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A comprehensive bibliometric analysis of current trends in outdoor and informal learning for science education

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Abstract

This article presents a thorough analysis of outdoor and informal learning in science education by applying bibliometric methodologies. A comprehensive search was conducted across scholarly databases using specific keywords related to outdoor and informal learning in science education. The data collected underwent thorough analysis using a range of bibliometric indicators to assess trends in publication, citation patterns, and collaboration networks within the field. Key aspects such as yearly publication rates, primary sources, and the geographic distribution of authors were explored in this study. The objective was to understand the network of collaboration and research diversity across different regions in outdoor and informal learning within science education. The bibliometric analysis revealed a steady increase in the number of publications over time, reflecting the growing significance of this topic. Citation patterns and collaboration networks highlighted key works and influential researchers shaping the field. The study also found global participation, with contributions from authors across numerous regions worldwide, demonstrating extensive geographic distribution. These findings provide valuable insights into current trends and important areas for future research. Academics, researchers, and policymakers can leverage this information to guide their work and develop targeted strategies to enhance outdoor and informal learning in science education.

Keywords: informal learning, outdoor learning, science education, bibliometric analysis

INTRODUCTION

The teaching of science in formal ways covers activities done away from regular classrooms. This includes places like museums and centers for natural sciences, groups within communities, or online platforms that help share knowledge regarding how the world works without being inside a normal classroom type setting. It wants to involve students in science-related activities, but in a more easygoing and not strict place. It usually uses shows on how things work, displays that interacted with visitors act as shortcuts without having someone do them step by step manually at most times. Non-formal science teaching is about making people curious, getting them to use their minds and understand science by learning through experience (Bell et al., 2009). Science teaching outside of school covers more educational activities, which happen beyond the common area, where we learn. This not only includes informal science learning, but other things too. This can be clubs for science, activities after school time, summer camps and other things planned (Eshach, 2007). These give chances to learn more about science beyond the regular hours at schools. Teaching science outside of school often tries to add to what students learn in class by giving them more chances. This lets kids discover scientific ideas without rules and has fun exploring new things (Remmen & Iversen, 2023).

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Contribution to the literature

- This paper provides a thorough literature review which outlines the current trends in outdoor and informal learning in science education where experiential pedagogy is highlighted as having a significant influence.
- Using critical analysis tools, it traces the growing scholarly discussion on alternative learning centers, highlighting the fact that their importance is gradually being recognized in the promotion of hands-on science and citizenship.
- Through the combination of empirical data and textbooks discovering, the present study comes out in the full picture and provides practical directions for instructors, policymakers and researchers to make science education experiential and interventional.

The two methods have the same parts. Both want real-world learning to keep students interested in science discoveries and adventures, also they focus on making kids excited about science by putting fun into studying it. Informal teaching of science happens in places like museums and science centers, while out-of-school classes that teach about nature cover a broad range of activities both inside clubs and after class (Dierking et al., 2003)

Both methods can be used in different places. Commonly, informal science lessons are found in places like museums, centers for learning about nature and animals. Also at zoos, water animal shows or parks with plants. Festivals showing off the wonders of science can be seen too! You may learn more from media talking about it all as well on online help-I will say stuff using just 200 words most used English. Meanwhile, teaching science outside of school is used in after-school programs. This also includes groups like community organizations and summer camps (Bell et al., 2009; Dierking et al., 2003). Moreover, there are online learning platforms that help teach these subjects too. National Research Council, National Science Education Standards Committee as these sources give detailed understanding about topics like informal learning of science and teaching outside school. They talk about what they have in common with each other, how they are different from one another, as well as where these methods can be used to teach more science skills.

Informal and outdoor science education is receiving increased recognition as a means of providing children with meaningful learning experiences in science. Such experiences can transpire beyond the conventional classroom setting, and can comprise hands-on experiments, trips to science centers and museums, and exploration of the outdoors.

Students can engage in hands-on activities and explore science in practical settings through informal and outdoor science instruction. These educational opportunities take place outside of the conventional classroom and may entail visits to scientific museums, state parks, and other outdoor locations. The attitudes of pupils toward science education have been shown to be positively impacted by informal and outdoor teaching programs (Alexandre et al., 2022). These programs also help students identify themselves as learners, develop conceptual understanding, and acquire the abilities needed to participate in scientific activities (Schilhab, 2021). Recently, innovative teaching methods have gained importance beyond the traditional classroom. A powerful method for engaging students in science has emerged that includes outdoor and informal learning experiences. In traditional science education, textbooks and lectures have been the primary teaching method (Gresnigt et al., 2014). In research, however, this traditional method may not fully engage students or develop scientific literacy (Fan & Geelan, 2013).

Educators and researchers have increasingly turned to outdoor and informal learning experiences to enhance science education. There are many benefits to be gained from engaging students through multifaceted learning experiences in nature beyond the four walls of a classroom, where they can actively explore and conduct experiments within natural environments (Turkmen, 2022). On the contrary, informal education, unfolding beyond the bounds of an official curriculum, in venues ranging from museums and science centers to citizen science initiatives, furnishes learners with opportunities for acquiring knowledge experientially (Adams, 2007). The advantages of engaging in outdoor and informal learning within the realm of science education are numerous. Such pedagogical approaches furnish students with opportunities to directly witness and engage with natural phenomena, thereby prompting them to pose inquiries, make observations, and cultivate their critical thinking abilities (Kiraga, 2023). As a result, pupils attain a more profound comprehension of scientific concepts, acquire an appreciation for the scientific method, and foster a sense of environmental responsibility (Zidny et al., 2020).

