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Research Article

Eco-literacy and Social Media: A Bibliometric Review

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ABSTRACT

The intersection of eco-literacy and social media is an intriguing subject of scholarly investigation, wherein acknowledging their mutual reliance is appropriately recognised. This study aimed to analyse the publication trends in Scopus and the Web of Science (WoS) concerning eco-literacy and social media research. The current study employed ScientoPy and VOSviewer software to analyse the evolution and publication trends, encompassing document types, source titles, highly cited papers, research themes, and institutions. This study utilises a combined dataset of 143 entries from the Scopus and WoS databases, with duplicate entries removed. The present study observed that the cumulative quantity of publications in both databases reached its highest point in 2021. The scholarly publication known as "Sustainability" is recognised for its extensive coverage of the topics of eco-literacy and social media. The term "environmental awareness" has the highest frequency, mentioned in 32 documents. In addition, the overlay visualisation demonstrates the prominence of keywords such as "sentiment analysis," "Twitter," "social networking sites," and "environment awareness" in the year 2020. This study provides a comprehensive global outlook on the current prominent topics within eco-literacy and social media, catering to the interests of potential readers and researchers. Furthermore, this bibliometric technique provides a variety of analyses that can assist in the organisation of data to develop theories and methodologies on eco-literacy and research on social media. Moreover, the present examination of datasets plays a pivotal role in elucidating concepts and facilitating the execution of rigorous research in eco-literacy and social media in future.

Keywords: Bibliometric, Eco-literacy, Scopus, Social media, Web of Science.

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INTRODUCTION

Social media platforms' proliferation and widespread adoption in contemporary digital landscapes have substantially transformed how individuals establish connections, communicate, and obtain information.[1] Concurrently, there has been a notable emphasis on global environmental consciousness and implementing sustainable policies.[2,3] The convergence of eco-literacy and social media gives rise to a compelling field of study wherein the significance of their connection is acknowledged. The enhancement of eco-literacy is essential and can be achieved by utilising innovative communication strategies that place audience engagement as a top priority. Examples of such systems include immersive journalism and the creation of promotional content within metaverse platforms.[4]

Eco-literacy entails acquiring knowledge about the interconnectedness between humans and the natural world, including floras, faunas, and geological formations. Eco-literacy, also known as ecological literacy, encompasses the comprehension of environmental concepts and principles and the capacity to utilise this knowledge to make well-informed decisions that promote environmental sustainability.[5] The idea involves understanding the interconnections within ecosystems, acknowledging the influence of human activities on the environment, and embracing sustainable behaviours.[6] Contrarywise, social media consists of several online platforms and tools that enable users to communicate, share information, and engage in other online activities.[7]

These days, well-known social media, such as Facebook, Twitter, and Instagram, are niche platforms and online communities that have become part of our daily lives. These social media have influenced us to obtain information not only for entertainment but also for educational determination. According to Kim and Cooke,[8] social media has the potential to effectively distribute information and opinions on both established and emerging environmental issues, thereby complementing traditional media platforms. This effectiveness is contingent upon thoroughly comprehending public awareness regarding these issues. Hence, this occurrence leads to heightened environmental consciousness and enhanced educational opportunities.[9-11] Furthermore, it is imperative to recognise that social media platforms provide

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disparate opportunities for disseminating ecological knowledge, facilitating dialogue, and promoting global action.[12]

The significance of investigating eco-literacy and social media resides in the capacity to leverage digital platforms to advance environmental consciousness, instruction, and involvement on a worldwide level.[13] The reason for examining the relationship between eco-literacy and social media lies in the potential to gain valuable knowledge regarding the effective utilisation of these platforms in tackling urgent environmental issues and promoting a sustainable future. Zuhriyah[14] highlights social media's significance in enhancing student achievement and fostering comprehension of diverse environmental issues. This approach should be approached with a dynamic and innovative perspective to yield positive outcomes. Furthermore, researchers can evaluate the extent, involvement, and efficacy of social media campaigns, online communities, and educational initiatives in augmenting eco-literacy levels among various demographic groups.[15-18] These insights play a critical role in developing evidence-based strategies to effectively utilise social media platforms for environmental communication and education.

