

Regarding the Blue Cluster, authors such as Booth P. (1999), Gow L. (1994), and Hall M. (2004), present high betweenness and PageRank. Booth P. (1999), for example, has a betweenness of 30.392 and a PageRank of 0.05, indicating a highly central and influential position in the network. Other authors, such as Entwistle NJ (1983) and Lucas U. (2001), are also relevant, although with slightly lower metrics. This cluster appears to represent a more established area of research, with influential authors who have been consistently cited over time. The presence of older works suggests that these are seminal and continue to influence subsequent studies.

As for the Purple Cluster, authors such as Biggs J. (2001), Marton F. (1976), and Sharma DS (1997) have betweenness and PageRank metrics varying between medium and high. Biggs J. (2001) has a betweenness of 1.686 and a PageRank of 0.024, while Sharma DS (1997) has a betweenness of 6.314 and a PageRank of 0.034. This cluster appears to combine foundational research with ongoing contributions. The presence of authors with high closeness and betweenness suggests that these works are frequently cited in different contexts, indicating a broad and lasting application.

In the Green Cluster, there are authors such as Lucas U. (2001) and Beattie V. (1997), who have high closeness, but low betweenness. This suggests that these authors are centrally located within their group, but do not necessarily function as bridges between different clusters. This cluster may represent a specific subfield or area of research where authors are interconnected but are not necessarily influential in other subfields. High centralization suggests a cohesive and well-defined research community.

Table 7. Co-citation Analysis

Red Cluster	Blue Cluster	Purple Cluster	Green Cluster
Kokina J (2017)	Booth P. 1999-1	Biggs J (2001)	Lucas U. (2001-1)
American Institute	Gow L. 1994	Marton F (1976)	Beattie V. (1997)
Qasim A (2020)	Boyce G.	Ramsden p. (1992-2)	Booth P. 1999-3
Issa H (2016)	Ramsden P. 1992-1	Sharma D.S. (1997-1)	
Sledgianowski (2017)	Entwistle N.J. 1983	Biggs J. (1999)	
association to	Objectives of 1990	Biggs J.B. (1987-1)	
Dzuranin AC. (2018)	Davidson R.A. (2002)	Bobe BJ (2020)	
Moffitt kC (2018)	Hall M. (2004)	Booth P. (1999-2)	
Sutton SG (2016)	Lucas U. (2001-2)	Byrne M. (2003)	
Appelbaum D (2017)	Ramsden P. (2003)		
Bakarich kM (2021)	Sharma D.S. (1997-2)		
Cooper LA (2019)	Albrecht W.S. (2000)		
Janvrin D. (2017)	Biggs J. (1987)		
Tapis GP (2020)	Biggs J.B. (1987-2)		
Al-htaybat K (2018)			
Coyne JG (2016)			
Dai J (2017)			

3.3 Co-authorship analysis

Co-authorship analysis is a bibliometric technique used to investigate collaboration between researchers, organizations, and countries in scientific publications. It identifies patterns of cooperation, collaboration networks, and the social structure of scientific communities. Furthermore, it allows mapping contributions over time, helping researchers to review intellectual development (Meyer & Bhattacharya, 2004; Donthu et al., 2021). Figure 4 shows a varied distribution and the presence of influential individuals in different clusters. In total, we identified seven clusters, each with its composition and main authors.

In Cluster 1, composed of 20 authors, Everaert P, Smith J, Tharapos M, and Zhang C stand out for their high betweenness and proximity centrality. These authors are fundamental in connecting subgroups and disseminating information in the network, indicating that they play critical roles in coordinating collaborative efforts and in the centrality of the network.

In contrast, in Cluster 2, composed of four authors, Jackling B and Natoli R emerge as the most influential. They are central nodes, facilitating efficient collaborations within the group. The presence of these central authors suggests a high efficiency in communication and in facilitating quick and effective collaborations between cluster members.

Therefore, Cluster 3, formed by eight authors, including Cheng X, Dunn R, Holt T, Inger K, Long J, Loraas T, Stanley J, and Wood D, presents an even distribution of influence. This indicates a highly interconnected network without a single point of failure, where all authors are of equal importance. The absence of a single extremely central node suggests greater network resilience against interruptions.

Finally, in Clusters 4, 5, 6, and 7, each with two authors, high cohesion and direct communication are observed. In Cluster 4, the authors are Er M and Ng A; in Cluster 5, Fogarty T and Goldwater P; in Cluster 6, Adha M and Afriadi B; and in Cluster 7, Al AJ and Al G M. Communication direct interaction between peers in these smaller clusters indicates strong internal cohesion, where efficiency and speed in collaborations are maximized.

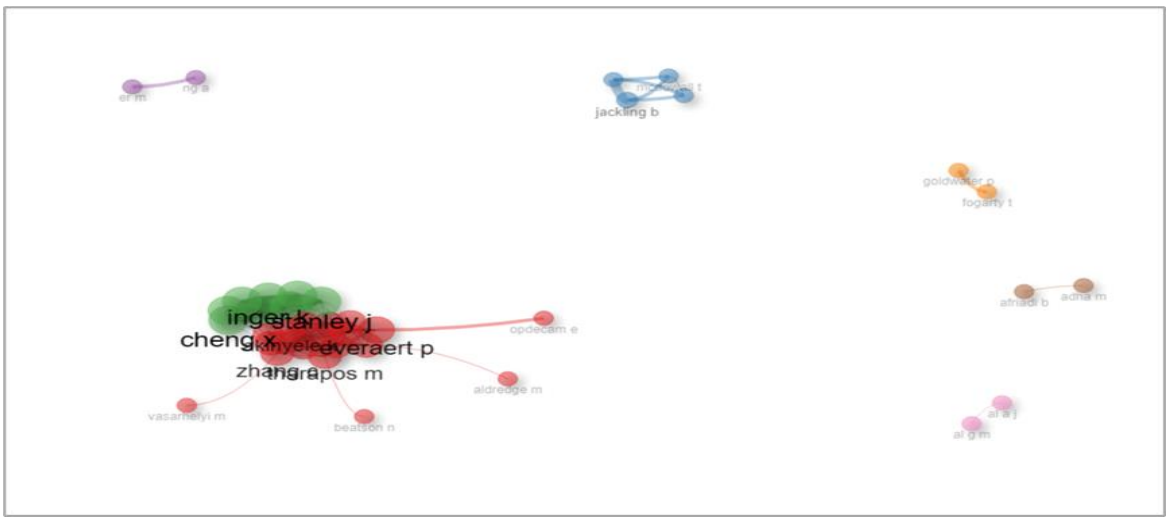

Figure 4. Co-authorship Analysis - collaboration network between authors

As illustrated in Figure 5, the collaboration network between countries is divided into three clusters, while the network of institutions is segmented into seven clusters, each represented by a different color. These clusters indicate that countries or institutions in the same group are cooperating.

