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Evaluating Research Trends and Gaps in Disaster Literacy within Science Education: A Bibliometric Perspective

Prasetyaningsih[1], Ida Kaniawati[1,*], Lala Septem Riza[2], Judhistira Aria Utama[3]
[1]Science Education Program, Universitas Pendidikan Indonesia, Jawa Barat, Indonesia.
[2]Computer Science Education Program, Universitas Pendidikan Indonesia, Jawa Barat, Indonesia.
[3]Physics Education Program, Universitas Pendidikan Indonesia, Jawa Barat, Indonesia.

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ABSTRACT

Purpose of the study: This study aims to evaluate research trends, gaps, and global patterns in disaster literacy within science education to identify areas for improvement and provide actionable recommendations for enhancing education strategies in disaster-prone regions.

Methodology: A bibliometric analysis was conducted using data from the Scopus database (2000-2024). Tools used include R Studio with the Bibliometrix package for generating visualizations such as co-occurrence networks, word clouds, and trend analyses. The dataset comprises 315 articles selected using “disaster literacy” and "science education".

Main Findings: Findings indicate an increasing focus on disaster literacy research, with eminent themes such as technology integration and project-based learning. However, significant gaps remain in contributions from developing nations and the long-term evaluation of disaster literacy programs. Collaborative international research has been identified as a growing trend.

Novelty/Originality of this study: This study uniquely combines bibliometric analysis with an evaluative approach to highlight disparities in disaster literacy research and propose strategies for improving curriculum integration and global collaboration. It advances understanding by identifying underexplored areas and providing a foundation for targeted educational interventions.

Corresponding Author:
Ida Kaniawati,
Science Education Program, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia,
Jl. Dr. Setiabudhi No. 229 Bandung 40154, Jawa Barat, Indonesia
Email: kaniawati@upi.edu

1. INTRODUCTION

Given the contemporary era of globalization and climate change, the significance of disaster literacy is growing [1]-[3]. Science education is essential for molding the public's understanding and awareness of the possibility of natural disasters and reducing their effects [4]-[7]. Literature research indicates that disaster literacy within the realm of science education encompasses not only theoretical knowledge but also the cultivation of practical skills and attitudes toward catastrophe response [8], [9]. This instruction seeks to enhance readiness, reaction, and adjustment to diverse forms of natural calamities.

With the rising frequency and intensity of natural catastrophes, assessing trends in disaster literacy research is essential for the successful and pertinent application of science education. Educational systems are essential in equipping communities to properly adapt to crisis scenarios [10]-[13]. This study evaluates patterns and gaps in disaster literacy research to determine the alignment of present academic efforts with the worldwide

necessity of fostering resilient and informed societies. This review offers practical insights for educators, policymakers, and academics to create more focused and effective educational initiatives.

Notwithstanding these endeavors, the literature study indicates that substantial deficiencies persist in the implementation and assessment of disaster literacy programs. While numerous studies focus on curriculum creation and pedagogical strategies (e.g., [14], [15]) few assess the enduring effects of disaster literacy on students' actual preparedness and response capabilities. For instance, in developed countries such as the United States and Japan, research has primarily concentrated on integrating disaster preparedness into educational curricula, but the long-term impact on students' practical disaster response remains understudied (e.g., [16], [17]). Moreover, most disaster literacy research is conducted in affluent nations, leaving a significant gap in the literature on disaster literacy in developing countries. Cultural and socioeconomic factors that affect the efficacy of disaster literacy education are frequently overlooked, as each society possesses distinct contexts and requirements for addressing disasters. In addition, there is a lack of international and multidisciplinary collaborative studies, which could offer a broader, more inclusive perspective on disaster literacy across different national and cultural contexts.

Current literature reviews reveal that the inclusion of disaster literacy in science education curricula continues to differ among countries and institutions. Several studies, such as those by Logayah et al and Fadilah et al, indicate a rise in student comprehension following the introduction of disaster literacy programs [1], [5]. For example, Logayah et al. demonstrated how disaster mitigation literacy improved in social studies contexts in Indonesia, while Fadilah et al, highlighted the positive outcomes of earthquake-focused disaster literacy programs in Indonesian universities [1]. However, other research emphasizes challenges in implementing these programs, such as insufficient resources and inadequate teacher preparation. For instance, research by Saregar et al, notes that many disaster literacy programs are hindered by a lack of specialized teacher training [13]. The objective of this study is to examine the current body of literature by employing a bibliometric methodology to discover trends, patterns, and areas of deficiency in disaster literacy within the field of science education.

