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Statistical literacy and social transformation : What the literature tells us and what it doesn't

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Statistical literacy is a key competency for informed citizenship and data driven decision making. This study presents a bibliometric analysis of statistical literacy literature, exploring its conceptual, theoretical and social dimensions. Using co-citation, bibliographic coupling, co-authorship and keyword co-occurrence analyses on a dataset of 361 publications, it maps disciplinary perspectives and research trends. Emphasizing the societal importance of statistical literacy the study offers policy relevant insights and practical recommendations. It highlights the need for interdisciplinary collaboration to foster statistical literacy across sectors. By synthesizing theoretical frameworks and identifying research gaps the findings contribute to advancing both academic understanding and strategic implementation in education, information science and public policy.

Keywords: *Statistical literacy, Bibliometric analysis, Social transformation, Statistics, Bibliometrics.*

1. Introduction

The integration of societal concepts into academic literature is essential for enabling societies to understand, deliberate and develop informed policies for the future. Scientific studies and academic debates safeguard emerging concepts from misinterpretation while fostering broader societal awareness. In this regard, academic support for socially relevant concepts is not only valuable but necessary for sustainable transformation and a better future. This study further contributes to the originality of the field by framing statistical literacy not merely as an educational

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construct, but as a multidimensional societal competency that bridges data interpretation with social transformation. Dijke-Droogers et al. [1] emphasize that the three domains of statistical literacy can be distinguished. Drawing on Watson and Callingham [2], [3], these domains are summarized as; the mean and chance domain, the graph and variation domain, the sampling and inference domain. In particular, the sampling and inference domain, which encompasses working with examples and making inferences, involves interpreting relationships between variables and plays a crucial role in statistical decision making. Konold [4] reinforces this point by noting that adults often hold intuitions about probability and statistics that conflict with accepted theory. Based on these studies, it can be inferred that persistent misconceptions in these areas have societal implications for statistical literacy, indicating that improving conceptual understanding at the individual level is a prerequisite for fostering informed decision-making and broader social transformation. By linking statistical literacy with societal challenges and policy-relevant outcomes, this study highlights its interdisciplinary significance, demonstrating how data skills can inform decision-making and drive social transformation across education, health, and governance domains.

Over four decades ago, Haack [5] stressed the importance of interpreting others' statistics for conducting one's own research, and Perry [6] introduced the concept of statistical literacy, encompassing statistical thinking, statistical communication, knowledge and social inference. Since then, statistical literacy has been adopted by individuals across at least one generation, moving from a theoretical framework to a social practice in which individuals act both as practitioners and transmitters of statistical knowledge.

Statistical literacy is now widely regarded as a critical competency in a data-driven society [7], [8]. Citizens are increasingly confronted with statistical information, whether in relation to the climate crisis, public health debates such as Covid-19, or media representations of data [9]. While statisticians have long emphasized the role of statistics in civic engagement [10], today's digital technologies and social platforms amplify both the opportunities and risks of engaging with data. The susceptibility of statistical information to manipulation underscores the urgency of equipping citizens with statistical literacy skills.

The conceptual development of statistical literacy has been shaped by diverse perspectives. Wallman [11] defined it as the ability to understand and critically evaluate statistical results in daily life, while Gal [12] emphasized interpretation, critical assessment and response to statistical information as key components. Later studies highlighted its socio-political relevance [13], [14], its links with data literacy and critical thinking [15], and its role in education [16], [17]. More recent work connects statistical literacy with public decision making, social statistics and the challenges of misinformation, particularly during crises [18], [19]. This growing body of definitions indicates a shift from a narrow technical skillset toward a socially embedded competency [20], [21].

Technological advances have further transformed statistical literacy into a practical necessity. Mobile applications, data visualization tools, and advanced software increasingly support individuals' ability to interpret and apply data in domains such as health, finance, and education [22]. However, the proliferation of unreliable data also highlights the

importance of critical questioning as a predictor of statistical literacy. These dynamics suggest that statistical literacy is central to enabling individuals to make informed decisions and societies to pursue evidence based policies [23], [24]. While previous research has primarily focused on educational or cognitive aspects, the present study advances new knowledge by examining the evolution of statistical literacy through an interdisciplinary and socially embedded lens. Against this backdrop, the present study investigates the evolution of statistical literacy in the academic literature through a comprehensive bibliometric analysis. Rather than merely documenting who has addressed gaps over time, the study seeks to uncover the intellectual structure, dominant research streams and emerging frontiers in this field. By mapping the trajectory of statistical literacy scholarship, it aims to (i) clarify how the concept has been theorized, contested and expanded, (ii) identify underexplored intersections between statistical literacy and broader societal transformations and (iii) establish a research agenda that advances both academic inquiry and practical applications. In doing so, this study contributes not only to consolidating the existing knowledge ecosystem but also to positioning statistical literacy as a pivotal driver of evidence based decision making and social change. In this way, the study introduces an integrative conceptual framing that extends beyond methodological replication, offering novel insights into how statistical literacy operates as a catalyst for societal resilience and informed governance

2. Method and Literature on Methodology

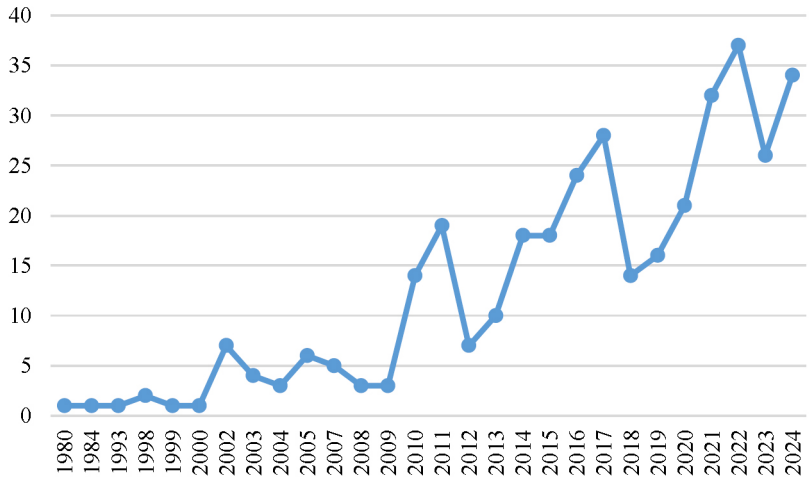
In the extensive body of scientific literature, determining which researchers make the most significant contributions to their respective fields is essential [25]. Ivancheva [26] stated that scientometrics has become an important component of the general science of science and a powerful tool in research and innovation policy. The analysis of scientific publications is a central component of the research process, providing a means of examining how knowledge is produced, disseminated, and evaluated within academia [27]. Bibliometric analysis applies statistical methods to assess qualitative and quantitative changes in a research domain, profile scholarly outputs and identify disciplinary trends. It offers valuable insights for evaluating scientific activity and impact [28], while bibliometric indicators are frequently used for rankings and productivity assessments with academic and socio-political implications [29].

Although related to systematic reviews, bibliometrics differs in scope. Systematic reviews exhaustively document narrow research areas, whereas bibliometric analysis is more versatile, ranging from citation impact assessments to identifying problematic publications [30], [31], [32]. Its historical roots include Lotka's [33] author productivity models, Bradford's [34] distribution law, and Otlet's early use of the term "*bibliometrics*" [35], [36]. Garfield's Science Citation Index and Pritchard's formal definition [37], [38], established the modern era. Today, bibliometrics is a rigorous, widely adopted method for exploring large volumes of scientific data [39]. Bibliometric approaches provide researchers with comprehensive overviews, identify gaps, generate research ideas, and contextualize

contributions [40]. However, citation counts can misrepresent contributions, database accuracy affects results and reliance on past trends may obscure emerging areas. Balanced integration of quantitative and qualitative methods is therefore necessary. Despite these limitations, bibliometrics is increasingly viewed as an essential methodology rather than a passing trend [35]. Its adoption has been accelerated by computing technologies and the internet, making it a core tool for evaluating research trends, collaborations, and influence [41]. Main applications include co-authorship, keyword co-occurrence, co-citation, citation analysis and bibliometric matching, each answering distinct questions about expertise, intellectual structures, theoretical richness, collaboration and conceptual dynamics [42], [43], [44]. Bibliometric methods are widely applied across disciplines, as reflected in studies aligned with the Frascati classification [45], [46], [47], [48]. Despite the maturity of bibliometric techniques, few studies have employed them to explore the interdisciplinary and societal dimensions of statistical literacy, leaving significant conceptual gaps that this study seeks to fill. In statistical literacy, however, applications remain limited and often framed through data literacy, with systematic reviews dominating [49], [50]. Marchy and Juandi analyzed literature on students' statistical literacy skills (1980-2023), stressing the need for further research, especially at the elementary level [51]. Friedrich et al. [52] examined factors shaping statistical literacy in K-12 STEM education and highlighted the importance of integrating statistical and data literacy. Building on this perspective, Hassanzadeh et al. [53] highlighted the interplay between science and knowledge indicators and their alignment with development goals, underscoring their role as levers for social and environmental progress. Bhardwaj and Jain [54] noted that mobile learning enables libraries to develop innovative information services that improve efficiency and reduce the

Table 1

Distribution of Statistical Literacy Publications by Year



Source: Created by the Author(s) Using WoS Data.

digital divide. Likewise, Library and Information Science (LIS) research has grown in significance and transformed with the rapid rise of information technologies [55]. Together, these studies broaden the conceptual landscape of statistical literacy by situating it within the wider discourse on knowledge systems, technological innovation, and equitable access to information. Table 1 presents the annual distribution of publications included in this study based on their counts.