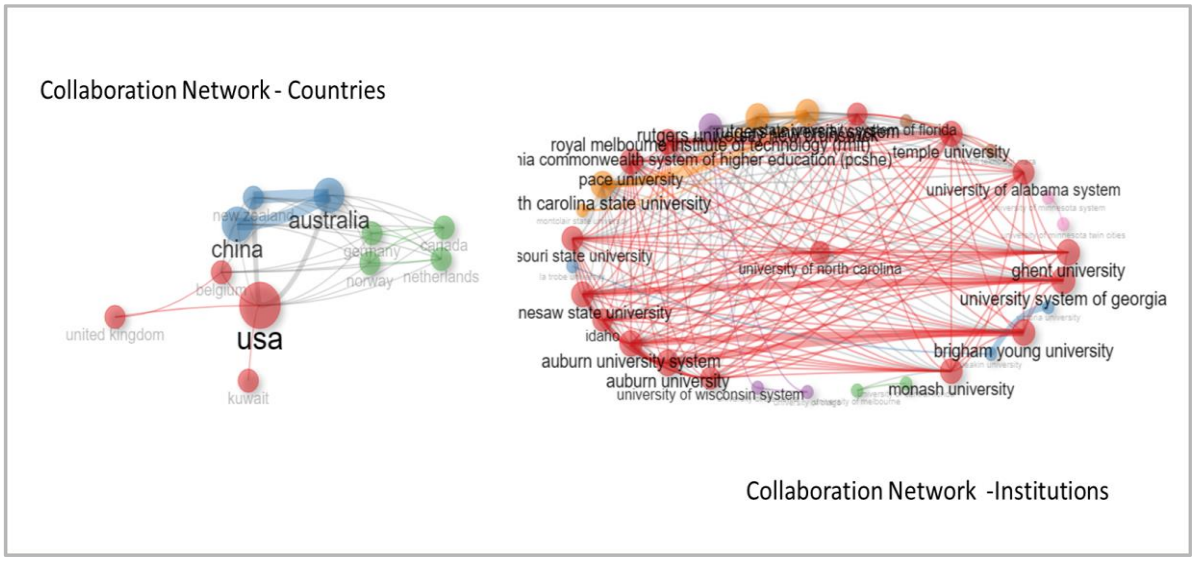

Figure 5. Co-authorship analysis - collaboration network between countries and institutions.

The analysis of collaboration clusters between countries shows that the USA occupies a central position in the global network, with high intermediation, proximity, and PageRank, demonstrating strong influence and connectivity. In Cluster 1, Belgium also has moderate influence, while the United Kingdom and Kuwait have lower centrality. In Cluster 2, China, Australia, and New Zealand exhibit high local connectivity and significant influence. In Cluster 3, Canada, Germany, Norway, and the Netherlands have an even distribution of connectivity and influence. In short, the US leads the global collaboration network, with other countries contributing in different ways depending on their clusters.

About institutions, the analysis of collaboration clusters shows different degrees of influence and connectivity. In Cluster 1, Monash University stands out for its high betweenness centrality, indicating an important role in facilitating connections between universities. Other institutions in this cluster, such as Auburn University and Brigham Young University, have a steady presence but are not major intermediaries. In Cluster 2, Deakin University has high betweenness centrality, being a prominent point within the cluster. Victoria University and La Trobe University show good local connectivity. In Cluster 4, the Royal Melbourne Institute of Technology (RMIT) is highly influential, similar to Monash University.

In Cluster 5, North Carolina State University and Rutgers University exhibit intermediate influence. In Clusters 6 and 7, universities such as Syiah Kuala University and the University of Minnesota Twin Cities

are highly connected within their specific clusters. In general, institutions such as Monash University and RMIT play central roles in the research collaboration network, while others such as Deakin University and Rutgers University also show significant influence, but to a lesser extent.

3.4 Word Co-Occurrence Analysis

Word co-occurrence analysis examines relationships between research topics, focusing on the content of publications (Donthu et al. 2021). Using the Co-Words Analysis technique, more and less explored themes are identified. Software generates networks with clusters (nodes), representing groups of words, where the lines indicate their relationships. The size of the nodes reflects the frequency of the keywords and the density indicates the maturity of the study; greater density suggests a more developed study.

3.4.1 Word analysis

3.4.1.1 Most relevant words

Figure 6 presents a quantitative analysis of keywords extracted from a corpus of 130 documents that focus on paradigm shifts in accounting education about artificial intelligence. Analysis of the keywords reveals that the study focuses on applying artificial intelligence (35 occurrences) in accounting education (38 occurrences). AI technologies, such as "deep learning" (10), "data analytics" (9), "machine learning" (6), "big data" (6), and "blockchain" (5), are explored in their integration in accounting education. Terms related to education, such as "accounting curriculum" (7), "approaches to learning" (6), and "teaching" (4), suggest a focus on innovative pedagogical methods. The importance of the professional context is highlighted by "accounting" (14) and "accounting profession" (6), indicating the link between accounting education and labor market practices. The combination of “deep learning” and “accounting education” suggests using advanced AI to improve accounting learning. The impact of AI technologies on student learning is highlighted by "students" (3) and "accounting students" (3). In summary, the study investigates how various AI technologies can be applied in accounting education, focusing on innovative teaching methods, process automation, and curriculum updating, aiming to improve both training and professional practice in accounting.