The primary research challenge in disaster literacy revolves around finding effective methods to include concepts and abilities related to disaster mitigation and adaptation in science education. An important obstacle is the insufficient incorporation of disaster literacy into an already packed curriculum, together with the absence of specialized training for instructors to successfully instruct this subject. Typical solutions involve creating curricula that combine science education with environmental studies and geography, as well as implementing project-based learning methods to enhance student involvement and comprehension. Additionally, several efforts entail partnering with external groups to deliver essential training and resources to schools and educators. Various explicit solutions are available in the scientific literature to enhance disaster literacy in the field of science education [5], [18]-[20]. Research has demonstrated the efficacy of project-based learning methods in educating children about natural disasters by engaging them in projects that replicate real-life scenarios. This approach enables students to cultivate problem-solving and critical thinking abilities, while also comprehending the tangible consequences of natural disasters in the actual world. Furthermore, the utilization of technology and digital tools, such as computer simulations and interactive learning programs, has the potential to enhance students' educational experiences. Research indicates that these tools increase students' comprehension of intricate topics pertaining to natural disasters and ways for mitigating their impact. Furthermore, these technologies are easily obtainable and can be used into remote education, which is particularly pertinent during a pandemic. Furthermore, the effectiveness of disaster literacy programs heavily relies on the implementation of rigorous and continuous training for teachers. Studies indicate that educators who get specialized training in disaster literacy exhibit more self-assurance and proficiency in delivering instruction on the subject matter. This training curriculum encompasses a comprehensive grasp of fundamental catastrophe theory, the utilization of instructional tools and technology, and pedagogical approaches suitable for the student’s age.

The literature study indicates that despite extensive efforts and research on disaster literacy in science education, there are still severe deficiencies in the execution and assessment of these programs. While several research concentrate on curriculum creation and teaching methodologies, only a limited number assess the enduring effects of disaster literacy on students' practical readiness and response. Furthermore, the majority of studies have been carried out in affluent nations, leaving the literature on disaster literacy in poor countries significantly lacking. Proposed solutions typically involve creating curricula that amalgamate science education with environmental and geographic studies, as well as employing project-based learning strategies to enhance student involvement and comprehension. Additional initiatives entail partnering with external entities to furnish essential training and resources to educational institutions and instructors. Research indicates that digital technology and tools, including computer simulations and interactive learning programs, possess significant potential to improve students' educational experiences in disaster literacy. The efficacy of these initiatives is significantly contingent upon continuous, high-caliber teacher training.

Notwithstanding these endeavors, the literature reveals considerable deficiencies in the execution and assessment of disaster literacy initiatives. A significant portion of the research emphasizes curriculum creation and pedagogical strategies, although there is a paucity of evaluations regarding the long-term effects of disaster

literacy on students' practical preparedness and response capabilities. Moreover, most of the research is performed in rich nations, resulting in a paucity of literature on disaster literacy in developing countries. Cultural and socioeconomic elements that affect the efficacy of disaster literacy education are frequently neglected, as each society possesses distinct contexts and requirements in the face of disasters.

This study aimed to address several critical evaluative inquiries, specifically: (1) In what manner do trends in disaster literacy research correspond to worldwide requirements? Are the most urgent catastrophe issues sufficiently reflected in research? (2) Have findings from disaster literacy research influenced educational policy or pedagogical practices? (3) How does the geographic distribution of research influence its global significance? Do substantial discrepancies exist between developed and developing nations regarding the incorporation of disaster literacy into science education? This study intends to employ bibliometric techniques to assess the present condition of disaster literacy research within scientific education. This study aims to identify gaps in the literature, particularly in underrepresented regions and themes, by analyzing collaboration patterns, thematic trends, and the impact of research findings; assess the alignment of disaster literacy research with global educational and policy needs; and offer evidence-based recommendations for enhancing the integration of disaster literacy into science education curricula and teacher training programs.

This work provides significant insights into how disaster literacy research might be utilized to foster more resilient communities via scientific education. This evaluation's outcomes aim to connect academic research, practical application, and policy creation, ensuring disaster literacy activities are both effective and globally equitable.

