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Bibliometric Analysis on the Use of Artificial Intelligence in Disaster Education

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This study conducts a bibliometric analysis of 210 articles published between 2001 and 2024 in journals indexed in the Web of Science (WoS) database to examine the integration of artificial intelligence (AI) in disaster education. Inclusion criteria focused on peer-reviewed journal articles that explicitly address disaster education with AI, particularly in the areas of text classification and question-and-answer (Q&A) systems. Exclusion criteria included conference proceedings, editorial notes, non-English articles, and studies unrelated to AI-enhanced education approaches. Using Biblioshiny, the research applies performance analysis and science mapping methods to examine publication trends, citation patterns, most productive authors, leading journals, influential institutions, and collaboration networks. The results reveal significant growth in AI-disaster education research since 2017. China leads in publication output, while Vietnam has the highest citation impact per article. Key themes emerging from the keyword co-occurrence analysis include artificial intelligence, deep learning, disaster management, and convolutional neural networks. This study offers important insights into how AI technologies (particularly machine learning and natural language processing) are reshaping disaster education.

Keywords: Disaster education, artificial intelligence, bibliometric analysis, text classification, Q&A systems, science mapping

INTRODUCTION

Disaster frequency and intensity, driven by climate change and other factors, are upcoming worldwide issues for which enhanced disaster preparedness is needed (Becken et al., 2014; Rosselló et al., 2020). The 2011 Great East Japan earthquake and tsunami is a clear example of how a major event can disrupt societies worldwide (Krausmann & Cruz, 2013; Koshimura & Shuto, 2015). Since then, the world has experienced several other major disasters, including the 2015 Nepal earthquake, the 2018 Indonesian Sulawesi tsunami, and the 2023 earthquakes in Turkey and Syria, which caused numerous casualties and posed significant challenges to disaster preparedness and education (Rehman et al., 2025). The February 2023 earthquakes in southeastern Türkiye were particularly devastating and highlighted the urgent need for effective disaster education and public awareness strategies (Karacaoğlu & Güner, 2024; Tupper & Karacaoğlu, 2025). At this point, AI-assisted disaster literacy education emerges as a necessary intervention to improve preparedness. Traditional disaster education, which adopts a classroom-based approach to learning and printed materials, has limitations in terms of access, relevance, and flexibility, especially in simulations of real disaster scenarios (Selby & Kagawa, 2012). This limitation necessitates the use of up-to-date, interactive, and personalized methods.

AI solutions can fill these gaps through interactive, experiential learning and scenario-based simulations and customized content, through technologies such as natural language processing and virtual reality (Suharini & Baharsyah, 2020; Tint et al., 2015). These technologies can transform passive access to information into active, customized learning. For example, AI-driven Q&A systems have been shown to improve knowledge recall and disaster preparedness (Xue et al., 2023). Moreover, AI has the capability of dismantling access barriers by providing digital training to the masses, such as rural or poverty-stricken communities (Cho & Hong, 2021; Galusha, 1997). The advantages point towards the potential of AI in refreshing disaster literacy, maximizing engagement and increasing preparedness on a mass scale.

The digitalization of learning accelerated by the pandemic has further emphasized the value of AI-based learning tools (Cone et al., 2022; Zancajo et al., 2022). However, the aspect of unequal technological access, data privacy and ethical use remains a significant issue in their widespread adoption. Mitigating these is crucial to enable that AI-based disaster education is not merely efficient but also inclusive (Buxmann et al., 2021; Dash et al., 2022).

This study therefore conducts a bibliometric analysis to review AI-based disaster education, focusing on text categorization and Q&A systems. A WoS search yielded 210 papers between 2001 and 2024 that were divided based on citation frequencies, top authors, highly cited journals, themes, and organizational contributions. This research intends to explore: (1) Where the most prolific disaster education and AI-based journals are actively publishing the most? (2) Who are the authors and papers most cited? (3) What are the subject matter and themes in the literature? (4) How many articles and what types of studies are there? (5) What are the most influential journals and publications? (6) What organizations and countries are most frequently cited?

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The study will provide an in-depth analysis of the use of AI in disaster literacy learning by responding to these questions, yielding insights on trends, research gaps and opportunities. The implications will inform future efforts to utilize AI to augment disasters readiness and resilience at individual and societal levels.

METHOD

In this study, the Web of Science (WoS) was used, which is an internationally accepted and recognized research database with multidisciplinary coverage through indices such as SCIE, SSCI, AHCI, CPCI, BKCI and ESCI (Aksnes & Sivertsen, 2019; Birkle et al., 2020). As it is known to be reliable and visible, WoS provides citation data and performance indicators such as the number of citations and the h-index, enabling robust estimates of the influence of science. Here, the data were collected on 2 March 2024 using the keywords "disaster education", "artificial intelligence", "text classification" and "question-answer solutions", making WoS a credible source to analyze trends in disaster literacy education and AI studies (Tsai & Wu, 2023; Yan & Zhiping, 2023).

Bibliometric Analysis as a Research Method

The evaluation of research relies increasingly on bibliometric methods measuring the amount and quality of scientific output. Performance analysis evaluates the performance of countries, organizations or researchers, while science mapping reveals the intellectual, social and conceptual structure of fields (Gutiérrez-Salcedo et al., 2018; van Raan, 1993). Drawing on citation networks and bibliographic information, these methods produce measures of development, influence, and output, shedding light on the natural, medical, applied, and social sciences. Bibliometric analysis subsequently offers a statistical approach to reading literature, depicting trends and gaps, and evaluating the visibility and impact of research (Kokol et al., 2021; Merigó & Yang, 2017). In this study, bibliometric techniques were used to disaster literacy education and artificial intelligence on the basis on Web of Science data with the aim of identifying significant contributions, following research trends and identifying areas of possible future study.

Data Collection

Data for this study were collected from the Web of Science (WoS) Core Collection database, known for its comprehensive indexing of high-quality scientific literature. The search was conducted on March 2, 2024, using the keywords "Disaster Education," "Artificial Intelligence," "Text Classification," and "Question-Answer Solutions." Only peer-reviewed journal articles published between 2001 and 2024 were included in the study.

