AUSBD, 2024; "Yapay Zeka ve Sosyal Bilimler Öğretim" Özel Sayısı
(Artificial Intelligence and Social Sciences Teaching" Special Issue), 65-75 Araştırma Makale
e-ISSN: 2651-3064 ResearchArtical

# A BIBLIOMETRIC ANALYSIS OF CHALLENGES WITH AI ADOPTION IN SOCIAL SCIENCES TEACHING

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**Abstract**

This research bibliometric review analyzed 16 publications from the Web of Science (WoS) database on the challenges with AI adoption in social science teaching (CAAST). Analysis of these publications, published between 2014 and 2023, is conducted using VOSviewer software. The review's objectives were to document the publication and citation trends, as well as the geographic distribution of the CAAST literature. Furthermore, the review aimed to identify key authors, author keywords, cited references, and sources, as well as scrutinize the intellectual framework of this knowledge repository. In 2023, CAAST research increased by 450% compared to the previous year, and the number of citations increased significantly by approximately 110%, indicating that CAAST has become a focus for researchers.

**Keywords:** Artificial intelligence (AI), Challenges, Adoption, Higher education, Social sciences,

# SOSYAL BİLİMLER ÖĞRETİMİNDE YAPAY ZEKANIN BENİMSENMESİ İLE İLGİLİ ZORLUKLARIN BİBLİYOMETRİK ANALİZİ

**Özet**

Bu araştırma bibliyometrik incelemesi, Web of Science (WoS) veri tabanından sosyal bilimler öğretiminde yapay zekanın benimsenmesi ile ilgili zorluklar (SÖYBZ) üzerine 16 yayını analiz etmiştir. 2014-2023 yılları arasında yayınlanan bu yayınların analizi VOSviewer yazılımı kullanılarak gerçekleştirilmiştir. İncelemenin amaçları, yayın ve atıf eğilimlerinin yanı sıra SÖYBZ literatürünün coğrafi dağılımını belgelemektir. Ayrıca inceleme, anahtar yazarları, yazar anahtar kelimelerini, atıfta bulunulan referansları ve kaynakları belirlemenin yanı sıra bu bilgi havuzunun entelektüel çerçevesini incelemeyi amaçlamıştır. 2023 yılında SÖYBZ araştırmalarının bir önceki yıla göre %450 oranında artması ve atıf sayısının yaklaşık %110 gibi önemli bir oranda artması, SÖYBZ'nin araştırmacılar için bir odak noktası haline geldiğini göstermektedir.

**Anahtar Kelimeler:** Yapay zekâ (YZ), Zorluklar, Benimseme, Yükseköğretim, Sosyal bilimler

## 1. Introduction

Artificial intelligence (AI) applications have gained massive popularity in recent years, and investments are increasing day by day (Fossen et al., 2024; Yi and Xiangyu, 2024). According to Whitby (2009), AI is one of the most challenging but potentially intriguing actions humanity has ever undertaken. In short, AI refers to robots and software that can learn, establish context, store data, and communicate with humans (Pannu, 2015). That is, AI imitates human intelligence through computers. On a worldwide basis, this technology is considered the innovation of the future. It is also one of the crucial innovations to alter education (Talan, 2021). This growing popularity, as in every field, is going to have a substantial influence on social science (Popenici and Kerr, 2017).

Traditional educational programs are changing to accommodate technological advancements (Sadiku et al., 2021). Given its potential in many spheres of life, AI can naturally also deliver high-quality education (Ouyang and Jiao, 2021). AI can aid the education system and help students learn

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Başvuru/Submitted: 13.09.2024 Kabul/Accepted: 25.10.2024

independently. For instance, chatbots can enhance the quality of students' self-study and constructivist learning, a process that students have expedited (Chen et al., 2020; Kabudi et al., 2021). However, AI also brings some challenges to education. AI has a multifaceted impact on education, such as its adoption, implementation, and ethical implications (Borenstein and Howard, 2020).

Although artificial intelligence makes significant contributions to education and training, various challenges also arise in education (Pedro et al., 2019). The first issue that arises in AI implementation is the notion of "ethicality." The use of AI in education raises concerns about bias, fairness, morality, transparency, and privacy (Garrett et al., 2020). In addition to these issues, AI practitioners and national policymakers must address issues such as sustainable development, inclusion and equity in the legal system, and education (Holmes et al., 2021; Dignum, 2021). Another important issue is how to prepare educators to adapt to AI development and AI integration (Pedro et al., 2019).

The aim of this study is to make an in-depth analysis of the challenges encountered in the process of integrating artificial intelligence into social science education. To get insight into the incorporation of AI in social science education, a bibliometric analysis was employed to examine the progress, areas of emphasis, and forthcoming directions of AI research. This study can provide a systematic analysis of previous literature and identify potential research opportunities.