LITERATURE REVIEW

Informal science education (ISE) as discussed by Dawson (2014) can be broadly defined as "science education that takes place in out-of-school settings" and is receiving increased attention from science education research. Informal and outdoor science education can improve student attention, content recall, and attitude

towards science, according to Moore et al. (2016). Studies have demonstrated that informal and outdoor education initiatives can enhance children's comprehension of scientific concepts and practices, as well as encourage physical activity and interaction with the natural world. (Soh & Meerah, 2013).

Science playgrounds have emerged as a popular approach to ISE, providing safe and challenging outdoor environments, where children can engage in play-based learning to explore scientific principles (Goldstein et al., 2019). Singh-Corresponding (2014). has revealed that outdoor learning experiences have a positive influence on students' attitudes towards science, as many students indicate that these experiences served as their initial introduction to specific science concepts.

Overall, informal, and outdoor education in science offers a valuable complement to formal classroom instruction, providing children with diverse and engaging opportunities to learn about the world around them (Chermayeff et al., 2001). The presence of informal and outdoor settings is crucial in science education, as they offer unparalleled chances for interactive and practical learning experiences. Bozdogan (2012) conducted a study to explore how educational visits outside the classroom should be organized for training purposes and to gain insight into the attitudes and practices of prospective science teachers. In addition, Goldstein et al. (2019) stated that informal and outdoor learning environments enhance health by promoting exercise and outside exploration. These chances can add to formal science instruction and give students unique and interesting ways to learn science.

Informal science learning environments, such as science centers and museums, provide students with engaging science experiences that can be related to curricular objectives (Ramey-Gassert, 1997). Ucko (2010) examined a cross-section of craft knowledge and research-based literature on science learning beyond the classroom, describe ISE programs, and discuss implications for enhanced science teaching. Jarman (2005) explored the use of ISE in the context of cub scouts, which involves active participation, creates excitement, and is different from school science. Informal and outdoor learning in science education can take place in places such as science museums, science centers, botanic gardens, zoos, and aquariums (Kim & Dopico, 2016).

ISE are emerging trends that aim to provide meaningful science learning experiences for children (Yunker et al., 2023). These approaches recognize the importance of engaging children in science learning across various contexts, such as nature centers, parks, and school-based programs with open green space (Avraamidou, 2015). Scientists and informal science learning organizations, such as museums and botanical gardens, working together can actively improve science literacy and promote increased involvement in the field of natural sciences (Alpert, 2018). However, it is important to enhance science teaching methods in early education and examine how teachers can effectively teach science concepts in an environment that encourages play (Gomes & Fleer, 2020).

Numerous studies (Cotic et al., 2020; Jose et al., 2017; Lu et al., 2020; Suryawati & Osman, 2017) have provided evidence that practical learning experiences in natural surroundings effectively enhance students' understanding of natural sciences and ignite their motivation levels. Contextual-based outdoor learning can also enhance students' curiosity and engagement in science by connecting scientific concepts to their everyday context according to Sekarini and Arty (2019).

Tisza et al. (2020) investigated the relation between the place of the activity and the gender and age of participants and activity leaders in informal and non-formal science learning activities.

Out-of-school learning environments in science education include exhibitions, science camps, Olympiads, photography galleries, and outdoor activities (Cabello & Savec, 2018). Dunlop et al. (2019) discussed the need for collaboration between formal and informal science educators to take advantage of increased choice in the informal sector and address criticisms of formal education.

The objective of this article is to provide a detailed bibliometric analysis. This analysis aims to offer insights into the research landscape surrounding outdoor and informal learning in science education by exploring the scholarly contributions, key concepts, influential authors, and publication trends. By acknowledging the current state of research and practice, we can promote and advance the amalgamation of outdoor and informal learning encounters in science education, thereby yielding advantages for both learners and the wider society.

Research Problem

What are the main trends revealed via a bibliometric study of the available literature, and to what degree has informal and outdoor learning been researched and incorporated into the area of science education?

Research Focus

The research focus of the study is to comprehensively review the corpus of literature on informal and outdoor learning in relation to science education. In addition to highlighting possible topics for additional study and development in science education, this analysis intends to discover patterns, trends, and critical insights relating to the use and efficacy of informal and outdoor learning modalities.

Research Aim and Research Questions

The main purpose of this bibliometric analysis is to present a comprehensive summary of the present state of inquiry in this domain, highlighting the leading tendencies, noteworthy works, and evolving study areas. The research questions are, as follows:

1. How has the number of publications on informal and outdoor learning in science education changed over time?
2. What are the most common keywords used in papers about informal and outdoor learning in science education?
3. What are the contributions of the most prolific authors in the subject of informal and outdoor learning in science education?
4. Which organizations are the most active in producing publications about informal and outdoor learning in science education?
5. What nations are at the forefront of research in the field of informal and outdoor learning in science education?
6. What subject areas of science education have received the greatest attention in terms of informal and outdoor learning?
7. What funding sources are actively supporting informal and outdoor learning in science education research?
8. How has the distribution of publications each year changed across different field sources?