Examining Table 1, increases in the number of publications are observed in 2002, 2011 and 2017. In recent years, the topic has been addressed in 32 WoS publications in 2021, 37 in 2022 and 34 in 2024. The increases in 2002, 2011 and 2017 are associated with the global emergence of discussions on evidence-based educational approaches, data-driven learning strategies, big data tools and data ethics [56], [57], [58], [59]. Particularly in the recent period, statistical literacy has been increasingly examined across diverse fields from communication and tourism to medical sciences and law, parallel to developments in statistics and mathematics education [60], [61], [62], [63].

Statistical literacy extends beyond developed countries, as reflected in the mission of the International Statistical Literacy Project (ISLP), which aims to support, establish, and engage in statistical literacy activities worldwide [64]. Enhancing statistical literacy in developing countries is crucial for achieving the Sustainable Development Goals and improving development outcomes [65]. Globally, vast databases provide data relevant to social policy and well-being and in the past decade, efforts have increased access to these data through dynamic displays and evidence-informed policy initiatives [66]. Umbach [67] notes that statistics and data have become central instruments in policy-making, offering insights into development progress and guiding decisions. Tiro [68] emphasizes that engagement with statistical data is unavoidable, as such presentations are pervasive in media and publications. North et al. [69] discuss implications for future interventions and capacity-building in statistics education in developing countries, while Helenius et al. [70] highlight the ISLP's recent successes in Latin America and their contributions to the project's future growth.

Overall, the literature shows that statistical literacy research is predominantly education focused and rarely extends to broader multidisciplinary domains. Comprehensive bibliometric analyses in social, economic, and technological contexts are notably absent. This study addresses this gap by adopting an interdisciplinary perspective that explores the intersection of statistical and data literacy and their combined impact on social transformation. By doing so, it contributes new empirical evidence and a novel conceptual synthesis that broadens the understanding of statistical literacy's evolution and its intersections with other domains such as health communication, policy design and digital citizenship. By situating statistical literacy within a wider bibliometric framework, it moves beyond prior education centered analyses and positions the concept as both an academic construct and a driver of societal development, laying a foundation for future research agendas and evidence based policy debates.

3. Data and Findings

This study addresses the following research questions using bibliometric approaches: Who are the central, peripheral, and integrative researchers in statistical literacy (co-citation)? How does the intellectual structure of research reflect theoretical diversity (bibliometric coupling)? What is the social structure of the field (co-authorship)? What are the dynamics of its conceptual structure (co-word) [44]? The Web of Science (WoS) Core Collection was selected as the literature source due to its authority, wide coverage, and inclusion of journals, conference proceedings, books and datasets [71]. It should be noted that WoS predominantly indexes English-language publications, which may bias the dataset toward Western scholarship; this represents a limitation when interpreting the interdisciplinary scope of the study. The search included all editions, and the dataset comprised articles, book chapters, editorial material, review articles, early access publications and books. These types were chosen to ensure peer-reviewed, comprehensive contributions, enhancing the reliability and validity of the analysis. Publication types such as proceedings papers, meeting abstracts, book reviews, corrections, letters, and notes were excluded, as they provide limited data for in-depth bibliometric analysis. The selected publication types allow the creation of a homogeneous dataset, supporting a clear presentation of major trends and significant contributions in statistical literacy. The research period spans from January 1, 1980, to December 8, 2024, capturing the full extent of the field's development. The following notation was used for constructing the data set based on the study's research keywords.

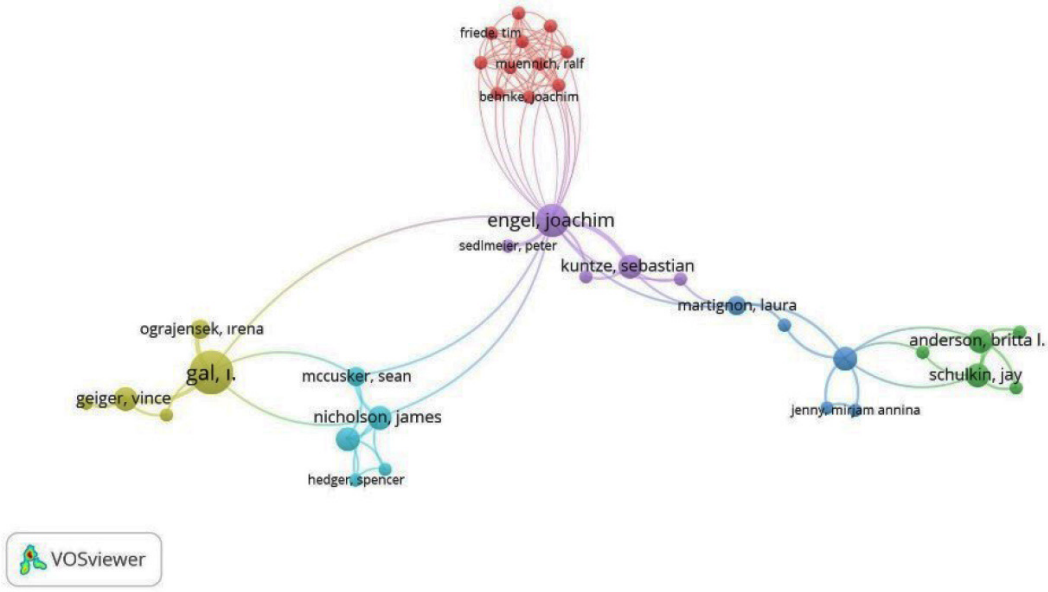
(TS = ("statistical literacy")) OR TS = ("statistic$ literacy") (1)

In addition to the concept of statistical literacy, the terms statistic literacy and statistics literacy are also encountered in the literature. Therefore the search criteria were formulated as shown in Equation 1 [72]. The search results yielded a total of 361 publications. This sample size was compared with the results from Rogers et al. [73] concerning adequacy and variability issues. Given that the sample size exceeds 200, it is considered appropriate. As a result this sample size is stated to minimize the effects of randomness in the analysis while allowing for a more accurate representation of trends and collaboration patterns in the literature. The VOSviewer software package was used in the study. The co-authorship approach was initially applied in the study. In bibliometric analysis the co-authorship approach aims to comprehensively analyze collaborations between authors [74]. Koseoglu et al. [75] stated that clean data provide more reliable and valid results compared to raw data containing redundant references. Prior to the analysis data cleaning or standardization was performed using the example shown in Equation 2.

gal,ı *gal,ı.*

gal,ıddo *gal,ı.* (2)

With the application of Equation 2, a total of 33 author records were standardized. To prevent name similarities, careful measures were taken by directly accessing the publications and conducting searches using the authors' unique IDs, ensuring that



Source: Analysis using VOSviewer.