## 2. Methodology and data

A systematic review was conducted to evaluate the challenges of Artificial intelligence (AI) in the social sciences. We applied the bibliometric analysis method to analyze quantitative information from literature data and create visual knowledge maps (Donthu et al., 2021). VOSviewer is a software tool that creates maps based on network data, allowing users to visualize and explore these maps (Eck and Waltman, 2023). We conducted descriptive, co-occurrence, and co-citation analyses to scrutinize AI research that addresses the challenges of integrating AI into the social sciences. The descriptive analysis concentrated on country distribution, highly cited literature, publication, and citation. The co-occurrence analysis included author keywords. We primarily used co-citation analysis to examine the theoretical foundations from three different points of view: references, sources, and authors.

This study focused on using the Web of Science core collection database as a source of information for literature searches. The Web of Science database is widely recognized as a high-quality database with standardized records (Falagas et al., 2008; Birkle et al., 2020). We reached the following conclusions after several variations of testing: ((((TS=(artificial intelligence OR AI)) AND TS=(challenge$)) AND TS=(education OR teaching)) AND TS=(integration OR adoption)) NOT TS=(K-12 OR “STEM education” OR "primary school" OR "secondary school" OR "high school"). The "article" and "reviewed article" published in English from 2014 to 2023 were filtered. The citation indexes were filtered to “Science Citation Index Expanded (SCI-EXPANDED)” and “Social Sciences Citation Index (SSCI).” In the first round, research directions were refined, yielding 74 articles. To ensure the uniformity of the findings, the titles, keywords, and abstracts of each record were examined manually. The chosen literature should concentrate on factors pertaining to the challenges of adopting artificial intelligence into social science teaching. Consequently, a total of 16 publications were ultimately acquired as the foundational data set for further investigations. The research design is illustrated in Figure 1.

## 3. Findings

### *3.1. Descriptive analysis*

#### *3.1.1. Highly cited literature*

Citations in scholarly publications serve as evidence for claims, measure research impact (Colavizza et al., 2020). Table 1 contains the most influential literature on the challenges of integrating AI into social science education from 2014 to 2023 (the top 5 most cited). The top five articles reflect research relevant to stakeholders such as educators, students, administrative staff, and the human-AI relationship. Sheshadri Chatterjee's article, "Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modeling," topped the list with 135 total citations in Education and Information Technologies in 2020. The model they developed suggests that it can help authorities facilitate the adoption of AI in higher education.