The correlation between eco-literacy and social media holds substantial implications for environmental communication, sustainability education, and digital media studies.[4,11,19] Hence, it depicted that the nexus of eco-literacy and social media makes a valuable contribution to the academic discourse. This can be attained by investigating the intersections when traditional approaches to environmental education are integrated with emerging digital communication technologies. Research on the interaction between users and environmental content on social media, and its impact on real-world environmentally conscious behaviours, is lacking or under-researched. Factors impacting users' desire to participate in eco-friendly actions triggered by social media exposure must be investigated.[20] The effectiveness of social media eco-literacy efforts may vary depending on cultural and sociological contexts. As a result, it is critical to explore how cultural norms, values, and socio-economic characteristics influence people's reactions to and perceptions of environmental messages on social media platforms.[21] In response to the exciting opportunities for exploration in the existing literature, this paper takes a fresh and innovative approach by conducting a bibliometric analysis that offers a unique perspective on the intricate interplay between eco-literacy and social media interaction.

Consequently, the current study aims to conduct a bibliometric analysis to examine the publication patterns and the progression of research on eco-literacy and social media. The need to perform a bibliometric analysis on eco-literacy and social media arises from the imperative to comprehensively understand the research domain. In addition, this analysis allows us to identify influential works, expand our understanding, promote collaboration, and offer guidance for future research efforts in advancing eco-literacy and using social media to cultivate environmental awareness.

The research questions presented below are considered crucial for enhancing the current study's understanding of previous research on eco-literacy and social media interaction:

1. What trends and patterns have been observed regarding the number of publications and types of publications related to eco-literacy and social media research?
2. What are the most prolific source titles where research on eco-literacy and social media has been published?
3. What are the current research themes or topics emerging in eco-literacy and social media research?
4. Who are the most influential academic works in eco-literacy and social media?
5. Which research institutions have significantly contributed to eco-literacy and social media research?

METHODOLOGY

This study employs bibliometric analysis to assess scholarly publications on eco-literacy and social media. Bibliometrics evaluates information using quantitative analyses of bibliographic mechanisms in scientific publications.[22] Bibliometrics plays a significant role in assessing the temporal evolution of a subject and identifying areas of research that require further investigation.[23,24] Bibliometric mechanisms provide researchers with the means to analyse the dynamics of a particular field by considering a wide range of information and sources. This procedure enhances existing knowledge and practises.[25,26] The present investigation prioritised using bibliometrics due to its capacity to provide a comprehensive viewpoint on the subject matter. By incorporating historical and contemporary works, bibliometrics acknowledges emerging research directions and their practical value.

Database and Software

An academic database is a carefully curated and efficiently organised collection of scholarly data stored electronically in a computer system. It is a valuable resource for researchers, providing them with a reliable and comprehensive documentation source. In this study, the Scopus and Web of Science (WoS) databases were suitable academic databases for analysing eco-literacy and social media publications. According to Abdullah,[27] Scopus and WoS have been widely utilised by scholars as the primary databases for finding relevant scholarly publications for their research. Similarly, both databases can be considered multidisciplinary, containing documents, offering a broad scope and coverage.[28] Additionally, they provide search analysis tools that can be utilised to generate representative statistics in bibliometrics analysis.[29]

A comprehensive search for publications was executed using specific search queries in Scopus and WoS by scrutiny of the title, abstract, and keyword searching. The following search

queries are; ("Ecoliteracy" OR "Eco literacy" OR "Eco-literacy" OR "Ecological literacy" OR "Environmental literacy" OR "Sustainability literacy" OR "Green literacy" OR "Climate literacy" OR "Nature literacy" OR "Conservation literacy" OR "Ecological intelligence" OR "Environmental awareness" OR "Eco-education" OR "Ecoeducation" OR "Eco education") AND ("Social media" OR "Online platforms" OR "Internet-based communication" OR "Digital media" OR "Online communities" OR "Social networking" OR "Digital engagement"). The search strategy is completed without filters such as languages, article types, and subject areas, but it covers scholarly works published until December 31, 2022.

ScientoPy and VOSviewer were two software used in this study to generate science mapping and visualisation networks. ScientoPy is a software tool implemented in Python, specifically designed to analyse publication data obtained from the Scopus and WoS databases. Currently, the system programming language is exclusively compatible with the mentioned databases. ScientoPy is of utmost importance in evaluating various publication parameters, including subject matter, authorship, country of origin, document type, and keywords.[30,31] VOSviewer is a free Java-based application created principally by Nees Jan van Eck and Ludo Waltman at Leiden University's Centre for Science and Technology Studies.[32] It is a tool for constructing and displaying bibliometric networks such as co-citations, bibliographic pairings, or co-authorship associations.

Pre-processing of Retrieved Datasets

The dataset that was obtained undertook an initial pre-processing stage, which involved the removal of duplicate entries and the merging of relevant data. The ScientoPy software was utilised for the processing of these tasks. Table 1 presents the initial findings of the collected data, revealing a cumulative count of 221 raw data entries sourced from Scopus and WoS publications. The findings indicate that 23 publications, accounting for 10.40% of the datasets, were excluded due to the automated document-type filtering procedure.