METHODOLOGY

Document Analysis

Data collected from Scopus academic databases using relevant search phrases linked to informal and outdoor learning in science education to conduct this bibliometric study. To track the growth of research output over time, the publication date of each article and categorize it into yearly bins. In addition, noteworthy authors publishing the most articles were determined. It was classified articles based on the authors' affiliations and identify the most active institutions and organizations in publishing research on informal and outdoor learning in science education. To determine which topics are most investigated in connection to informal and outdoor learning, it was categorized articles depending on their subject areas within science education (e.g., social sciences, computer sciences, etc.). To gain a deeper understanding of the funding behind research in this field, it was analyzed the articles and categorized the funding sources based on their sponsors. These sponsors included government agencies, foundations, and educational institutions, among others. In its capacity to cover the expenses of fields might not otherwise arise funded research, supported and created a broad expanse newer literature. Funding from such sources often reinforces the entire process of knowing by influencing new lines of inquiry and validating already accepted conclusions, whether they reappear in the same form or only slightly altered. Therefore, money from research sponsors must be looked upon with a critical eye to keep literature both honest and unbiased. Before analyzing the data, it was cleaned by eliminating duplicates, fixing inconsistencies, and dealing with missing information. To ensure the accuracy and relevance of our study, it was also eliminated papers that are not directly relevant to the theme of informal and outdoor learning in science education.

Sample of Bibliometric Analysis

Samples of bibliometric study of informal and outdoor learning in science education include a wide range of research publications, including scholarly articles in prestigious education journals. A total of 145 studies scanned in the Scopus database between 1990 and 2023 were identified and a total of 88 articles were analyzed by excluding conference proceedings, book or book chapters and review studies. Researchers may map out the growth of this multidisciplinary domain, identify significant authors, institutions, and journals, find new research themes, and analyze the influence of informal and outdoor learning on science education through time by methodically studying these materials. Such bibliometric evaluations give vital insights into the evolution and expansion of this educational technique, giving evidence on its efficacy and prospects.

Instrument & Procedures

Several critical phases are often included in the instrument and processes for performing a bibliometric examination of informal and outdoor learning in science education. To choose relevant materials from diverse academic databases such as ERIC, Google Scholar, Scopus, or Web of Science researchers must define inclusion and exclusion criteria. To extract data like publishing patterns, citation networks, author affiliations, and keywords, it was used VOSviewer as bibliometric software and Scopus analyzer and Excel tools. In the domain of research, citation analysis, co-authorship analysis, and co-citation analysis are commonly employed to ascertain pertinent papers, authors, and research collectives. To illustrate the intellectual framework of the research landscape, bibliometric mapping methodologies like co-word analysis and co-citation clustering are utilized.

Data Analysis

The data analysis step of a bibliometric analysis of informal and outdoor learning in scientific education entails processing and analyzing the collected

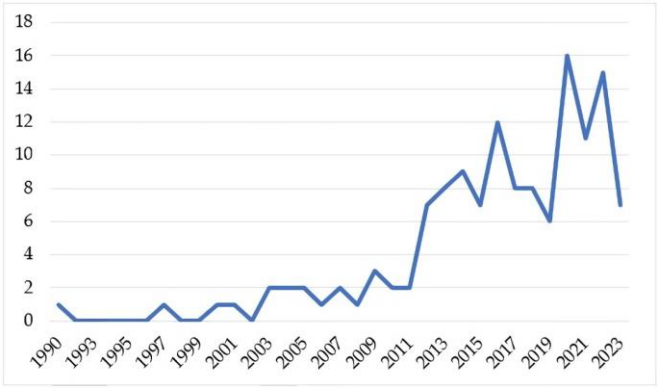

Figure 1. Number of articles per year (Source: Authors' own elaboration)

bibliographic data to make useful conclusions. To detect trends, patterns, and links in a dataset, researchers use statistical and visualization approaches. To depict the intellectual structure of the field, this may entail creating citation networks, co-authorship graphs, and keyword co-occurrence maps. To quantify the effect and influence of publications, authors, and institutions, quantitative metrics such as article counts, and author keywords are frequently utilized.

RESULTS

Number of Publications per Year

The research examines the number of articles published annually. The study uncovers fascinating trends in scholarly discussions. A slow but steady interest in the subject is also noticed. The initial years marked infrequent contributions. A noticeable increase was observed with the turn of the millennium. Over time there was a wavering movement in the number of articles. This reflects changing teaching paradigms as well as shifts in educational priorities. The data shows peaks of research productivity specifically in the years 2012, 2016, and 2020. These peaks symbolize enhanced academic focus. The number of publications from 1990 to 2023 is shown in **Figure 1**, and this data was used to show how outdoor and informal learning research in science education has changed over time. It stretches from 1990 to 2023. The outcomes of the study shine light on evolution of outdoor learning in science education. Alongside it highlights informal learning too. This underscores the vibrant nature of educational research. It also demonstrates its responsiveness to evolving instructional methodologies.