Figure 1

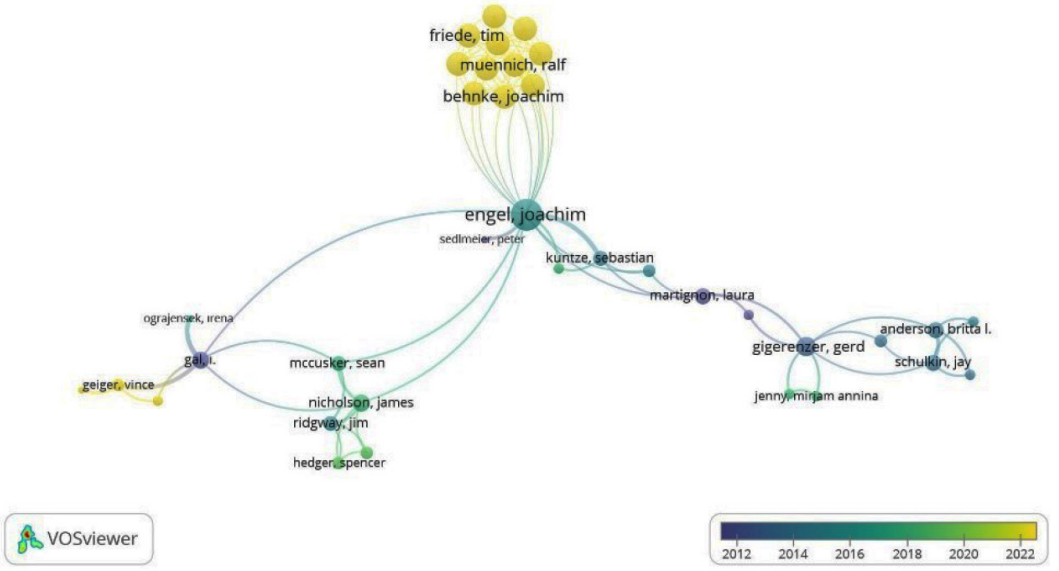
Co-authorship Approach Network Visualization Findings

standardization was applied to all identified authors. After the adjustments were made the total number of authors reached 875. In the analysis outputs 36 authors with connections were grouped into 6 clusters. The co-authorship analysis revealed distinct thematic clusters: Cluster 1 primarily focuses on the conceptual foundations of statistical literacy, emerging trends and core educational practices, while Cluster 2 emphasizes active citizenship, competency development and assessment methodologies. The remaining illustrating the diverse yet interconnected nature of research in the field. The number of iterations for the program's analysis menu was set to 1000. The results regarding the connection status are presented in Figure 1.

The results of the co-authorship analysis reveal varying levels of collaboration and academic influence among key authors in the field. Joachim Engel, with a total link strength of 19, stands out as one of the most connected researchers, supported by 33 citations and a normative citation count of 7.37. These figures underscore both the breadth of Engel's collaborative network and the influence of his scholarly contributions. Similarly, Iddo Gal, with 10 documents and 435 citations, demonstrates a substantial academic impact. His normative citation value of 20.15 further highlights the central importance of his work in shaping the statistical literacy literature. By contrast, Sebastian Kuntze exhibits a more modest collaborative profile, with 4 links and only 9 citations, suggesting a narrower impact. Other influential contributors include Gerd Gigerenzer, with 134 citations and a

normative citation value of 6.14, and Laura Martignon and Britta L. Anderson, who despite fewer collaborative connections, achieved 77 and 43 citations, respectively. Authors such as Jay Schulkin and James Nicholson, with limited collaborations and citations, maintain narrower spheres of influence. Jim Ridgway presents a more nuanced case; with 64 citations, a normative citation value of 8.90, 3 documents and 4 links, his research demonstrates strong recognition within a specific scholarly community, though collaborations remain limited. The relatively high normative value suggests that his work holds particular significance within a targeted network rather than across a broader field.

This study focused on articles rather than books, reflecting both data availability and the higher citation frequency of articles, which ensures the capture of up to date research dynamics. The search strategy was also based on topic indicators to maximize relevance. The group of authors highlighted in red at the top of Figure 1 (Sarah Friedrich, Uwe Siebert, Markus Pauly, Ursula Garczarek and Olaf Wolkenhauer) each exhibit 12 citations, a normative citation count of 5.55, and a total link strength of 11. Their metrics indicate comparable levels of academic recognition and equal contributions to collaboration networks. However, the limitation of each to only 1 document and 1 co-author suggests that their influence remains localized, with restricted collaborative reach. The similarity in normative citation values further emphasizes that their recognition is consistent but confined within specific domains. Overall, the findings highlight both the diversity and concentration of scholarly collaborations in statistical literacy. While certain authors exert broad influence through extensive networks, others remain restricted to narrower circles. This imbalance suggests that research networks are often clustered around a limited



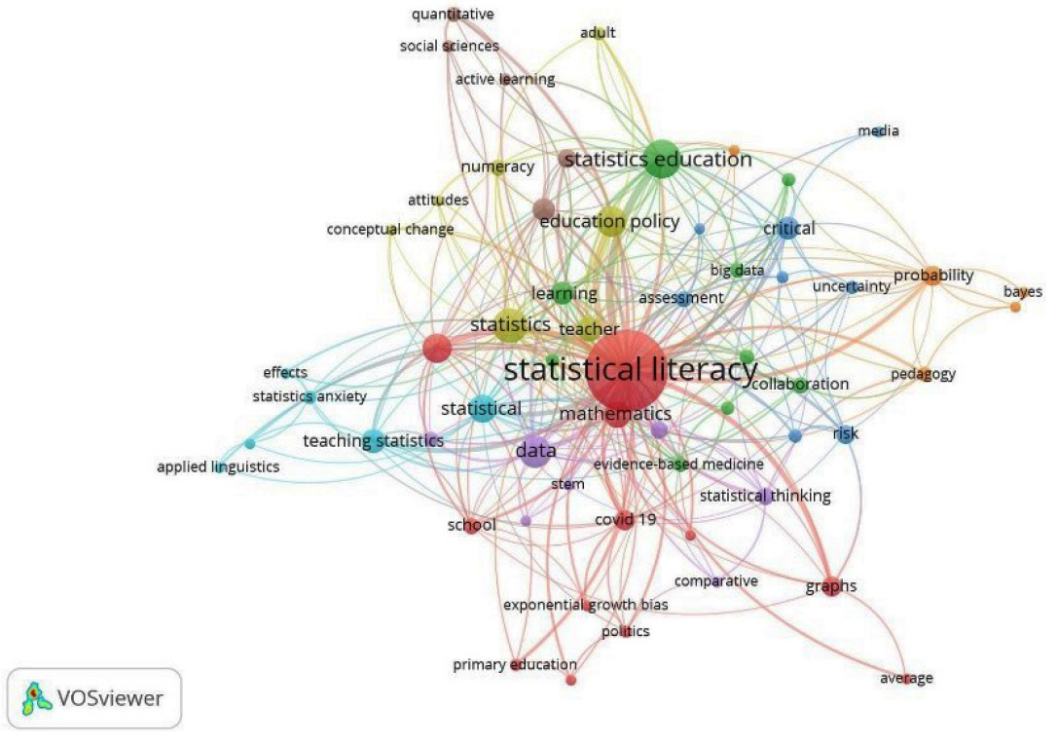
Source: Analysis using VOSviewer.

Figure 2

Co-authorship Approach Overlay Visualization Findings

number of central figures, leaving some contributions less integrated into the wider academic discourse. The overlay visualization of these collaboration patterns is presented in Figure 2.

The overlay co-authorship analysis illustrates the temporal evolution of authors' contributions and collaborative interactions. Joachim Engel, with an average publication year of 2015.83, has produced more recent work, indicating alignment with emerging trends. In contrast, Iddo Gal (2012.30) reflects a longer academic trajectory with foundational contributions to statistical literacy. Sebastian Kuntze (2014.67) and Laura Martignon (2011.50) contributed earlier, supporting a more established literature, while Gerd Gigerenzer (2013.33) and Britta L. Anderson (2014.33) were active in the mid-2010s, intensifying interactions within their peer group. Authors such as Sarah Friedrich, Uwe Siebert, Markus Pauly, Ursula Garczarek, and Olaf Wolkenhauer, indicated by recent co-authorship segments, demonstrate ongoing engagement with current research trends. These patterns provide insights into the shifting academic influence and network dynamics of key researchers over time. Following this, the analysis proceeded to keyword co-occurrence, a method essential in fast growing or interdisciplinary fields for tracking topic development and forecasting future research directions. Data cleaning and standardization



Source: Analysis using VOSviewer.