A total of 198 publications were identified during the initial stage prior to commencing the identical datasets removal process. The study identified 55 duplicates, accounting for 48.70% of the dataset. These duplicates were identified within the Scopus database. In the present study, 143 publications have been deemed suitable for inclusion. Among these, 85 publications (59.40%) are sourced from the Web of Science (WoS), while the remaining 58 publications (40.60%) are derived from Scopus. Enough datasets containing over 100 entries existed, enabling the execution of bibliometric analysis.

RESULTS

The results of the present study are obtainable to answer each research question outlined in the methodology section. The graphical visualisations of ScientoPy and VOSviewer are deployed to depict the findings.

Publication Patterns and Trends

This study examines the publication trends and patterns of the research on the intersection of eco-literacy and social media. Specifically, this section analyses the number of publications and the types of documents published in this field. The data presented in Figure 1 depicts the patterns of growth observed in eco-literacy and social media publications throughout recent years. The field

Table 1: Data Combination and Duplicates Exclusion.

Data Pre-processing Output	Information	Number	Percentage (%)
Initial datasets processing	Raw datasets from WoS	132	-
	Raw datasets from Scopus	89	-
	Documents omitted by type	23	10.40
	Total publications after selecting document types (Research articles, conference papers, book chapters, review papers, and proceedings)	198	89.59
	WoS datasets	85	42.90
	Scopus datasets	113	57.10
Duplicates removing	Duplicated publications from WoS	0	0.00
	Duplicated papers from Scopus	55	48.70
Reliable and valid datasets	Publications in WoS	85	59.40
	Publications in Scopus	58	40.60
	Total of valid datasets	143	64.70

of study under consideration is relatively nascent, as evidenced by the earliest publication found in the Scopus database dating back to 2010. The WoS database recorded no publications in the year 2010. However, this figure experienced a notable increase to 25 publications by 2022. According to the Scopus database, the number of publications in 2010 amounted to 2, whereas this figure experienced a notable increase to 11 by 2022.

The timeline graph, as illustrated in Figure 1, indicates that the number of publications between 2010 and 2018 in both databases was observed to be fewer than five. Howbeit, there has been an increase in publications since 2020, with the Web of Science (WoS) databases surpassing Scopus. The total number of publications in both databases peaked in the year 2021. The observed phenomenon may be ascribed to the increased attention given to environmental issues during the COVID-19 pandemic. Furthermore, there has been a notable rise in the utilisation of social media platforms to enhance public consciousness regarding environmental concerns and facilitate connections among individuals who share an interest in sustainability.

Figure 2 provides an overview of the carefully reviewed document categories to identify the most relevant publications on eco-literacy and social media research from Scopus and WoS. Based on the data presented in Figure 2, the article category had a relatively higher number of documents, totalling 79, while conference papers had a count of 33. These two document types have more than 30 compared to another three sources, proceeding papers, reviews, and book chapters. It is indicated that there was a substantial amount of primary research conducted in this field, as demonstrated by the increasing number of articles. Furthermore, it is essential to acknowledge that conference papers often serve as concise versions of extensive research articles presented at conferences or academic events. It is indirectly expounded that

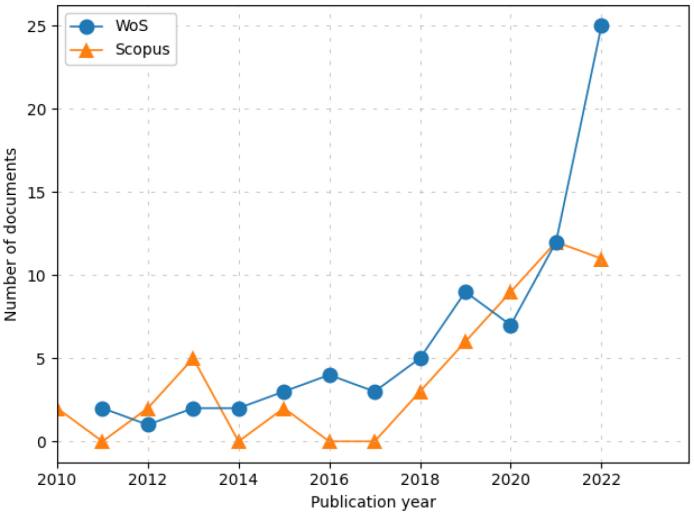

Figure 1: The evolution of publication growth (Source: Author, using ScientoPy 2.1.3).