Most Frequently Used Keywords

Keywords play a role in highlighting the contents of a publication, and high frequency keywords provide insights into popular fields within science education. Investigating trending topics relies heavily on the use of keyword analysis. This study explores the most used terms that capture the core of the research via the lens of bibliometric analysis. The predominance of "informal learning" highlights the necessity for a holistic approach to learning and emphasizes the need of non-traditional educational environments and approaches for science education.

The key role of "science education" denotes the main issue, stressing the analysis of educational approaches and their consequences for the study of science. The nexus of "informal learning", astronomy education and "artificial intelligence" highlights the creative fusion of cutting-edge technological developments with fundamental scientific fields. The combination of these terms illustrates the multifaceted environment that underpins the investigation and opens the door to a thorough understanding of the complex interactions between informal learning, science education, technology-assisted learning, and artificial intelligence.

When it comes to papers, co-occurrence indicates how frequently keywords occur together. The co-occurrence map reflects the frequency and proximity of keywords, which gives insight into the field's knowledge structure (**Figure 2**).

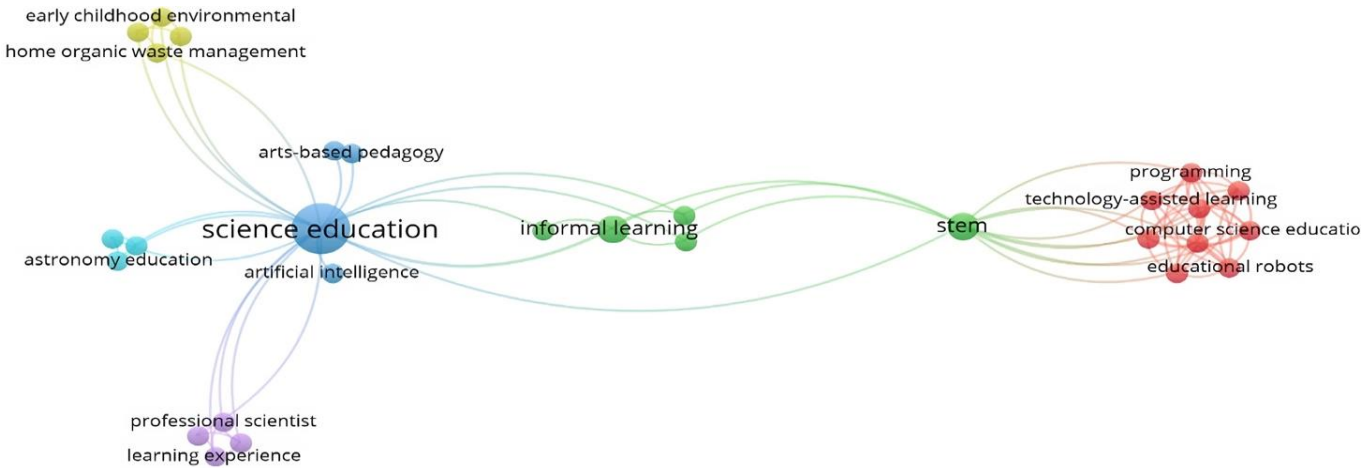

Figure 2. Keywords' networks (Source: Authors' own elaboration)

Number of Articles by Author

This analysis dives into the authors' prolificacy. Zimmerman, H. T. is a prime contributor with six articles. Each piece reveals his deep engagement with the subject. Bozdogan, A. E., Habig, B., and Salmi, H. have three articles each to their credit. They clearly mark significant inputs in this scholarly discourse. Authors such as Adams, J. D., Carrier, S. J., Gupta, P., Kersting, M., McClan, L. R., Price, C. A. have two articles each.

The relation between the productivity of the authors and either formal correspondences on informal learning or field letters the degree to which this is a scholarly topic that has found an audience. If more authors take part in its production, it suggests a growing trend for informal and outdoor studies. More money being poured into research; attention from policymakers or wider popular appeal to people who can make long-term development plans at school level and beyond a study like that tracks the trend over time as tracked via author productivity then authors have an indicator of the present situation in their field. They will know who is contributing to what and to what extent full scholarly exploration has been carried out (**Figure 3**).

This will help to set future directions for research on informal and outdoor learning, as well as educational practices in this area. These pieces bring a diverse range of scholarly input to the fore. Their efforts have shed light on outdoor learning's impact on science education. It clearly shows academic exploration's dynamic nature.

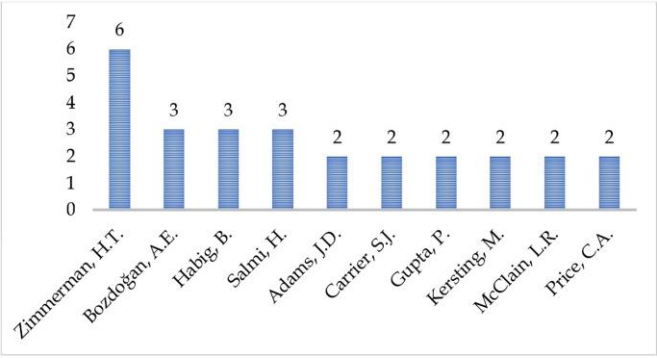

Figure 3. Number of articles by author (Source: Authors' own elaboration)

Figure 4 shows collaboration network between authors in research on informal and outdoor learning in science education.