Inclusion criteria were:

- Articles focusing on the integration of artificial intelligence in disaster education;
- Articles using or referencing methods such as text classification and question-and-answer systems;
- Articles in English;
- Peer-reviewed journal articles.

Exclusion criteria were:

- Conference proceedings, editorial notes, book chapters, and reviews;
- Non-English publications;
- Studies not related to the educational applications of artificial intelligence in disaster situations.

A total of 210 articles meeting these criteria were included in the final analysis. To enhance the transparency and reproducibility of the data collection process, the study expanded its methodological description in accordance with bibliometric reporting standards (Figure.1).

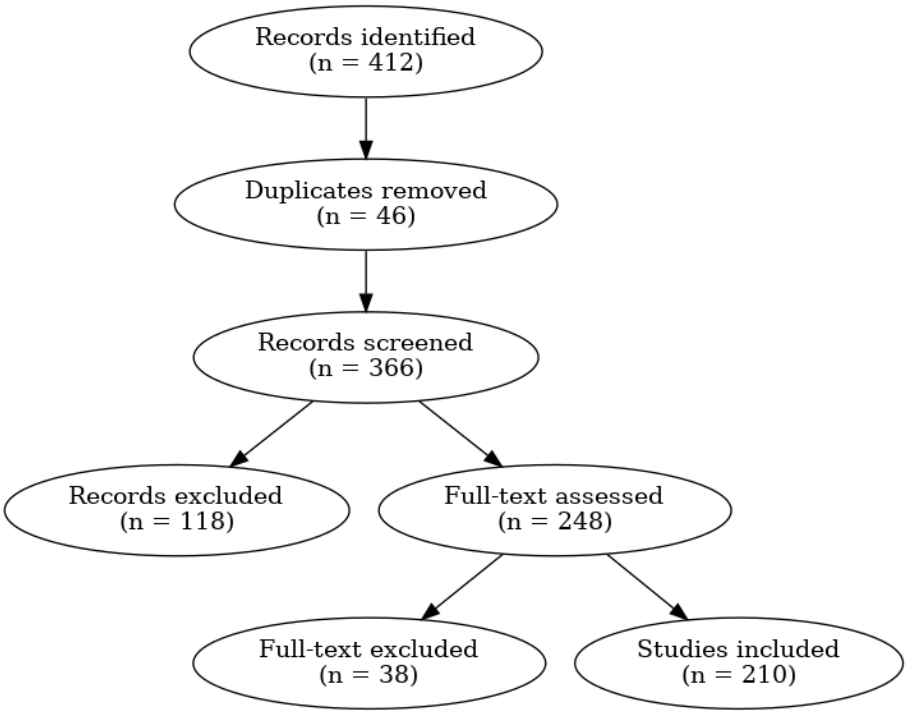

Figure 1. PRISMA Diagram

A PRISMA flow diagram was created to illustrate the multi-stage process of identification, screening, eligibility assessment and inclusion, and was incorporated into the study. A total of 412 records were retrieved from the Web of Science Core Collection. After removing 46 duplicates, the remaining 366 records were screened by title and abstract. A further 118 records were excluded as they were irrelevant. A full-text assessment was conducted for the remaining 248 articles, and 38 were excluded due to reasons such as publication in a language other than English, lack of peer review, insufficient bibliographic detail, or absence of relevance to AI–disaster education. Ultimately, 210 articles met the inclusion criteria and were incorporated into the bibliometric analysis.

Data Analysis

The study analyzed Web of Science articles using the keywords "Disaster Education", "Artificial Intelligence", "Text Classification" and "Question and Answer Solutions". Article titles, authors, citations, years of publication and abstracts of the articles were analyzed using statistical measures to note trends in research across years, citation impact and seminal studies. Citation analysis indicated the seminal publications that have shaped the field, and the results in general provided an overview of disaster literacy education and AI research. This provided an insight into the feasibility and efficacy of AI-based solutions for this discipline.

FINDINGS

The findings of this study are presented according to the six research questions outlined in the introduction. Each subsection presents evidence based on bibliometric indicators, visual analysis, and citation-based metrics. This evidence is presented graphically rather than in tables.

Quantity and Type of Publications

This section presents the distribution of publications over time, the types of articles published, authorship structures, and the degree of international collaboration in the field. Figure 2, indicating a sharp growth between the period of 2018 to 2023, is indicative towards the growing interest and study interest in disaster education and the incorporation of AI. This growth is because of various factors like the wider application of new technologies and techniques of training and disaster preparedness becoming more vital for societies. As of 2018, published articles grew at a fast pace and peaked in 2023 at 72. Another 10 articles were published in two months in 2024. This fast growth may be attributed to many reasons including the impact of natural disasters, higher citations for influential research, and contributions from elite institutions. Therefore, 2018–

2023 is a dramatic increase in the quality, diversity, and pertinence of research into disaster education and AI integration.

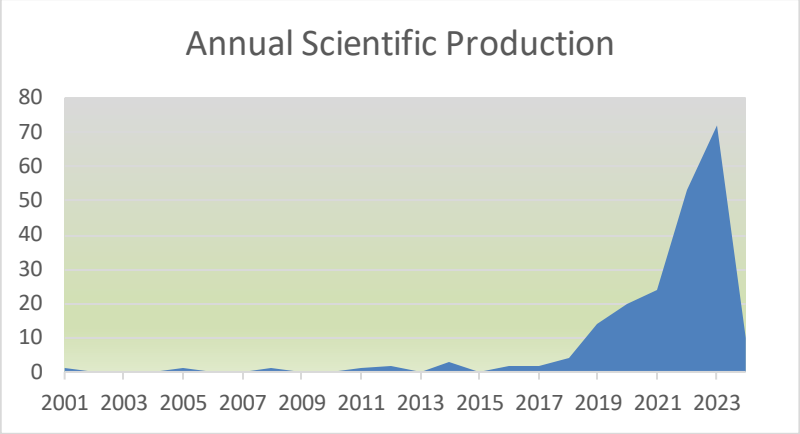

Figure 2. Total Number of Articles Per Year (2001-2024)

From 2001 to 2024, 210 disaster education and AI integration articles were published across 130 sources with a mean annual compound growth of 10.53%, depicting the rising significance of the subject. The literature is relatively new and groundbreaking, with a mean age of 2.76 years, and the mean number of citations as 15.78 depicts high levels of influence. Research articles are the most common outputs, but early access and proceeding papers also dominate. The field covers 828 authors with 4.56 co-authors per paper, six single-author reports, indicating strong cooperation. Global cooperation is at 36.19%, indicating diverse global participation and growing cross-border work. All these are the measures of an energetic expanding research field marked by rising output, impact, and cooperation.