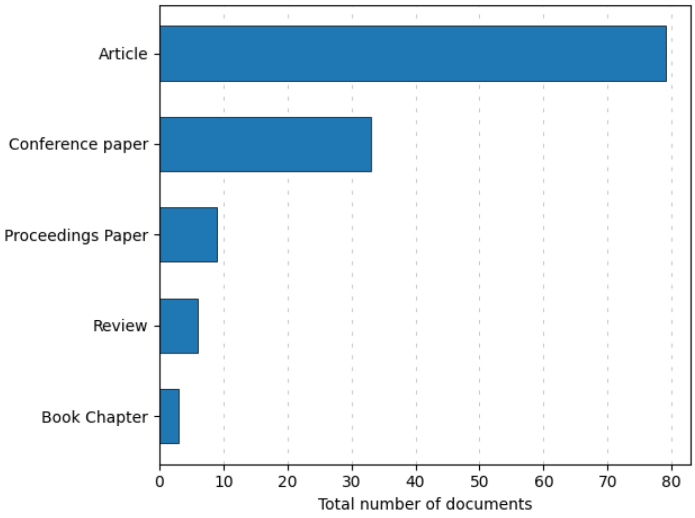

Figure 2: Bar-trend graph of document types (Source: Author, using ScientoPy 2.1.3).

significant attention and discussion surround eco-literacy and social media research within the literary conference circuit.

Prolific Source Titles

The study included a selection of source titles that were identified as being highly productive in terms of publishing research on the topics of eco-literacy and social media. These titles were found to be the most prolific among other sources of publication in this field. This study has identified the top ten source titles, as depicted in Figure 3. According to the data presented in Figure 3, a significant proportion of scholarly works on the intersection of eco-literacy and social media are disseminated through esteemed academic journals and conference proceedings. The source titles that have more than three documents include "Sustainability", "IOP Conference Series: Earth and Environmental Science", "ACM International Conference Proceeding Series", and "Environmental Awareness and the Role of Social Media". The journal "Sustainability" publishes the most on eco-literacy and social media. The IOP Conference Series: Earth and Environmental Science publishes the second most eco-literacy and social media research. These two journals and conference proceedings are well-respected and have high impact factors, indicating high-quality research. These journals and conference proceedings publish the most eco-literacy and social media research, indicating increasing interest among scholars and practitioners.

Research Themes or Topics Emerging

This study employs ScientoPy and VOSviewer to analyse the authors' keywords and examine the prevailing research trends and intriguing topics in eco-literacy and social media. Figure 4 illustrates the ten most prominent research keywords on eco-literacy and social media. The selection of keywords in the list

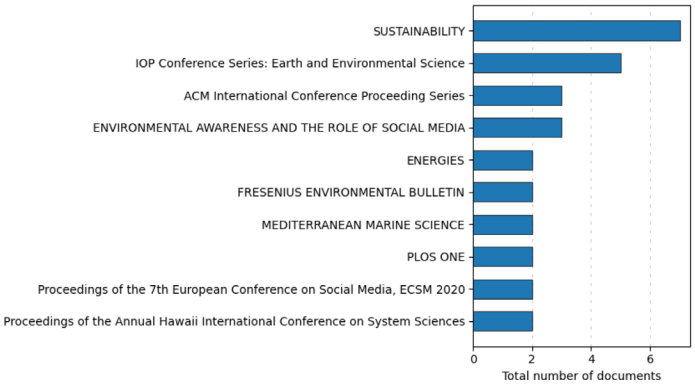

Figure 3: The prolific source titles (Source: Author, using ScientoPy 2.1.3).

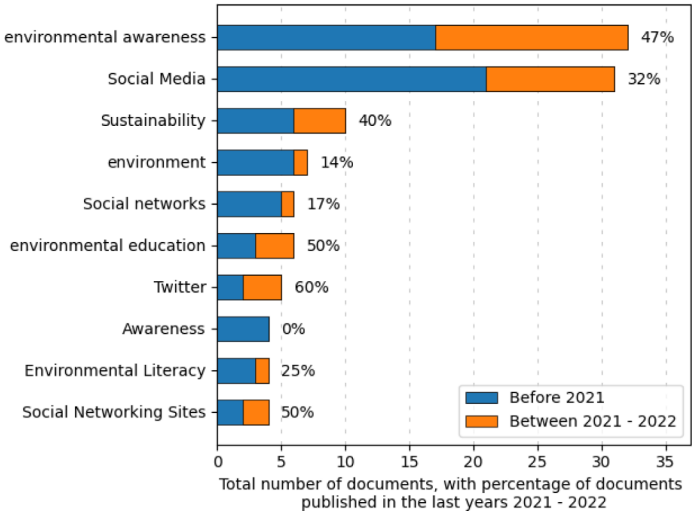

Figure 4: The bar-trend graph of research themes and topics emerging (Source: Author, using ScientoPy 2.1.3).

was determined by considering the frequency of their occurrence in the documents, as indicated by the blue bars. Additionally, orange represented the percentage of documents published within the past two years (PDLY), specifically in 2021 and 2022.