Articles by Affiliation

This study uses a careful bibliometric methodology to identify the complex dynamics and trends behind this changing instructional field. The study is supported by a plethora of data derived from varied associations, each of which contributes unique viewpoints and insights. It draws on a sizable corpus of scholarly work. Pennsylvania State University stands out among them

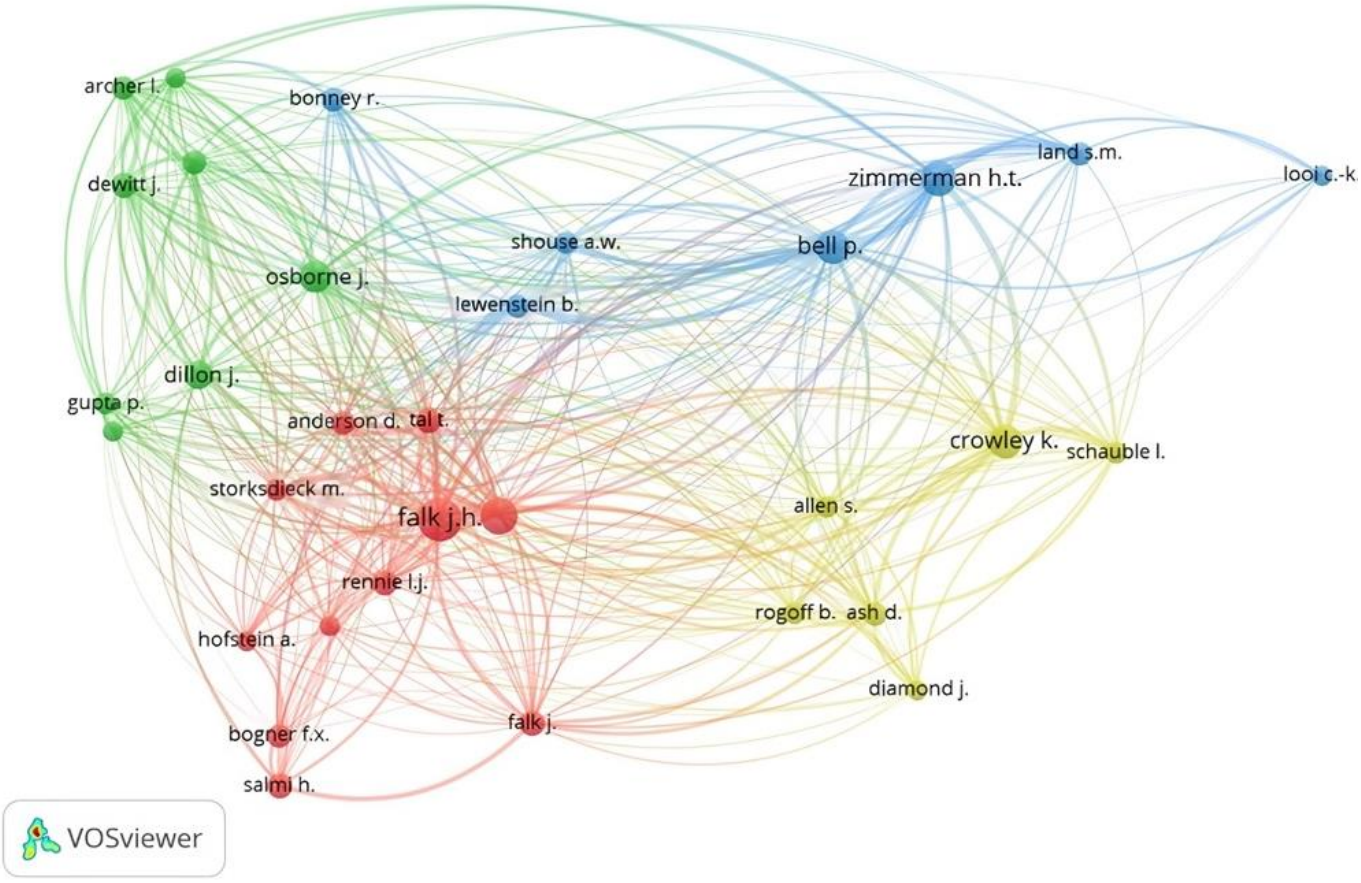

Figure 4. Collaboration network between authors (Source: Authors' own elaboration)

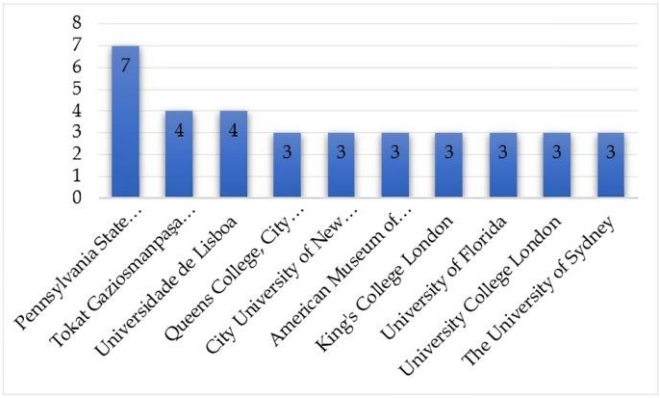

Figure 5. Number of articles by affiliation (Source: Authors' own elaboration)