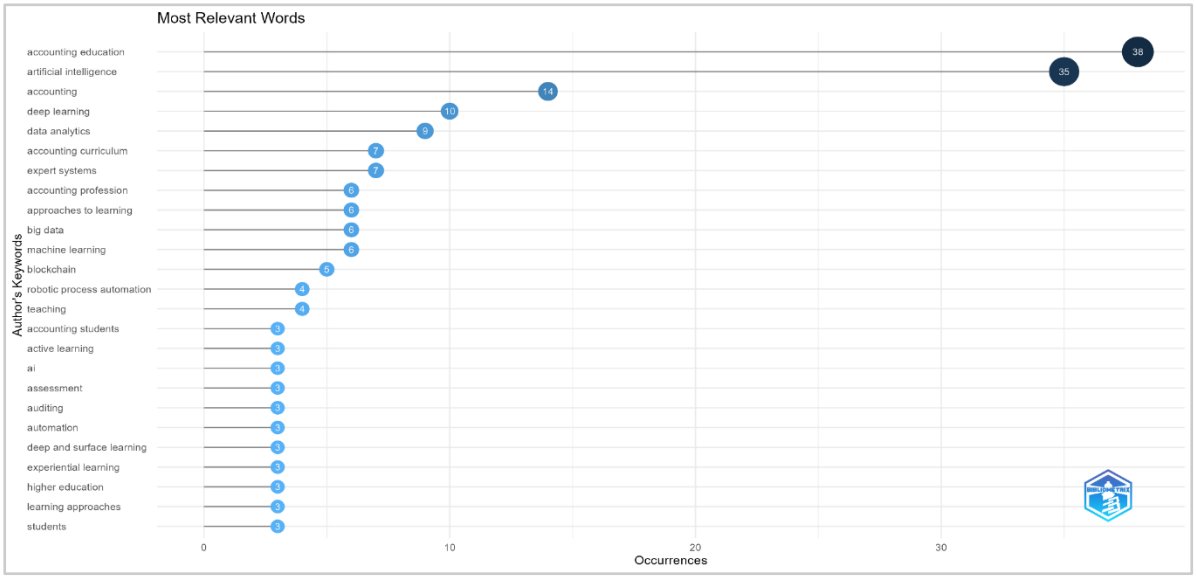

Figure 6. The twenty-five most relevant words.

The analysis of the frequency of words over time, presented in Figure 6, reveals some trends regarding the application of artificial intelligence in accounting education. The mentions of "accounting

education" increased from 0 in 1988 to 37 in 2024, and "artificial intelligence" from 1 in 1988 to 35 in 2024. This growth can be attributed to global advancement in information technology and the increasing digitalization of education. In the 1990s and 2000s, the internet and digital technologies significantly transformed the way knowledge was disseminated, setting the stage for the adoption of AI in education.

Terms like "deep learning" and "data analytics" have only appeared since the 2000s, with "deep learning" increasing from 1 in 1997 to 10 in 2024, and "data analytics" growing from 0 in 1988 to 9 in 2024. This coincides with the explosion of big data and the development of deep learning algorithms, which have gained prominence with the popularization of technologies such as neural networks and increased computational capacity. These advances reflect the technological revolution that began in the 2000s with the massification of the internet and the arrival of Web 2.0.

Starting in the 2000s, "accounting curriculum" and "approaches to learning" began to be mentioned consistently, indicating an increase in interest in updated curricula and new teaching methods. This period marked the transition from traditional teaching methods to more innovative and interactive approaches, driven by easier access to information and online education.

Terms such as "accounting profession" and "expert systems" have maintained a stable frequency over the years, with a slight increase, suggesting continued attention to these topics. This reflects the continuous development of specialized systems and their practical application in accounting, in line with technological maturity and the gradual acceptance of new technologies in professional practices.

As of 2019, there has been a sharp increase in mentions of "data analytics" and "artificial intelligence", coinciding with the Fourth Industrial Revolution, characterized by the fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. The COVID-19 pandemic has also accelerated the adoption of digital and AI technologies as remote education and work have become the norm.

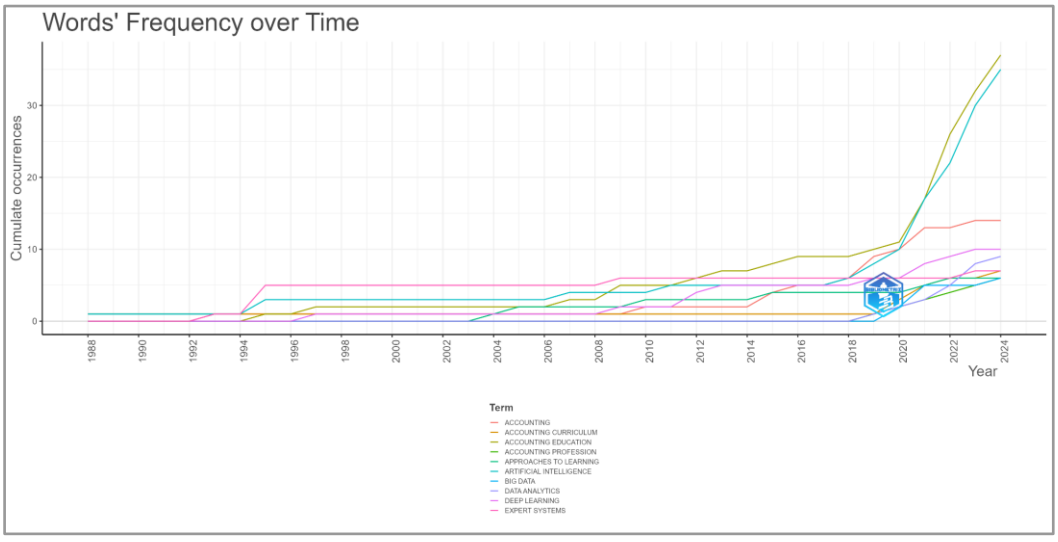

Figure 7. Accumulation of the top ten words by frequency of occurrence.

Therefore, the constant and significant growth in interest in the application of artificial intelligence in accounting education, with a focus on emerging technologies and pedagogical innovations, reflects global transformations driven by technological advancement and changes in educational and professional demands over the last few decades. A Convergence between "accounting education" and technological terms suggests an increasing integration of AI and new technologies in the accounting curriculum, adapting to the needs of an increasingly digitalized and interconnected world.

3.4.1.2 Trending Topics

The bibliometric study presented in Figure 8 indicates that artificial intelligence has significantly shaped the academic landscape of accounting education. Shows how the field has dynamically adapted to emerging trends and global events that influence educational priorities and methods.

Expert systems, with a frequency of seven mentions and dates of relevance concentrated between 1995 and 2002, indicate that they were an initial focus of interest, but that their importance decreased over time. In contrast, deep learning, mentioned ten times, shows significant growth starting in 2012, with a recent spike in 2021. This increase highlights how more advanced AI techniques are being incorporated into accounting practices, enabling more complex and efficient analyses.

Artificial intelligence, with thirty-five mentions, has become one of the most discussed topics recently, with highlights between 2020 and 2023. The application of AI in accounting provides automation of routine tasks, improved audit accuracy, and predictive capacity through models predictive. At the same time, the term big data, mentioned 6 times with a concentration of interest between 2020 and 2021, highlights the growing importance of analyzing large volumes of data.