Most Cited Authors and Influential Papers

The most productive and most cited authors were identified along with their publication trends, co-authorship patterns, and citation performance based on h-index and normalized impact. Analysis of productive writers in disaster studies and AI integration works to ascertain key contributors, research trends, and collaboration networks

Analysis of The Most Prolific Writers

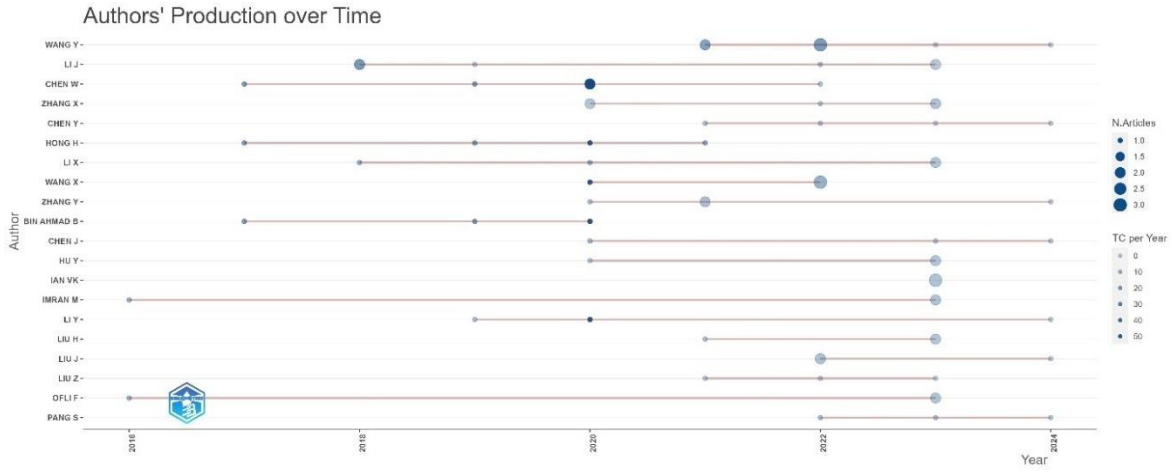

Figure 3. Production of The Most Prolific Authors Over Time (2001-2024)

Figure 3 presents authors' scientific contributions in a visual format, where document numbers correspond to bubble size and color intensity to show the timeline of the authors. Productive writers such as "Bin Ahmad B," "Chen W," "Hong H," "Li J," "Wang X," And "Wang Y" emerge, regularly producing impactful work. Specifically, the years 2022 and 2023 are significant for writers such as "Wang Y," "Li J," "Zang X," "Chen W,"

And "Chen Y." Figure 3 also identifies maximum-output writers in disaster education and AI integration such as Bin Ahmad B, Chen W, Hong H, and Li Y. Bin Ahmad B shows steady growth since the year 2017, while others such as Chen J and Chen Y show declining output with time. Authors such as Wang X, Wang Y, Chen W, and Bin Ahmad B stand out in terms of high citation and document rates, indicative of impactful work. The citation impact varies, with Wang Y having high citations per document compared to Wang X, whose rates are lower despite extensive work.

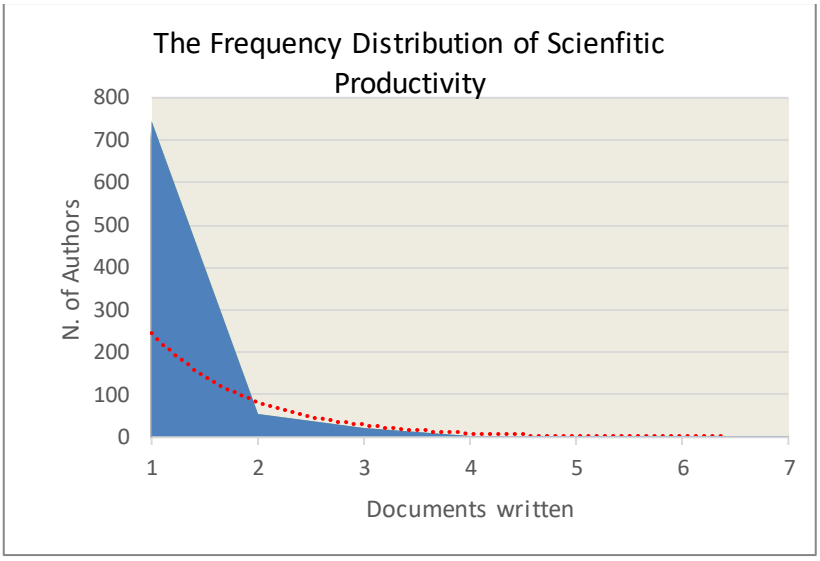

Figure 4. Frequency Distribution of Scientific Productivity (Lotka's law)

International collaboration among authors stands at 36.19%, reflecting diverse global participation. While some, like Bin Ahmad B and Hong H, favored single-author works, others such as Chen W and Wang Y collaborated more frequently. Key contributors—Bin Ahmad B, Chen W, Hong H, Wang X, Wang Y, and Li Y—produced highly cited documents, marking significant contributions. According to Lotka's law (Figure 4) distribution, most authors (around 85-90%) have authored only one publication, indicating that a small group of authors contribute repeatedly to the field. Overall, productivity in the field is widely distributed but generally low, with a few authors driving most of the research.