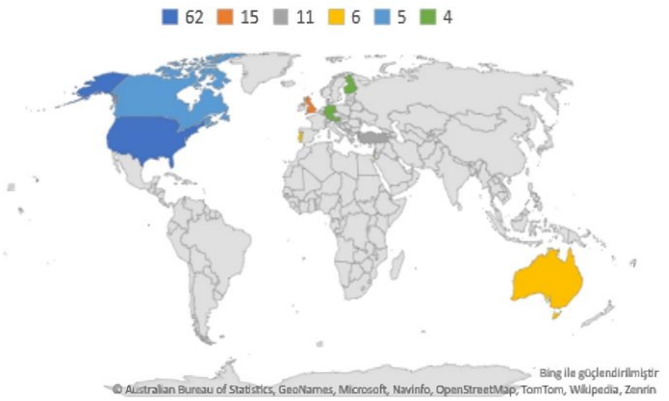

Figure 7. Number of articles by country (Source: Authors' own elaboration)

with a sizable corpus of seven papers, demonstrating the university's ongoing dedication to cutting-edge education. Affiliations like Gaziosmanpasa University and Universidade de Lisboa, who each contributed four papers outlining the cross-cultural attraction of outdoor and informal learning methodologies, demonstrate the worldwide spread of this phenomenon. Institutions such as Queens College contribute three articles to deepening debates.

City University of New York, American Museum of Natural History and King's College London contributes likewise. University of Florida, University College London and University of Sydney are the other contributors (**Figure 5**).

Together these efforts form a broad mosaic of varied perspectives. Outdoor learning in science education has many facets that these efforts help illuminate. They also help highlight evolving trends for teachers to consider. This adds subtlety to our understanding of its implications for teaching overall. These cumulative efforts shed light on the many characteristics of outdoor and unstructured science learning, encouraging a comprehensive awareness of its changing patterns and ramifications for the educational environment.

Figure 6 shows collaboration between affiliations regarding research about informal and outdoor learning in science education.

Articles by Country

This study project uses a clever bibliometric technique to sort through the complex webs of this developing pedagogical subject. A wide range of nations appear as significant contributors within the extensive tapestry of scholarly contributions, each providing unique perspectives and insights on the subject.

The United States presents a significant corpus of 62 papers that highlights its key role in influencing cutting-edge educational paradigms, positioning it as a crucial player in this debate.

Like the United States, the United Kingdom makes a major contribution with 15 publications, demonstrating its dedication to supporting innovative methods to scientific teaching. In addition to these, nations like Australia, Austria, Canada, Germany, Finland, Israel, Portugal, and Turkey each contribute to the story and, because of their many relationships, together account for a wealth of information (**Figure 7**).

A thorough knowledge of the dynamic trends and transformational potential of outdoor and informal

Figure 6. Affiliations' networks (Source: Authors' own elaboration)

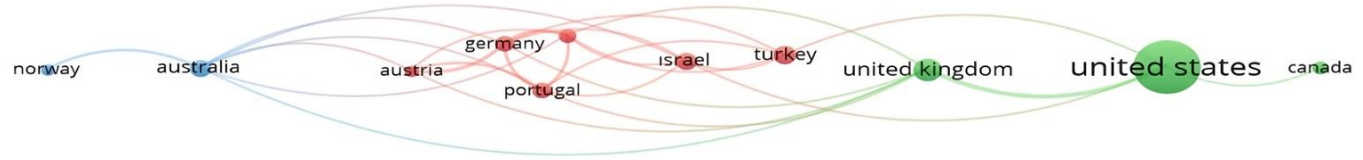

Figure 8. Network of international cooperation between countries (Source: Authors' own elaboration)

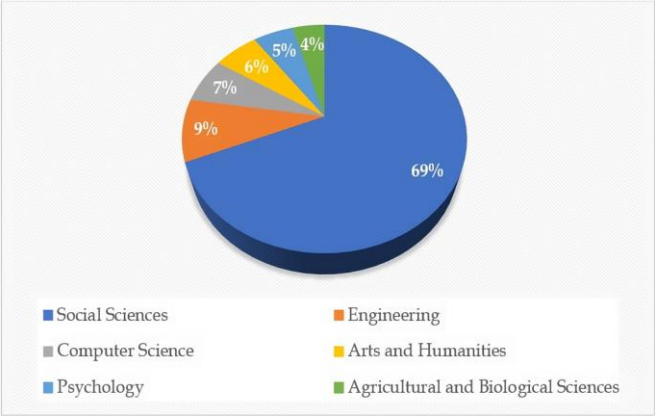

Figure 9. Number of articles by subject area (Source: Authors' own elaboration)