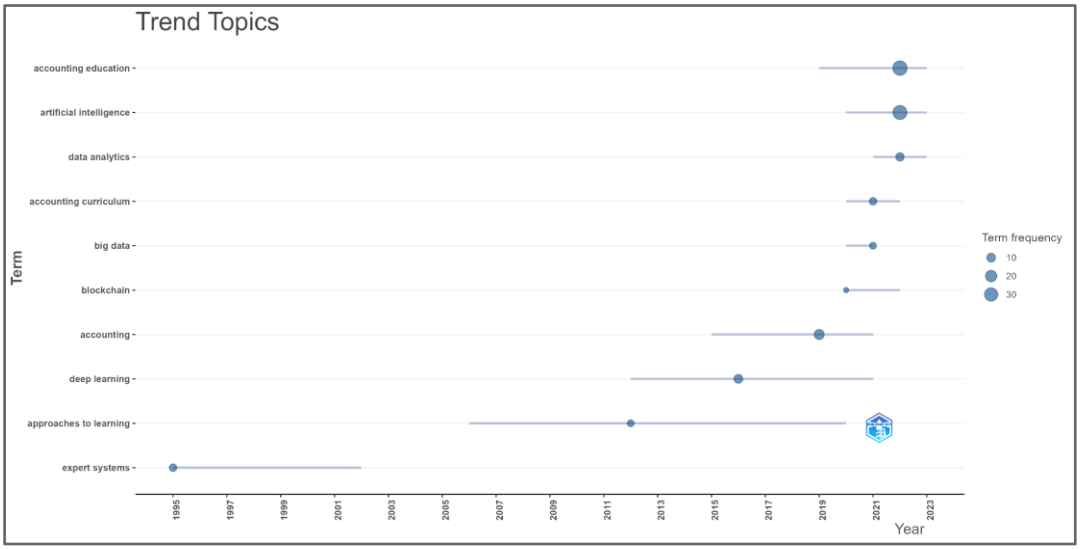

Figure 8. Trending topic over time.

The terms accounting education and accounting curriculum, with 37 and 7 mentions respectively, show a significant concern with updating educational content to reflect these new technological trends. Between 2019 and 2023, there has been a notable increase in attention paid to accounting education, suggesting an effort to prepare future professionals with the skills needed to manage new AI tools and advanced data analytics. The accounting curriculum, especially, adapts to include topics such as blockchain, mentioned five times since 2020, and data analytics, with nine mentions as of 2021.

The integration of artificial intelligence in accounting teaching is also reflected in the approaches to learning, mentioned six times. The evolution from 2006 to 2020 shows a growing interest in innovating teaching methodologies to incorporate emerging technologies. This includes using machine learning tools to personalize teaching, utilizing chatbots for student support, and incorporating AI-based simulations for more realistic accounting practices.

3.4.2 Network analysis

3.4.2.1 Co-occurrence network

The keyword network map is provided in Figure 9. The analysis of word co-occurrence clusters shows the structure and central themes of artificial intelligence (AI) research in accounting education. Four clusters were indicated and different colors were used for each of them. The author's keyword network map shows the intersection between "artificial intelligence" and "accounting education." Core keywords indicate a focus on emerging technologies such as "machine learning" and "blockchain" and innovative teaching methods. Connections between "auditing", and "accounting", and these terms suggest the application of AI in accounting and auditing.

Additionally, references to "students", "education", and "learning" highlight improving learning with AI, while mentions of "China" and "Australia" suggest specific case studies in those countries.

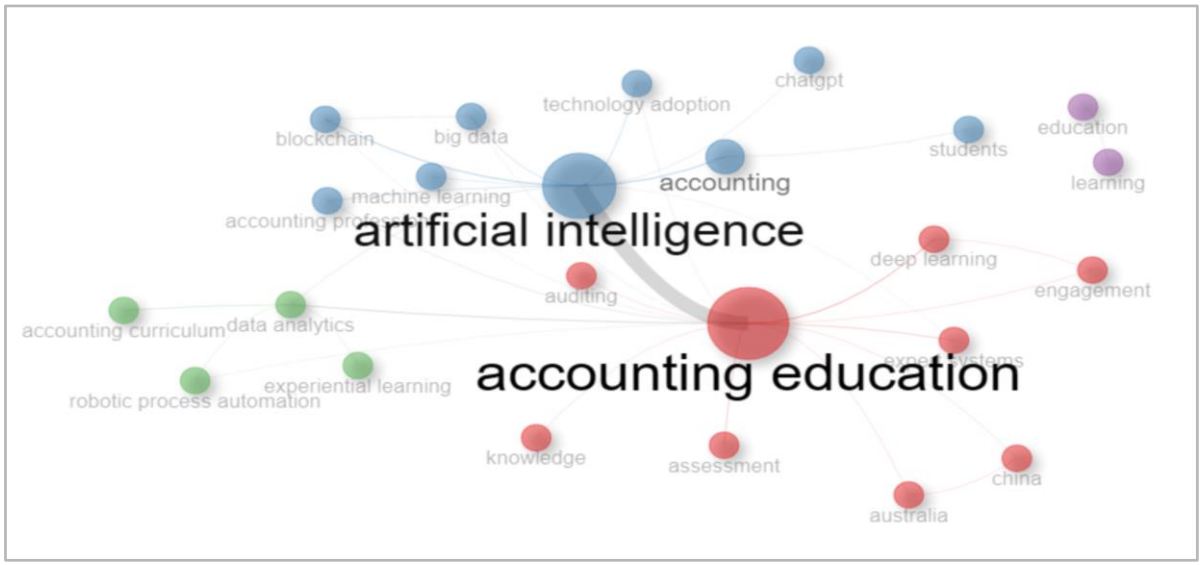

Figure 9. Network map based on author keywords

In Cluster 1, the term accounting education stands out as the most central, with high betweenness, indicating its significant relevance in the co-occurrence network. Related terms, such as deep learning, expert systems, assessment, auditing, Australia, China, engagement, and knowledge, are closely connected, suggesting an interest in how advanced technologies and educational practices are applied in accounting education in different geographic and assessment contexts.

Regarding Cluster 2, artificial intelligence and accounting are the main terms, reflecting an emphasis on the application of AI in accounting. The presence of terms such as big data, machine learning, blockchain, students, technology adoption, and ChatGPT suggests an exploration of emerging technologies and their adoption in the field of accounting.

When it comes to Cluster 3, data analytics is central, pointing to the focus on data analysis within the accounting curriculum. Related terms, such as accounting curriculum, robotic process automation, and experiential learning, indicate the integration of automation and practical learning in accounting education.

Therefore, in Cluster 4, the terms education and learning are central and indicate a comprehensive focus on education and learning, possibly acting as hubs that connect different areas of research.

In short, accounting education is central, reflecting a continued focus on improving accounting education through new technologies. Detailed research into the application of AI in accounting is highlighted by the presence of artificial intelligence and accounting.

Emerging technologies such as big data, blockchain, and robotic process automation are gaining increasing relevance in accounting education, while pedagogy and teaching methodologies remain central concerns. These clusters reflect an evolving field of research, integrating emerging technologies into accounting education and maintaining the effectiveness of pedagogical and curricular practices.

3.4.2.2 Thematic map

The Thematic Map is presented in Figure 10. This map offers a comprehensive view of the current state of research in the area, highlighting central and well-developed themes, promising areas still under development, specialized niches, and possible declines or emergencies. This analysis can help researchers and professionals direct their efforts to areas with greater potential for impact and innovation.