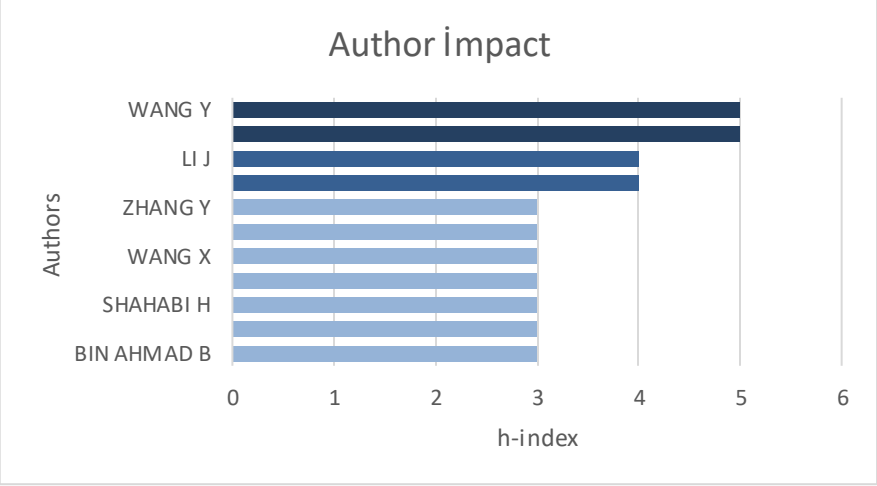

Figure 5. Most Productive Authors According to H_Index

A researcher's h-index reflects impact by linking publications to citation counts—for example, an h-index of 5 means at least 5 papers have 5+ citations. Chen W's 2020 paper with 258 citations and Wang Y's 2021 paper with 61 highlight influential contributions. While high h-index values indicate impact, differences in fields and career stages mean no universal benchmark applies.

Analysis of The Most Cited Documents

Citation analysis in disaster education and AI shows differences between global and local impact. For instance, Arora A (2021, Sci Total Environ) received 91 global citations, while Khan S (2022, Symmetry-Basel) showed a 14.29% gap between local and global citations. Ullah K (2022, Geosci Front) had stronger local impact, whereas some articles had little to none. Overall, citation counts and local/global ratios highlight which studies are most influential in the field.

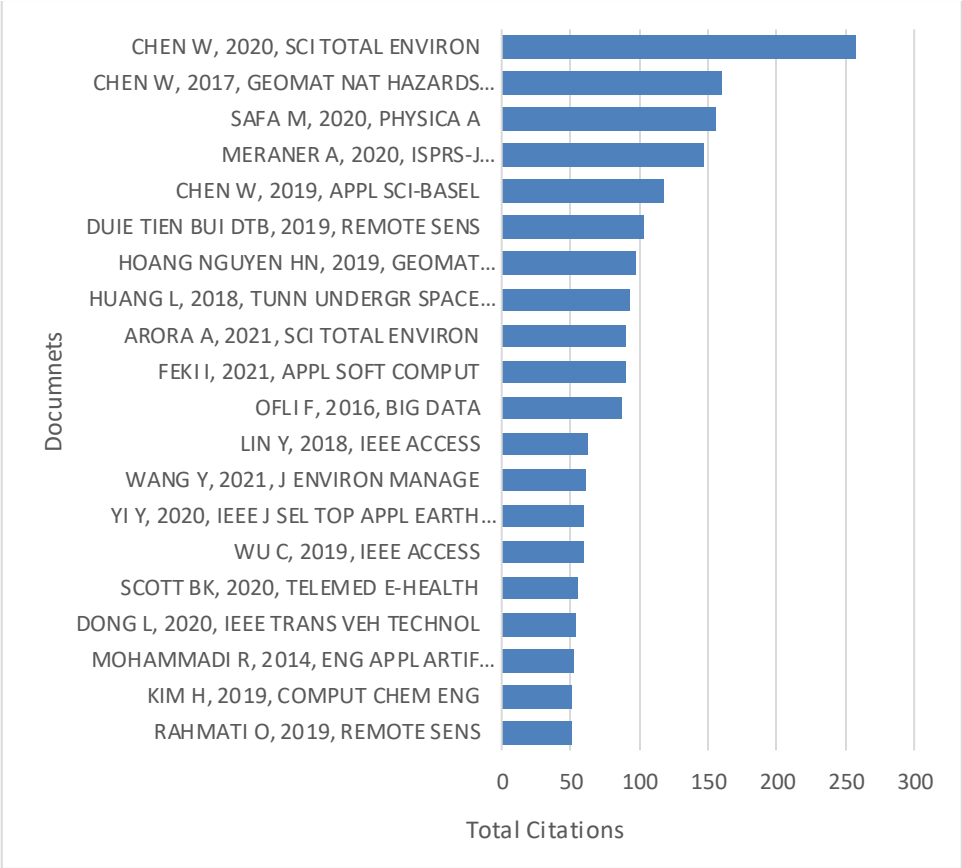

Figure 6. Most Cited Documents (2001-2024)

Analysis of local and global citations reveals varying impact levels among articles. For example, Chen W (2019, Applied Sciences, Basel) received 118 global citations, whereas Khan S (2022, Symmetry, Basel) received 21. Local citation rates reveal recognition within the field; for example, Arora A (2021, Sci Total Environ) received 14.29%. Normalized citations highlight relative influence: Wang RQ (2020, IEEE Access) scored 10.00 locally and Chen W (2019) showed a strong impact at both the local and global levels. Lin Y (2018, IEEE Access) also stands out, having achieved a high number of normalized local citations despite a low rate. These measures help to identify the most influential studies in disaster education and AI.

Most Influential Journals and Impact Metrics

In this section, the contributions of different countries and institutions in terms of publication volume and citation impact are analyzed, focusing on regional leadership and scientific impact.

Resource Dynamics and Bradford's Distribution

Understanding resource dynamics and Bradford's distribution is essential to scientific inquiry because it results in understanding literature that is currently available and planning strategies for conducting new research. Bradford's distribution provides the researcher with strategic guidance because it indicates the emphasis of a particular topic in specific sources. The tools aid the researcher in staying current with literature advancements, having effective access to resources, and achieving maximum utilization of limited resources.