2. RESEARCH METHOD

This study employs a descriptive research methodology with an evaluative framework to address the established research topics. The assessment methodology employs bibliometric analysis, enabling researchers to examine trends, patterns, collaborations, and the impact of disaster literacy research within science education. This method was selected due to bibliometric analysis offering comprehensive quantitative insights [17], [18] into scientific publications, geographic distribution, and prevailing research subjects. The study dataset comprises scientific publications (articles, conference papers, book chapters, reviews, books, editorials, letters, and short surveys) regarding disaster literacy in science education sourced from the Scopus database. Scopus was chosen for its comprehensive coverage, high reliability, and inclusion of peer-reviewed publications from diverse disciplines, making it a widely recognized source for bibliometric studies. Additionally, Scopus offers robust tools for citation and network analysis, which are crucial for examining research trends and collaborations. The retrieved items span the period from 2000 to 2024. The year 2000 was chosen as the starting point because preliminary searches indicated that the earliest indexed articles on disaster literacy in science education appeared around this year, marking the beginning of scholarly interest in this field. The inquiry utilized the terms “Disaster literacy” and “Science education” to guarantee the data's pertinence to the study's goal. The search yielded 315 articles that satisfied the inclusion criteria.

This analysis aims to assess multiple facets of literature through an evaluative framework that emphasizes: (1) Research Productivity: Annual publication count to discern temporal trends; (2) Geographical Distribution: Assessment of research contributions from various nations to comprehend international collaboration trends and geographical disparities; (3) Research Quality: Determined by the average citation count, premier impact publications, and prominent authors; (4) International Collaboration: Networks of collaboration derived from co-authorship analysis to ascertain the extent of global cooperation; (5) Principal Research Topics: Identification of predominant keywords and topics by co-word analysis; (6) Thematic Relevance: Correlation between study issues and worldwide educational and policy requirements; and (7) Future Research Opportunities: Identification of unexamined topic voids in literature.

The Scopus database ensures data accuracy, being one of the most reputable venues for scientific publishing. The search procedure is conducted meticulously with pertinent keywords and is verified to confirm that the received material aligns with the inclusion requirements. Furthermore, employing R Studio software for analysis guarantees consistent data processing and facilitates accurate interpretation of results. The process analysis and evaluation are as shown in Figure 1.