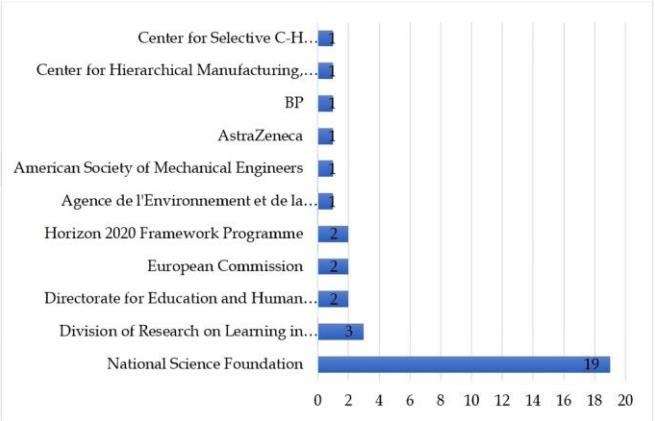

Figure 10. Number of articles by funding sponsor (Source: Authors' own elaboration)

learning in scientific education across varied cultural and educational contexts is fostered by these cumulative efforts, which weave together to depict a worldwide mosaic of ideas.

Figure 8 shows a network of international cooperation between countries in research on informal and outdoor learning in science education.

Articles by Subject Area

The research work employs a careful bibliometric approach. It unmasks the complex nuances of this evolving educational landscape. A focus on diverse subject areas brings multiple domains into view. Each holds distinct points of view that add to the conversation. Social sciences secure a key position. They build up a crucial body of 135 articles. This highlights the wide interest in merging outdoor with informal learning methods in education. Other disciplines like engineering inform this study. Computer science adds to the rich exploration as well. Arts also contribute valuable insights along with humanities. Psychology plays a part just like agricultural sciences do. Biological sciences are no different (**Figure 9**).

They all add depth to this multidisciplinary edifice. Their combined efforts make for a vivid tableau of ideas. They form an image rich in variety fostering broad understanding. This relates to how outdoor learning can be administered in science education across myriad academic disciplines.

Articles by Funding Sponsor

National Science Foundation (NSF) has demonstrated leadership by providing funding for an impressive total of 19 papers. This research has received significant support from the NSF's division of research on learning in formal, which has also provided funds for an additional three papers. The directorate for education has also mirrored this support by funding two more papers. The European Commission has demonstrated its commitment by funding two papers, and the Horizon 2020 Program has strengthened this commitment by funding two additional papers. Other sponsors, such as the Agence de l'Environnement and the American Society of Mechanical Engineers, have also played a role by funding one paper each. NSF-funded the Center for Hierarchical Manufacturing has also contributed, as has the Center for Selective C-H Functionalization, which has received NSF funding (**Figure 10**). Overall, these contributions have been instrumental in advancing research and promoting academic excellence. Articles supported by sponsors often come from the necessity in point of finance for conducting research. This is especially so in any areas that might call upon the use of expensive equipment, for example large-scale studies or tree multi discipline inquirists. Securing such sponsorship is crucial; it makes possible studies that could not otherwise have been undertaken, hereby contributing to both knowledge and the generation of practical answers for real problems.

Articles per Year by Journal

The conversation on outdoor and informal learning in science education has been greatly influenced by a variety of platforms. Reputable journals including "Journal of Research in Science Teaching," "Cultural Studies of Science Education," and "Journal of Science Education and Technology" have made significant contributions with six, five, and five papers, respectively, advancing the scientific debate. Furthermore, publications including "Science Education," "Journal of Baltic Science Education," and "Journal of Biological Education" each provided four, three, and three articles, respectively, further enhancing the intellectual engagement. In addition, platforms including "Asia Pacific Science Education," "EURASIA Journal of Mathematics Science and Technology Education," and "International Electronic Journal of Elementary Education" each provided two pieces, bringing complex viewpoints to the conversation (**Figure 11**).

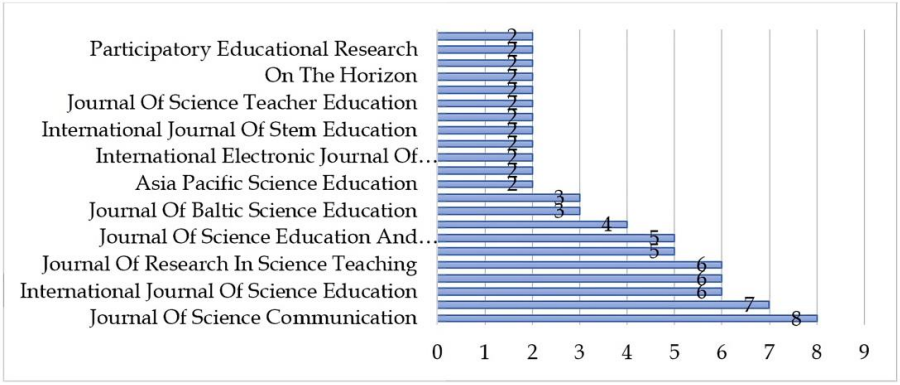

Figure 11. Number of articles per year by source (Source: Authors' own elaboration)

Figure 12. Journals' network (Source: Authors' own elaboration)

Figure 12 shows the journals and their networks on the research of informal and outdoor learning in science education. Journals about informal and outdoor learning can work together by making special issues, holding joint events or meetings. They can also team up to do their editing jobs better. Working together helps journals join forces, share knowledge, and reach more people. This makes their writing better known and gives them a greater choice of others. By looking at how much teamwork and connections there are between different study journals, researchers can see the linked nature of their field. This lets them understand many points from a lot of viewpoints or mixed ideas, which helps make informal education better outside school more advanced too.