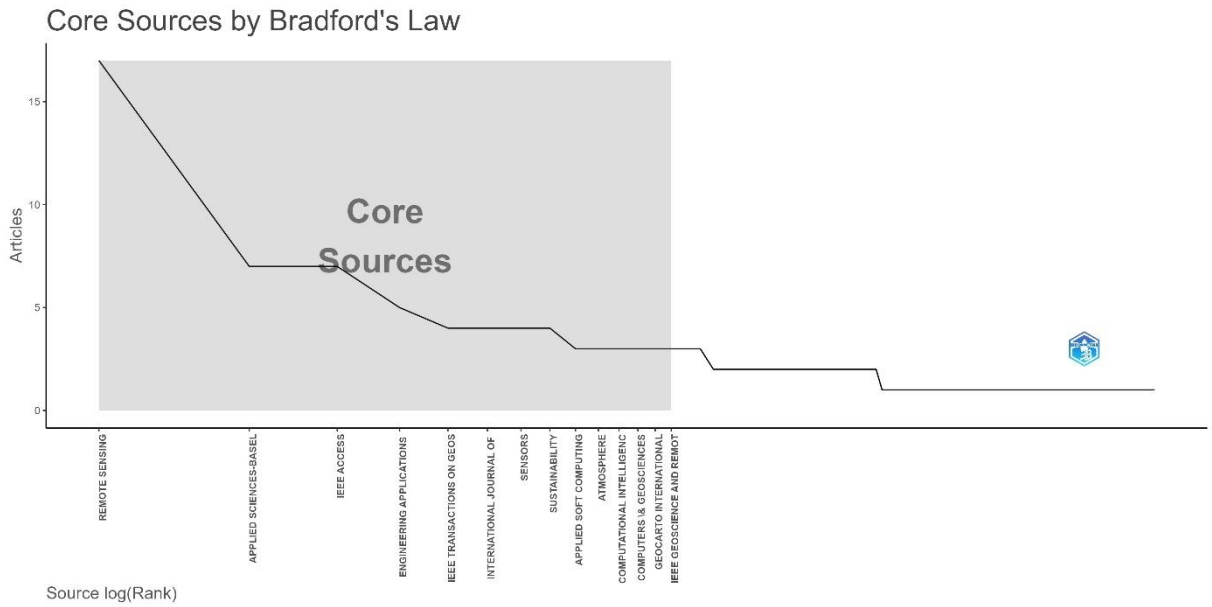

Figure 7. Distribution of Titles According to Bradford Law

Among disaster education and AI, Remote Sensing is the most productive with 17 articles, followed by Applied Sciences-Basel and IEEE Access with seven each, Engineering Applications of Artificial Intelligence with five, and IEEE Transactions on Geoscience and Remote Sensing with four. Specialist journals such as Atmosphere and International Journal of Pattern Recognition and Artificial Intelligence also contribute. Bradford's law is evident, with research concentrated in a few major journals. Remote Sensing has shown sustained growth in citations, peaking in 2023–2024, while Applied Sciences Basel and IEEE Access have also gained momentum, particularly since 2020 (Figure 7). Trends show the enhanced influence of the selected journals and the growing reputation of studies on disaster education and AI.

Most Productive Journals

Remote Sensing has the highest number of citations at 17, followed by IEEE Access and seven for Applied Sciences-Basel. Metrics show the broadest distribution for Remote Sensing with the highest h-index, and IEEE Access with low h- and g-indices but a high average number of citations. Engineering Applications of Artificial Intelligence has moderate impact, whereas Geocarto International, IEEE Transactions on Geoscience and Remote Sensing, and Sensors are outstanding cases of high m-index values. Applied Sciences Basel, Applied Soft Computing and Computers and Geosciences have moderate performance, whereas special issues such as Atmosphere have less impact. Altogether, the numbers name Remote Sensing as the highest-impact journal, with the others contributing to a lesser extent in impact and helping researchers identify the most suitable places for publication.

Institutional and Country-Level Contributions

In this section, the contributions of different countries and institutions in terms of publication volume and citation impact are analyzed, focusing on regional leadership and scientific impact.

Most Productive Countries

A country-wise list of research on disaster education and AI adoption in 2024 identifies China leading the pack with 324 citations, followed by the United States (96) and Iran (52). Publication activity was very slow before 2016, but it picked up sharply from there, and China consistently dominated. The US has never been lower than second position, though Iran held it for one year (2021–2022), only to be overthrown by the US again in 2023–2024. Other contenders are Japan, South Korea and Saudi Arabia, whereas European nations (Germany, UK, Spain and Austria) and American nations (the US and Canada) are still in the playing field but behind Asians. Bangladesh, Australia and Vietnam produce at a lower rate but add geographical diversity to the business (Figure 8).