Figure 3

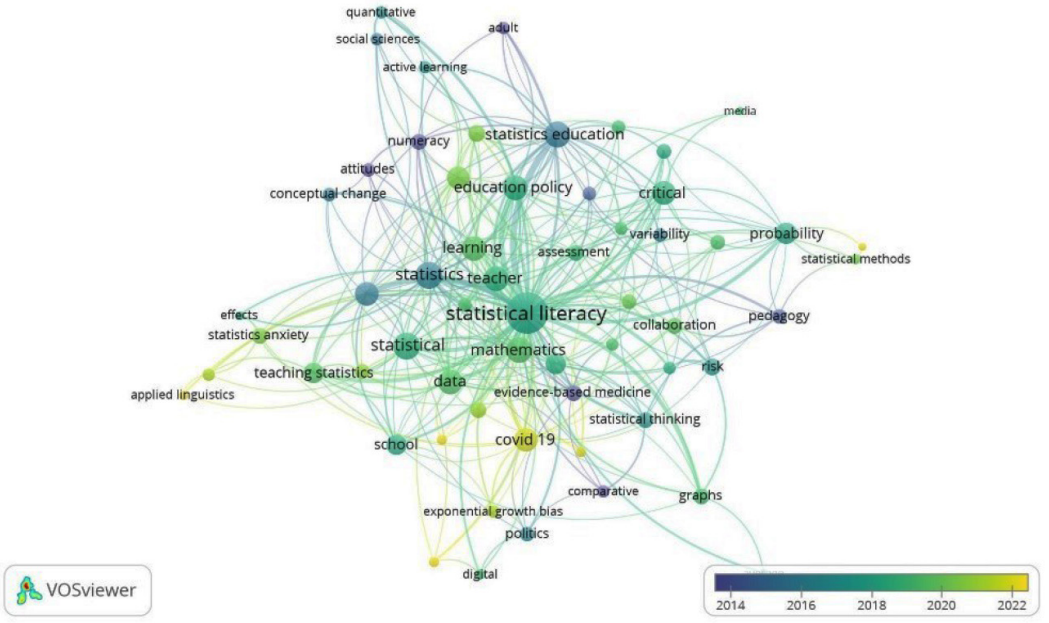
Co-occurrence of Keywords Network Visualization Findings

were conducted according to the framework outlined in Equation 3, ensuring consistent and interpretable results [76], [77]. An example of one of the frameworks used in the study is provided in Equation 3.

$$\begin{matrix} \textit{coronavirus} & \textit{covid 19} \\ \textit{covıd-19} & \textit{covid 19} \end{matrix} \tag{3}$$

When the framework presented above was applied, standardization was performed on 268 keywords. In the analysis options, the minimum occurrence value for a keyword was set to 3, resulting in the grouping of 59 items into 8 clusters. The analyzed clusters reflect the multidimensional structure of the field by combining its conceptual foundations with applied aspects. The prominent clusters which can be labeled as statistical literacy, conceptual foundations and education; active citizenship, competence and assessment; and applied data and health research represent both the theoretical and practical dimensions of the field. In the application settings, evaluation was conducted based on occurrence weights. The resulting network visualization is presented in Figure 3.

The co-occurrence analysis of keywords related to statistical literacy highlights the main research trends and focal topics within the field. "*Statistical Literacy*" emerges as the most prominent keyword, with 56 links and 174 occurrences, underscoring its centrality in the literature. "*Statistics*" and "*Statistical*" with 24 links and 25 and 19 occurrences respectively, are closely connected to statistical literacy, reflecting its strong ties to general



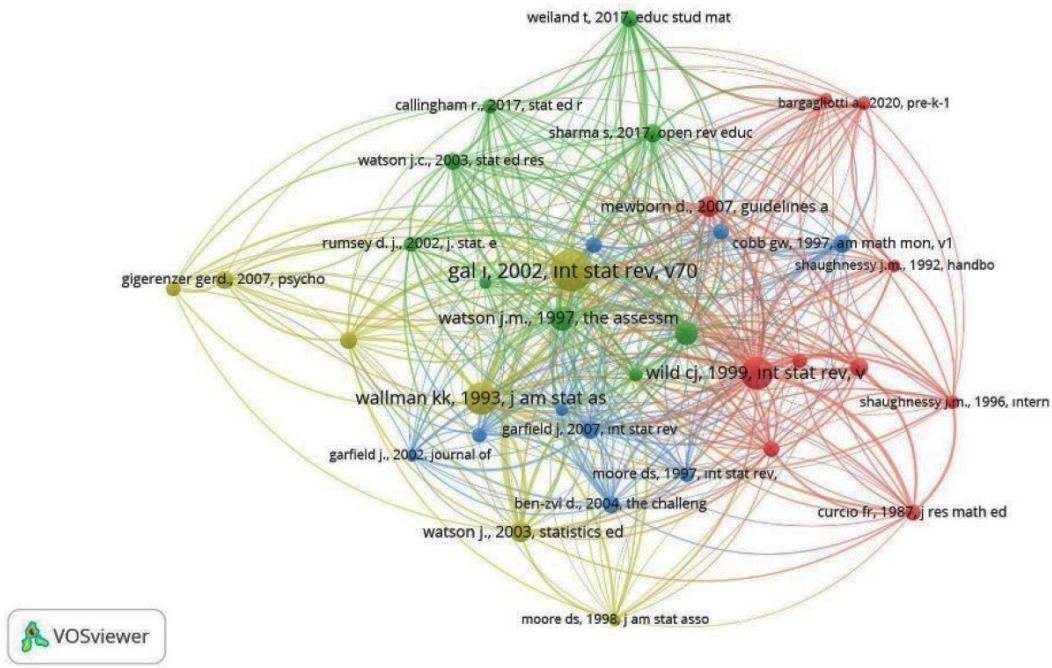
Source: Analysis using VOSviewer

Figure 4

Co-occurrence Approach of Keywords Overlay Visualization Findings

statistical knowledge. "*Statistics education*" (23 links, 38 occurrences) emphasizes the critical role of educational approaches, while "*Education policy*" (21 links, 25 occurrences) and "*Teaching*" (18 links, 22 occurrences) highlight the influence of policy and pedagogy on statistical literacy. The terms "*Data*" and "*Covid*" with 20 and 18 links respectively, signal growing research on data driven education and the pandemic's impact on statistical understanding. Overall, these keyword connections demonstrate how statistical literacy is intertwined with data analysis and educational transformation, illustrating evolving research priorities and emerging interdisciplinary trends. Figure 4 presents the overlay visualization results of the co-occurrence approach of keywords.

The overlay visualization results of the keywords reveal the evolution of research on statistical literacy over time and the topics that are more closely associated with recent trends. The terms "*Statistical Literacy*" and "*Statistical*" which are fundamental concepts, are associated with research from around 2018, indicating that these topics have been more extensively studied and have become more prominent in the literature in recent years. The terms "*Statistics*" and "*Statistics education*" were more intensively examined around 2016 and 2015, suggesting that these areas have a long research history and have developed a more in-depth literature over time. Keywords such as "*Education policy*", "*Teaching*" and "*Data*" peaked around 2018, while the term "*Covid*" with its high average publication year



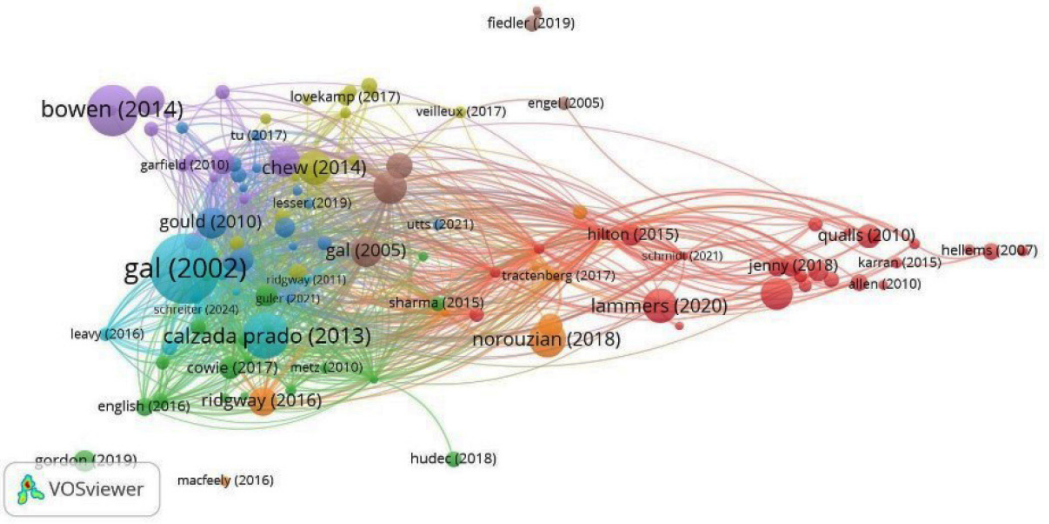
Source: Analysis using VOSviewer.

Figure 5

Co-Citation Approach Network Visualization Findings

of 2021, reflects the impact of the pandemic on education and statistical literacy topics. Additionally, terms like "*Applied Linguistics*", "*K12 education*", "*Health literacy*" and "*Primary education*" show high average publication years from 2022 and 2023, indicating that these are newer and emerging research areas. This suggests that fields such as education and health literacy, especially in the context of the pandemic, have garnered more attention in recent years. Overall, the overlay visualization results reflect the continuity of research on various keywords and academic trends, showing which topics are linked to older research and which are associated with more recent studies. The network visualization results of the co-citation analysis approach are presented in Figure 5.