According to the data presented in Figure 4, the term "environmental awareness" exhibits the highest frequency, appearing in 32 documents. This statement emphasises comprehending and advocating for increased consciousness regarding environmental concerns and obstacles. The PDLY is notably high at 47%. This finding indicates that recent studies have emphasised the significance of promoting environmental consciousness through diverse platforms, such as social media, between 2021 and 2022.

The term "Social media" ranks second in frequency of usage, appearing in 31 documents. This observation signifies the acknowledgement of social media platforms as influential instruments for communication, involvement, and dissemination of information within eco-literacy. The prevalence of research conducted in the past two years, as indicated by a PDLY of 32%, highlights the ongoing investigation into the changing

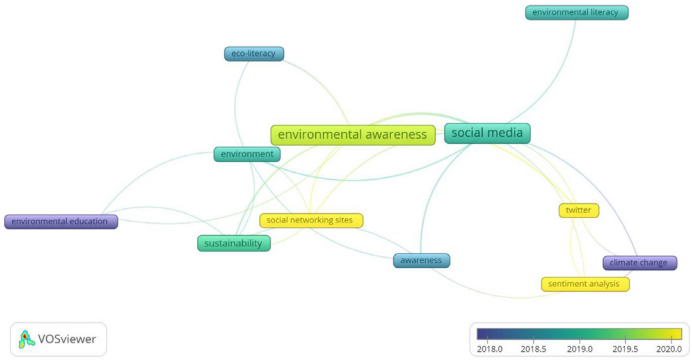

Figure 5: The overlay visualisation of the co-occurrence of authors' keywords (Source: Author, using VOSviewer 1.6.19).

role of social media in advancing environmental awareness and education.

The term "sustainability" is present in 10 documents, suggesting the importance of incorporating sustainable practises and principles into initiatives to promote ecological literacy. The PDLY of 40% demonstrates the growing importance placed on integrating sustainability principles into social media campaigns and educational initiatives.

Additional terms such as "environment," "social networks," "environmental education," "Twitter," and "environmental literacy" further enhance the comprehensive comprehension of the research domain. The diverse quantities of documents and PDLY observed in this study indicate distinct research emphases and the dynamic nature of eco-literacy and social media studies.

The present analysis utilises the VOSviewer software to gain an understanding of the interrelationships among the keywords that have been employed in prior studies. Examining the various types of relationships among the main keywords studied since 2010 is of utmost importance. The co-occurrence of authors' keywords, as illustrated in Figure 5, was analysed with a minimum keyword occurrence threshold of 4. Therefore, out of a total of 495 keywords, only 13 keywords satisfied the predetermined threshold.

Author keywords are crucial for scholars seeking to identify research trends. In addition, it is imperative to recognise the significance of author keyword analysis in evaluating the progression of research subjects. In this study, VOSviewer was employed for conducting mapping analysis in the context of keyword analysis. The VOSviewer software visually represents the co-occurrence of these words, as depicted in Figure 5. The spatial separation of nodes within this visual representation of a network signifies the degree of association between phrases or concepts. Each node symbolises a specific term or concept. The overlay visualisation, as depicted in Figure 5, illustrates that the keywords "sentiment analysis", "Twitter", "social networking sites", and "environment awareness" were prominent in 2020. These keywords represent the current research emphasis on eco-literacy and social media.

The Most Influential Academic Works

Typically, citations per publication were used to evaluate a publication's relative impact on the discipline. A citation indicates the number of times all database documents cite an article. Using ScientoPy, the number of citations was obtained from the Scopus and WoS databases during the preprocessing phase. The top ten most-cited papers on eco-literacy and social media with at least 13 citations are displayed in Table 2. "Social media for environmental sustainability awareness in higher education" (Hamid *et al.*)[9] received the most citations, with 69.

Finch *et al.*[33] authored the paper that garnered the second-highest number of citations. The article "The public health implications of social media usage in the context of natural disasters, environmental disasters, and other environmental concerns" has garnered 56 citations. The paper titled "An integrated WebGIS framework for volunteered geographic information and social media in soil and water conservation" by Werts *et al.*[34] garnered 37 citations, making it the third most frequently referenced publication. This article has garnered similar citations to the paper by Simeone and Scarpato[35] and aligns with their stance.