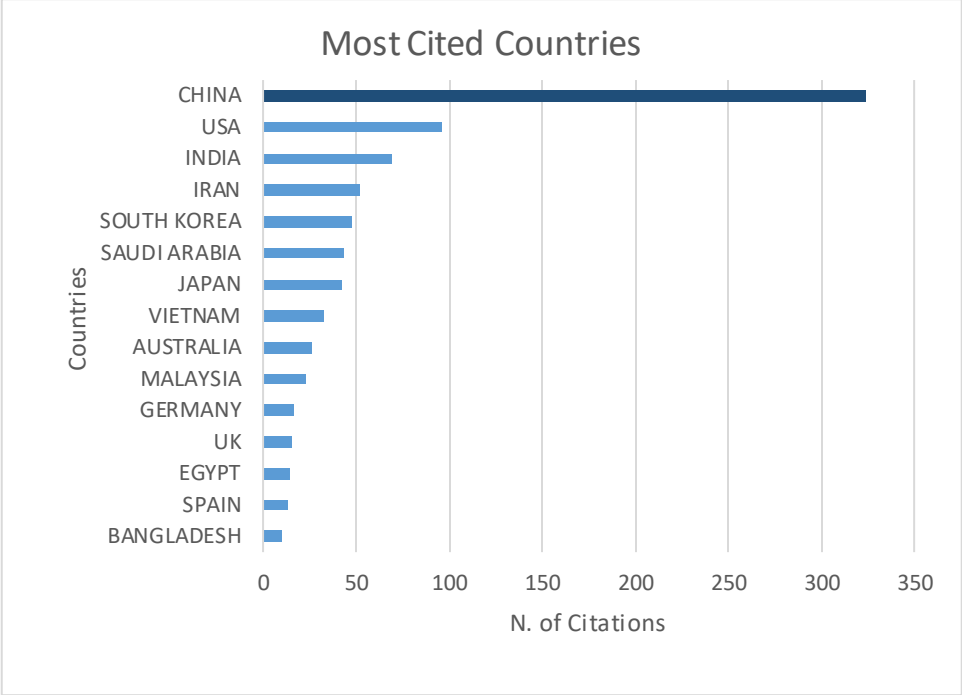

Figure 8. Most Cited Countries

Citation performance has other nuances: China leads not only in number of citations but also in average citations per paper (14.00). Iran is big-time impact with 38.80 citations per paper on average, and Vietnam is staggering at an average of 74.40 citations per paper, although it only has a lower number of articles. Generally, these trends show that as much as China dominates the quantity of research outputs, countries such as Iran and Vietnam provide research disproportionate in its high-impact classification, reflecting the widespread and significant worldwide action in AI and disaster education.

Most Cited Universities

An institutional analysis shows that Ton Duc Thang University is the highest productive disaster study and AI research university with 19 articles. Many Asian institutions are also prominent, particularly Chinese universities Wuhan University, Duytan University and China University of Geosciences, with the highest citation rate (Figure 9).

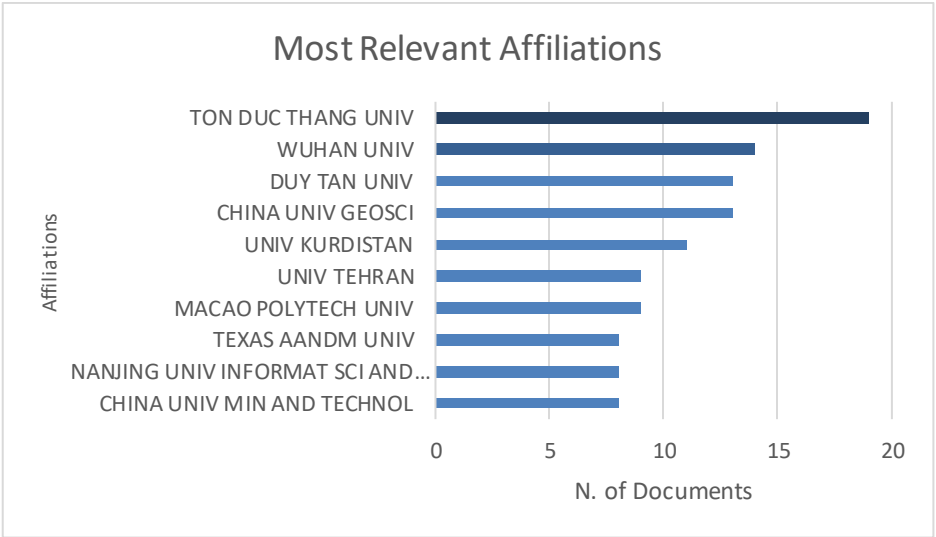

Figure 9. Most Relevant Connections (2001-2024)

China dominates in total output and citations, while Iran and Vietnam have achieved a large average number of citations per paper, showing their significant contribution to the field. Remote Sensing is the top cited

journal, followed by Applied Sciences-Basel and IEEE Access. Overall, the quantity and impact of research in this field have enhanced progressively, with Asia — led by China — taking the lead.

Themes and Topics in the Literature

Keyword analysis and co-occurrence mapping were used to identify thematic focus areas in the literature, revealing key research topics, emerging trends, and frequently used terminologies.

Keyword Analysis

Keyword analysis can reveal gaps, trends, and research priorities in the integration of AI and disaster education (Dhamija & Bag, 2020). By keyword frequency and co-occurrence, researchers can learn more about the most important topics within the field as well as where studies will need to be conducted in the future. Keyword analysis also supports more effective literature reviews by directing attention towards the most important terms.

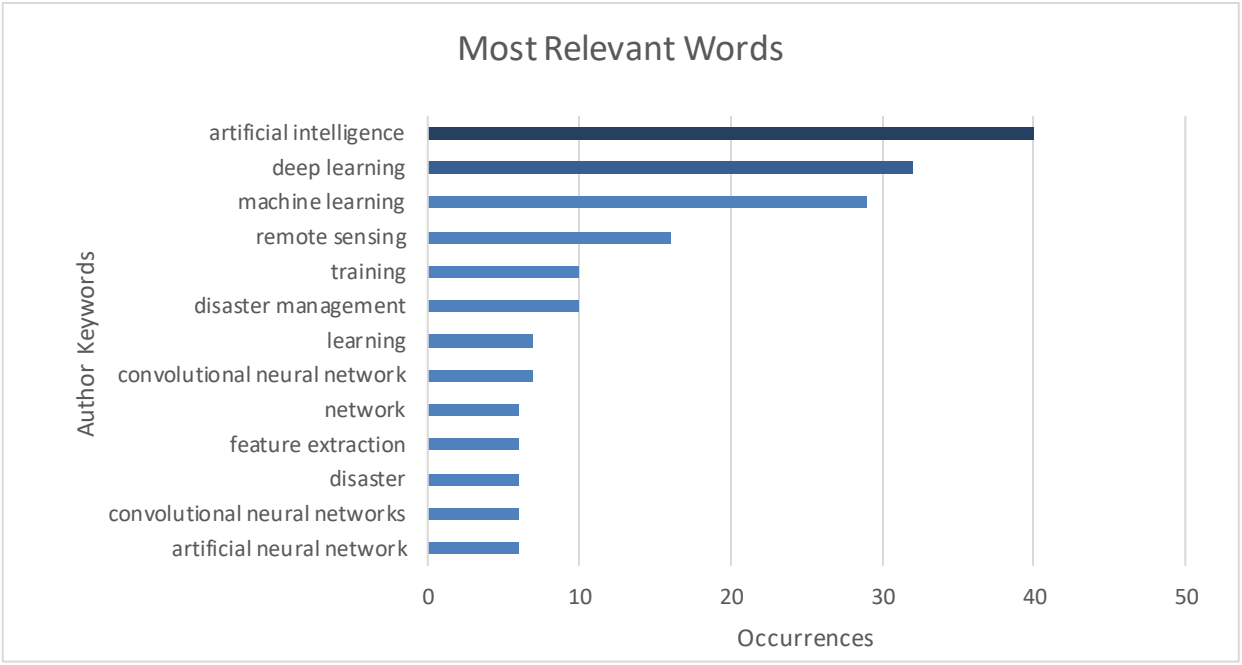

Figure 10. Most Frequently Used Keywords in Articles on AI Integration in Disaster Education