The application of the co-citation approach was carried out through cited references. The minimum number of citations for a cited reference was set to 10, resulting in a total of 35 items. The co-citation analysis results provide meaningful data on the key sources in the literature and their academic impact levels. For example, Gal [12], with 34 links, 106 total link strength, and 112 citations, stands out, indicating that Gal [12]'s work is one of the important references in the field and has a broad academic influence. Wallman [11], with 33 links and 66 citations, also emerges as a significant source, but its total link strength remains lower compared to Gal's work. Other key sources include Wild [78] and Watson [79], each with 34 links and 64 and 38 citations, respectively, indicating significant impact in the literature. Watson [80], with 26 links and 27 citations, shows less influence, while Mewborn, with 27 links, has a more limited impact but still remains an important part of the literature. These data allow for a better understanding of each source's position, impact strength, and contribution to other works in the field. Such analyses are a crucial tool in



Source: Analysis using VOSviewer.

Figure 6

Bibliographic Network Visualization Findings

identifying which studies play a key role and in determining the years when these sources had more influence. The bibliographic matching approach results are presented in Figure 6.

The results in Figure 6 were evaluated based on citations to assess the impact and interactions of key sources in the statistical literacy literature. Gal [12], with 46 links, a total link strength of 109, and 330 citations, emerges as the most influential source, serving as a foundational reference with broad academic reach. Bowen [81], despite a high citation count of 181, has 7 links, suggesting a more focused impact. Chew (56 links, 80 citations) also demonstrates notable influence, while Norouzian (2 links, 96 citations) shows a more limited effect [82], [83]. Lammers [84] and Kurz-Milcke [85] display lower link strengths but remain widely referenced, with 85 and 74 citations respectively. Gal [86], with 62 links and 156 total link strength, generates extensive connections despite a lower citation count (66). Tishkovskaya (79 links, 247 total link strength) demonstrates the highest impact in terms of interactions [87]. Sources such as Gal [88], Koparan [89] and Weiland [20] (link strengths 151-154) show broad influence across research networks, whereas Tishkovskaya [90] (link strength 247) confirms engagement with a wide academic community. Krauss [91] and Von Roten [92], with link strengths of 109 and 143; Berndt, Schmidt [63], with 156 and 124, respectively, also indicate substantial influence. These findings underscore link strength as a key indicator of a source's significance in scholarly interactions [93]. In terms of normative citation, Schreiter [94] leads with 11.33, signaling both numerical and interactional impact. Lammers [84], with 11.37, is similarly influential. Bowen [81], Ridgway [95] and Norouzian [83], with normative citation values of 7.97, 7.65 and 7.68, respectively, exhibit more limited interactions despite high citation counts. These data highlight normative citation as a crucial metric for evaluating a source's relative value and influence within the academic community. A comprehensive evaluation of these bibliographic matching results is presented in the following section of the study.

Conclusions

This study applied bibliometric techniques (co-citation, bibliographic matching, co-authorship, and co-word analyses) to reveal the intellectual, social and conceptual structures of statistical literacy research. The results highlight the central, peripheral, and integrative roles of researchers, the richness of theoretical frameworks combining data analysis, education, and policy, as well as the collaboration and conceptual networks shaping the field. Core concepts such as "*Statistical Literacy*", "*Data*" and "*Teaching*" alongside emerging themes including "*Covid*" and "*Health literacy*" demonstrate the multidimensional character of the field and its strong connections to broader processes of societal transformation.

From a theoretical standpoint, the findings show that statistical literacy has developed along distinct intellectual trajectories, with central researchers shaping fundamental approaches while integrative actors bridge disciplines and foster theoretical diversity. The analysis also reveals certain imbalances in the field, such as clustered networks around

core researchers and themes, indicating concentrations of influence that may shape both theoretical development and practical application. From a practical perspective, the analysis demonstrates that statistical literacy remains heavily concentrated in educational contexts, while broader multidisciplinary and sociological dimensions are still underrepresented. These insights contribute to positioning statistical literacy not only as an educational concern but also as a driver of evidence based societal change. Building upon these findings, it is evident that the growing prominence of information literacy in higher education and academic research underscores the evolving competencies required for effective engagement with data. Most publications are concentrated in educational research and Library and Information Science, yet closely related domains such as health literacy, education, and higher education indicate that statistical literacy intersects with multiple fields [96]. Furthermore, Egghe et al. [97] identified collaboration within the scientific environment as a key factor shaping research productivity. Therefore, statistical literacy research requires enhanced collaborative efforts across disciplines and institutions, enabling more robust comparisons and integration of insights, which can strengthen both conceptual development and practical application.

Several policy implications arise from this research. First, the integration of statistical literacy into school and university curricula must be strengthened, particularly by linking it to digital literacy in the post-Covid educational landscape. Second, fostering interdisciplinary collaborations with domains such as health literacy and applied linguistics will broaden the impact of the field. Third, expanding co-authorship networks and supporting collaboration among central and emerging researchers will facilitate the diffusion of innovative perspectives. Finally, targeted training programs for policymakers in education and health can ensure that statistical evidence is more effectively interpreted and incorporated into decision making processes. For instance, the 2023 peak in publications on health literacy highlights the growing relevance of statistical literacy in public health contexts, suggesting that policies aimed at integrating statistical and health literacy could support evidence-based decision making in healthcare education and practice.

Statistical literacy is a critical competency that enables individuals to make data-informed decisions, thereby playing a pivotal role in societal transformation. However, the literature does not fully capture the broad trajectory from individual skill acquisition to societal impact. In other words, the literature does not clearly tell us how statistical literacy translates into societal transformation. While our analysis demonstrates significant progress in understanding statistical literacy, it also reveals that the field has insufficiently addressed the diffusion of these skills across diverse societal groups. Central researchers and theoretical frameworks have been well characterized, yet multidisciplinary and sociological perspectives that encompass societal transformation remain underexplored. Moreover, analyses indicate that statistical literacy research is heavily concentrated in specific domains such as education and health, while studies that could inform broad policy interventions or reach wider population segments are limited. This highlights gaps in the classification of statistical literacy levels across different social groups and in policies aimed at enhancing these competencies. In sum, although the literature provides a solid

foundation for defining and teaching statistical literacy, it offers limited insight into its societal implications and long-term effects, underscoring the need for future interdisciplinary and policy-oriented research.

This study has several limitations. The bibliometric analysis is inherently constrained by the coverage and accuracy of the selected database, which may exclude relevant publications or contain incomplete records. While bibliometrics provides valuable insights into structural and thematic trends, it cannot fully capture the qualitative depth of individual contributions. Future research should integrate bibliometric approaches with qualitative analyses to explore the nuanced dynamics of statistical literacy. Attention should also be given to multidisciplinary intersections and the sociological dimensions of statistical literacy beyond educational contexts. Expanding research on hierarchical classifications of statistical literacy across societal groups and developing a shared definitional framework would strengthen the basis for both academic advancement and evidence informed policy making.

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Statements and Declarations;

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References

[1] M. Dijke-Droogers, P. Drijvers, and A. Bakker, "Effects of a learning trajectory for statistical inference on 9th-grade students' statistical literacy," *Mathematics Education Research Journal*, vol. 37, pp. 187-210, 2025. [Online]. Available: https://doi.org/10.1007/s13394-024-00487-z [Accessed Nov. 3, 2025].

[2] J. M. Watson and R. Callingham, "Statistical literacy: A complex hierarchical construct," *Statistics Education Research Journal*, vol. 2, pp. 3-46, 2003. [Online]. Available: https://doi.org/https://doi.org/10.52041/serj.v2i2.553 [Accessed Nov. 3, 2025].

[3] J. Watson and R. Callingham, "Statistical literacy: From idiosyncratic to critical thinking," in *Curricular Development in Statistics Education: International Association for Statistical Education Roundtable*, G. Burrill and M. Camden, Eds. Voorburg, The Netherlands: International Association for Statistical Education, 2004, pp. 116-137.

[4] C. Konold, "Issues in assessing conceptual understanding in probability and statistics," *Journal of Statistics Education*, vol. 3, no. 1, pp. 1-9, 1995. [Online]. Available: https://doi.org/10.1080/10691898.1995.11910479 [Accessed Nov. 3, 2025].

[5] D. G. Haack, "Teaching statistical literacy," *Teaching Statistics*, vol. 1, no. 3, pp. 74-76, 1979.

[6] L. M. Perry, "Statistical literacy," in *Proceedings of the annual meeting of the American Statistical Association section on statistical Education*, The ASA, pp. 92-96, 1983.