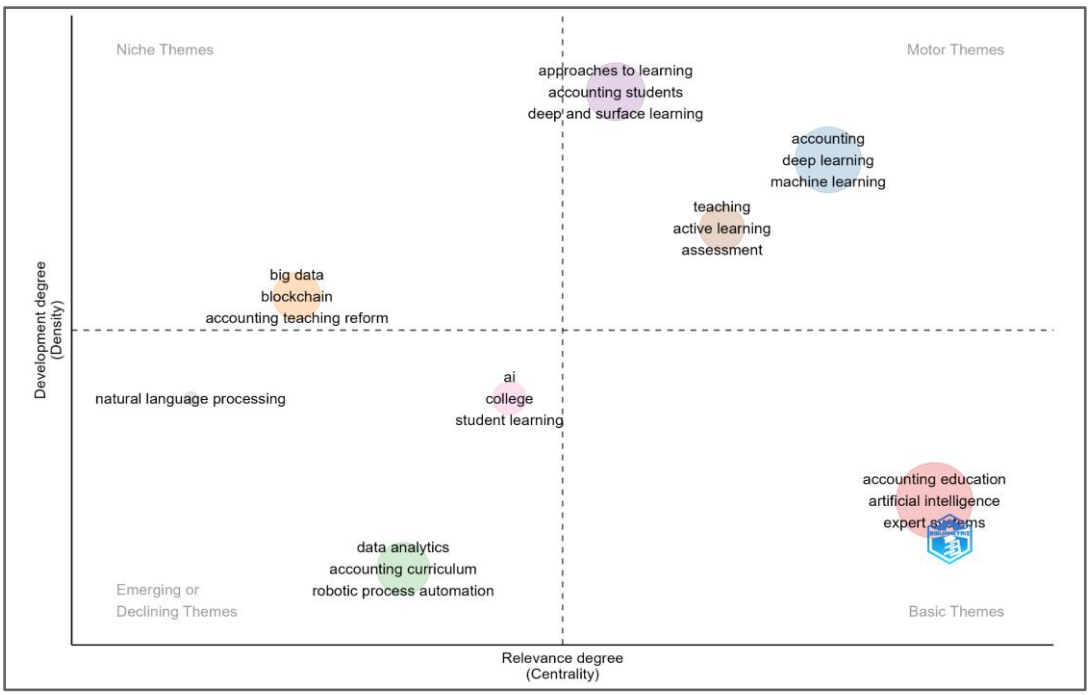

Figure 10: Thematic map based on authors' keywords

In the "Accounting Education" cluster, the terms "accounting education" and "artificial intelligence" stand out, both with high Betweenness Centrality values, indicating that they play significant roles in connecting various concepts within accounting education. Terms such as "expert systems" and "auditing" have lower Betweenness Centrality values, suggesting that they are less critical in connecting themes, but are still relevant. In the "Accounting" cluster, the term "accounting" has the highest Intermediation Centrality, emphasizing its central role in discussions about accounting. The significant presence of AI-related terms such as "deep learning" and "machine learning" highlights the growing importance of these technologies in accounting. In the "Data Analytics" cluster, the term "accounting curriculum" is a key theme, indicating discussions about the integration of data analysis into accounting education. The presence of "robotic process automation" suggests a focus on automation in the field. In the "Approaches to Learning" cluster, terms such as "approaches to learning" and "deep and surface learning" suggest an emphasis on pedagogical strategies in accounting education. The inclusion of "course experience" indicates attention to the quality and effectiveness of educational experiences. In the "Big Data" cluster, "big data" is central, reflecting its critical role in modern accounting practices. The presence of "blockchain" and "business analytics" indicates a focus on advanced technologies and their applications in accounting. In the "Teaching" cluster, terms such as "teaching" and "active learning" are prominent, suggesting an emphasis on effective teaching methodologies in accounting education. The role of "assessment" indicates the importance of evaluating student learning and performance. Finally, in the "AI" cluster, the centrality of the term "AI" reflects its growing importance in accounting education and practice. The inclusion of "college" suggests discussions around AI in the context of higher education.

3.4.2.3 Thematic evolution

The graphical visualization covers a bibliometric analysis of teaching paradigms in accounting and the influence of Artificial Intelligence from 1986 to 2024. Thematic evolution can be understood by analyzing historical trends and global contexts during each period, as visualized in Figure 11.

In the period from 1986 to 2012, the global context was marked by the beginning of the information age, with the growth of the internet and the increase in the use of personal computers in the 1990s. During this period, the focus was on traditional accounting practices and methods of conventional teaching. The main topics were accounting, accounting education, learning approaches, and early forms of artificial intelligence, which were limited to specific applications.

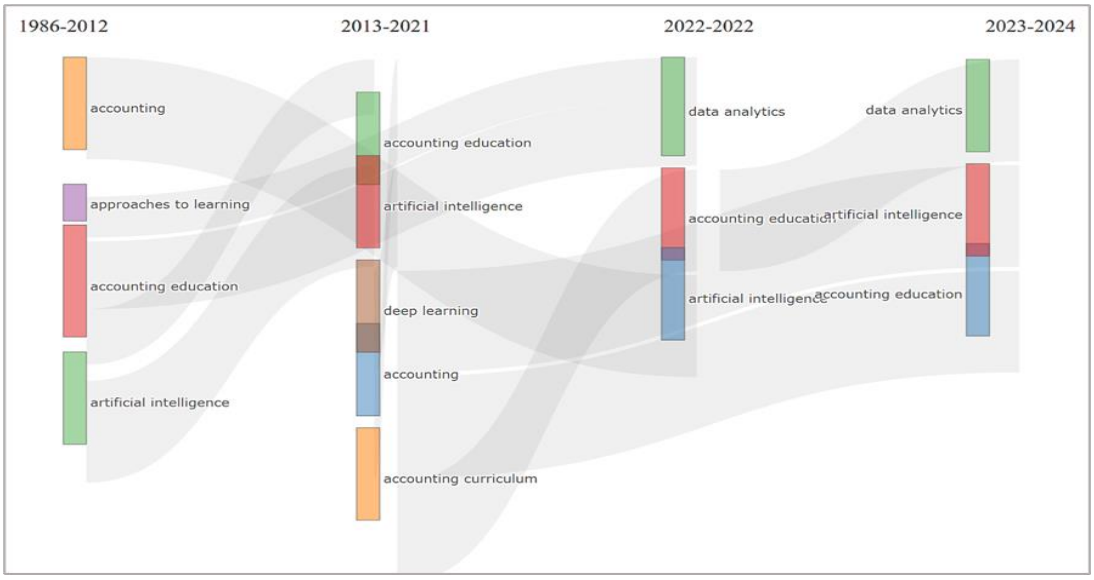

Figure 11. Thematic evolution (algorithm used - Edge Betweenness)

Between 2013 and 2021, there was a significant advance in information technology, with an exponential growth in computational capacity and the emergence of big data. This period was marked by the substantial development of artificial intelligence, especially in machine learning and deep learning. Digital education and technologies have become more widely adopted, with the increased use of online learning platforms and digital tools. Key topics included accounting education, artificial intelligence, deep learning, and accounting curricula adapted to include new technologies.