Analysis reveals that "Artificial Intelligence" is the most utilized keyword, reflecting its central role in the industry. "Deep Learning" and "Machine Learning" are close second, both rising exponentially since 2016 and demonstrating their importance for modelling advanced data sets. Remote sensing ranks fourth, reflecting its application for disaster monitoring and education. Some of the other words, such as "Training", "Disaster Management" and "Convolutional Neural Networks" (CNNs), also occur, although with varying trends: "Training" increased and then dropped off after 2022; "Disaster Management" has steadily risen in frequency since 2018; and CNNs have risen sharply since 2019 for image processing applications (Figure 10).

Overall, the keyword trend from 2015 to 2024 indicates growing focus on AI-driven methods to disaster education. Deep learning, remote sensing and machine learning have become more popular, and there is a growing focus on disaster management and CNN-based solutions. This reflects the evolution in the field towards more advanced, data-driven and technology-dependent methods of addressing disaster preparedness and education.

Figure 11. Tree Map of Keywords in AI Integration in Disaster Education (2001-2024)

"Artificial Intelligence" is the oldest and most powerful trend, peaking after 2020 at a frequency of 40, and sustaining well until 2023. Deep learning and machine learning too show sustained growth, especially from 2021. Disaster Management suddenly spiked in 2020 and sustained well until 2022, while Training came into favor after 2022, as a response towards themes focused on education. Convolutional neural networks were particularly prevalent in 2019 and 2020, showing enduring applicability in image processing. Other terms such as "Artificial Neural Network", "Network" and "GIS" appeared at intervals, highlighting their application to specific subtopics. AI and deep learning are central themes, with disaster management and niche techniques gaining significance over time (Figure 11).

The keyword co-occurrence is also represented as a map of the network where the frequency of connections between a keyword and other related keywords are mapped. The greater the frequency of connections, the bigger the circles of the keywords to indicate increasing importance in the network. The resultant density in the map shows a tripolar pattern with the terms "Artificial Intelligence", "Machine Learning", and "Deep Learning".

Common Citation Analysis

Overall citation analysis shows interdependence between disaster education research and AI. This reveals correlated work, identifies trends, and discloses collaboration opportunities (Dwivedi et al., 2023; Jiang et al., 2019). Deep learning demonstrates large betweenness and closeness using centrality measurements, whereas artificial intelligence demonstrates the highest page rank, reflecting their centrality. Cluster analysis further refines the network: "Images", "Earthquake", and "Skills" are of low centrality, whereas "Flood", "ANN", and "Segmentation" are of moderate importance. The System cluster is extremely central, which shows high connections, whereas the Coast cluster is extremely central and dense and is, therefore, a concept worth keeping in mind. These findings show the prominent terms and clusters that are shaping the research landscape.

Collaboration Network Among Authors and Countries

This section explores collaboration networks among authors, countries, and journals by examining citation clusters and scholarly connections within the research community. It is crucial to understand the network of

collaboration among countries and writers to know how scientific productivity, knowledge transfer and interdisciplinary innovation occur (Farooq, 2024). This research reveals how scientists collaborate with each other and on which specific research topics they collaborate, which reveals the structural characteristics of the scientific community and potential collaboration.

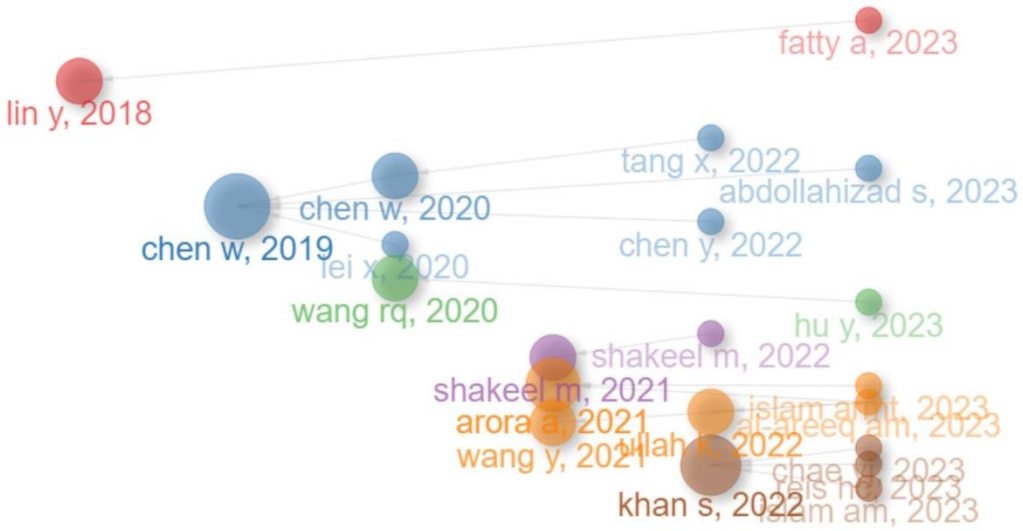

Figure 12. Historical Direct Citation Network

Cluster analysis identifies journal groups with similar centrality measures. Journals in the first group, such as "Multimedia Tools and Applications," "IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing," and "IEEE Transactions on Pattern Analysis and Machine Intelligence," form a prominent cluster with high frequency, centrality, and impact. The elevated centrality and influence of these journals indicate their significance within a specific research domain. Journals in the second group, including "Symmetry-Basel," "International Journal of Pattern Recognition and Artificial Intelligence," and "ISPRS International Journal of Geo-Information," similarly create a high-cluster characterized by centrality and impact. Strong connections among these journals imply their ability to attract researchers and readers interested in similar subject areas.