Productive Institutions

The examination of the data presented in Table 2 indicates that a substantial proportion of the top ten institutions featured in the compilation. However, eight institutions have collectively published a meagre total of two scholarly papers. The notable achievement of various institutions from different countries is exemplified by Amity University Gwalior from India, China University of Mining and Technology from China, Clemson University from the United States, Jiangnan University from China, Nelson Mandela Metropolitan University from South Africa, Rey Juan Carlos University from Spain, University Complutense Madrid from Spain, and the University of KwaZulu Natal from South Africa. These institutions have exhibited their dedication to academic research and scholarly contributions by consistently producing two published papers. This accomplishment shows these establishments' exceptional calibre and efficiency within their respective areas of academic pursuit. Furthermore, this phenomenon highlights the international scope of academic cooperation, as educational establishments from various nations have equally contributed to the advancement of research and the dissemination of knowledge.

DISCUSSION

Considering the absence of any previous study that has examined the articles on eco-literacy and social media from a bibliometric perspective, conducting a thorough analysis of the existing research using analytical tools would make a valuable contribution to the literature. This study examines the current state of research on eco-literacy and social media on a global scale. Simultaneously, it offers valuable insights into scholarly collaboration by employing a visualisation technique to depict the interconnections among prominent studies and researchers within the discipline. This is achieved through an analysis of the most frequently referenced papers.

Bibliometric studies employing analytical tools are essential for comprehensively understanding subject areas. Researchers can examine patterns in scientific research on a specific topic or field. This includes analysing the increase in published works, identifying popular subjects, examining the sources from which these works originate, and categorising the types of documents produced. Additionally, they can guide fellow researchers within the same field by identifying research institutions and individuals who have demonstrated effectiveness in their research endeavours. The utilisation of social media platforms plays a significant role in enhancing eco-literacy and promoting the dissemination of relevant information on environmental awareness and related concerns that are prevalent today. This phenomenon can be discerned by examining this study's prevailing research topics and themes. Therefore, researchers assessing the present state of affairs in the field can explore novel and innovative avenues for further research.

The findings of this research on the convergence of eco-literacy and social media provide substantial insights into the publication patterns and trends observed in this particular domain. As illustrated in Figure 1, the analysis of publication growth indicates a steady increase in research activity in this field since 2010. Notably, there has been a significant rise in publications since 2018. The observed expansion can be ascribed to the rising emphasis placed on environmental concerns, specifically in the COVID-19 pandemic, and the escalating utilisation of social media platforms to promote environmental consciousness and sustainability endeavours. According to Trawnih *et al.*,[42] the environmental context was the primary determinant of social media adoption during the Covid-19 pandemic crisis. This discovery holds potential value for decision-makers and practitioners in their efforts to evaluate the factors that impact the implementation of social media. Al-Dmour *et al.*[43] emphasised that utilising social media platforms can effectively enhance public awareness regarding behavioural modifications related to public health and safeguarding individuals against COVID-19. Hence, the surge in publications during 2018 and beyond indicates a potential correlation between eco-literacy and social media, which the COVID-19 pandemic may have influenced. This phenomenon has also garnered significant attention in social media over the past two years.

According to Figure 2, journal articles and conference papers are the predominant document types published in this field. This statement implies that the advancement of eco-literacy and social media research heavily relies on primary research and scholarly discussions. The prevalence of articles and conference papers

Table 2: Top ten most cited sources.

Authors	Title	Citation	Document Type
Hamid *et al.* (2017)[9]	Social media for environmental sustainability awareness in higher education.	69	Review
Finch *et al.* (2016)[33]	Public health implications of social media use during natural disasters, environmental disasters, and other environmental concerns.	56	Review
Werts *et al.* (2012)[34]	An Integrated WebGIS Framework for Volunteered Geographic Information and Social Media in Soil and Water Conservation.	37	Article
Simeone and Scarpato[35] (2020)	Sustainable consumption: How does social media affect food choices?	37	Article
Karahan and Roehrig (2015)[36]	Constructing Media Artifacts in a Social Constructivist Environment to Enhance Students' Environmental Awareness and Activism.	35	Article
Cooper *et al.* (2019)[37]	Developing a global indicator for Aichi Target 1 by merging online data sources to measure biodiversity awareness and engagement.	31	Article
Flores and Kuhn (2018)[38]	Latino Outdoors: Using Storytelling and Social Media to Increase Diversity on Public Lands.	21	Article
Unterfrauner *et al.* (2019)[39]	The environmental value and impact of the Maker movement-Insights from a cross-case analysis of European maker initiatives.	20	Article
Loia and Adinolfi (2021)[40]	Teleworking as an Eco-Innovation for Sustainable Development: Assessing Collective Perceptions during COVID-19.	19	Article
Caldevilla-Dominguez *et al.* (2021)[41]	Twitter as a Tool for Citizen Education and Sustainable Cities after COVID-19.	16	Article

indicates the considerable focus and discourse surrounding this subject within educational and conference environments. According to the findings of Garousi and Fernandes,[44] it was observed that journal articles and conference papers receive an average of 12.6 and 3.6 citations, respectively. This outcome supports the prevailing notion that, in general, journal articles tend to have a more significant impact compared to conference papers. Journal articles are commonly regarded as sources of research findings that possess higher authority and comprehensiveness.[45] The research articles undergo thorough peer review procedures, guaranteeing the high quality and credibility of the presented research findings.

