International Research Journal of Multidisciplinary Scope (IRJMS), 2026; 7(1): 648-666

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2026.v07i01.08191

Mapping the Research Landscape of Statistical Reasoning in Education using PRISMA: A Bibliometric Analysis

Tanti Listiani[1,2] *, Dhoriva Urwatul Wustqa[1], Kuswari Hernawati[1], Wahyu Setyaningrum[1], Heri Retnawati[1]

[1]Mathematics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia, [2]Department of Mathematics Education, Faculty of Education, Universitas Pelita Harapan, Tangerang, Indonesia. *Corresponding Author's Email: tantilistiani.2023@student.uny.ac.id, tanti.listiani@uph.edu

Abstract

Statistical reasoning skills are essential for students, especially when processing statistical data. Without statistical reasoning, students will experience difficulties interpreting and concluding data. This study aims to map the research landscape on statistical reasoning by reviewing publication trends, prominent authors, influential journals, and key topics developing in this field. The methodology was a systematic review with PRISMA guidance, complemented by bibliometric analysis using VOSviewer software and R Studio-Bibliometrix. The selected years are 2005 to 2025. The analysis results show a significant increase in 2023, but in 2025 there will be a decrease because the year of analysis is still 2025. The search is based on article titles, abstracts, and keywords. A study was conducted on 180 relevant articles to investigate educational statistical reasoning. VOSviewer is used to see visualizations of the relationship between keywords; R Studio is used to see more trending trends. Software Publish or Perish Harzing is also used for citation analysis. The results indicate that the United States is the most prolific country in this field, with 65 publications out of 180 articles analyzed. At the same time, the most prolific author is Ben-Zvi, D., with eight articles. This study contributes significantly to understanding the scientific map of statistical reasoning. It is an initial reference for researchers and educators designing evidence-based research and policies for the future.

Keywords: Bibliometric, Mathematics Education, PRISMA, Statistical Reasoning, Systematic Review.

Introduction

Statistical reasoning skills are an essential cognitive aspect in dealing with the complexity of data-based information in the modern era (1, 2). In education, statistical reasoning helps students understand statistical concepts in depth, performing mathematical procedures and interpreting data, evaluating results, and making relevant conclusions (3). Statistical reasoning is the foundation for designing studies, analyzing data, and drawing valid conclusions (4). Meanwhile, this ability is needed to understand the risks, trends, and uncertainties inherent in data, thereby supporting evidence-based policy-making processes (5). Statistical reasoning involves understanding and interpreting statistical data to make informed decisions, involving cognitive skills such as critical thinking and systematic data analysis, which are esential in both academic contexts and daily life (1). The research identified several levels of statistical reasoning: (a) Idiosyncratic Reasoning, a basic level in which students are only able to write down known data (3-6); (b) Verbal reasoning, the ability to describe data orally; (c) Transitional Reasoning, an intermediate level where students can calculate measures such as mean, median, and mode; (d) Procedural Reasoning, an advanced level where students can apply statistical procedures to solve problems (3, 5–7); and (e) Integrated Process Reasoning, the highest level in which students can integrate various statistical processes and apply them comprehensively .

Factors that influence statistical reasoning include mathematical ability, where higher initial skills correlate with higher levels of reasoning, as well as attitudes and anxiety, where positive attitudes increase reasoning while high anxiety decreases it (8). Teaching statistical reasoning presents its challenges due to the abstract nature of concepts such as hypothesis testing and inferential statistics. There remains a need for reliable and valid assessment tools that cover different levels of reasoning with strong content validity (9, 10). In educational implications, incorporating statistical

(Received 13th September 2025; Accepted 24th December 2025; Published 20th January 2026)

reasoning into the curriculum can strengthen critical thinking and data analysis skills that are important in the significant data era (11, 12).

Learning strategies should be directed to develop all levels of reasoning through varied teaching approaches and assessments tailored to the different learning needs. Understanding the level of statistical reasoning and the factors that influence it can help educators improve teaching practices and strengthen students' ability to interpret and use data effectively.

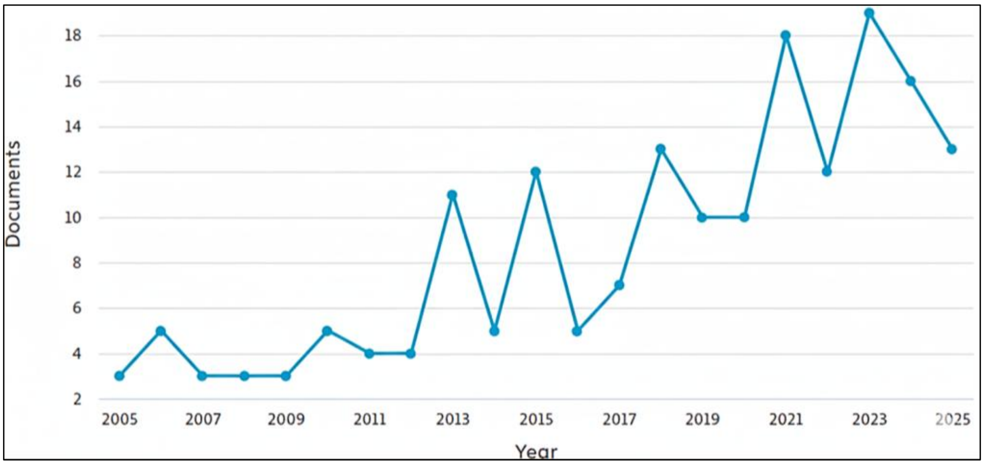

Figure 1: Documents by Year from Scopus.com

Figure 1 shows the trend of the number of documents published per year from 2005 to 2025. The data is presented in two forms: a table list on the left and a line graph on the right. The number of publications shows an increasing trend despite fluctuations from year to year. In the early period (2005–2010), the number of publications was still relatively low, ranging from 2 to 5 documents per year. Entering the period 2011–2016, the number of publications began to increase although fluctuating, with a temporary peak of 12 documents in 2013 and 14 documents in 2015. A more consistent increase was seen from 2017 onwards. In 2018, the number of documents reached 13, then continued to grow with the highest peak in 2023, namely 19 documents. 2021 also recorded a high number of publications with 18 documents, and in 2022 as many as 12 documents. In recent years, 2024 recorded 16 documents and 2025 recorded 13 documents. The figure for 2025 is likely to be temporary because the current year is not yet finished, so the number of publications recorded is lower than in previous years. Thus, this graph shows that research productivity has developed significantly in the last two decades, with a more pronounced increase after 2017. Fluctuations that occur every few years show the dynamics of research interest, but overall, the trend is positive.

This study frames statistical reasoning within three key educational theories. Connectivism highlights the role of digital networks, data analysis tools, and scholarly collaboration. Its consistent with bibliometric findings on research interconnectedness. Communities of Practice emphasizes that statistical reasoning develops through social participation in academic and professional communities. Meanwhile, the Teacher Professional Learning Framework links its growth to strengthened teacher competencies through continuous research engagement and training. Integrating these perspectives demonstrates how learning ecosystems and professional collaboration shape the ongoing development of statistical reasoning in education.

Although research on statistical reasoning has grown over the last two decades, most studies focus on specific topics such as levels of reasoning, assessment tools, or teaching strategies in isolated educational contexts. What remains unclear is how statistical reasoning as a field has evolved conceptually and methodologically across global research ecosystems. Existing literature lacks a comprehensive synthesis that connects research outputs to broader theoretical frameworks, such as networked learning through Connectivism, social knowledge-building through Communities of Practice, and educators' growth as modeled in Teacher Professional Learning frameworks.

Therefore, a systematic mapping of scholarly productivity, collaboration structures, and thematic development is needed to better understand how statistical reasoning is conceptualized, practiced, and advanced within the learning sciences and mathematics education community. This study seeks to fill that gap by employing a systematic review and bibliometric analysis to reveal how the field is structured and where future inquiry should be directed.

This research is expected to make a strategic contribution to statistical course that rely on data analysis in decision-making, such as social sciences, medicine, economics, and public policy. By mapping a comprehensive scientific map, the results of this study can be a basis for researchers and practitioners to design further research, formulate learning curricula, and strengthen statistical literacy in the general society. RQ1: What is the current trend and the impact of publishing on implementing statistical reasoning in education? RQ2: Which countries, authors, and institutions are most productive and influential in researching statistical reasoning in education? RQ3: How do authors and countries collaborate in publications about statistical reasoning in education? RQ4: What are the dominant themes among scholars regarding statistical reasoning in education?