In the period from 2022 to 2024, the global context was characterized by accelerated digital transformation, especially due to the COVID-19 pandemic, which boosted the adoption of digital technologies in teaching. There has been significant integration of data analytics into various disciplines, including accounting. Innovation in education has come

to the fore, with a growing emphasis on digital skills and the use of AI to personalize learning. The main topics during this period were data analytics, accounting education, and artificial intelligence, reflecting the growing importance of these technologies in improving accounting education.

Therefore, figure xx shows a clear evolution in the application of AI technologies in accounting teaching, following and benefiting from global technological advances. The initial period focused on traditional practices, while more recent periods show an increasing integration of emerging technologies such as deep learning and data analytics, consistent with the global digital transformation and the need to prepare students for a more technology-based work environment. data. The application of AI in accounting education has enabled a more modern and efficient approach to accounting education.

3.4.3 Factor analysis

Factor Analysis in the context of bibliometric studies is a statistical method used to understand complex relationships within academic research data, such as publications, citations, and research trends (Wang et al., 2022). The main objective is to simplify and reduce the complexity of the data, identifying a smaller number of factors or constructs that can explain the relationships between a larger set of observed variables (Campos et al., 2020; Crawford & Lomas, 1980).

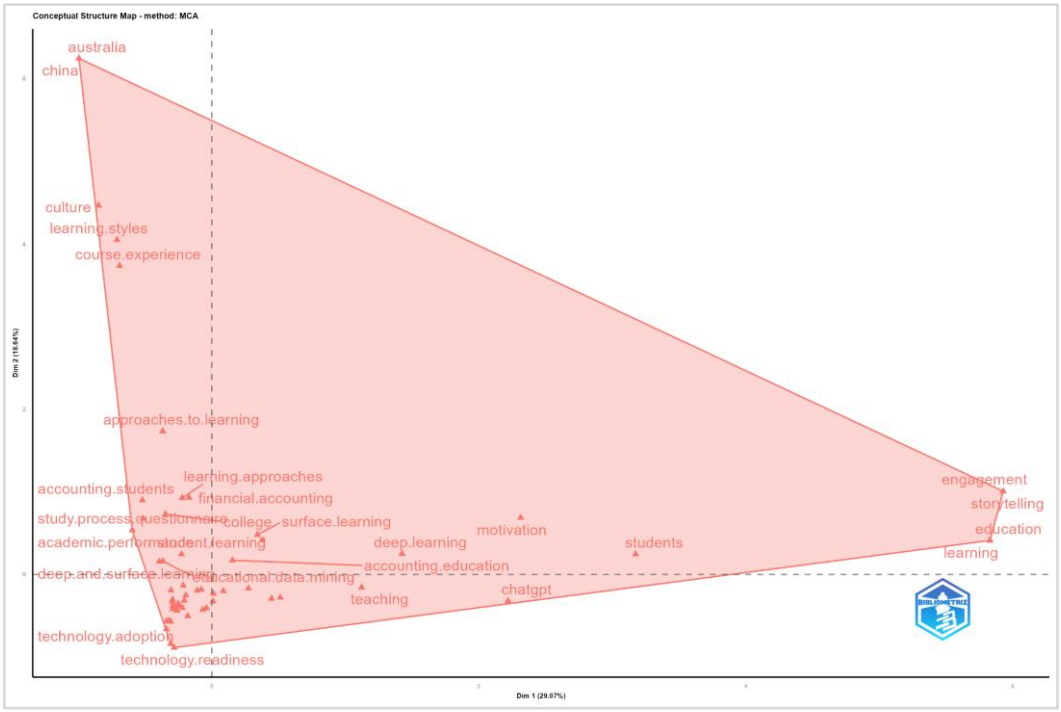

Figura 12: Mapa de Estrutura Conceitual

As a result of the factor analysis, when the keywords of the articles on AI in Accounting teaching in this study are examined, the terms are distributed along two dimensions (Dim1 and Dim2) and the association with a single cluster. In Dimension 1 (Dim1), terms such as education, learning, engagement, storytelling, and students present high positive values, indicating a significant focus on education, learning, and student engagement.

Furthermore, terms such as deep learning, ChatGPT, and motivation also have high positive values in Dim1, suggesting an emphasis on the application of advanced technologies and the study of student motivation. In Dimension 2 (Dim2), we have China, Australia, culture, and course experience have high positive values, indicating a concern with geographic and cultural aspects in accounting education. Terms such as learning styles and study process questionnaires reflect an interest in the diversity of learning styles and the evaluation of study processes.

All terms are associated with a single cluster, suggesting that research is concentrated around a core set of interrelated topics, with a primary focus on education and learning, integration of emerging technologies, and geographic and cultural diversity. AI research in accounting education is focused on three main areas:

1. Integration of Emerging Technologies: Terms such as deep learning, ChatGPT, and data analytics indicate a substantial emphasis on the application of advanced technologies in accounting education.
2. Student Engagement and Motivation: Terms such as engagement, students, and motivation reflect a significant concern with student involvement and motivation in the learning process.
3. Geographic and Cultural Influences: Terms such as China, Australia, and culture demonstrate an interest in understanding how different geographic and cultural contexts affect accounting education.

4 DISCUSSIONS

The discussion addresses a framework, in Figure xx, that combines four main analyses to investigate the application of artificial intelligence (AI) in accounting education, offering an understanding of the factors that influence scientific production and the challenges faced by countries like Brazil. The analysis of citations, co-citations, co-authorship, and co-occurrence of words reveals the importance of influential authors, the interconnection between researchers, interdisciplinary collaboration, and the identification of emerging themes. Next, the proposed research agenda will be presented, which suggests exploring emerging technologies, conducting longitudinal studies, promoting geographic and cultural diversity, using innovative methodologies, and investigating the ethical and social implications of AI, see Table 8.