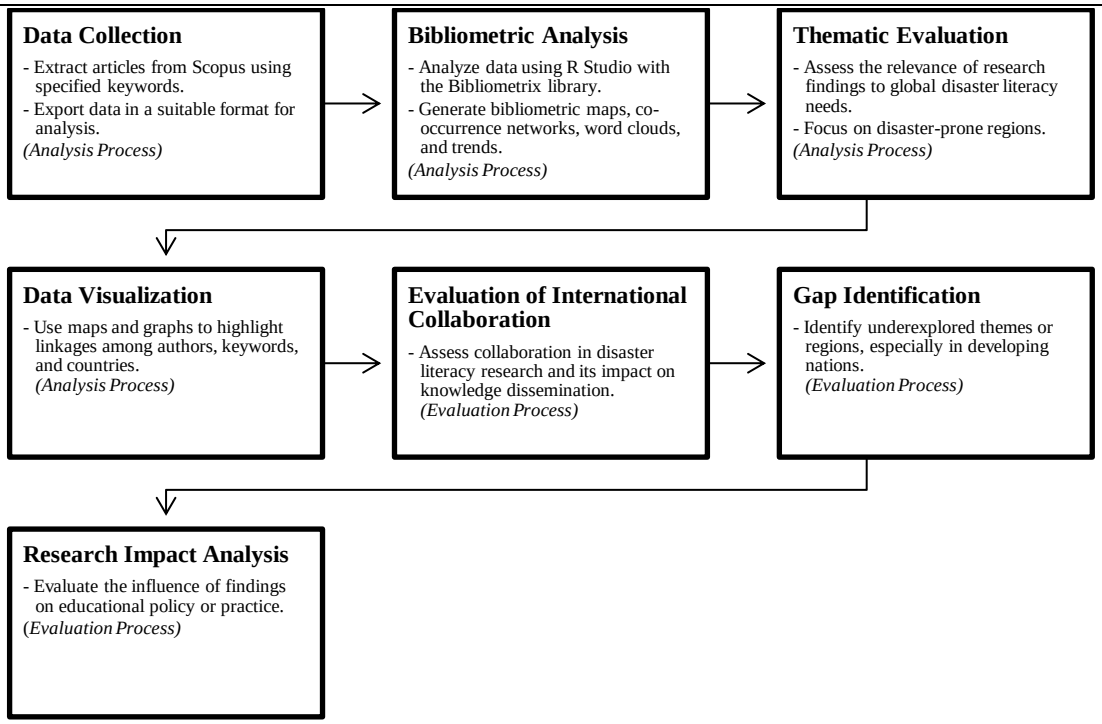

Figure 1. Process Analytical Methodology and Evaluation Procedures

Figure 1. illustrates a methodical framework for analyzing and assessing disaster literacy research, providing a comprehensive view from data collection to impact evaluation. In the preliminary phase, data acquired via a bibliometric methodology enables researchers to elucidate worldwide patterns and trends. Thematic analysis and data visualization yield insights into the pertinence of research within the global environment, particularly in nations confronting substantial disaster risks. The evaluation phase underscores the significance of international cooperation in broadening research scope and information distribution while identifying deficiencies that reveal the necessity for research in underrepresented areas.

The concluding phase of this graphic, research impact analysis, underscores that disaster literacy in science education must extend beyond theoretical examinations. Research findings should be incorporated into educational curricula and policies to foster more resilient societies. This strategy aligns with prior research demonstrating the significance of a cross-sectoral approach in disaster education to cultivate communities better equipped to confront global crises [7], [21].

3. RESULTS AND DICUSSION

3.1. Bibliometric data

The study reveals a substantial rise in the quantity of scientific education articles focused on disaster literacy throughout the last ten years. Co-word analysis identified recurring subjects in the literature, including "disaster mitigation," "project-based learning," and "computer simulation." The collaboration networks reveal that most studies are initiated by industrialized countries, with robust international cooperation. This survey observed a rise in international collaboration and a broadening of research themes, in contrast to earlier studies. Nevertheless, the literature indicates that this research does not represent poor nations. The report also emphasizes the absence of long-term impact evaluations despite the introduction of new technologies and educational approaches.

The significance of these findings rests in the identification of deficiencies and the necessity for additional research in developing nations, as well as the requirement for ongoing assessment of disaster literacy initiatives. The practical implications encompass suggestions for enhancing teacher education and using technology in the instruction of disaster literacy. Figure 1 displays three field-plot correlations about the author, keyword, and nation.

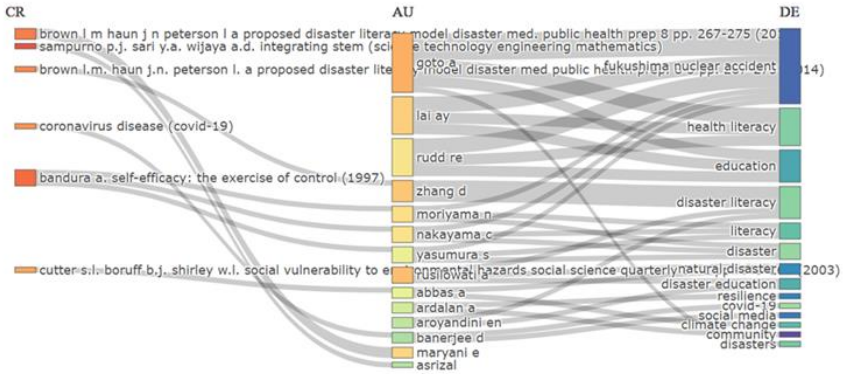

Figure 2. Three field-plot relationships about author, keyword, and country of disaster literacy in science education.

Figure 2. displays a notable correlation between the keywords used by a specific author and the country from where the study originates. This implies that specific locations possess specific interests or competence in the intersection of disaster literacy and science education.