Methodology

Research Design

This study uses the Systematic Literature Review (SLR) with bibliometric analysis to map the research landscape related to statistical reasoning in education. This approach aims to identify, evaluate, and synthesize relevant studies systematically and transparently and uncover patterns of publication, scholarly collaboration, and development of key themes in literature. Systematic Literature Review (SLR) is a structured methodology to identify, evaluate, and synthesize all relevant studies on a particular research question or topic. This process is rigorous and verifiable, including the formulation of research questions, protocol development, literature search, screening, quality assessment, data extraction, and synthesis (13, 14). Bibliometric Analysis is a quantitative method used to analyze bibliographic materials. This analysis helps understand scientific publications' growth, performance, and impact. This method involves the use of various indicators such as the number of citations, h-index, and impact factors to assess the influence of research outputs (15–17).

Data Resource

This study utilized only the Scopus database because bibliometrics analyses are mainly performed by retrieving publications from Scopus database (18). The publication time range is set from 2005 to 2025, to reflect the latest trends in the development of statistical reasoning over the past decade. Literature search uses a combination of keywords such as: "statistical reasoning", "reasoning in statistics", "statistical in education", and "statistical thinking". The total identified articles were 1990 articles. Additionally, the study utilized Microsoft Excel to compute each publication's citation frequency and percentage as well as to create appropriate graphical representations.

PRISMA Guidance

The literature selection process follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) stage. The PRISMA guidelines are essential to ensure that systematic review and meta-analysis are conducted rigorously and transparently, to produce high-quality evidence for clinical decision-making and further research (19, 20). The PRISMA protocol includes four main stages, namely identification, screening, eligibility and inclusion.

Identification, the initial search was done by entering keywords in the selected database (21). The articles found are extracted into the *reference manager* i.e., Mendeley to avoid duplication.

Table 1 are the keywords that included in searching phase "statistical reasoning", "reasoning in statistics", "statistical in education", and "statistical thinking". At the identification stage, 1990 articles were obtained. Screening, titles and abstracts were screened to assess their initial relevance to the focus of the study (22).

Table 1: The Search String for the Identification Phase

Searching phase	Search string
Identification	(TITLE-ABS-KEY ("statistical reasoning") OR TITLE-ABS-KEY ("reasoning in statistics") OR TITLE-ABS-KEY ("statistics reasoning in education") OR TITLE-ABS-KEY ("statistical thinking"))

Table 2: The Search String for the Screening Phase

Searching phase	Search string
Screening	(TITLE-ABS-KEY ("statistical reasoning") OR TITLE-ABS-KEY ("reasoning in statistics") OR TITLE-ABS-KEY ("statistics reasoning in education") OR TITLE-ABS-KEY ("statistical thinking")) AND PUBYEAR > 2004 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "MATH") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "COMP")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

Table 2 shows the screening stage selected for the years 2005-2025, the scope chosen is limited to "Social Sciences", "Computer Sciences", and "Mathematics". From the 1990 selected articles, screening was then carried out where 1027 articles were obtained. In addition, the scope of his journal related to statistical reasoning in the field of education is also seen. For unrelated journals, exclusion is carried out. The language chosen was only English then only journal articles were selected, in these section 726 articles were obtained. In addition, in terms of language, only English was chosen, where there were 688 articles.

The inclusion criteria included articles written in English. The primary focus is on *statistical reasoning* in the context of education, learning, assessment, or understanding of statistical concepts. Published in peer-reviewed journals in the 2005–2025 timeframe. The exclusion criteria include non-scientific articles, such as editorials, opinions, or conference reports that are not peer-reviewed.

The article is reviewed to evaluate suitability based on inclusion and exclusion criteria (23). At the eligibility stage, journals relevant to the statistical context in the field of education are selected; other than that, exclusion is carried out. In this section, choose suitable journals such as Statistics Education Research Journal, Teaching Statistics, Educational Studies in Mathematics, etc. In this section, 207 articles based on the appropriate journals were obtained. Furthermore, the selection excludes several keywords unrelated to statistical reasoning in education, such as Apis, Arabic, Capstone, Bell Test Loophole and others. To exclude this keyword, 181 articles were obtained. At this stage, in addition to narrowing the corpus to 181 eligible articles through title, abstract, and scope screening, the researcher carried out a systematic quality appraisal. This appraisal aimed to ensure that each included study demonstrated methodological soundness, conceptual relevance to statistical reasoning, and credible evidence to support the synthesized findings in this review.

Inclusion, articles that met the criteria were included in the final analysis, namely 180 articles detected in R Studio and then analyzed using the program. Articles with a primary focus on mathematical statistics without exploration of the reasoning aspect. The PRISMA flowchart in Figure 2 will display the number of initial and final articles, which transparently visualizes the screening and literature selection process.

Figure 2 shows the PRISMA-based identification, screening, and inclusion process of publications on statistical reasoning retrieved from the Scopus database (2005–2025).

The systematic screening process resulted in 180 journal articles deemed relevant and included for bibliometric analysis after applying subject area, language, and topical relevance criteria.

Bibliometric Analyze

Bibliometric analysis was performed to identify trends and patterns in the collected literature (24–26). Some of the software and analysis packages used in this study include:

VOSviewer, used to create and visualize bibliometric maps, such as co-authorship and keyword networks (27). R-Studio Program for more in-depth statistical and thematic analysis.

The types of analysis carried out include co-authorship analysis which is to identify collaborations between authors or institutions. Keyword co-occurrence, to explore thematic relationships based on the co-occurrence of keywords in publications. Journal and citation analysis, to determine the most productive and influential journals in this field. Thematic

evolution, to map the development of statistical reasoning research themes over time.
This analysis is expected to be able to describe the intellectual structure and dynamics of research development in statistical reasoning, so that it can make a strategic contribution to the development of statistical education science and practice in the future.