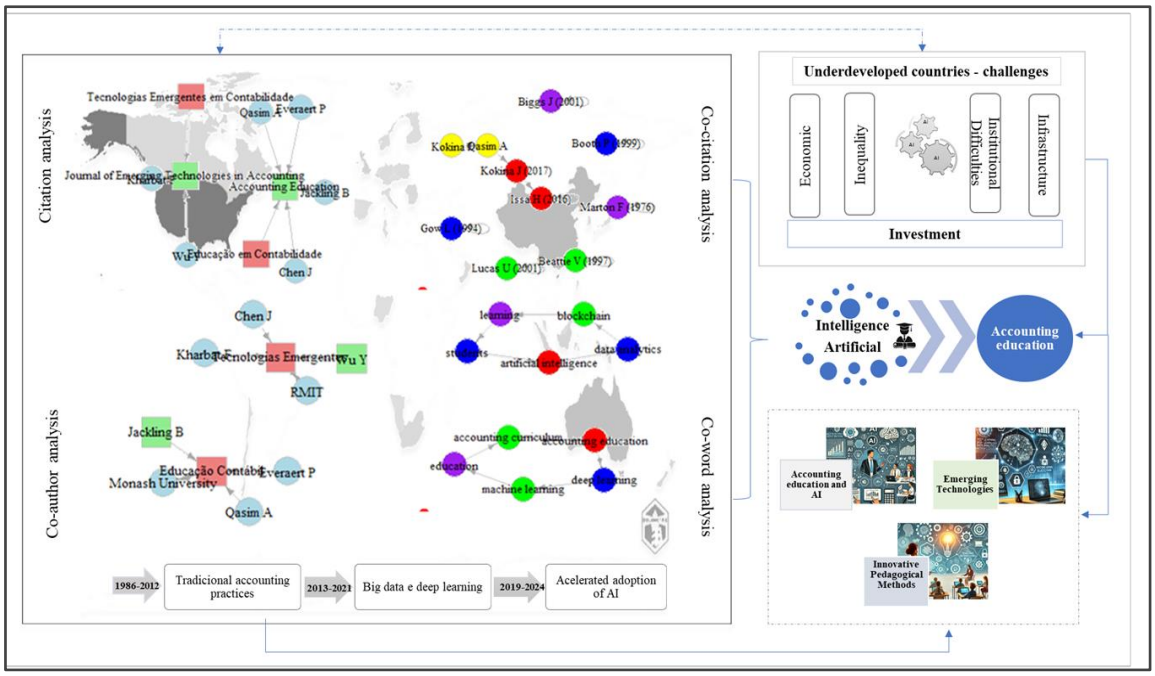

Figure 13. Framework State of the art of the application of AI in accounting education

The Figure illustrates a framework that combines four main analyses to explore research in accounting education and artificial intelligence (AI). Each detail of the figure offers an understanding of the factors that contribute to scientific production in this area and the challenges faced by countries like Brazil.

In the citation analysis, it is highlighted that the most influential authors in the area of AI applied to accounting education are Qasim A, Kharbat F, and Everaert P. Journals such as "Accounting Education" and "Journal of Emerging Technologies in Accounting" are identified as key sources of knowledge. Disciplines such as Accounting Education and Emerging Technologies in Accounting are central to this analysis. Recommended experts, such as Chen J, Jackling B, Wu Y, and Everaert P, are cited as essential readings to deepen knowledge in this field. This analysis suggests that scientific production in developed countries is robust, which can be attributed to better resources and infrastructure.

Co-citation analysis reveals clusters of authors frequently cited together, indicating interconnected research groups. Core clusters include Kokina J (2017) and Issa H (2016) in the red cluster, Booth P (1999) and Gow L (1994) in the blue cluster, Biggs J (2001) and Marton F (1976) in the purple cluster, and Lucas U (2001) and Beattie V (1997) in the green cluster. Core researchers such as Booth P and Kokina J play key roles in their respective clusters; while linking researchers such as Issa H and Qasim A connect different clusters, promoting interdisciplinarity and the integration of new technologies. The evolution of the research structure demonstrates a continuous adaptation to new technologies and developments in the field of accounting education. This implies that there is a strong and connected network of researchers in developing countries, which can facilitate faster and more integrated advances in the field.

Co-authorship analysis reveals patterns of collaboration between researchers in emerging technologies and accounting education. Key factors for these collaborations include institutional proximity, shared interests, and collaborative funding. Such collaborations result in a higher number of citations, indicating the relevance and impact of joint work. Central nodes such as Qasim A, Kharbat F, Monash University, and RMIT are influential in the collaboration network, with the US leading globally in terms of scientific output. This suggests that international and institutional collaboration is an important factor for the success and visibility of research, something that countries such as Brazil need to develop more intensively.

Word co-occurrence analysis identifies key themes and terms that frequently appear in the literature. The application of AI in accounting education is the main focus, with terms such as “accounting education” and “artificial intelligence” being common. Emerging technologies such as “deep learning,” “data analytics,” “machine learning,” and “blockchain” are frequently mentioned. Evolution over time is highlighted, with traditional accounting practices prevailing from 1986 to 2012, big data and deep learning gaining importance from 2013 to 2021, and the accelerated adoption of AI from 2019 to 2024. Conceptual

blocks include clusters of related terms such as "accounting education" and "deep learning," "artificial intelligence" and "accounting," "data analytics" and "accounting curriculum," and "education" and "learning." Related themes include improving accounting learning and practice through the integration of AI, incorporating emerging technologies into accounting curricula, and developing new pedagogical methodologies. This indicates a rapid evolution and diversification of study areas, where adaptation to new technologies is important.

The results revealed that the most productive countries regarding artificial intelligence (AI) in accounting education are the USA (133), followed by China (33) and Australia (27). Brazil is not among these countries due to several economic and institutional challenges. Studies suggest some reasons for this. Coelho et al. (2023) discuss Brazil's institutional difficulties, examining public policies and critical constitutionalism. Silva (2013) explores opportunities for Brazil's foreign policy in the context of the "Next Eleven" countries. Schonerwald et al. (2020) analyze the impact of geography, institutions, and international trade on the BRICS countries, noting that China's economic success defies conventional institutional indicators. Baumann (2022) compares Brazil's economic performance with other emerging economies and high-income countries, highlighting the role of human capital in national wealth.

The figure also addresses the challenges faced by underdeveloped countries, such as Brazil, to excel in AI studies in accounting. These challenges include economic and institutional difficulties, lack of infrastructure, inequality, and insufficient investment. Economic challenges refer to limited financial resources and economic instability that hinder investment in research and development, especially in advanced areas such as AI. Institutional difficulties include inefficiencies and complexities within public policies and institutional frameworks that constrain the effectiveness of educational and research initiatives. The lack of adequate technological and educational infrastructure impedes the support and sustainability of high-quality scientific research and innovation. Inequality refers to socioeconomic disparities that impact access to education and research opportunities, resulting in a talent gap and lower overall productivity in scientific fields. Insufficient funding in high-tech and innovation sectors limits progress and competitiveness in AI research and application.