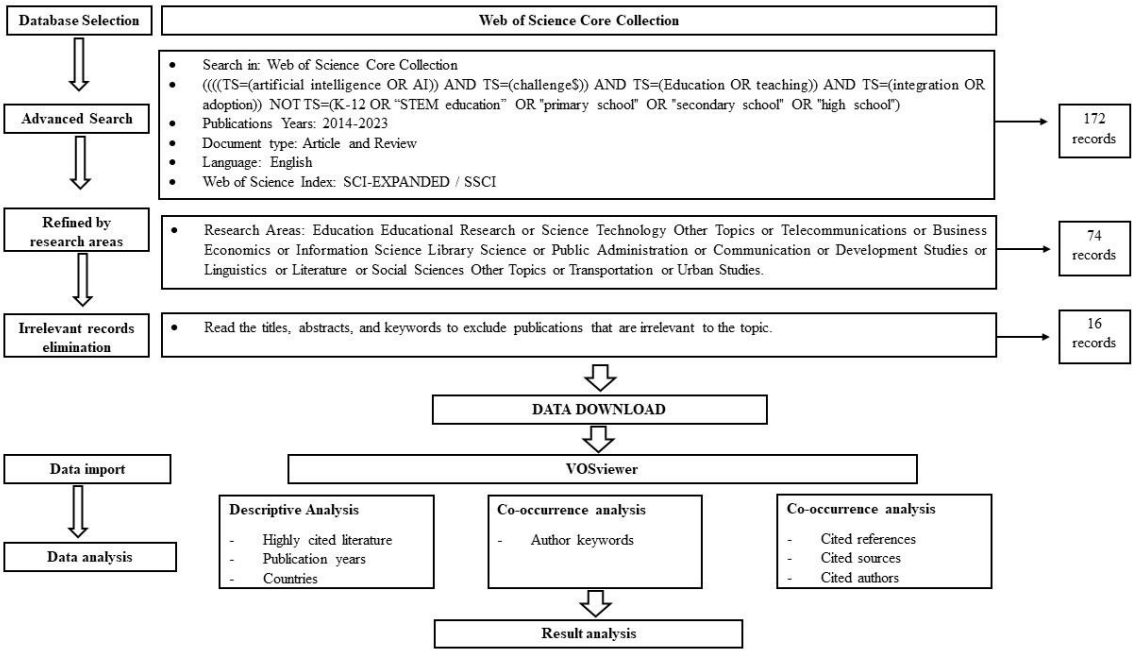


**Figure 1.** Outline of research design

**Table 1.** Highly cited literature (top 5)

| R | Title (Year) | Total citations | First author | Affiliations | Journal |
|---|---|---|---|---|---|
| 1 | Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modelling (2020) | 135 | Sheshadri Chatterjee | Indian Institute of Technology (IIT) Delhi | Education And Information Technologies |
| 2 | Students' voices on generative AI: perceptions, benefits, and challenges in higher education (2023) | 64 | Cecilia Ka Yuk Chan | University of Hong Kong | International Journal of Educational Technology in Higher Education |
| 3 | Practical and ethical challenges of large language models in education: A systematic scoping review (2023) | 28 | Lixiang Yan | Monash University | British Journal of Educational Technology |
| 4 | Towards utilising emerging technologies to address the challenges of using Open Educational Resources: a vision of the future (2021) | 24 | Ahmed Tlili | Beijing Normal University | Educational Technology Research and Development |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Human and artificial intelligence collaboration for socially shared regulation in learning | 21 | Sanna Jarvela | University of Oulu | British Journal of Educational Technology |

Source: Own elaboration based on Web of Science data. **R= "**Ranking"

*3.1.2. Publication and citation trends.*

Publication and citation trends are crucial research indicators, and the variation in the quantity of literature over time shows the level of popularity of the associated topic (van Wesel, 2015). Figure 2, based on the yearly number of publications and citations from 2014 to 2023, depicts the changes in the literature over time. As shown in Figure 2, research on the difficulties of integrating AI into social science teaching has received increasing attention in recent years. Although there were no publications or citations between 2014 and 2019, there was a slowly rising trend between 2020 and 2022. In 2023, the number of publications increased from 2 to 11 compared to the previous year, as did the number of citations, which increased significantly from 41 to 86. The increasing interest in the integration of AI in social science teaching is a predictable trend.

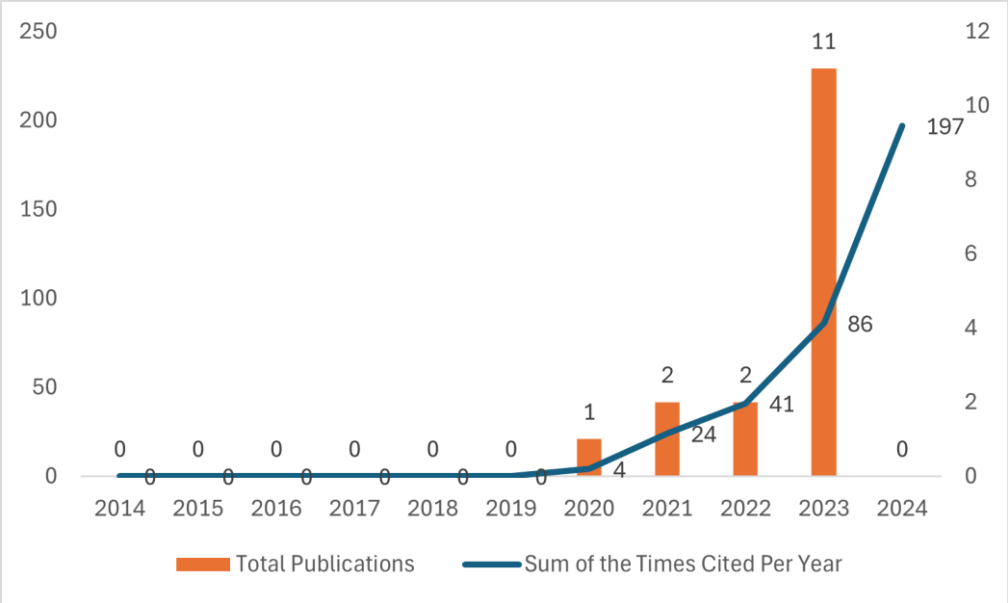


**Figure 2.** Number of publications and citations per year

*3.1.3. Country distribution*

The integration difficulties associated with artificial intelligence in social sciences education have garnered significant study interest worldwide. In terms of publications, Chinese academics lead with 4 publications and 25%, followed by Australian, Indian, Spanish, and American authors (3 publications, 18.75%). Also contributing are publications by German and Saudi Arabian (2 publications, 12.50%) researchers. Table 2 presents the distribution ranking of countries.

**Table 2.** Ranking of the countries with publications between 2014 and 2023

| R | Countries/Regions | Record Count | % of 16 | R | Countries/Regions | Record Count | % of 16 |
|---|---|---|---|---|---|---|---|
| 1 | Peoples R Chına | 4 | 25.000 | 9 | Fınland | 1 | 6.250 |
| 2 | Australıa | 3 | 18.750 | 10 | Ireland | 1 | 6.250 |
| 3 | Indıa | 3 | 18.750 | 11 | Italy | 1 | 6.250 |
| 4 | Spaın | 3 | 18.750 | 12 | Kuwaıt | 1 | 6.250 |
| 5 | Usa | 3 | 18.750 | 13 | Lebanon | 1 | 6.250 |
| 6 | Germany | 2 | 12.500 | 14 | Norway | 1 | 6.250 |
| 7 | Saudı Arabıa | 2 | 12.500 | 15 | Taıwan | 1 | 6.250 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | Canada | 1 | 6.250 | 16 | Wales | 1 | 6.250 |