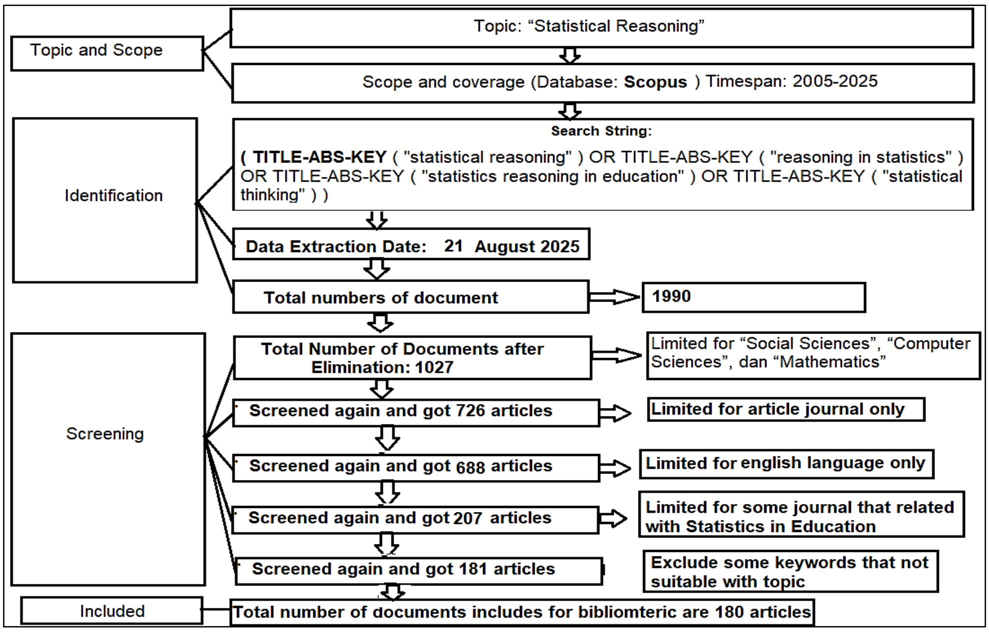

Figure 2: Document Selection Using the PRISMA Method

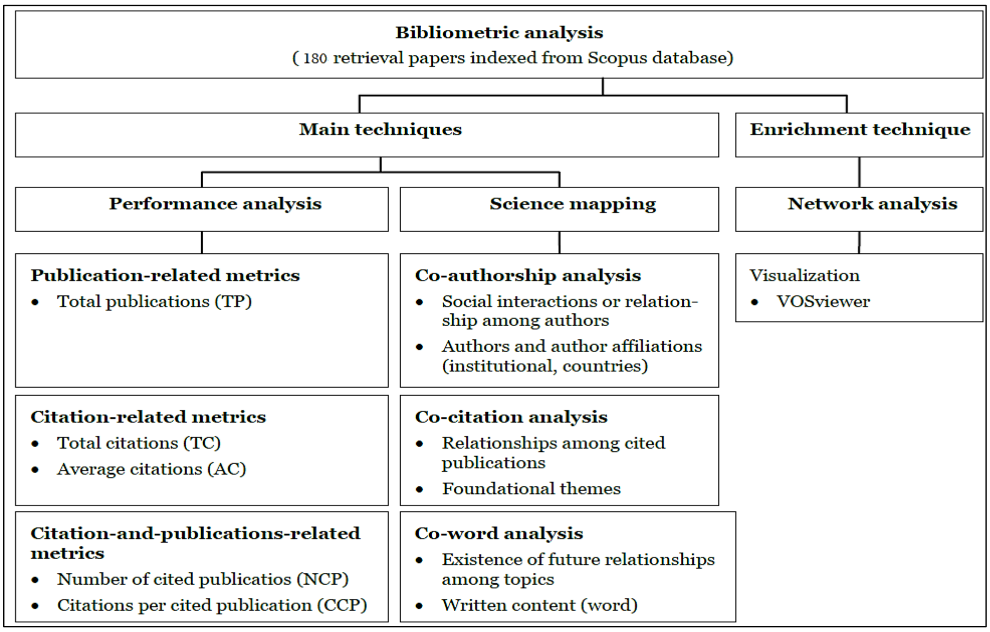

Figure 3: The Bibliometric Analysis Toolbox for This Research

Results

In this section, it represents the current trend in this topic using two aspects based on the growth in publications and the type of documents and sources please see in the Figure 3.
Figure 3 framework of bibliometric analysis applied to 180 Scopus-indexed publications. The analysis integrates performance analysis, science mapping, and network visualization techniques to examine publication productivity, citation impact, and thematic as well as collaborative structures in the research field.

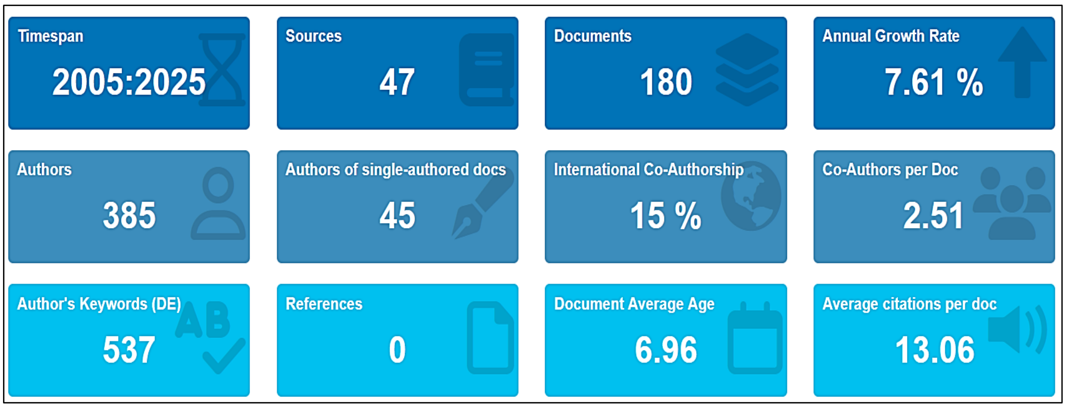

Figure 4: Main Information Regarding Research (Analysis with R Program)

Figure 4 presents statistics on academic publications from 2005 to 2025, covering 180 documents from 47 sources. The number of authors involved reached 385 people, with 45 documents written by one author alone. The publication's annual growth rate was 7.61%, indicating a consistent upward trend. International collaboration was recorded at 15%, and the average number of authors per document was 2.51. The author uses 537 keywords (Author's Keywords/DE). The average age of the document was 6.96 years, and each document received an average of 13.06 citations, reflecting a considerable level of influence in the academic community.

The results presented here are based on the results obtained in the R Studio Program. The data presented relate to publication trends from year to year and the countries that collaborate and are most productive. In addition, the authors also identify the most productive institutions and researchers, the sources of publications that produce the most documents in this field, and the documents that have the highest number of citations.

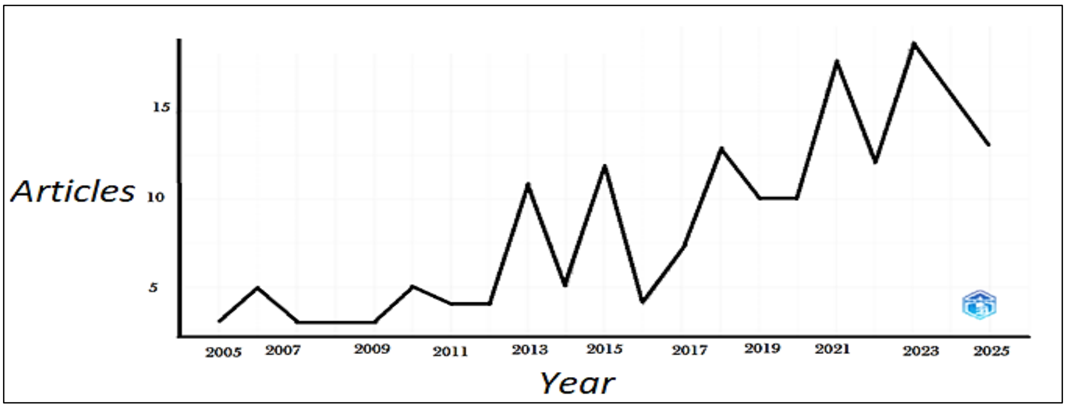

Figure 5: Number of Publications from 2005-2025 (with R Program)

Figure 5 shows the annual scientific production from 2005 to 2025 which an upward trend despite fluctuations. In the early period (2005–2011), the number of publications was still low, averaging only 2 to 5 articles per year. Entering the 2012–2017 period, there began to be an increase in productivity, although it was not stable, with a temporary peak in 2015 of around 12 articles. Furthermore, the 2018–2025 shows more consistent and significant growth, with the highest peak in 2022 reaching around 18 articles. Although in 2024–2025 there will be a slight decline, the number of publications remains at a higher level than in the previous period. Overall, this graph indicates a positive development in research activities, with a relatively straightforward trend of improvement from year to year.

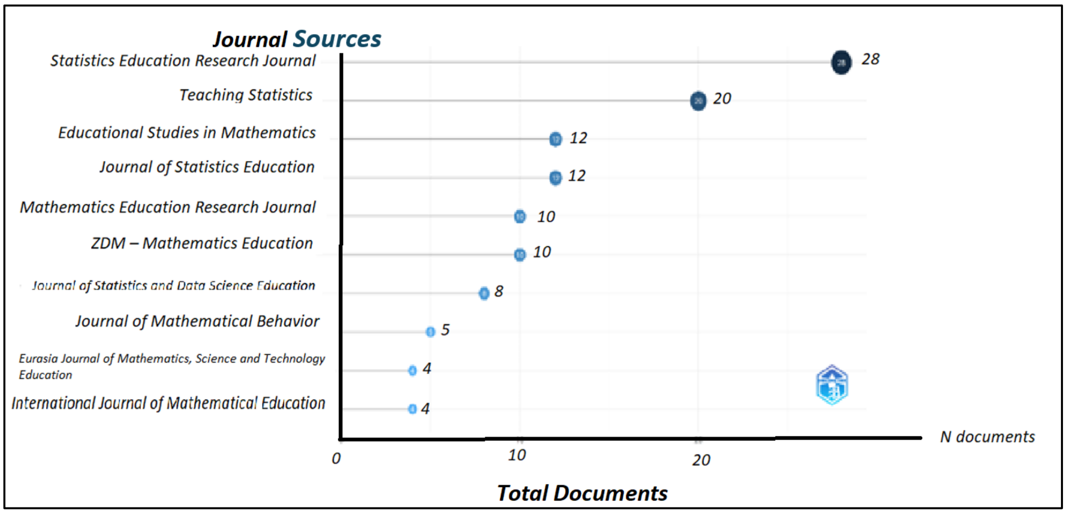

Figure 6. Most Relevant Sources

Figure 6 is the results of the analysis of publication sources which show that research in this field is the most published in *the Statistics Education Research Journal* with a total of 28 documents, followed by *Teaching Statistics* with 20 documents. Furthermore, *the Educational Studies in Mathematics* and *the Journal of Statistics Education* each contributed 12 documents, while *the Mathematics Education Research Journal* and *ZDM – Mathematics Education* each contributed 10 documents. The *Journal of Statistics and Data Science Education* recorded 8 documents, followed by *the Journal of Mathematical Behavior*, *Eurasia Journal of Mathematics, Science and Technology Education*, and *the International Journal of Mathematical Education in Science and Technology* which each has 4–5 documents. These findings show that the main publication channels for related research are dominated by journals that focus on statistics and mathematics education, with the top two journals*, the Statistics Education Research Journal* and *Teaching Statistics,* being the main forum for disseminating research results in these fields.