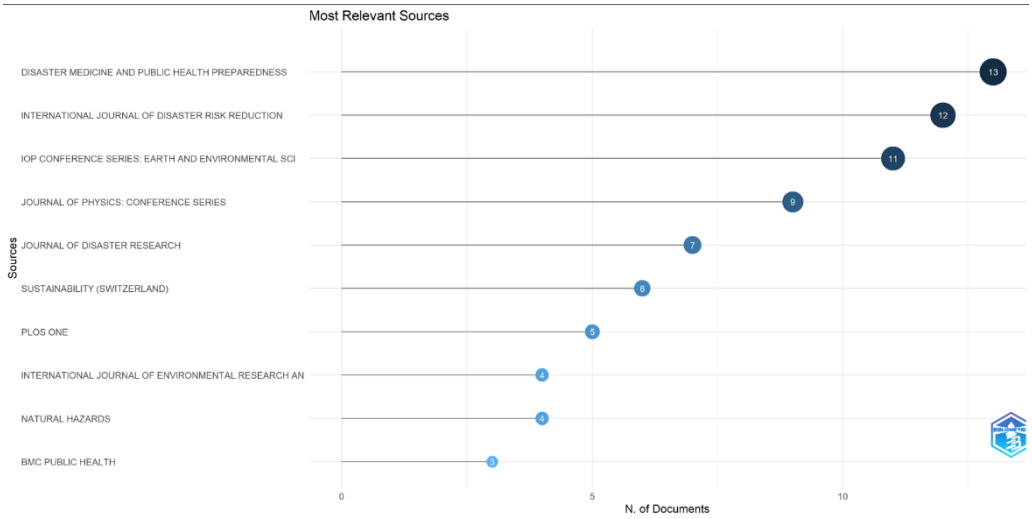

Figure 3. The top ten peer-reviewed journals of disaster literacy in science education.

The journals that are most commonly referenced in this field have been identified. These publications are anticipated to establish the benchmarks for research in disaster literacy and scientific education. They provide a platform for critical discourse and widespread dissemination of influential studies.

Figure 4. The word cloud of disaster literacy in science education.

Word cloud visualization offers a means to gain an understanding of the most commonly utilized terms in this field of study. The prevalence of specific phrases indicates the prevailing patterns, topics, and areas of emphasis in the discipline. This can signify the progression of the research subject and identify areas that may require additional investigation.

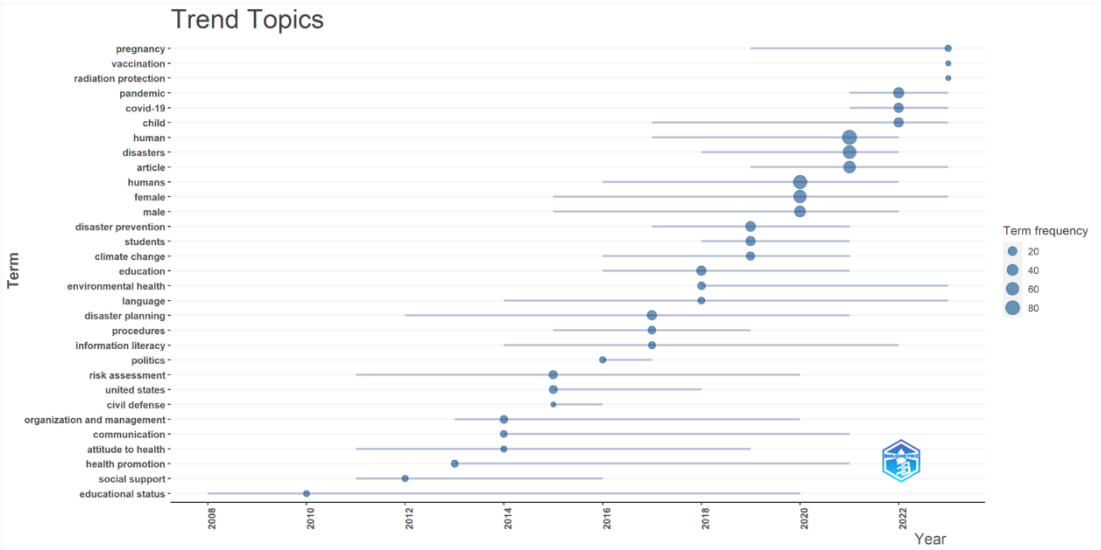

Figure 5. The Trend topics of disaster literacy in science education.

Figure 5. depicts the visual representation of trending topics based on the frequency of occurrence of specific terms in the scientific literature related to the themes of disaster literacy and science education. Each term listed on the vertical axis represents a particular topic or theme, while the horizontal axis represents the time range from 2008 to 2022. The size of the circle reflects the frequency of occurrence of the term; the larger the circle, the more frequently the term appears in literature.