Source: Own elaboration based on Web of Science data. **R= "**Ranking"

*3.2. Co-occurrence analysis*

*3.2.1. Author keywords*

Co-occurrence network analysis is used to present the findings, serving to refine and summarise the subjects (Sedighi, 2016). The display of keywords as nodes shows their size as a direct function of their popularity. The lines connecting nodes reflect their instances of co-occurrence, whereas the thick lines demonstrate a strong level of relationship (Ding and Cronin, 2011). Figure 3 illustrates a co-occurrence network consisting of 9 nodes, which serve to indicate the scholarly emphasis. A thesaurus file was utilized to amalgamate phrases throughout the construction of the author keywords map (Eck and Waltman, 2023). This file was used to combine abbreviated terms into full terms (e.g., 'AI' and 'artificial intelligence'). We also used it to correct spelling differences (e.g., "curricula" and "curriculum").

As a result, the analysis yields two clusters, nine nodes, and 24 lines, which reveal the subjects of significant wide-ranging and contemporary importance and their interconnections. These author keywords represent the field's focal points between 2014 and 2023.

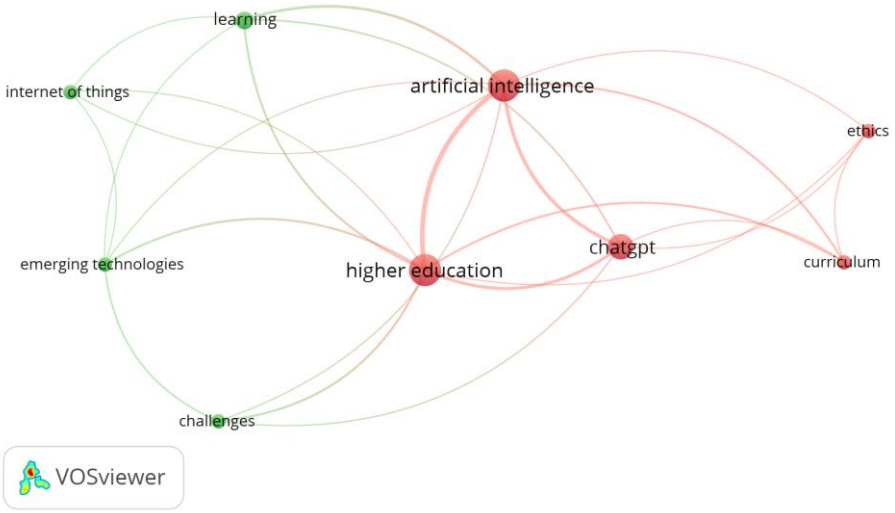


**Figure 3**. Co-occurrence author keywords

*3.3. Co-citation analysis*

*3.3.1. Cited references*

Co-citation analysis is a technique used to examine the cognitive framework of scientific research by monitoring the paired citations of publications included in source articles. It generates clusters of research that share common themes, and when combined with single-link clustering and multidimensional scaling methods, it can effectively map specific study domains and the entire field of science (Zupic and Čater, 2015). It can be challenging for VOSviewer to process the cited references in files from databases like Web of Science, as these references may come in a variety of formats. This can lead to various ambiguities and inconsistencies (Eck and Waltman, 2023). To obtain more reliable data, we matched the references to their DOI (Digital Object Identifier) numbers using a thesaurus file.

Figure 4 depicts the reference mapping's co-citations with the VOSviewer program set to a linking criterion of at least two citations between 2014 and 2023. It consists of four clusters with 28 cited reference nodes and 170 links. Kasneci et al.'s (2023) study (DOI: 10.1016/j.lindif.2023.102274), which has the highest total link strength, addresses the challenges of using big language models in education from both the student's and teacher's points of view.

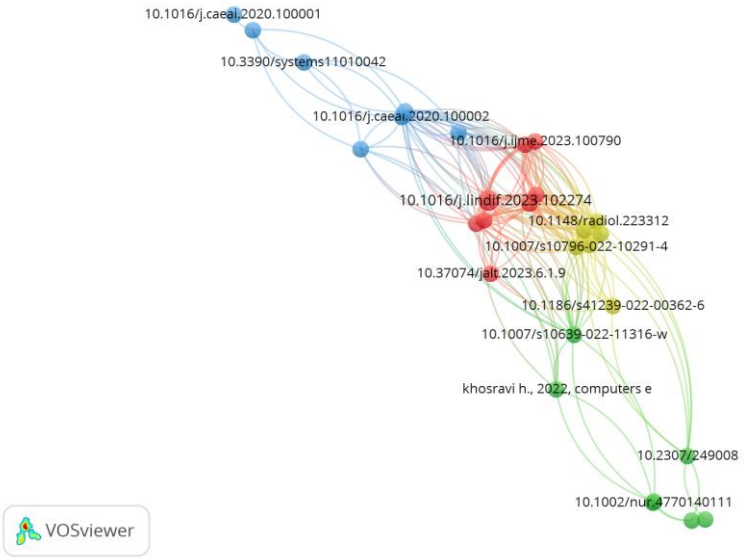


**Figure 4.** Co-citation analysis of references

*3.3.2. Cited sources*

The co-citation of the most productive journals demonstrates their intellectual connections (Castanha and Wolfram, 2018). We used a thesaurus file to combine phrases while building the cited sources map (Eck and Waltman, 2023). We used this file to correct spelling differences, such as "arxıv" and "arxiv." Among the 862 sources that were identified, 14 publications satisfied the criterion of having a minimum of 6 citations. Figure 5 displays that 151 citations are obtained from 14 scholarly publications. Figure 6 shows the citations and total link strength in studies on the challenges of integrating AI into social science teaching.