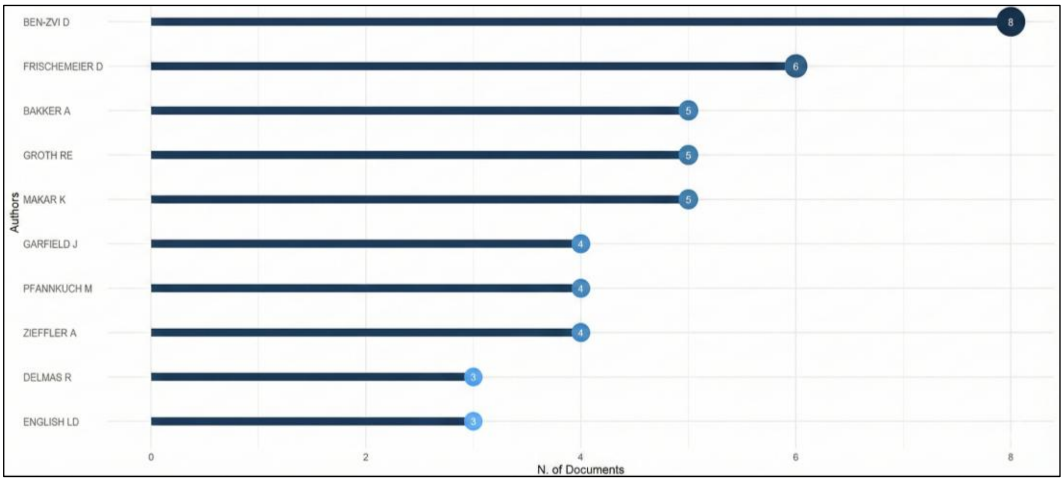

Figure 7: Most Relevant Authors

Figure 7 shows the results of the analysis of the most relevant authors show that Ben-Zvi D is the most contributor with 8 documents, followed by Frischemeier D with 6 documents. Furthermore, there are three authors who have the same contribution, namely Bakker A, Groth RE, and Makar K, each with 5 documents. Other authors who also played a considerable role were Garfield J, Pfannkuch M, and Zieffler A, who each contributed 4 documents. The Delmas R and English LD added 3 documents contributions. Overall, this distribution shows that research in this area is dominated by a few key authors who consistently produce publications, with Ben-Zvi D being the most prolific and influential figure in the publication network.

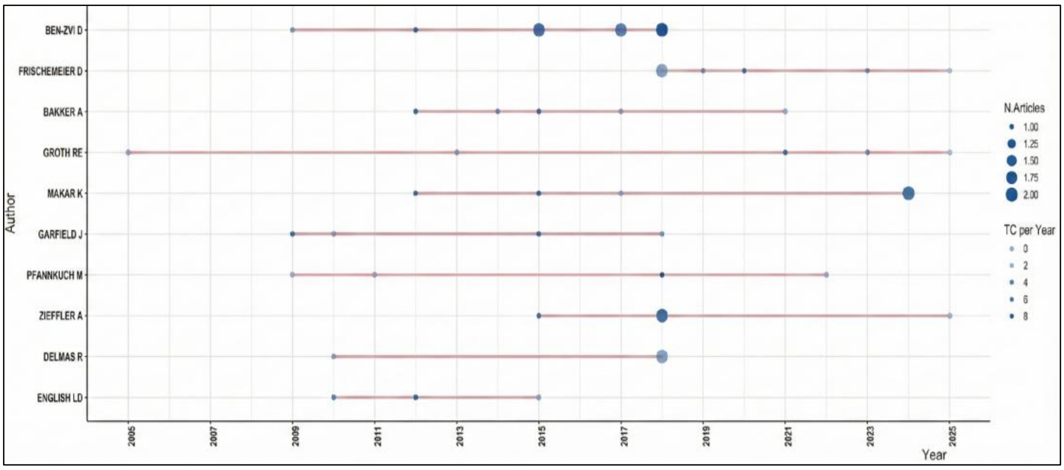

Figure 8: Authors' Production Over Time

Figure 8 shows the "Authors' Production over Time" graph shows the productivity dynamics of the major authors' publications in the period 2005 to 2025. Ben-Zvi D has the most consistent productivity with article contributions from the early 2010s to 2018, including several publications with a high number of citations. Frischemeier D began to be active in a later period, around 2017 to 2024, with a tendency to continue to be productive. Meanwhile, Bakker A, Groth RE, and Makar K showed stable engagement over long spans of time, each producing articles in different periods. Garfield J and Pfannkuch M were also seen to be active from the late 2000s to the mid-2010s, although their productivity was relatively limited. Zieffler A and Delmas R had a peak contribution around 2015–2017, while English LD showed productivity spread out since the early 2010s but with fewer articles. Overall, this graph shows that the contributions of the main authors are spread across different periods, with a tendency to increase the intensity of publication in the mid-2010s, which marks a phase of productivity growth in this field of research.

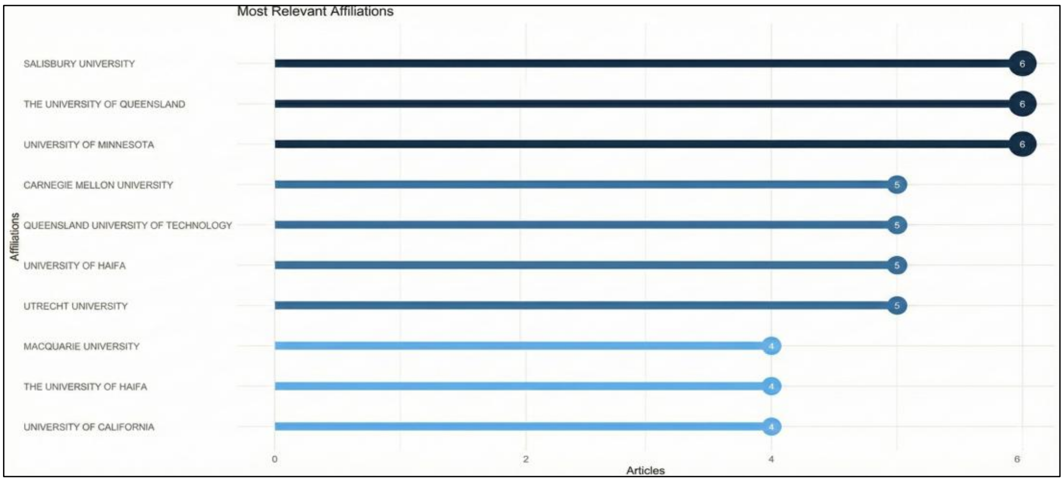

Figure 9: Most Relevant Affiliations

Figure 9 shows the results of the most relevant affiliation analysis show that Salisbury University, The University of Queensland, and the University of Minnesota are the institutions with the highest contributions, each producing 6 articles. Furthermore, there are several universities with the same contribution, namely Carnegie Mellon University, Queensland University of Technology, University of Haifa, and Utrecht University, which each contributed 5 articles. Meanwhile, Macquarie University, The University of Haifa, and the University of California were recorded to have lower contributions with 4 articles each. These findings indicate that research in this area is concentrated at a number of well-known universities in the United States, Australia, and Europe, with a strong dominance of institutions focused on statistics and mathematics education.

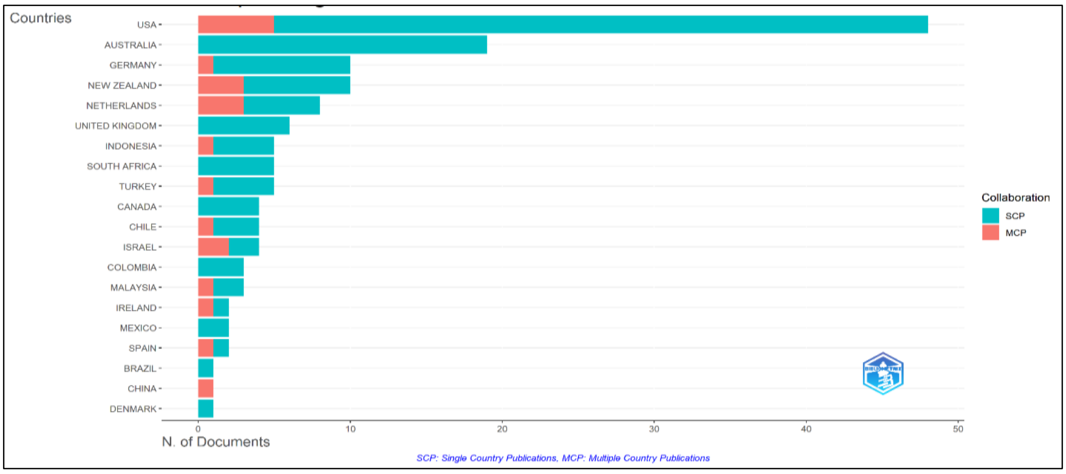

Figure 10: Corresponding Author's Countries

Figure 10 shows the "Corresponding Author's Countries" graph shows the distribution of the countries of origin of the authors of the correspondence in the publications analyzed. The United States (USA) occupies the top position with the greatest number of documents, at 49 publications, far surpassing any other country. Australia followed in second place with a significant contribution, followed by Germany, New Zealand, the Netherlands, and the United Kingdom. Indonesia also emerged as one of the contributing countries with a considerable number of publications. In addition, other countries such as South Africa, Turkey, Canada, Chile, Israel, Colombia, Malaysia, Ireland, Mexico, Spain, Brazil, China, and Denmark made smaller contributions. The pattern of collaboration can be seen through two categories, namely Single Country Publications (SCP) which dominates in most countries, and Multiple Country Publications (MCP) which shows international cooperation, especially in large countries such as the USA, Australia, Germany, and New Zealand. Overall, these results confirm the dominance of the United States in publications, followed by several other developed countries that actively collaborate across countries.