To overcome these challenges, Brazil and other underdeveloped countries must invest adequately in infrastructure, effective educational policies, and high-tech and innovation areas. In addition, addressing socioeconomic inequalities and investing in research, researcher training, and international collaboration are important steps to improve Brazil's position in the application of AI in accounting education. These initiatives can help transform current barriers into opportunities, allowing Brazil to become an example of the effective application of AI in accounting education.

The adoption of these measures will also have a direct impact on accounting students' success in the proficiency exam to become accountants. With improved educational infrastructure and the use of emerging technologies, students will have access to advanced tools and resources that will facilitate the learning and practical application of accounting knowledge. Integrating AI into the curriculum can provide personalized study methods, immediate feedback, and realistic simulations of accounting scenarios, better preparing students for the challenges of the proficiency exam. Furthermore, investment in training teachers and researchers will contribute to a more solid and up-to-date education, increasing approval rates and raising the standard of accounting education in Brazil.

Therefore, the framework presented not only maps the existing scientific production but also highlights the critical areas of intervention necessary for Brazil to overcome its limitations and stand out globally in research and application of AI in accounting education.

Table 9. Research Agenda

	Future Agenda	**Research questions**
	Exploration Technologies Emerging:	Investigate the impact of emerging technologies such as blockchain, big data analytics, and machine learning on accounting curriculum and practice. Study the integration of more advanced AI tools, such as virtual assistants and intelligent tutoring systems, to improve the learning experience
	Analysis Longitudinal:	Conduct longitudinal studies to assess the long-term effects of applying AI to accounting education, including the impact on students' skills and performance after graduation.

	Future Agenda	Research questions
	Diversity Geographic Cultural:	Expand research to include greater geographic and cultural diversity, exploring how different educational and cultural contexts influence the adoption and outcomes of using AI in accounting education.
	Methodologies Innovative Search:	Utilize innovative research methodologies, such as controlled experiments and big data analytics, to gain deeper, more robust insights into the effectiveness of AI in accounting education.
	Ethical Impact and Social:	Explore the ethical and social implications of using AI in accounting education, including privacy issues, algorithmic bias, and the impact on students' future employment opportunities.
	Collaboration Multidisciplinary:	Promote collaboration between academics in accounting, computer science, education, and other disciplines to develop integrated and innovative approaches to teaching accounting.
	Engagement Students:	Investigate strategies to increase student engagement and motivation through AI, including the use of gamification, adaptive learning, and personalized feedback.
	Development of Skills Digital	Focus on developing students' digital skills, preparing them to deal with emerging technologies in the field of accounting.
	Impact on the Job Market:	Study how AI education applied to accounting is preparing students for changes in the job market and new professional demands
	Case Studies and Real Practices:	Carry out case studies that demonstrate the practical application of AI in accounting teaching and practice, providing concrete examples of success and challenges faced.

Source: prepared by the authors based on the bibliographic portfolio

The agenda suggests exploring emerging technologies such as blockchain, big data analytics, and machine learning, and integrating advanced AI tools to improve learning. It recommends longitudinal studies to assess the effects of AI on accounting education, in addition to including greater geographic and cultural diversity in research. It proposes the use of innovative methodologies and the investigation of the ethical and social implications of AI, as well as the promotion of multidisciplinary collaboration. In addition, it highlights the importance of strategies to increase student engagement, develop digital skills, and prepare students for the demands of the job market. Practical case studies are also recommended to demonstrate the application of AI in accounting.

5. CONCLUSION

5.1 Summary of Findings

This study investigated the literature on the application of artificial intelligence (AI) in accounting education, focusing on research trends, prominent authors, institutions, and areas of interest. A bibliometric analysis of 130 articles published between 1986 and 2024 was conducted using the Biblioshiny tool.

Initially, a citation analysis was performed, evaluating the number of publications and impact indicators. Subsequently, co-citation analysis examined the connections between documents and journals, while co-authorship analysis revealed collaboration networks among authors, countries, and institutions. Following this, keyword co-occurrence analysis identified emerging themes. Additionally, a conceptual structure map, a keyword network map, and a thematic map were developed. Finally, a framework integrating all the results was elaborated, proposing a research agenda to guide future studies on the use of AI in accounting education.

The most influential authors in the field were identified as Qasim A, Kharbat F, and Everaert P, with journals such as "Accounting Education" and "Journal of Emerging Technologies in Accounting" being primary sources. The University of North Carolina stood out as the most productive institution, followed by the University of International Business and Economics in Fuzhou. Co-citation analysis revealed clusters of authors frequently cited together, such as Issa (2016) and Kokina (2017). Keyword co-occurrence analysis highlighted the application of AI in accounting education as a central theme, with a growing trend of integrating emerging technologies like blockchain and AI into the accounting curriculum.

The countries with the highest scientific output regarding AI in accounting education were the United States, China, and Australia, while Brazil faces economic and institutional challenges. To overcome these challenges, adequate investment in infrastructure, effective educational policies, and international collaboration are necessary.

5.2 Implications

The results of this study indicate a shift towards practical learning in accounting education. To bridge the gap between theoretical knowledge and practical application, accounting programs should incorporate experiential learning methods, including case studies, simulations, and real-life problem-solving exercises.

The increasing adoption of online and hybrid learning models, accelerated by the COVID-19 pandemic, underscores the importance of developing robust digital learning platforms. In addition to technical knowledge, it is crucial to develop soft skills such as critical thinking, effective communication, adaptability, and teamwork capabilities.

Educators and policymakers should regularly update the accounting curriculum to ensure alignment with current industry trends. A comprehensive and innovative approach to accounting education can prepare a new generation of professionals capable of navigating the technological landscape of contemporary business.

5.3 Limitations

The study presents limitations due to the narrow scope and limited range of literature analyzed, focusing predominantly on academic articles published in English. This may induce bias towards the perspectives of English-speaking countries, disregarding significant contributions from other regions. Additionally, the exclusive focus on AI in accounting education ignores other relevant information technologies.

5.4 Suggestions

For future research, a systematic and in-depth literature review is recommended, incorporating a wider variety of sources, including grey literature and industry reports. This will provide a more comprehensive view, including practical insights and emerging trends.

Future investigations should examine the literature on accounting education from various regions and languages, resulting in a more balanced global perspective. Longitudinal studies are necessary to capture the latest technological advances and emerging trends, integrating qualitative research methods such as in-depth interviews and case studies.

Exploring a broader range of emerging technologies and conducting contextualized research can elucidate how global trends are adapted in different regional and institutional contexts.

Collaboration between academic institutions and the accounting industry should be intensified to ensure the continued relevance and effectiveness of accounting education. An initiative-taking approach can help educators and policymakers prepare for future technological changes.

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