*3.3.3. Cited authors*

An author's co-citation map illustrates the intellectual connections among scholars worldwide. When a third publication cites two publications, they are considered co-cited (González-Valiente et al., 2019). We used a thesaurus file to create a co-citation analysis map of the authors. We used this file to correct spelling differences such as “danzon-chambaud, samuel” & “danzon-chambaud, s” as well as “muñoz-basols, j” & “munozbasols, j”. 26 of the 1042 identified authors met the criterion of a minimum of 3 citations of an author.

Figure 7 details the author network of co-citation papers published between 2014 and 2023 regarding the challenges of adopting AI in social science teaching. The findings can aid researchers in comprehending the magnitude of links and situating their contribution within the network. Figure 7 reveals five broad intellectual cluster groups based on co-citation analysis, while Figure 8 shows the citation and total link power of authors in these five cluster groups.

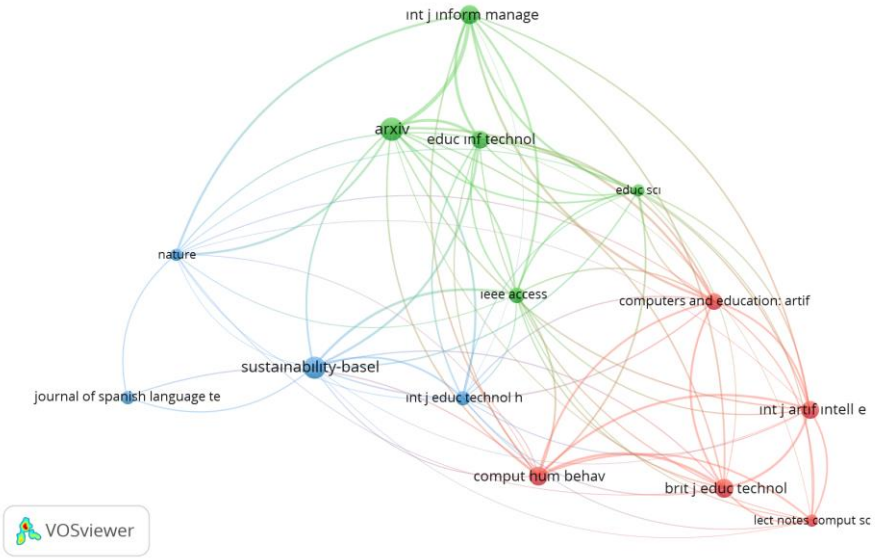


**Figure 5.** Co-citation analysis of sources

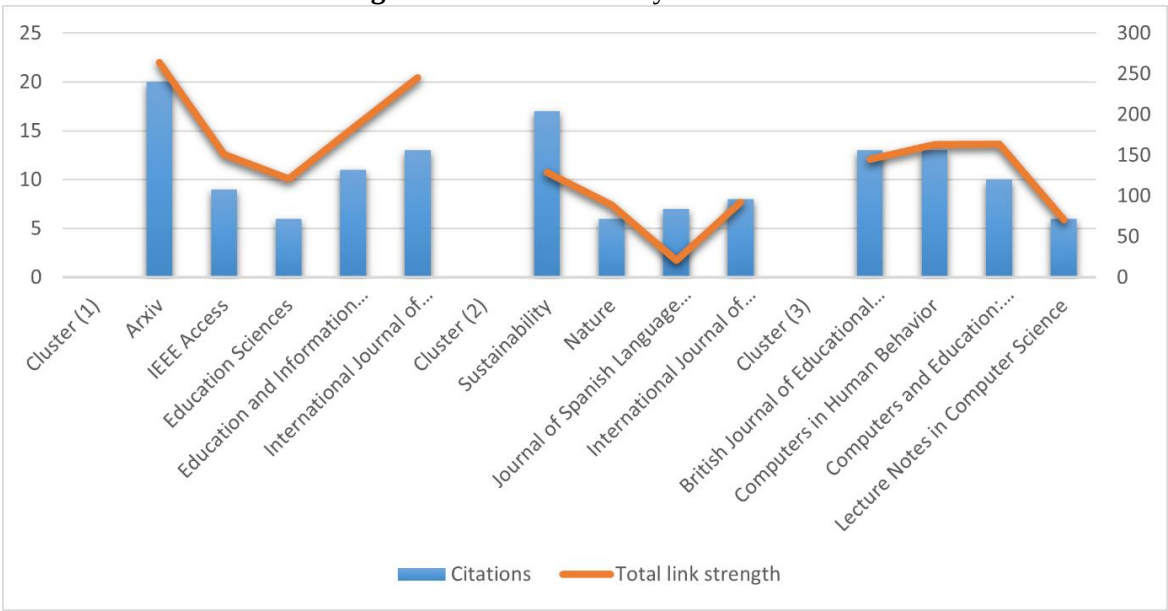