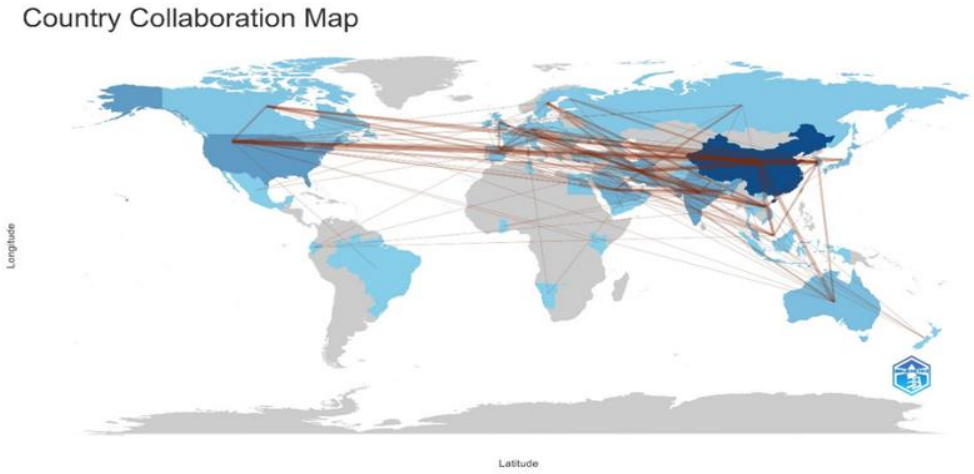

Figure 13. Most Collaborative Countries in AI Integration in Disaster Education (2001-2024)

Figure 13 shows the studies on the use of artificial intelligence in disaster education by countries. The color tones on the map represent the number of scientific productivities; China, which has the highest number of articles and scientific productivity, is seen in dark blue, while the USA is seen in light blue.

RESULT and DISCUSSION

An analysis of publications between 2001 and 2024 reveals a sharp increase in both the quantity and impact of studies related to disaster education and artificial intelligence. Key contributors include Bin Ahmad B, Chen W, Hong H, and Li Y, who have significant international collaborations. The high h-index values of leading authors highlight their influence in the field (Brembs et al., 2013; Johnson et al., 2014).

Journals such as IEEE Access, Engineering Applications of Artificial Intelligence, and Remote Sensing are among the most prominent, with Remote Sensing showing significant growth and impact (Huang et al., 2022). Metrics such as the h-index, g-index, and m-index indicate that Remote Sensing has the highest overall impact, Applied Sciences-Basel has a strong g-index, and IEEE Access maintains a stable citation average. These results confirm the growing importance of engineering and applied sciences journals in disaster and artificial intelligence research. However, it is important to note that citation increases are generally seen in earlier publication years due to the time required for citations to accumulate (Li et al., 2021; Pendlebury, 2009).

Karacaoğlu et al. (2025) offer important recommendations for researchers, educators, and practitioners aiming to develop AI-based disaster literacy education, while emphasizing the need for further expansion in the field of disaster literacy and advocating for more comprehensive research that includes diverse datasets, diverse application contexts, and more complex scenarios.

The findings of our study provide an important synthesis of prior studies (Başer & Sofuoğlu, 2025; Brown & Peterson, 2014; Çalışkan & Üner, 2021; Erkin & Kiyan, 2025; Genç et al., 2022; Güzel, 2024; İşleyen et al., 2025; Karacaoğlu, 2024; Karacaoğlu & Biamba, 2025; Taşkıran Eskici et al., 2025; Tusam et al., 2024; Zhang et al., 2021) and for other researchers in the field of disaster literacy. First, the strong presence of keywords such as *education*, *question-and-answer systems*, and *deep learning* indicates a growing shift toward interactive, student-centered educational technologies. Such technologies are increasingly being used in out-of-school learning environments (e.g., mobile learning applications, virtual simulations), which are particularly important in disaster situations where traditional education may be disrupted. Furthermore, the rise of AI-enabled disaster education highlights the need for teacher professional development in integrating intelligent systems into formal curricula. For example, question-and-answer models can be integrated into classroom instruction to increase situational awareness and engagement, particularly for children and adolescents, who are key groups in disaster preparedness. These findings suggest that future education research should focus not only on AI tool development but also on pedagogical strategies, student outcomes, and equity of access, especially across socioeconomically diverse regions.

CONCLUSION

An analysis of scientific articles on disaster education and the integration of artificial intelligence between 2001 and 2024 provides valuable insights. The increase in citation counts and average citations reflects the growth in the field and suggests that new research may be cited in the future. The collaboration among authors and the level of international participation are notable. Analysis of journals highlights the prominence of "Remote Sensing", "Applied Sciences-Basel" and "IEEE Access". Country analysis indicates China's dominance, with notable contributions from the US and Iran. Key terms such as "artificial intelligence", "deep learning" and "machine learning" stand out, indicating the focus areas of researchers. The strong connections among these terms reflect concentrated research interests. The term “disaster management” is frequently associated with artificial intelligence. In conclusion, the field is experiencing an increase in scientific activity, emphasizing the need for new research.

Furthermore, the findings offer significant implications for the field of education. The dominance of keywords such as "question-answer systems," "deep learning," and "training" indicates a trend toward interactive and personalized learning. This trend is particularly important for out-of-school learning environments during disasters, where traditional education is disrupted. The study highlights the need for further research on how to pedagogically integrate AI-based tools and the need to consider teacher training and access inequalities.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the author(s) with respect to the research, authorship, or publication of this article.

Ethics Approval

This study is derived from Demet Karacaoğlu's master's thesis conducted at the Institute of Graduate Education at Bakırçay University, İzmir. The study was approved by the university's Research and Publication Ethics Board as part of the thesis approval process. Because the research is based entirely on bibliometric data obtained from publicly available scientific sources and does not involve human subjects or personal data, no additional ethical approval was required. The research complies with ethical standards of academic conduct and data integrity.

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Research and Publication Ethics Statement

This study did not involve human participants, personal data, or any interaction with living subjects. All analyzed data were obtained from publicly available scientific publications in databases. Therefore, it did not require ethics committee approval. The research was conducted in accordance with the principles of academic integrity and responsible data use.

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