[7] U. Hasanah, S. Putrawangsa, F. A. Setiawati, and E. Purwanta, "Statistical literacy in primary education: An analysis of Indonesian fifth-graders' data interpretation and analysis skills," *Journal on Mathematics Education*, vol. 15, no. 4, pp. 1327-1348, 2024. [Online]. Available: https://doi.org/10.22342/jme.v15i4.pp1335-1356 [Accessed Jan. 17, 2025].

[8] C. J. Wild, "Statistical literacy as the Earth moves," *Statistics Education Research Journal*, vol. 16, no. 1, pp. 31-37, 2017. [Online]. Available: https://doi.org/10.52041/serj.v16i1.211 [Accessed Jan. 17, 2025]

[9] C. Büscher, "Adapting Habermas' construct of communicative rationality into a framework for analyzing students' statistical literacy," *Educational Studies in Mathematics*, vol. 117, pp. 121-141, 2024. [Online]. Available: https://doi.org/10.1007/s10649-024-10325-5 [Accessed Jan. 18, 2025].

[10] J. Engel, "Statistical literacy for active citizenship: A call for data science education," *Statistics Education Research Journal*, vol. 16, no. 2, pp. 44-49, 2017. [Online]. Available: https://doi.org/10.52041/serj.v16i1.213 [Accessed Dec. 20, 2024].

[11] K. K. Wallman, "Enhancing statistical literacy: Enriching our society," *Journal of the American Statistical Association*, vol. 88, no. 421, pp. 1-8, 1993.

[12] I. Gal, "Adults' statistical literacy: Meanings, components, responsibilities," *International Statistical Review*, vol. 70, no. 1, pp. 1-25, 2002. [Online]. Available: https://doi.org/10.1111/j.1751-5823.2002.tb00336.x. [Accessed Jan. 19, 2025].

[13] P. Lehohla, "Promoting statistical literacy: A South African perspective," in *Proceedings of the Sixth International Conference on Teaching Statistics (ICOTS-6)*, B. Phillips, Ed. Cape Town, South Africa, 2002.

[14] D. J. Rumsey, "Discussion: Statistical literacy: Implications for teaching, research and practice," *International Statistical Review*, vol. 70, pp. 32-36, 2002. [Online]. Available: https://doi.org/10.1111/j.1751-5823.2002.tb00339.x. [Accessed Jan. 19, 2025].

[15] M. Schield, "Information literacy, statistical literacy, data literacy," *IASSIST Quarterly*, vol. 28, no. 2-3, pp. 6-11, 2004.

[16] D. Ben-Zvi and J. Garfield, *The challenge of developing statistical literacy, Reasoning and Thinking*. Dordrecht, The Netherlands: Kluwer Academic Publishers, 2004. [Online]. Available: https://doi.org/10.1007/1-4020-2278-6. [Accessed Nov. 4, 2024].

[17] R. Callingham, "Assessing statistical literacy: A question of interpretation," in *Proceedings of the seventh international conference on teaching statistics (ICOTS-7)*, Salvador, Brazil, 2007.

[18] L. D. English and J. M. Watson, "Development of probabilistic understanding in fourth grade," *Journal for Research in Mathematics Education*, vol. 47, no. 1, pp. 28-62, 2016. [Online]. Available: https://doi.org/10.5951/jresematheduc.47.1.0028 [Accessed Dec. 28, 2024].

[19] S. Sharma, "Definitions and models of statistical literacy: A literature review," *Open Review of Educational Research*, vol. 4, no. 1, pp. 118-133, 2017. [Online]. Available: https://doi.org/10.1080/23265507.2017.1354313 [Accessed Jan. 14, 2025]

[20] T. Weiland, "Problematizing statistical literacy: An intersection of critical and statistical literacies," *Educational Studies in Mathematics*, vol. 96, no. 1, pp. 33-47, 2017. [Online]. Available: https://doi.org/10.1007/s10649-017-9764-5 [Accessed Jan. 18, 2025].

[21] N. G. Bailey and A. W. McCulloch, "Describing critical statistical literacy habits of mind," *The Journal of Mathematical Behavior*, vol. 70, n. 101063, 2023. [Online]. Available: https://doi.org/10.1016/j.jmathb.2023.101063 [Accessed Jan. 25, 2025].

[22] D. A. Hoz-Ruiz, E. Howard, and R. Hijón-Neira, "The enhancement of statistical literacy: A cross-institutional study using data analysis and text mining to identify statistical issues in the transition to university education," *Information*, vol. 15, no. 9, p. 567, 2024. [Online]. Available: https://doi.org/10.3390/info15090567 [Accessed Jan. 7, 2025].

[23] S. C. Morton, "Statistics: From evidence to policy," *Journal of the American Statistical Association*, vol. 105, no. 489, pp. 1-5, 2010. [Online]. Available: https://doi.org/10.1198/jasa.2010.ap09811 [Accessed Dec. 15, 2024].

[24] S. G. Pantula, "Statistics: A key to innovation in a data-centric world!," *Journal of the American Statistical Association*, vol. 106, no. 493, pp. 1-5, 2011. [Online]. Available: https://doi.org/10.1198/jasa.2011.ap10508 [Accessed Jan. 22, 2025].

[25] G. Mustafa and M. T. Afzal, "Formulating rules to identify key researchers in computer science: A quantitative approach," *COLLNET Journal of Scientometrics and Information Management*, vol. 19, no. 1, pp. 91-122, 2025, [Online]. Available: https://doi.org/10.47974/CJSIM-2024-11007. [Accessed Nov. 2, 2025].

[26] L. Ivancheva, "Scientometrics today: A methodological overview," *COLLNET Journal of Scientometrics and Information Management*, vol. 2, no. 2, pp. 47-56, 2008, [Online]. Available: https://doi.org/10.1080/09737766.2008.10700853. [Accessed Nov. 2, 2025].

[27] J. A. Basualdo, M. S. Grenóvero, E. Bertucci, and N. B. Molina, "Bibliometric analysis of scientific literature on intestinal parasites in Argentina during the period 1985-2014," *Revista Argentina de Microbiología*, vol. 48, no. 2, pp. 171-179, 2016. [Online]. https://doi.org/10.1016/j.ram.2016.03.005 [Accessed Jan. 12, 2025].

[28] A. Rey-Martí, D. Ribeiro-Soriano, and D. Palacios-Marqués, "A bibliometric analysis of social entrepreneurship," *Journal of Business Research*, vol. 69, no. 5, pp. 1651-1655, 2016. [Online]. Available: https://doi.org/10.1016/j.jbusres.2015.10.033 [Accessed: Jan. 18, 2025].

[29] A. Abbott, D. Cyranoski, N. Jones, B. Maher, Q. Schiermeier, and R. Van Noorden, "Do metrics matter? Many researchers believe that quantitative metrics determine who gets hired and who gets promoted at their institutions. With an exclusive poll and interviews,

Nature probes to what extent metrics are really used that way," *Nature*, vol. 465, no. 7300, pp. 860-863, 2010.

[30] D. Tranfield, D. Denyer, and P. Smart, "Towards a methodology for developing evidence-informed management knowledge by means of systematic review," *British Journal of Management*, vol. 14, no. 3, pp. 207-222, 2003. [Online]. Available: https://doi.org/10.1111/1467-8551.00375 [Accessed Jan. 19, 2025].

[31] O. Ellegaard, "The application of bibliometric analysis: Disciplinary and user aspects," *Scientometrics*, vol. 116, no. 1, pp. 181-202, 2018. [Online]. Available: https://doi.org/10.1007/s11192-018-2765-z [Accessed Jan. 19, 2025].

[32] J. Kaur, F. Radicchi, and F. Menczer, "Universality of scholarly impact metrics," *Journal of Informetrics*, vol. 7, no. 4, pp. 924-932, 2013. [Online]. https://doi.org/10.1016/j.joi.2013.09.002 [Accessed Jan. 19, 2025].

[33] A. J. Lotka, "The frequency distribution of scientific productivity," *Journal of the Washington Academy of Sciences*, vol. 16, no. 12, pp. 317-323, 1926.

[34] S. C. Bradford, "Sources of information on specific subjects," *Engineering*, vol. 137, pp. 85-86, 1934.

[35] I. Passas, "Bibliometric analysis: The main steps," *Encyclopedia*, vol. 4, no. 2, pp. 1014-1025, 2024. [Online]. Available: https://doi.org/10.3390/encyclopedia4020065 [Accessed Jan. 15, 2025].

[36] Y. Ding, R. Rousseau, and D. Wolfram, *Measuring scholarly impact: Methods and practice*. Cham, Switzerland: Springer, 2014.

[37] E. Garfield, "Citation indexes for science; a new dimension in documentation through association of ideas," *Science*, vol. 122, no. 3159, pp. 108-111, 1955.