**Figure 6.** Citation and total link strength of sources

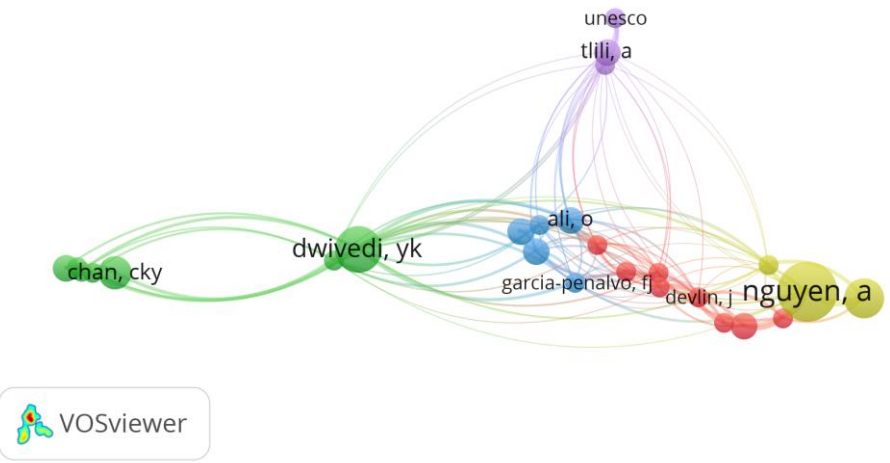


**Figure 7.** Co-citation analysis of authors

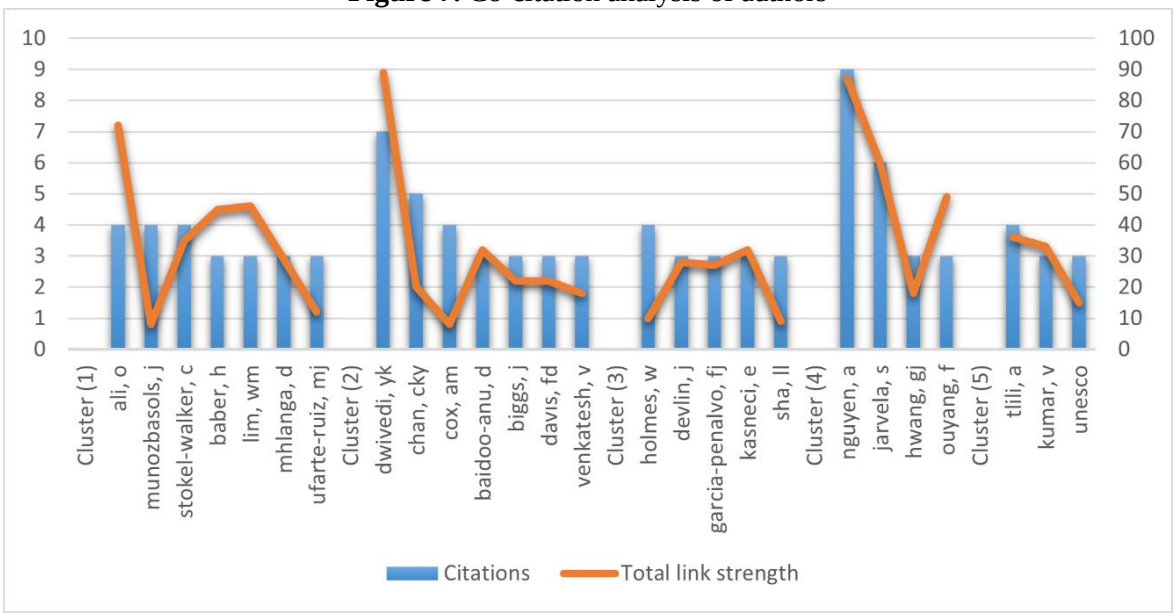


**Figure 8.** Citation and total link strength of authors

## 4. Discussion and conclusions

### *4.1. Theoretical Implications and Conclusions*

The research identifies a gap in the current literature regarding the CAAST. Although AI has emerged as an essential tool in education, particularly in STEM (science, technology, engineering, and math) education, its adoption in the social sciences has progressed more slowly, and numerous challenges remain inadequately examined (Zhai and Krajcik, 2024). The restricted quantity of publications on this subject (16 papers from WoS) signifies that this is an emerging field with a paucity of extensive research. This study bridges the gap by offering a systematic analysis of the body of existing CAAST literature, concentrating on publication and citation trends, geographic distribution, key authors, and intellectual frameworks. This aids in mapping the current state of research and identifying areas that require more investigation.