Based on Figure 5, many main trends may be observed: (1) Emergence and Dominance of Terminology: Terms such as "pandemic," "COVID-19," "climate change," and "disaster prevention" have appeared frequently in certain years, indicating a significant focus on these themes in literature during specific periods. The terms "COVID-19" and "pandemic" indicate a significant increase in frequency from 2020 to 2022, which is in line with the occurrence of the global pandemic. This indicates that literature on disaster literacy and science education has directly responded to this worldwide event; (2) Temporal Development: Several terms indicate consistent temporal development. For example, the term "climate change" has increasingly been a subject of discussion from 2014 to 2022, indicating growing attention to the issue of climate change in the context of education and disaster literacy. The term "disaster prevention" also indicates an increasing trend, with its frequency starting to rise since 2016 and reaching its peak in 2022; (3) Terminological Variability: Some terms appear sporadically, such as "vaccination" and "radiation protection," likely reflecting the literature's response to particular events or issues during a specific period. The network co-occurrence analysis reveals a strong relationship between the main themes in disaster literacy and science education. This example illustrates the strong correlation between "climate change education" and "disaster preparedness", suggesting that comprehension of disasters is frequently contextualized within the framework of climate change. This is important because it demonstrates that disaster education focuses on the actual occurrence of disasters and the broader environmental factors contributing to disaster risks.

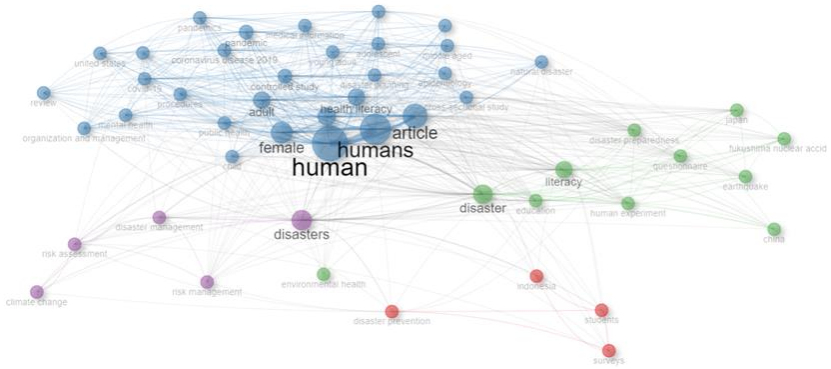

Figure 6. The co-occurrence network of disaster literacy in science education.

Co-occurrence network research reveals the interconnectedness of various keywords in the literature. The text uncovers fundamental topics and their interconnections, exposing an intricate web of principles that characterize catastrophe literacy and science education. The bibliometric analysis process provides useful insights into the present condition of research on disaster literacy within the framework of scientific education. The correlation between author keywords and countries signifies the spatial dispersion of expertise and specific areas of concentration. The analysis reveals that nations susceptible to natural calamities, such as Japan, Indonesia, and the United States, play a significant role in the discourse on disaster literacy. Among these, developed countries like Japan and the United States contribute the most publications, often focusing on advanced technologies and systematic approaches to disaster education. Meanwhile, developing countries like Indonesia contribute fewer publications but provide valuable insights into local and community-based disaster education practices. This highlights the necessity for region-specific research that considers local circumstances and difficulties, particularly in underrepresented developing nations where disaster risks are often more severe.

The correlation between author keywords and nations suggests a spatial clustering of research on disaster literacy in the field of scientific education. Countries prone to frequent natural catastrophes, such as Japan and Indonesia, tend to make a greater contribution to this body of literature. The heightened urgency and pertinence of the subject of disaster literacy in these nations may account for the escalated research efforts in this domain. Studies conducted in these nations frequently concentrate on techniques for mitigating disasters, community adaptation, and educational initiatives aimed at improving disaster preparedness.

The compilation of the top 10 peer-reviewed journals provides a valuable reference for upcoming studies, highlighting the venues where influential findings are published. Researchers aspiring to make contributions to this subject should contemplate these publications as prospective platforms for publishing their work. The journals that are most commonly referenced offer a valuable understanding of the main sources of significant research in the discipline. For instance, the International Journal of Disaster Risk Reduction is frequently referenced for its notable emphasis on techniques aimed at reducing the impact of disasters, particularly in terms of education. Similarly, the Journal of Environmental Education serves a crucial role in connecting the ideas of environmental literacy and disaster literacy [22]-[25], providing a valuable understanding of how both literacies can be utilized in science education.

Word clouds and co-occurrence networks visually depict the topic landscape of disaster literacy in scientific education. These methods are especially valuable for detecting deficiencies in the existing body of literature and emerging patterns. For instance, if a specific keyword or topic is not adequately represented, it suggests that there is a promising area for additional investigation. The word cloud offers a comprehensive summary of the prevailing terms in the pertinent literature. The frequent use of terms like “resilience,” “preparedness,” and “risk reduction” suggests that research in educational environments primarily emphasizes preparedness and risk reduction. The prevalence of these terms also indicates a notable focus on creating educational programs and teaching methods that equip students to respond successfully to natural disasters.