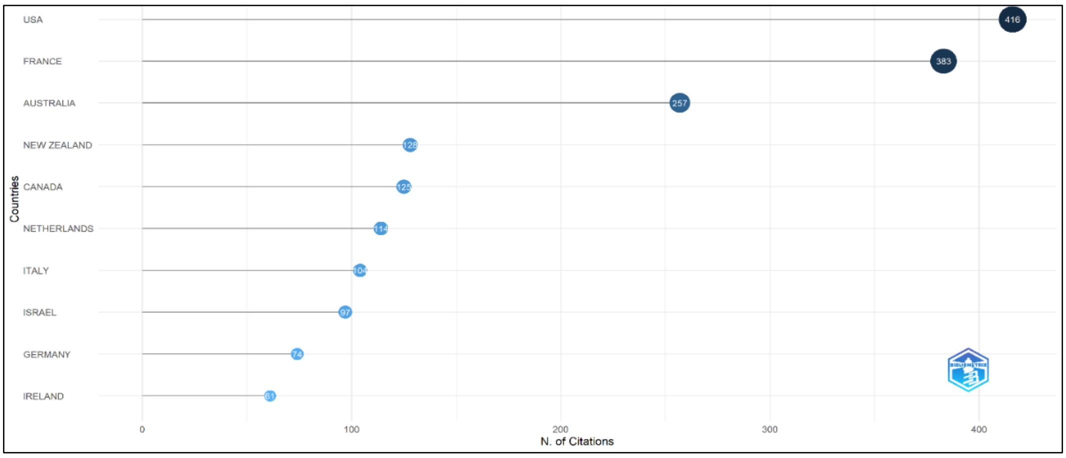

Figure 11: Most Cited Countries

Figure 11 the "Most Cited Countries" graph shows the distribution of countries with the highest number of citations in the publications analyzed. The United States (USA) occupies the highest position with a total of 416 citations, followed by France with 383 citations and Australia with 257 citations. Other countries that also showed considerable contributions were New Zealand (128 citations) and Canada (123 citations). Meanwhile, the Netherlands, Italy, Israel, Germany, and Ireland each accounted for a lower number of citations, ranging from 31 to 112 citations. Overall, these data show that publications from developed countries, particularly the USA, France, and Australia, have the highest academic impact in this field, as reflected in the high number of citations received. These findings confirm the important role these countries play in shaping the direction and development of global research.

Figure 12 shows the "Most Relevant Words" graph displays the most frequently appearing keywords in related publications. The results showed that "statistical reasoning" was the most dominant keyword with 47 occurrences, followed by "statistical thinking" with 40 occurrences and "statistical education research" with 30 occurrences. Furthermore, the keyword "statistical education" appeared 17 times, while "statistical literacy" and "teaching" appeared 14 times respectively. Other keywords that are also used quite often include "teaching statistics" (13 times), "statistics" (11 times), and "informal statistical inference" (10 times). These findings indicate that the main focus of research in this area revolves around the development of statistical reasoning and thinking, as well as the study of statistical literacy and education, which are core topics in the relevant research literature.

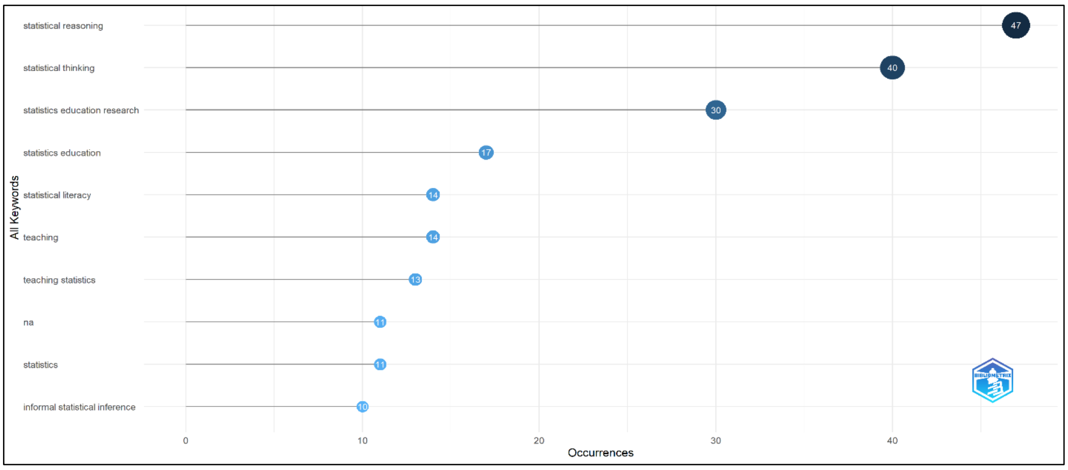

Figure 12: Most Relevant Words

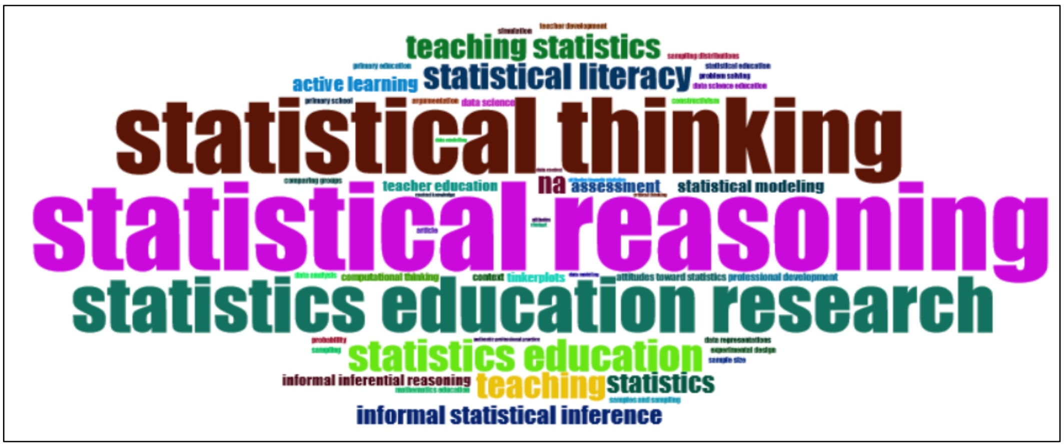

Figure 13: Word Cloud Picture

Figure 13 of the word cloud shows the most prominent keywords in related publications, with the font size reflecting the frequency of use. The terms "statistical reasoning", "statistical thinking", and "statistical education research" dominate, indicating that the main topic of research focuses on the development of statistical reasoning, statistical thinking, and the study of statistical education. In addition, keywords such as "statistical education", "statistical literacy", "teaching statistics", and "informal statistical inference" also appear in a large size, indicating that literacy, teaching, and informal approaches in statistical inference are important themes that are widely researched. The presence of other keywords such as "assessment", "active learning", and "teacher education" shows that issues related to learning strategies, evaluation, and teacher education are also part of the main discourse. Overall, this word cloud illustrates the research concentration on strengthening statistical thinking skills as well as developing more effective statistical education practices.

Figure 14 of the treemap shows the distribution of the most used keywords in publications, with the size of the box indicating the frequency with which they appear. The keyword "statistical reasoning" dominates with 47 occurrences (14%), followed by "statistical thinking" with 40 occurrences (12%) and "statistical education research" with 30 occurrences (9%). Furthermore, the keyword "statistical education" appeared 17 times (5%), while "teaching" and "statistical literacy" appeared 14 times (4%) respectively. Other keywords that are also quite prominent are "teaching statistics" (13 times), "statistics" (11 times), as well as "informal statistical inference", "active learning", and "assessment" which have a smaller portion (2–3%).

Overall, this treemap shows that research in this field is very focused on the themes of statistical reasoning, statistical thinking, and statistical education research, with supporting issues related to literacy, teaching, active learning, and assessment. This confirms that the main focus of the literature lies in the development of critical thinking skills in statistics as well as the application of effective learning strategies.