[38] A. Pritchard, "Statistical bibliography or bibliometrics," *Journal of Documentation*, vol. 25, no. 4, pp. 348-349, 1969.

[39] P. Ahmad, J. A. Asif, M. K. Alam, and J. Slots, "A bibliometric analysis of periodontology 2000," *Periodontology 2000*, vol. 82, no. 1, pp. 286-297, 2020.

[40] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, "How to conduct a bibliometric analysis: An overview and guidelines," *Journal of Business Research*, vol. 133, pp. 285-296, 2021. [Online]. Available: https://doi.org/10.1016/j.jbusres.2021.04.070 [Accessed Jan. 15, 2025].

[41] J. Bar-Ilan, "Informetrics at the beginning of the 21st century - A review," *Journal of Informetrics*, vol. 2, no. 1, pp. 1-52, 2008.

[42] R. Dwivedi, S. Nerur, and V. Balijepally, "Exploring artificial intelligence and big data scholarship in information systems: A citation, bibliographic coupling, and co-word analysis," *International Journal of Information Management Data Insights*, vol. 3, no. 2, n. 100185, 2023. [Online]. Available: https://doi.org/10.1016/j.jjimei.2023.100185 [Accessed Dec. 28, 2024].

[43] A. Klarin, "How to conduct a bibliometric content analysis: Guidelines and contributions of content co-occurrence or co-word literature reviews," *International Journal of Consumer Studies*, vol. 48, no. 2, n. e13031, 2024. [Online]. Available: https://doi.org/10.1111/ijcs.13031 [Accessed Jan. 19, 2025].

[44] I. Zupic and T. Čater, "Bibliometric methods in management and organization," *Organizational Research Methods*, vol. 18, no. 3, pp. 429-472, 2015.

[45] J. Anders and M. S. Vitevitch, "The effect of the COVID pandemic on clinical psychology research: A bibliometric analysis," *Behavioral Sciences*, vol. 14, no. 6, n. 463, 2024. [Online]. Available: https://doi.org/10.3390/bs14060463 [Accessed Jan. 17, 2025].

[46] T. Brughmans and M. A. Peeples, "Trends in archaeological network research: A bibliometric analysis," *Journal of Historical Network Research*, vol. 1, pp. 1-24, 2017.

[47] U. Khan, H. U. Khan, S. Iqbal, and H. Munir, "Four decades of image processing: A bibliometric analysis," *Library Hi Tech*, vol. 42, no. 1, pp. 180-202, 2024. [Online]. Available: https://doi.org/10.1108/LHT-10-2021-0351 [Accessed Jan. 2, 2025].

[48] G. Rusmayadi, S. Supriandi, and R. Pahrijal, "Trends and impact of sustainable energy technologies in mechanical engineering: A bibliometric study," *West Science Interdisciplinary Studies*, vol. 1, no. 09, pp. 843-853, 2023.

[49] M. Pinto, C. Gómez-Camarero, F. J. García-Marco, and D. Caballero-Mariscal, "A strategic approach to information literacy: data literacy. A systematic review," *Profesional de la Información*, vol. 32, no. 6, n. e320609, 2023. [Online]. Available: https://doi.org/10.3145/epi.2023.nov.09 [Accessed Jan. 17, 2025].

[50] C. Yan, H. Wang, and X. Luo, "Knowledge mapping of data literacy: A bibliometric study using visual analysis," *Journal of Librarianship and Information Science*, n. 09610006241285512, 2024. [Online]. Available: https://doi.org/10.1177/09610006241285512 [Accessed Jan. 19, 2025].

[51] F. Marchy and D. Juandi, "Student's statistical literacy skills (1980-2023): A systematic literature review with bibliometric analysis," *Journal of Education and Learning Mathematics Research (JELMaR)*, vol. 4, no. 1, pp. 31-45, 2023.

[52] A. Friedrich, S. Schreiter, M. Vogel, S. Becker-Genschow, R. Brünken, J. Kuhn, J. Lehmann, and S. Malone, "What shapes statistical and data literacy research in K-12 STEM education? A systematic review of metrics and instructional strategies," *International Journal of STEM Education*, vol. 11, no. 1, n. 58, 2024. [Online]. Available: https://doi.org/10.1186/s40594-024-00517-z [Accessed Jan. 6, 2025].

[53] M. Hassanzadeh, B. Akhgar, and F. Navidi, "Integrating knowledge and science indicators (kientometrics) towards a rational framework of investigations: A comparative approach," *COLLNET Journal of Scientometrics and Information Management*, vol. 8, no. 2, pp. 247-256, 2014. [Online]. Available: https://doi.org/10.1080/09737766.2014.1015298 [Accessed Nov. 3, 2025].

[54] R. K. Bhardwaj and P. K. Jain, "Research trends in mobile learning: A global perspective," *COLLNET Journal of Scientometrics and Information Management*, vol. 9, no. 2, pp. 205-224, 2015. [Online]. Available: https://doi.org/10.1080/09737766.2015.1069960 [Accessed Nov. 3, 2025].

[55] M. Damar, J. K. Pal, T. Dhar, J. Haines, and G. Özdağoğlu, "Visualizing intellectual patterns in LIS research: A bibliometric mapping based on major LIS journals intersecting with computer science," *COLLNET Journal of Scientometrics and Information Management*, vol. 18, no. 2, pp. 179-196, 2024. [Online]. Available: https://doi.org/0.47974/CJSIM-2023-0103 [Accessed Nov. 3, 2025].

[56] R. E. Slavin, "How evidence-based reform will transform research and practice in education," *Educational Psychologist*, vol. 55, no. 1, pp. 21-31, 2019. [Online]. Available: https://doi.org/10.1080/00461520.2019.1611432 [Accessed Nov. 2, 2025].

[57] J. Scheerens, "Evidence-based educational policy and practice: The case of applying the educational effectiveness knowledge base," *Journal of Educational, Cultural and Psychological Studies*, no. 9, pp. 83-99, 2014. [Online]. Available: https://doi.org/10.7358/ecps-2014-009-sche [Accessed Nov. 2, 2025].

[58] L. Rodríguez-Mazahua, C. A. Rodríguez-Enríquez, J. L. Sánchez-Cervantes, et al., "A general perspective of big data: Applications, tools, challenges and trends," *Journal of Supercomputing*, vol. 72, pp. 3073-3113, 2016. [Online]. Available: https://doi.org/10.1007/s11227-015-1501-1 [Accessed Nov. 1, 2025].

[59] S. Verma and N. Garg, "The trend and future of techno-ethics: A bibliometric analysis of three decades," *Library Hi Tech*, vol. 42, no. 5, pp. 1579-1600, 2024. [Online]. Available: https://doi.org/10.1108/LHT-10-2022-0477 [Accessed Nov. 1, 2025].

[60] H. Forgasz, J. Hall, and T. Robinson, "Evaluating pre-service teachers' statistical literacy capabilities," *Mathematics Education Research Journal*, vol. 36, pp. 231-258, 2024. [Online]. Available: https://doi.org/10.1007/s13394-022-00438-6 [Accessed Nov. 2, 2025].

[61] B. Baylock, "Statistical literacy for judicial officers," *Judicial Officers Bulletin*, vol. 36, no. 10, pp. 105-106, 2024. [Online]. Available: https://search.informit.org/doi/10.3316/informit.T202411250000200163757242 [Accessed Nov. 2, 2025].

[62] G. Burrill and A. Dickson, "Statistical literacy and the role of communication," in *IASE 2023 satellite conference - fostering learning of statistics and data science, conference proceedings series*, E. Jones, Ed., Mar. 2024, p. Topic 3. [Online]. Available: https://doi.org/10.52041/iase2023.306 [Accessed Nov. 3, 2025].

[63] F. M. Schmidt, J. M. Zottmann, M. Sailer, M. R. Fischer, and M. Berndt, "Statistical literacy and scientific reasoning & argumentation in physicians," *GMS Journal for Medical Education*, vol. 38, no. 4, pp. 1-17, 2021. [Online]. Available: https://doi.org/10.3205/zma001473 [Accessed Jan. 16, 2025].

[64] E. Falck, P. Campos, A. D'Amelio, and R. Helenius, "Global challenges and perspectives in statistical literacy: An analysis of ISLP activities and insights from country coordinators and NSO resources," *Statistical Journal of the IAOS*, vol. 41, no. 3, pp. 940-951, 2025. [On-

line] Available: https://doi.org/10.1177/18747655251335741 [Accessed Nov. 3, 2025].