This study collected AI research from the Web of Science database on the challenges of adopting AI in social sciences education and conducted a systematic analysis of it. Utilizing descriptive, co-occurrence, and co-citation analysis, a comprehensive knowledge map was constructed to accurately represent the framework, key elements, and new trends. The results are succinctly described as follows:

First, AI research on the integration of AI into social sciences has shown a significant increase. While the number of articles published in 2021 and 2022 was 2, it increased to 11 in 2023. This indicates that the number of studies conducted has increased by 450%. In addition, the overall citation count in 2022 amounted to 41, and in 2023 it reached 86. This is an approximate boost of 110%.

Second, the results indicate that Chinese scholars rank highest at 25%, although numerous other industrialized countries (regions) also make substantial contributions.

Thirdly, the top five most cited articles about artificial intelligence education in social sciences reflect research on stakeholders such as educators, students, and administrative staff. In addition, the author keywords of the 16 analyzed articles revealed technology-related topics such as "artificial intelligence," "Internet of Things," and "ChatGPT," as well as broad and current issues related to education such as "curriculum," "learning," and "ethics." These author keywords represent the CAAST field's focal points between 2014 and 2023.

Fourth, most of the articles are published in top education and technology journals such as *"British Journal of Educational Technology," "Education and Information Technologies,"* and *"Etr&D-Educational Technology Research and Development."* CAAST research also covers a wide range of areas such as business, management, environment, telecommunication, communication, and sustainability.

*4.2. Practical Implications and Conclusions*

The study's findings also provided practical insight into the future direction of using artificial intelligence in social science teaching. First, the practical implications of AI for higher education in social sciences is to promote the use of AI technology to personalize students' learning needs, as increasing student numbers due to migration to large cities bring various challenges in teaching (Al-Badi et al., 2022). For example, the review found one study confirming that emerging technologies (such as AI and blockchain) allow students to receive immediate learning feedback and interventions regardless of learning time or location (Tlili et al., 2021).

Secondly, the findings of this study can encourage stakeholders (e.g., academics, students, administrative staff) to map the acceptance, expectations, and perceptions of AI technology (Chatterjee and Bhattacharjee, 2020; Chan and Hu, 2023). The study can provide important information for education policymakers to identify AI's areas of difficulty, which can help integrate AI into social science teaching. They can explore and better apply the challenges of AI technology to enhance stakeholders' experiences.

*4.3. Limitations and suggestions for future research*

This study specifically examined English articles referenced in the Web of Science core collection database. Therefore, the results may not be applicable to publications within other databases or journals. To obtain deeper insights, future studies may also include databases such as Scopus, JSTOR, and ERIC. The study's findings indicate that there were not any articles on CAAST from 2014 to 2019, and very few were published from 2020 to 2022 (See figure 2). This indicates that CAAST research is still in its early stages. Hence, there remains ample opportunity for future research.

First, it is necessary to examine the financial consequences of integrating artificial intelligence into social science teaching. Previous studies focus on stakeholders' perceptions (Chan and Hu, 2023) and AI learning (Järvelä et al., 2023). Future research could explore the cost implications of integrating AI into social science teaching.

Second, artificial intelligence ethics is a fundamental concern (Nguyen et al., 2022). The review found a study on the ethical applications of AI technology in social science teaching (Mouta et al., 2023), but it is recommended that future studies explore ethical challenges such as privacy, data security, accessibility, and equity in detail.

## References

Al-Badi, A., Khan, A., & Eid-Alotaibi. (2022). Perceptions of learners and instructors towards artificial intelligence in personalized learning. *Procedia Computer Science*, *201*, 445–451. https://doi.org/10.1016/j.procs.2022.03.058

Birkle, C., Pendlebury, D. A., Schnell, J., & Adams, J. (2020). Web of Science as a data source for research on scientific and scholarly activity. *Quantitative Science Studies*, *1*(1), 363–376. https://doi.org/10.1162/qss_a_00018

Borenstein, J., & Howard, A. (2020). Emerging challenges in AI and the need for AI ethics education. *AI and Ethics*, *1*(1). https://doi.org/10.1007/s43681-020-00002-7

Castanha, R. C. G., & Wolfram, D. (2018). The domain of knowledge organization: A bibliometric analysis of prolific authors and their intellectual space. *KNOWLEDGE ORGANIZATION*, *45*(1), 13–22. https://doi.org/10.5771/0943-7444-2018-1-13

Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, *20*(1), 1–18. https://doi.org/10.1186/s41239-023-00411-8

Chatterjee, S., & Bhattacharjee, K. K. (2020). Adoption of artificial intelligence in higher education: A quantitative analysis using structural equation modelling. *Education and Information Technologies*, *25*(5), 3443–3463. https://doi.org/10.1007/s10639-020-10159-7