DISCUSSION, CONCLUSIONS, & IMPLICATONS

The investigation into literature on outdoor and informal learning in science education yielded a variety of noteworthy results. In the first place, there is a mounting body of research in this realm, demonstrating the increasing appreciation for outdoor and informal learning experiences in science education.

An examination of the number of publications in the field of informal and outdoor learning in science education each year reveals some intriguing tendencies. This indicates that there is a rising interest in mixing informal and outdoor learning methodologies into science teaching. As technology progresses and the globe becomes more linked, educators are looking for new ways to engage children in scientific learning in non-traditional locations such as museums, nature reserves, and online platforms. This is reflected in the growing number of studies focusing on informal and outdoor learning, as indicated by this bibliometric study.

Researchers examined the literature on informal and outdoor learning in science education and came up with a few key findings. Numerous research has been done in this area, and they all support the idea that informal learning opportunities outdoors are beneficial for science education (Dyment, 2005; Hein, 2009; Katz et al., 2011; Sahrakhiz et al., 2018).

Keyword analysis gives useful insights into the core themes and subjects in the field of informal and outdoor learning in science education. Keywords like "outdoor learning," "informal learning" and "science education" are widely utilized in literature, demonstrating their importance (Eshach, 2007). This shows that educators and researchers are emphasizing non-formal and experiential learning techniques as viable instruments for teaching science. This finding is consistent with the results of our bibliometric analysis.

The arrangement of papers by affiliation and country emphasizes the worldwide aspect of informal and outdoor science education research. Several institutions and nations are actively participating in this field's advancement, encouraging a vibrant interchange of ideas and practices. This multidisciplinary approach allows for a thorough examination of the many facets of informal and outdoor science teaching (Wang et al., 2023). The organization of articles by affiliations, countries and the worldwide direction of informal and

outdoor science education research coincide with the results of our bibliometric study.

Analyzing articles per year by journal reveals the platforms and publications most utilized to distribute research findings in this subject. This data is useful for researchers, educators, and policymakers interested in learning about the most recent advancements and best practices in informal and outdoor science education (Macià & García, 2016). It's very helpful for researchers to know the titles of journals, where studies are shared. When you read the newest books in your area, it's like hearing all the latest talk. Also, when you know the journals that are important to you it's like having a personal guide. Then finding what you need will be easier among all those academic publications and peer reviewed articles.

A widespread collaboration has been observed among researchers who focus on outdoor and informal learning in science education. Co-authorship networks demonstrated strong connections between researchers from different institutions and countries, indicating the global nature of this research area (Pelacho et al., 2021; Riesch et al., 2013). The practice of collaborating has facilitated the sharing of expertise, resources, and best practices among individuals, making significant contributions towards the expansion of knowledge in this field.

Understanding the funding sources for research in this sector gives useful insights into the financial assistance available for studies connected to informal and outdoor science education. This funding assistance is critical for developing discipline and adopting novel teaching practices in science education (Braund & Reiss, 2006). Several sources were identified as funding providers for research in outdoor and informal learning in science education. This field has received investments from government agencies, educational institutions, and non-profit organizations (King et al., 2018). Being able to secure funding has assisted in conducting research and studies, developing educational programs, and disseminating research findings.

The field of outdoor and informal learning in science education has been advanced through the collaboration of researchers. Thanks to collaborative efforts in research, there has been an improvement in sharing knowledge, expertise, and resources. This has resulted in innovative practices adopted in education along with wider availability of research results. The involvement of different nations in research collaborations has fostered a broader range of perspectives and idea exchange, promoting diversity and inclusivity in this specific field.

Finally, the bibliometric analysis reported in this work gives a thorough review of current research on informal and outdoor learning in scientific education. The expanding number of publications, the popularity of certain keywords, and the worldwide reach of this research all point to the growing relevance of these pedagogical techniques in improving scientific education. The field's multidisciplinary character, as well as financing from a variety of sources, emphasizes its importance in tackling modern concerns and encouraging scientific literacy among students.

The discoveries made in this analysis of the literature have various ramifications for research, practice, and policy in outdoor and informal learning in science education. In this bibliometric research, we looked at the landscape of informal and outdoor learning in the context of science education. Our analysis uncovered many major trends such as number of articles by country, by journal, by author per year etc. and patterns that offer insight on the effect and relevance of these alternative learning methodologies.

The dramatic rise in research production in this area over the previous ten years demonstrates the expanding understanding of the significance of informal and outdoor learning in scientific education. To sum up, the literature review on science education's outdoor and informal learning highlights a growing amount of research that acknowledges the importance Collaboration among researchers and financial backing have helped progress the field and share research discoveries. This review underscores the significance of conducting more research, incorporating outdoor and informal learning into educational practice, and fostering supportive policies.

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