Examining the prominent source titles depicted in Figure 3 demonstrates that esteemed scholarly journals and conference proceedings are compelling platforms for disseminating eco-literacy and social media research. Principal sources include academic journals such as "Sustainability" and conference proceedings such as the "IOP Conference Series: Earth and Environmental Science". The growing interest and significance of eco-literacy and social media research among scholars and practitioners is evidenced by these sources' high impact factor and publication volume. One plausible explanation is that publications in high-impact and reputable journals tend to receive more citations. Consequently, researchers should submit their scientifically sound work to these journals to maximise the impact and visibility of their research and publication (Vaishya *et al*,)[46] Furthermore, Korytkowski and Kulczycki[47] have demonstrated that implementing policy instruments within the national research evaluation system, academic promotion procedures, and competitive grants has resulted in a notable rise in articles with an apparent impact factor. Significantly, this increase has not come at the expense of publication quality, as assessed by a bibliometric indicator.

Figure 4 illustrates the predominant research themes and emerging topics within eco-literacy and social media domains. The term "environmental awareness" emerges as the most commonly used keyword, highlighting the importance of promoting awareness regarding environmental issues and challenges. The prevalence of the term "environmental awareness" in the emerging research areas of eco-literacy and social media indicates that scholars and professionals acknowledge the significance of leveraging social media platforms to enhance public consciousness regarding

environmental issues. This is consistent with the research conducted by Torkar and Bogner,[48] which emphasises the importance of increasing awareness in influencing individuals' environmental values and attitudes. According to the research conducted by Torkar and Bogner,[48] it was determined that the recognition and promotion of environmental awareness play a significant role in comprehending an individual's environmental values and attitudes, alongside altruistic and biospheric concern. Hence, the rationale for establishing a connection between eco-literacy and social media resides in their mutual aim of utilising social media platforms to augment environmental consciousness, cultivate a sense of environmental accountability, and promote sustainable behaviours. This amalgamation facilitates the propagation of eco-literacy principles and knowledge via a medium that is easily accessible and captivating, thereby ultimately fostering the advancement of environmental awareness and proactive measures.

Furthermore, the analysis of keyword co-occurrence using VOSviewer in Figure 5 demonstrates the relationships between various research themes and concepts. Keywords such as "sentiment analysis," "Twitter," and "environmental awareness" have gained prominence in recent years, reflecting the evolving research focus and the role of social media in facilitating environmental awareness and education. The prevalence of the term "sentiment analysis" indicates a scholarly inclination towards investigating the sentiment or emotional aspects conveyed in social media content on environmental matters. Sentiment analysis uses computational techniques to examine and comprehend individuals' attitudes, opinions, and emotions through social media posts. Therefore, sentiment analysis plays a crucial role in social media-related research by aiming to identify individuals' opinions expressed in various texts and capturing their corresponding polarities, which can be either positive or negative.[49] This research topic demonstrates an increasing scholarly focus on comprehending public sentiment regarding environmental issues and employing sentiment analysis methodologies to acquire valuable insights into public attitudes and perceptions.

The prominence of the keyword "Twitter" in the keyword co-occurrence analysis indicates the acknowledgement of Twitter as a unique social media platform within the realm of environmental awareness and education. Twitter is widely recognised for its ability to facilitate real-time information sharing and extensive user base.[50] It is a highly influential platform for engaging in discussions and promoting activism on environmental matters.[51] It indicated that researchers are currently investigating the potential of Twitter in disseminating environmental messages and its ability to foster engagement and awareness.[8] Additionally, they are studying the impact of environmental campaigns and initiatives on this social media platform.[52] Twitter can be utilised as an effective educational tool by promoting the sharing of resources, fostering awareness of current events, and facilitating connections among students, professionals, and faculty members.[53] Therefore, by thoroughly comprehending the level of awareness regarding environmental matters among its target audience, social media can serve as an efficient platform for distributing information and viewpoints on established and emerging environmental issues.