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*(8), 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Colavizza, G., Hrynaszkiewicz, I., Staden, I., Whitaker, K., & McGillivray, B. (2020). The citation advantage of linking publications to research data. *PLOS ONE*, *15*(4), e0230416. https://doi.org/10.1371/journal.pone.0230416

Dignum, V. (2021). The role and challenges of education for responsible AI. *London Review of Education*, *19*(1). https://doi.org/10.14324/lre.19.1.01

Ding, Y., & Cronin, B. (2011). Popular and/or prestigious? Measures of scholarly esteem. *Information Processing & Management*, *47*(1), 80–96. https://doi.org/10.1016/j.ipm.2010.01.002

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Eck, J. N. V., & Waltman, L. (2023). *VOSviewer Manual*. https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.20.pdf

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and Weaknesses. *The FASEB Journal*, *22*(2), 338–342. https://doi.org/10.1096/fj.07-9492lsf

Fossen, F. M., McLemore, T., & Sorgner, A. (2024). Artificial intelligence and entrepreneurship. *Social Science Research Network*. https://doi.org/10.2139/ssrn.4863772

Garrett, N., Beard, N., & Fiesler, C. (2020). More Than "If Time Allows": The role of ethics in AI education. *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society*. https://doi.org/10.1145/3375627.3375868

González-Valiente, C. L., León Santos, M., Arencibia-Jorge, R., Noyons, E., & Costas, R. (2019). Mapping the Evolution of Intellectual Structure in Information Management Using Author Co-citation Analysis. *Mobile Networks and Applications*. https://doi.org/10.1007/s11036-019-01231-9

Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Shum, S. B., Santos, O. C., Rodrigo, M. T., Cukurova, M., Bittencourt, I. I., & Koedinger, K. R. (2021). Ethics of AI in education: Towards a community-wide framework. *International Journal of Artificial Intelligence in Education*, *32*(1), 504–526. https://doi.org/10.1007/s40593-021-00239-1

Järvelä, S., Nguyen, A., & Hadwin, A. (2023). Human and artificial intelligence collaboration for socially shared regulation in learning. *British Journal of Educational Technology*, *54*(5). https://doi.org/10.1111/bjet.13325

Kabudi, T., Pappas, I., & Olsen, D. H. (2021). AI-enabled adaptive learning systems: A systematic mapping of the literature. *Computers and Education: Artificial Intelligence*, *2*, 100017. https://doi.org/10.1016/j.caeai.2021.100017

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., & Stadler, M. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*(102274). https://doi.org/10.1016/j.lindif.2023.102274

Mouta, A., Torrecilla-Sánchez, E. M., & Pinto-Llorente, A. M. (2023). Design of a future scenarios toolkit for an ethical implementation of artificial intelligence in education. *Education and*

*Information Technologies*. https://doi.org/10.1007/s10639-023-12229-y

Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B.-P. T. (2022). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, *28*(28). https://doi.org/10.1007/s10639-022-11316-w

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, *2*(1), 100020. https://doi.org/10.1016/j.caeai.2021.100020

Pannu, A. (2015). Artificial intelligence and its application in different areas. *Artificial Intelligence*, *4*(10), 79-84.

Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development. *MINISTERIO de EDUCACIÓN*. https://hdl.handle.net/20.500.12799/6533

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, *12*(1). https://doi.org/10.1186/s41039-017-0062-8

Sadiku, M. N. O., Ashaolu, T. J., Ajayi-Majebi, A., & Musa, S. M. (2021). Artificial Intelligence in Education. *International Journal of Scientific Advances*, *2*(1). https://doi.org/10.51542/ijscia.v2i1.2

Sedighi, M. (2016). Application of word co-occurrence analysis method in mapping of the scientific fields (case study: The field of informetrics). *Library Review*, *65*(1/2), 52–64. https://doi.org/10.1108/lr-07-2015-0075

Talan, T. (2021). Artificial intelligence in education: A bibliometric study. *International Journal of Research in Education and Science*, *7*(3), 822–837. https://eric.ed.gov/?id=EJ1308142

Tlili, A., Zhang, J., Papamitsiou, Z., Manske, S., Huang, R., Kinshuk, & Hoppe, H. U. (2021). Towards utilising emerging technologies to address the challenges of using open educational resources: A vision of the future. *Educational Technology Research and Development*, *69*(2), 515–532. https://doi.org/10.1007/s11423-021-09993-4

van Wesel, M. (2015). Evaluation by citation: Trends in publication behavior, evaluation criteria, and the strive for high impact publications. *Science and Engineering Ethics*, *22*(1), 199–225. https://doi.org/10.1007/s11948-015-9638-0

Whitby, B. (2009). *Artificial intelligence*. Rosen Pub.

Yi, R., & Xiangyu, W. (2024). Application and discussion of computer communication technology in artificial intelligence field. *Journal of Artificial Intelligence Practice*, *7*(2). https://doi.org/10.23977/jaip.2024.070218

Zhai, X., & Krajcik, J. (Eds.). (2024). *Uses of artificial intelligence in STEM education*. Oxford University Press.

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*(3), 429–472. https://doi.org/10.1177/1094428114562629