[65] E. Paul, "The challenges for improving statistical literacy in developing countries: Case study of Tanzania," in *Proceedings of the 61st ISI World Statistics Congress*, Marrakech, Morocco, Jul. 16-21, 2017, pp. 1859-1865.

[66] J. Ridgway, J. Nicholson, and S. McCusker, "Statistical literacy, globalisation, and the internet," presented at the *58th World Statistical Congress*, Dublin, Ireland, 2011, pp. 952-961.

[67] G. Umbach, "Statistical and data literacy in policy-making," *Statistical Journal of the IAOS*, vol. 38, no. 2, pp. 445-452, 2022. [Online]. Available: https://doi.org/10.3233/SJI-220962 [Accessed Nov. 2, 2025].

[68] M. A. Tiro, "National movement for statistical literacy in Indonesia: An idea," *Journal of Physics: Conference Series*, vol. 1028, no. 1, p. 012216, 2018. [Online]. Available: https://doi.org/10.1088/1742-6596/1028/1/012216 [Accessed Nov. 2, 2025].

[69] D. North, I. Gal, and T. Zewotir, "Building capacity for developing statistical literacy in a developing country: Lessons learned from an intervention," *Statistics Education Research Journal*, vol. 13, no. 2, pp. 15-27, 2014. [Online]. Available: https://doi.org/10.52041/serj.v13i2.276 [Accessed Nov. 2, 2025].

[70] R. Helenius, A. D'Amelio, P. Campos, and S. Macfeely, "ISLP country coordinators as ambassadors of statistical literacy and innovations," *Statistics Education Research Journal*, vol. 19, no. 1, pp. 120-136, 2020. [Online]. Available: https://doi.org/10.52041/serj.v19i1.125 [Accessed Nov. 2, 2025].

[71] C. Birkle, D. A. Pendlebury, J. Schnell, and J. Adams, "Web of Science as a data source for research on scientific and scholarly activity," *Quantitative Science Studies*, vol. 1, no. 1, pp. 363-376, 2020.

[72] Z. M. Özmen and A. Baki, «Statistics instructors› perceptions of statistics literacy in different undergraduate programs," *International Journal of Research in Education and Science*, vol. 7, no. 3, pp. 852-871, 2021.

[73] G. Rogers, M. Szomszor, and J. Adams, "Sample size in bibliometric analysis," *Scientometrics*, vol. 125, no. 1, pp. 777-794, 2020.

[74] W. Tian, R. Cai, Z. Fang, Y. Geng, X. Wang, and Z. Hu, "Understanding co-corresponding authorship: A bibliometric analysis and detailed overview," *Journal of the Association for Information Science and Technology*, vol. 75, no. 1, pp. 3-23, 2024. [Online]. Available: https://doi.org/10.1002/asi.24836 [Accessed Jan. 19, 2025].

[75] M. A. Koseoglu, H. E. Arici, and N. C. Arici, "Does data curation matter in citation and co-citation analysis? Evidence from a top service journal," *COLLNET Journal of Scientometrics and Information Management*, vol. 17, no. 2, pp. 269-287, 2023. [Online]. Available: https://doi.org/10.47974/CJSIM-2020-0011 [Accessed Nov. 2, 2025].

[76] L. Leydesdorff and L. Vaughan, "Co-occurrence matrices and their applications in information science: Extending ACA to the web environment," *Journal of the American Society for Information Science and Technology*, vol. 57, no. 12, pp. 1616-1628, 2006.

[77] X. Zhou, M. Zhou, D. Huang, and L. Cui, "A probabilistic model for co-occurrence analysis in bibliometrics," *Journal of Biomedical Informatics*, vol. 128, pp. 1-8, 2021. [Online]. Available: https://doi.org/10.21203/rs.3.rs-634136/v1 [Accessed Jan. 17, 2025].

[78] C. J. Wild and M. Pfannkuch, "Statistical thinking in empirical enquiry," *International Statistical Review*, vol. 67, no. 3, pp. 223-248, 1999.

[79] J. M. Watson, "Assessing statistical thinking using the media," in *The Assessment Challenge in Statistics Education*, vol. 12, pp. 107-121, 1997.

[80] J. Watson and R. Callingham, "Statistical literacy: A complex hierarchical construct," *Statistics Education Research Journal*, vol. 2, no. 2, pp. 3-46, 2003.

[81] W. G. Bowen, M. M. Chingos, K. A. Lack, and T. I. Nygren, "Interactive learning online at public universities: Evidence from a six-campus randomized trial," *Journal of Policy Analysis and Management*, vol. 33, no. 1, pp. 94-111, 2014.

[82] P. K. Chew and D. B. Dillon, "Statistics anxiety update: Refining the construct and recommendations for a new research agenda," *Perspectives on Psychological Science*, vol. 9, no. 2, pp. 196-208, 2014.

[83] R. Norouzian and L. Plonsky, "Eta-and partial eta-squared in L2 research: A cautionary review and guide to more appropriate usage," *Second Language Research*, vol. 34, no. 2, pp. 257-271, 2018.

[84] J. Lammers, J. Crusius, and A. Gast, "Correcting misperceptions of exponential coronavirus growth increases support for social distancing," *Proceedings of the National Academy of Sciences*, vol. 117, no. 28, pp. 16264-16266, 2020.

[85] E. Kurz-Milcke, G. Gigerenzer, and L. Martignon, "Transparency in risk communication: graphical and analog tools," *Annals of the New York Academy of Sciences*, vol. 1128, no. 1, pp. 18-28, 2008.

[86] I. Gal, "Towards 'probability literacy' for all citizens: Building blocks and instructional dilemmas," in *Exploring probability in school: Challenges for teaching and learning*, Boston, MA: Springer US, pp. 39-63, 2005.

[87] S. Tishkovskaya and G. A. Lancaster, "Statistical education in the 21st century: A review of challenges, teaching innovations and strategies for reform," *Journal of Statistics Education*, vol. 20, no. 2, pp. 1-56, 2012.

[88] I. Gal, "Teaching for statistical literacy and services of statistics agencies," *The American Statistician*, vol. 57, no. 2, pp. 80-84, 2003. [Online]. Available: https://doi.org/10.1198/0003130031469 [Accessed Dec. 25, 2024].

[89] T. Koparan, "An examination of statistical literacy models and their components," *Turkish Journal of Education*, vol. 4, no. 3, pp. 16-28, 2015.

[90] S. Tishkovskaya and G. A. Lancaster, "Statistical education in the 21st century: A review of challenges, teaching innovations and strategies for reform," *Journal of Statistics Education*, vol. 20, no. 2, pp. 1-56, 2012.

[91] S. Krauss, P. Weber, K. Binder, and G. Bruckmaier, "Natural frequencies as numerical representation of proportions and uncertainty - research desiderata and some answers," *Journal für Mathematik-Didaktik*, vol. 41, pp. 485-521, 2020. [Online]. Available: https://doi.org/10.1007/s13138-019-00156-w [Accessed Jan. 19, 2025].

[92] F. C. Von Roten and Y. De Roten, "Statistics in science and in society: From a state-of-the-art to a new research agenda," *Public Understanding of Science*, vol. 22, no. 7, pp. 768-784, 2013.

[93] H. Gao and S. Wang, "The intellectual structure of research on rural-to-urban migrants: a bibliometric analysis," *International Journal of Environmental Research and Public Health*, vol. 19, no. 15, n. 9729, 2022.

[94] S. Schreiter, A. Friedrich, H. Fuhr, S. Malone, R. Brünken, J. Kuhn, and M. Vogel, "Teaching for statistical and data literacy in K-12 STEM education: a systematic review on teacher variables, teacher education, and impacts on classroom practice," *ZDM–Mathematics Education*, vol. 56, no. 1, pp. 31-45, 2024. [Online]. Available: https://doi.org/10.1007/s11858-023-01531-1 [Accessed Jan. 19, 2025].

[95] J. Ridgway, "Implications of the data revolution for statistics education," *International Statistical Review*, vol. 84, no. 3, pp. 528-549, 2016.

[96] M. Kappi and B. S. Biradar, "Scientometric analysis and visualisation of global information literacy from higher education perspective," *COLLNET Journal of Scientometrics and Information Management*, vol. 16, no. 1, pp. 125-143, 2022. [Online]. Available: https://doi.org/10.1080/09737766.2021.2017763 [Accessed Nov. 2, 2025].

[97] L. Egghe, M. Goovaerts, and H. Kretschmer, "Collaboration and productivity: An investigation into 'Scientometrics' journal and 'UHasselt' repository," *COLLNET Journal of Scientometrics and Information Management*, vol. 2, no. 1, pp. 83-89, 2008. [Online]. Available: https://doi.org/10.1080/09737766.2008.10700843 [Accessed Nov. 2, 2025].