The trend subjects can be categorized into three primary domains: (1) Reaction to Global occurrences: The surge in occurrence of phrases like “COVID-19” and “pandemic” demonstrates the swift response of the scientific literature to major global occurrences. Within the realm of science education, the pandemic has served as a significant catalyst for assessing and enhancing disaster literacy, specifically regarding how educational systems may instruct individuals on effective strategies for responding to future pandemics and similar catastrophic events; (2)(Heightened Emphasis on Climate Change: The ongoing rise in conversations about “climate change” indicates that science education's attention to disaster literacy is more centered on wider environmental concerns, specifically climate change. This signifies an increasing recognition of the significance of equipping young individuals to tackle intricate and enduring environmental concerns; (3) Educational priority: The growing prevalence of the word “disaster prevention” indicates that disaster prevention is gaining significant attention in the field of disaster literacy education. This might be interpreted as an endeavor to provide students with the knowledge and abilities required to proactively prevent or mitigate the consequences of disasters, rather than solely reacting to them after they have already happened.

Disaster literacy is a field that combines different disciplines and examines the intersection between science education and disaster-related knowledge [26]-[34]. Integrating disaster literacy into the scientific curriculum helps improve students' comprehension of natural phenomena and the social and environmental consequences of catastrophes [5], [35]-[38]. Consequently, this can aid in the development of communities that are more capable of withstanding challenges and adversity. It is crucial to include disaster literacy as a fundamental component of science education, particularly in regions that are prone to disasters. Literacy in this context encompasses not just comprehension of natural occurrences [5], [39], [40], but also the aptitude to undertake suitable measures during emergency circumstances [36], [41]. Incorporating disaster literacy into the scientific education curriculum can cultivate a generation that is better equipped and resistant to disasters, while also fostering a heightened understanding of the significance of environmental preservation.

3.2. Evaluation process

3.2.1. Trends in disaster literacy research and the most urgent disaster challenges

Research trends indicate a growing reaction to global concerns, including climate change and pandemics. The prevalence of subjects like "disaster prevention" and "climate change" indicates that this research addresses matters with extensive worldwide ramifications. Technology-driven research, including computer simulations, has emerged as a principal method to enhance disaster literacy teaching [22], [42]. Nevertheless, disaster literacy that addresses local requirements, particularly in developing nations, remains little examined [43], [44]. This is crucial as disaster literacy must be tailored to address specific community requirements, including culturally relevant education and infrastructural limitations.

While certain studies have sought to address emerging concerns like the COVID-19 epidemic, the primary emphasis continues to be on formal curriculum-based schooling. The absence of studies investigating community-based disaster literacy to aid communities in effective catastrophe mitigation is apparent. Research by Sun and Yuan, emphasized the significance of community-based solutions in enhancing community comprehension of catastrophe risk [39]. Consequently, contemporary research trends mirror overarching global requirements yet are deficient in locally pertinent elements applicable to emerging nations.

Research on disaster literacy that concentrates solely on global issues sometimes overlooks local disparities, including individuals' access to technology and educational approaches. Developing nations, frequently the most affected regions, necessitate context-specific strategies, including the utilization of basic media for community engagement [45]-[51]. This signifies the necessity for equilibrium between global and local research to enhance the efficacy of disaster literacy.

3.2.2. Influence on educational policy or pedagogical practice

Currently, the literature indicates that the direct influence of research on educational policy remains constrained. Despite the widespread implementation of methodologies like project-based learning and technological integration in education, their influence on educational policy remains markedly insufficient. Saregar shows that the majority of research concentrates solely on the development of teaching methodologies, neglecting to assess their implementation and impact on the official curriculum [52]-[54]. This presents a challenge in assessing the efficacy of research in altering current educational practices.

Conversely, research focused on enhancing teacher capacity to include disaster literacy in education remains limited. Educators frequently experience diminished confidence in instructing disaster literacy content due to insufficient specialized training [56]-[57]. While technology-based training is useful in simulations, it frequently overlooks the practical requirements of teachers for incorporating this subject into regular lessons. Consequently, subsequent studies ought to concentrate on the effects of implementation in curriculum creation, educator training, and student evaluation.