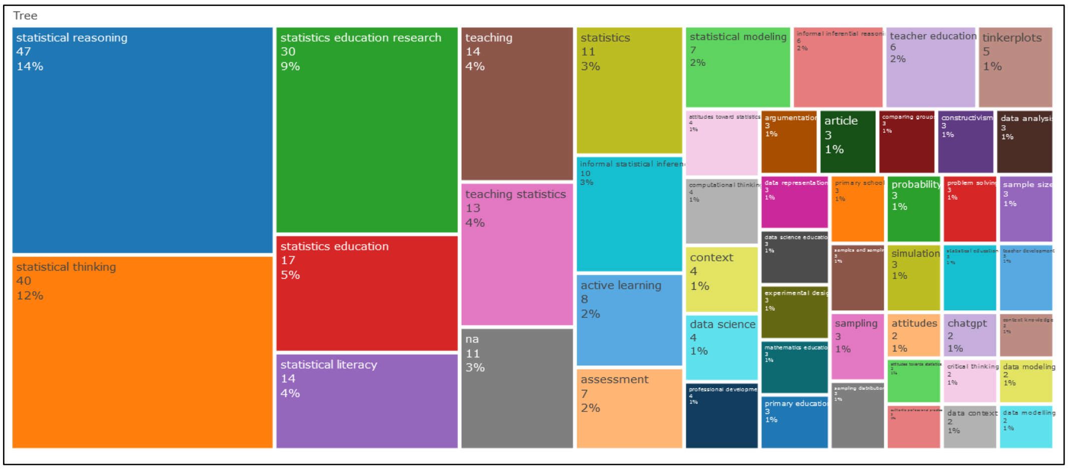

Figure 14: Treemap

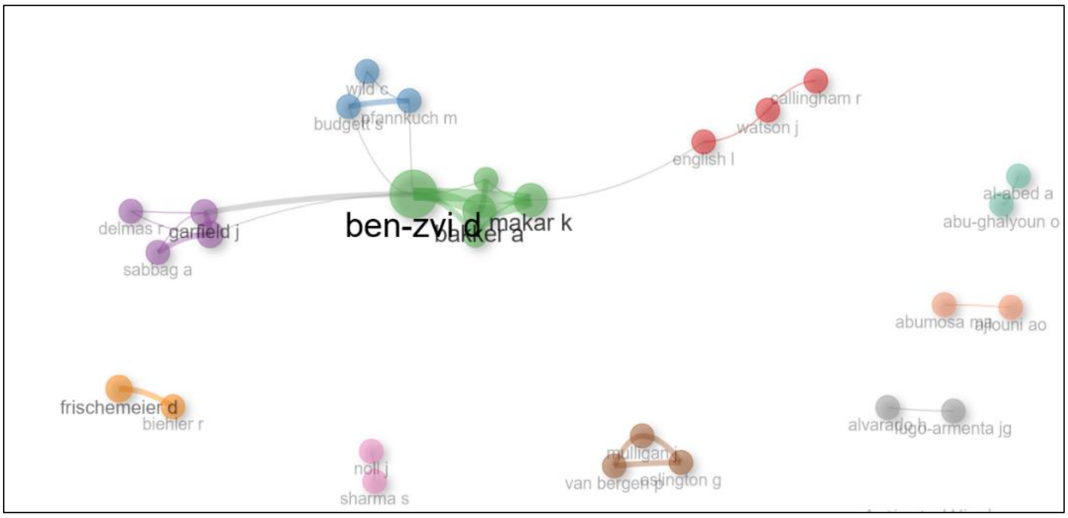

Figure 15: Co-authorship Network Visualization

Figure 15 is a visualization of the co-authorship network that shows the pattern of collaboration between authors in research in the field of statistics education. It can be seen that Ben-Zvi, D. and Makar, K. emerged as the core authors with the largest nodes, indicating a high level of productivity as well as a role as the main liaison of various other research groups. The collaborative network is divided into several clusters, including: the green cluster as the main center involving Ben-Zvi and Makar who contribute a lot to the topics of *statistical reasoning* and *statistical thinking*; the purple cluster consisting of Garfield J and Delmas R, known for their contributions to the development *of assessment* and *statistical literacy*; and the blue cluster with Wild S and Pfannkuch M which focuses on *statistical thinking* and *data modeling*. In addition, there is a red cluster involving Watson J and Callingham R, focusing on *statistical literacy* and *curriculum design*; an orange cluster with Frischemeier D and Biehler R who often research *teacher education* and the use of *digital tools* in statistical learning; and a brown cluster with Mulligan J and Van Bergen which tend to be related to *mathematics education* and *numeracy*. Beyond that, there are several small clusters (gray, pink, light green) that show more limited collaboration, usually new researchers or those working in specific contexts. In general, this network shows that research in *statistical reasoning, thinking, and literacy* is dominated by central figures who form the core of global collaboration, but also begins to develop with the emergence of new researchers who build their own clusters according to the theme or research area.

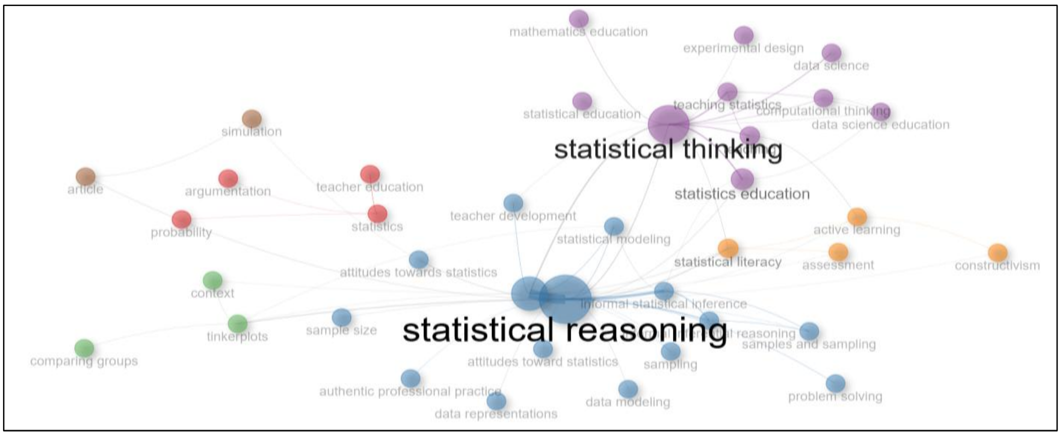

Figure 16: Network Visualization

Figure 16 is a network visualization of the results of co-word analysis that shows the relationship between research themes in the field of statistics education. It can be seen that statistical reasoning (the largest node is dark blue) is at the center of the network, confirming its role as the dominant theme that comes up most often while connecting it to various other topics. In addition, statistical thinking and statistics education (large purple nodes) also occupy an important position as the main companion that is often directly related to *statistical reasoning*. Several support clusters have also strengthened this network, such as statistical literacy (orange) which is closely related to *assessment, constructivism,* and *active learning*, illustrating a focus on pedagogical approaches to the development of statistical literacy; teacher education (red) related to *simulation* and *argumentation*, emphasizing the importance of simulation-based teaching strategies and discussions; and data science and computational/statistical thinking (light purple) connected to *mathematics education* and *experimental design*, reflecting the integration of statistical research within the framework of the modern STEM curriculum. In addition, there are also smaller nodes such as TinkerPlots and comparing groups (green) that show concern for the use of data visualization software for exploration-based learning. In general, this pattern indicates that *statistical reasoning* plays a central hub, *statistical thinking* as a major conceptual theme, and *statistical literacy* as an applicative theme related to pedagogy, while cluster *teacher education, simulation, and argumentation* affirm the important role of teacher development in statistical education research.

Figure 17 illustrates the thematic map of research in the field of statistics education which is mapped into four quadrants based on *the dimensions of relevance/centrality* and *development/density*. In the Motor Themes quadrant (top right), topics such as *problem solving, statistical methods, uncertainty, statistical reasoning, statistical literacy, teacher education,* and the use of *TinkerPlots software* are the main drivers that are very relevant and well developed, indicating the direction of applicable and innovative research. The Niche Themes quadrant (top left) is filled with more specific topics such as *data representations,* *elementary students, predictive reasoning, flipped classroom,* and *project-based learning* that have conceptual depth but are relatively limited in scope. Meanwhile, the Emerging/Declining Themes quadrant (bottom left) shows themes that are still ambiguous, such as *data science, STEM, quantitative skills, textbooks, attitudes,* and *misconceptions*, which can be interpreted as new areas that are growing (especially the integration of *STEM* and *data science*), or conversely old themes whose relevance is beginning to decline (e.g. *textbooks* or *attitudes*). The Basic Themes quadrant (bottom right) includes *statistical thinking, statistics education, primary school, descriptive statistics, probability distributions,* and *teaching*, which are the basic foundations of research, are central but have not been worked on in depth.