The rationale behind the findings depicted in Figures 4 and 5 is based on the notable prevalence of keywords associated with sentiment analysis, Twitter, and environmental awareness. The findings demonstrate the shifting research emphasis and underscore the significance of social media in promoting environmental awareness and education. Examining keyword co-occurrence offers valuable insights into the interconnections among different research themes and concepts, ultimately enhancing our comprehension of the correlation between eco-literacy and social media within environmental issues.

Table 2 displays the compilation of the most impactful academic works, determined by the number of citations per publication. These extensively referenced papers offer valuable insights into the present state of eco-literacy and the discourse surrounding social media. The paper titled "Social media for environmental sustainability awareness in higher education" by Hamid *et al.*[9] has garnered the highest number of citations, signifying its notable influence within the field. Research papers that garner substantial citations indicate their extensive utilisation and acknowledgement within the scholarly community. Consequently, these influential papers serve as valuable resources for researchers who aim to comprehend the present status of eco-literacy and social media discourse. They aid in shaping their research directions and expanding upon the existing knowledge base. The examination of productive institutions depicted in Figure 6 underscores the contributions made by

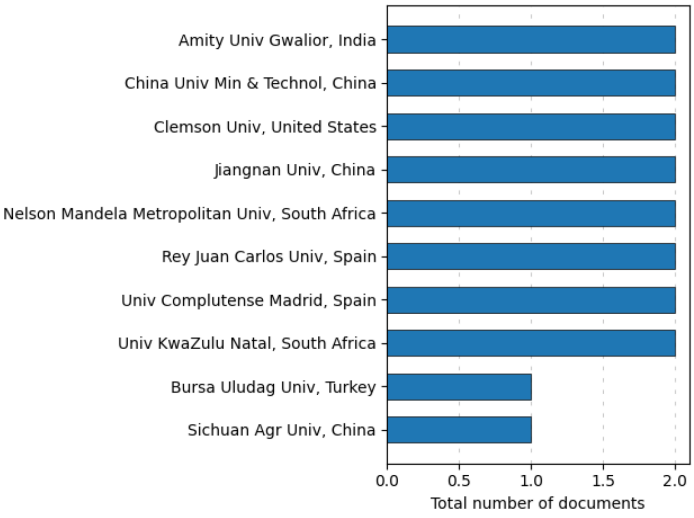

Figure 6: The top ten most productive institutions (Source: Authors, using ScientoPy 2.1.3)

diverse institutions across various countries. Amity University Gwalior, China University of Mining and Technology, Clemson University, Jiangnan University, Nelson Mandela Metropolitan University, Rey Juan Carlos University, University Complutense Madrid, and the University of KwaZulu Natal have consistently demonstrated their commitment to eco-literacy and social media research by producing two published papers. This consistent output highlights their dedication and excellence in these areas.

CONCLUSION

This study has substantially contributed to the knowledge and practises surrounding eco-literacy and social media through bibliometric analysis. This study has yielded valuable insights into the present state of research in this field by analysing publication patterns, research themes, influential works, and productive institutions. The results of this study emphasise the increasing attention given to eco-literacy and social media, as indicated by the consistent rise in research efforts over time. Recognising significant research themes, such as "environmental awareness," and acknowledging social media platforms like Twitter as practical tools for promoting environmental consciousness highlight social media's crucial role in enhancing awareness regarding environmental concerns. In addition, evaluating influential academic works by considering their citation count has revealed a selection of pivotal papers that have profoundly impacted the field. These works are crucial references for researchers and practitioners who aim to comprehend and contribute to eco-literacy and social media discourse.

Even though this study may contribute significantly to the body of knowledge and practices in eco-literacy and social media research, it is imperative to recognise the limitations of this study. The analysis was performed utilising the WoS and Scopus databases, which may not encompass all pertinent publications within the field. Moreover, the bibliometric analysis emphasises quantitative metrics, such as the number of publications and citations. On the other hand, it should be noted that the qualitative aspects of the publications, such as the calibre of the research or the significance of the findings, are not comprehensively reflected.

Future research endeavours may seek to overcome these limitations by incorporating a broader array of databases and implementing a more thorough assessment of the publications' quality and impact. Moreover, it is recommended that future research endeavours delve into distinct subcategories within eco-literacy and social media. For instance, investigations could focus on evaluating the efficacy of various social media tactics in fostering environmental consciousness or examining the influence of social media influencers on the development of eco-friendly behaviours. Using bibliometric analysis in the context of eco-literacy and social media offers a valuable means of comprehending publication patterns, research trends, and influential works within this field. This knowledge can inform future research endeavours, guide practitioners in implementing effective strategies, and contribute to improving eco-literacy and promoting environmental sustainability through social media platforms.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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