Moreover, there is a conspicuous absence of educational policy studies that incorporate disaster literacy research. Most studies fail to assess the influence of research on national or local education policy, which are critical components in formulating education-based mitigation strategies. Collaboration between scholars and policymakers is essential for developing more pertinent and adaptable educational solutions [39]. This highlights the necessity for more proactive research to facilitate the integration of findings into policy.

3.2.3. Geographical disparities in research and the importance of incorporating disaster literacy into scientific education in developed vs developing countries

The disparate geographical allocation of research constitutes a primary barrier to comprehensively grasping global requirements. The majority of research occurs in industrialized nations, whereas developing countries, frequently exhibiting greater disaster susceptibility, are inadequately represented in the literature. This indicates a deficiency in addressing the local environment of developing nations, necessitating more flexible educational strategies. Research by Chu et al. indicates that the advancement of disaster literacy in rich nations frequently depends on sophisticated technologies, which may not be pertinent or available in countries with inadequate infrastructure [7].

Moreover, emerging nations encounter obstacles regarding financing and global cooperation. Demonstrate that international collaboration frequently benefits rich nations, obstructing the dissemination of knowledge and technology to underdeveloped nations [58]. Research conducted locally in these nations frequently uses more rudimentary approaches, which are generally disregarded by prestigious journals. Consequently, a more comprehensive international partnership plan is essential to mitigate the geographical inequality in disaster literacy research.

This disparity in research contributions may diminish the global efficacy of disaster literacy education. Disaster literacy formulated with a developed country-centric perspective may not be entirely applicable to populations in developing nations that encounter distinct barriers, including local culture and language. Consequently, global collaboration must account for distinct local requirements to guarantee that the proposed solutions are pertinent and can be executed efficiently [59]-[63].

The findings indicate the necessity for strategic measures to augment the significance and efficacy of disaster literacy education, especially within the framework of scientific education curricula: (1) Curriculum Enhancement: Explicitly incorporate disaster literacy themes into science education curricula utilizing technology-driven and project-based methodologies; (2) Educator Development: Augment teacher training on disaster literacy, emphasizing the application of digital tools and innovative pedagogical strategies; (3) Strengthened Global Collaboration: Broaden international collaboration networks to encompass additional developing nations, prioritizing technology transfer and local capacity development; and (4) Contextualized Research: Promote research that considers cultural and social contexts, enabling the customization of disaster literacy education to meet local requirements.

Incorporating disaster literacy into scientific education significantly improves students' awareness and readiness for disasters. This study's conclusions offer insights into research trends and gaps while also guiding the formulation of more effective educational policies and programs. By addressing spatial and thematic deficiencies, disaster literacy education can serve as a more effective instrument for cultivating resilient and catastrophe-conscious societies.

4. CONCLUSION

This study indicates that disaster literacy patterns in scientific education have significantly evolved over the past decade, responding to global issues including climate change and the COVID-19 pandemic. The prevalence of subjects like "disaster prevention," "climate change," and technology-enhanced learning indicate that research has concentrated on educational innovation. Nonetheless, thematic and regional disparities persist as significant obstacles. Developing nations, frequently encountering the greatest disaster risks, are inadequately represented in the literature.

The findings of this study underscore the importance of addressing local requirements and cultural factors in disaster literacy education to enhance its relevance and impact globally. Theoretically, the study enriches the understanding of how socio-economic and cultural differences influence the effectiveness of disaster literacy programs, emphasizing the need for contextualized approaches. Practically, it highlights significant gaps in the integration of disaster literacy into formal educational curricula, teacher training, and community preparedness initiatives. For instance, while pedagogical techniques such as project-based learning and technological tools show promise, their application remains inconsistent across regions, and their influence on educational policies is still limited. These insights call for immediate action to bridge these gaps and develop disaster literacy initiatives that are both inclusive and adaptable to the needs of diverse communities.

Despite its contributions, this study has several limitations that future research should address. The reliance on Scopus as the primary data source may exclude relevant studies indexed in other databases, potentially limiting the comprehensiveness of the findings. Additionally, the study focuses on bibliometric analysis and does not provide in-depth qualitative insights from educators, policymakers, or local communities. Future research should expand to include a broader range of data sources, conduct longitudinal studies to evaluate the long-term impact of disaster literacy programs and explore successful case studies across various cultural and geographic contexts. Furthermore, fostering international and multidisciplinary collaborations is essential to developing holistic strategies for disaster literacy education that cater to both global challenges and local specificities.

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