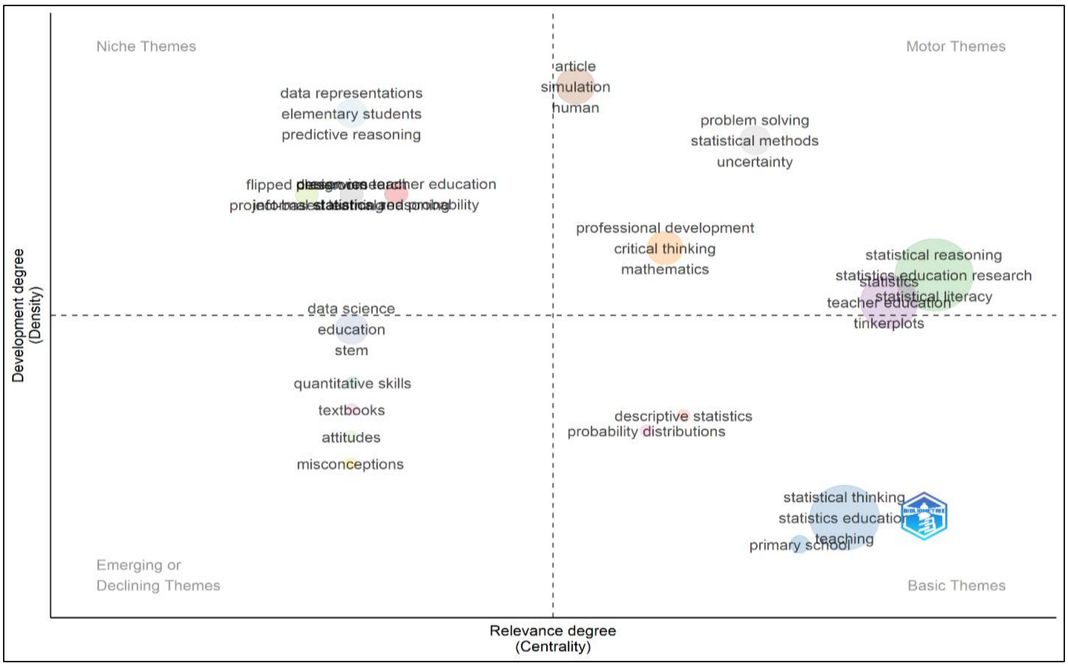

Figure 17: Network Visualization Map of the Co-Authorship Based on Author

Overall, this map shows that statistics education has a strong foundation in statistical reasoning and statistical thinking, with development directed at problem-solving-based learning strategies, increasing statistical literacy, and the use of technology. At the same time, there is a great opportunity to strengthen the integration of STEM and data science as emerging themes, as well as deepen the exploration of basic topics such as *descriptive statistics* and *probability distributions*. If combined with the results of *the previous thematic map*, it can be concluded that statistical reasoning is the main motor of research, statistical thinking functions as a fundamental concept that bridges theory and application, statistical literacy develops closely related to pedagogical strategies, and data science and STEM are beginning to occupy a strategic position as new themes connected to statistics education.

Figure 18 is the result of an analysis of co-authorship networks in the field of statistical education, which is visualized using VOSviewer. Each node represents an author, while the connecting line indicates a collaborative relationship in the publication. Different colors indicate the existence of a collaboration cluster that is interconnected. The visualization results show that Ben-Zvi, D. emerged as a central node with a high level of connectivity to various other authors, especially with Bakker, A. and Makar, K. who also had a central position in the red collaboration group. This group appears to dominate the network because it contains authors who focus on research related to statistical reasoning, inquiry-based learning, and the use of technology in statistical education.

In addition, there are other groups such as Garfield, J. – Zieffler, A. – Delmas, R. – Sabbag, A. (green cluster), which contribute strongly to the development of statistical reasoning assessment instruments and the development of a curriculum based on Guidelines for Assessment and Instruction in Statistics Education (GAISE). Pfannkuch, M. – Wild, C. – Budgett, S. (blue cluster), which stands out with its research related to statistical thinking and real-context approaches in learning. English, L. – Callingham, R. (yellow cluster), with a focus on the integration of mathematics and statistics education, particularly in learning at the elementary school level. This network shows that research in the field of statistics education is supported by a number of key figures with a close collaborative network. Ben-Zvi, Bakker, and Makar can be considered the core of the international research community, while Garfield *et al*. and Pfannkuch *et al*. have made strong contributions in the field of assessment and the development of statistical frameworks.

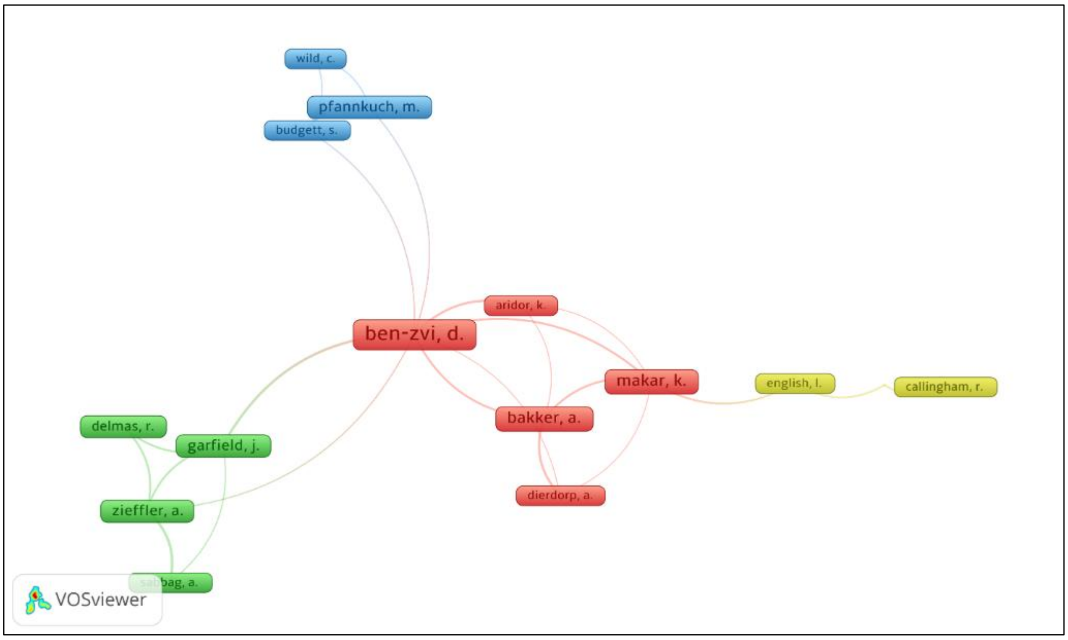

Figure 18: Network Visualization Map of Co-Authorship Based on Country

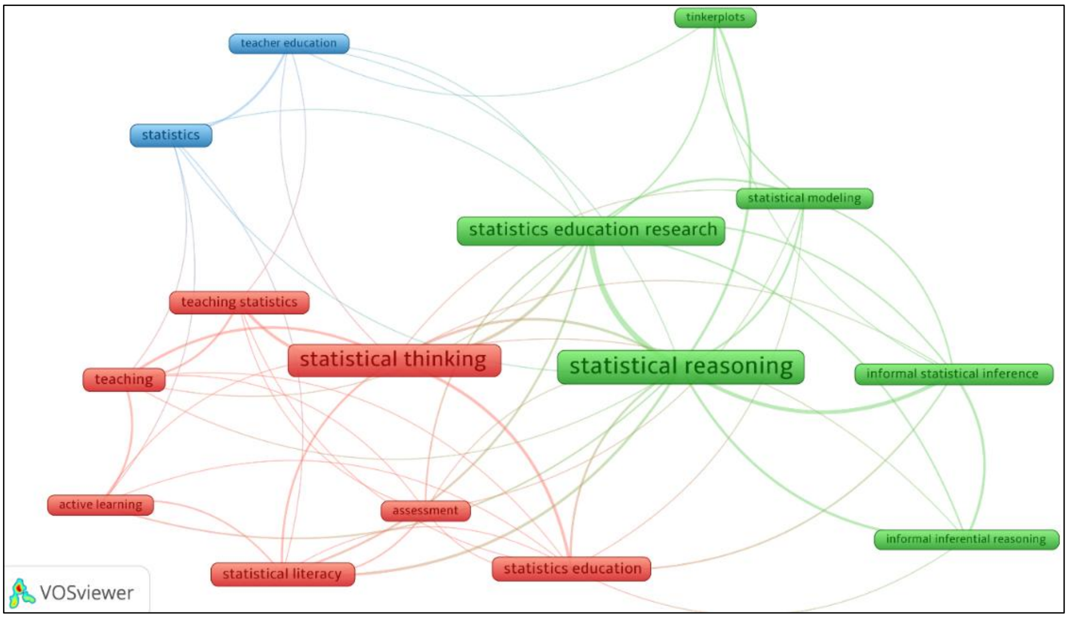

Figure 19: VOSviewer Visualization of Co-occurrence Based on Index Keywords

Figure 19 shows a map of the keyword co-occurrence network in statistical education research visualized through VOSviewer. Each node represents a keyword that is frequently used in publications, while the connecting line indicates the co-existence between keywords in a scientific article. Different colors form clusters, each of which represents a specific research theme. From this visualization, three main clusters were found. The green cluster places *statistical reasoning* as the dominant core, with a close relationship between *statistical education research, statistical modeling,* *informal statistical inference, informal inferential reasoning,* and the use of software such as *TinkerPlots*. This confirms that *statistical reasoning research* is developing strongly in the context of conceptual models, informal inferential reasoning, and technological support. The red cluster focuses on *statistical thinking, statistical education, statistical literacy, assessment,* and *active learning*. This theme represents the pedagogical dimension, namely how literacy, thinking, and statistical reasoning are built through active learning strategies and appropriate assessment. The close relationship between *teaching statistics* and *active learning* shows that active-based learning is an important pillar in statistics education. Meanwhile, the blue cluster highlights *statistics* and *teacher education*, which focuses on the integration of statistics education in teacher education programs. The position of this cluster in relation to the green and red clusters shows that teacher education serves as a bridge between pedagogy-based research and research on statistical reasoning.

Overall, this network emphasizes that statistical reasoning is the main research center in contemporary statistics education, which is supported by two important domains: pedagogical development (*statistical thinking, literacy, assessment, active learning*) and the context of teacher *education* implementation). Thus, the development of research in this field not only builds a theoretical construction of statistical reasoning, but also emphasizes practical application through innovative learning design, assessment, and the use of technology in statistical learning.

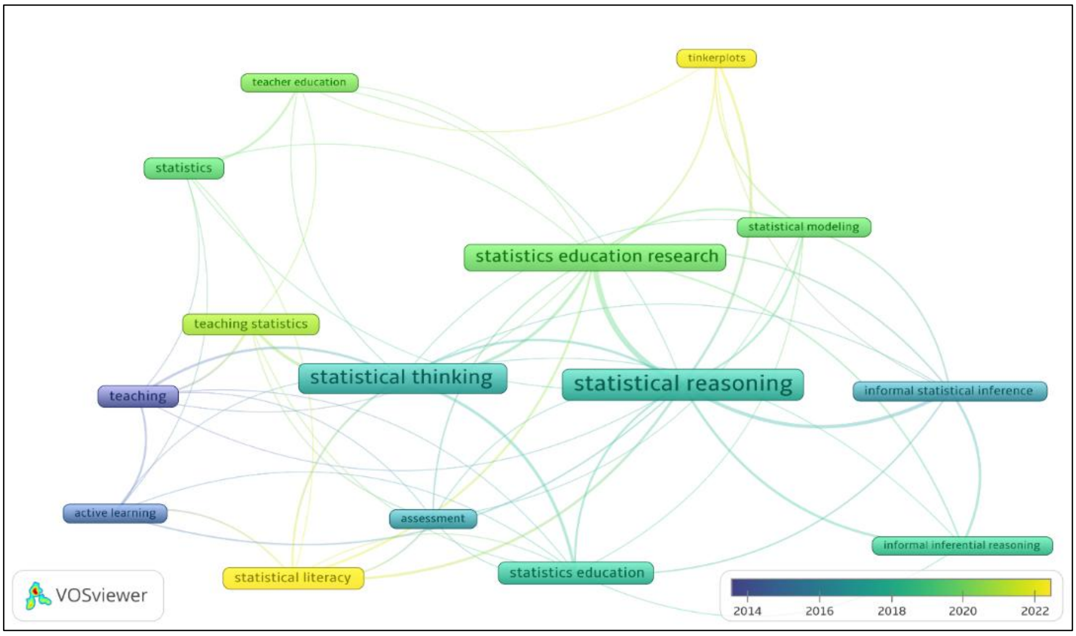

Figure 20: VOSviewer Overlay Visualization of Co-occurrence Based on Keywords

Figure 20 shows a map of keyword co-occurrence with a temporal visualization overlay in research in the field of statistics education. The color of the node indicates the dominant period of occurrence of each keyword in the literature, with gradations from blue (early, around 2014–2016), green (middle period, 2016–2019), to yellow (most recent period, 2020–2022). From this visualization, several important patterns appear. First, the consistent core keywords are *statistical reasoning* and *statistical thinking*, which emerged since the middle period (bluish-green) and continues to develop to this day. Both occupy a central position in the network, signifying their role as core concepts in statistical education research. Second, the initial development of the research (2014–2016, in blue) focused more on basic pedagogical aspects, with keywords such as *teaching*, *active learning*, and *assessment*. In this period, research was largely directed at teaching strategies to build an initial understanding of statistics. Third, the middle phase (2016–2019, in green) shows the strengthening of the pedagogical dimension and the context of teacher education, with keywords such as *statistics education research*, *teacher education*, and *statistics*. This marks a shift in research attention towards the development of teacher education and empirical research in statistical learning. Fourth, the latest research trends (2020–2022, in yellow) show the emergence of new themes such as *TinkerPlots*, *statistical modeling*, and *informal inferential reasoning*. These themes indicate a direction of research that emphasizes more on the use of technology, the development of conceptual models, and the strengthening of informal inferential reasoning.

Overall, this map illustrates the evolution of statistical education research: from an initial pedagogical focus (*teaching, active learning, assessment*), progressing towards the integration of teacher education and statistical reasoning theory (*teacher education, statistical reasoning, statistical thinking*), to moving to contemporary issues emphasizing the integration of technology and conceptual understanding (*TinkerPlots, statistical modeling, informal inferential reasoning*). This shift suggests that the direction of research is now more complex, balancing the pedagogical dimension with technological innovation and advanced conceptual reasoning.

Discussion

Bibliometric analysis was carried out to map the development of research related to *statistical reasoning, thinking, and literacy* in statistics lectures. The results of the analysis are displayed through a map of author collaboration, keyword networks, publication distribution by country, and the rate of citations of the author's country.

Author Collaboration Network

The author's collaborative network map shows that there are several main clusters that act as research centers in this field. The names Ben-Zvi and Makar stand out with the large size of the nodes, indicating high productivity and strong connections with other authors. These two authors also serve as a liaison between clusters, demonstrating their role as *bridging authors* in connecting global research networks. In addition, other authors such as Garfield, Wild, English, and Callingham have also appeared who have made significant contributions to this topic. This pattern indicates that research on *statistical reasoning* is more led by a few key authors who are consistently collaborative, while most other authors tend to work in small groups with limited connectivity.

Keyword Co-Occurrence

Keyword analysis shows that the terms statistical reasoning, statistical thinking, and statistical literacy dominate the research map. These three keywords are closely related, showing that research in this field focuses on developing students' competencies in understanding, interpreting, and using statistical data critically. In addition, related keywords such as assessment, education, and learning appeared, which emphasized that the research context is generally in the realm of higher education. These findings show the consistency of the main themes of research as well as opportunities to develop interdisciplinary studies, for example by linking statistical literacy with digital literacy or the use of learning technology.

Distribution of Publications by Country of Author

The distribution of the correspondent authors' publications shows that the United States is the country with the highest publication contributions, followed by Australia, Germany, New Zealand, and the Netherlands. These countries dominate both in terms of single country *publications (SCPs*) and international collaborations (*Multiple Country Publications / MCPs*). An interesting finding is that some developing countries, including Indonesia, Malaysia, Turkey, and South Africa, are starting to be included in the publication map although the numbers are still limited. This shows the potential for research growth in the region, which can be enhanced through international collaboration with established countries in this field.

Countries with the Highest Citations

When viewed from the number of citations, a slightly different pattern can be seen. The United States remains ranked first with 416 citations, confirming its role as a major center in this research. However, what is interesting is that France occupies the second position with 383 citations, although the number of publications is not as large as that of the Anglo-Saxon countries. This shows that research from France has a very high impact internationally. Australia is in third place with 257 citations, followed by New Zealand with 128, Canada with 125, Netherlands with 112, and Italy with 106. In contrast, although Germany is quite productive in the number of publications, the number of citations is relatively low with 71. These findings confirm that the quality of publication and the relevance of the topic determine the level of citations rather than just the number of articles published.

Synthesis of Results

Overall, the bibliometric results show that statistical reasoning, thinking, and literacy research is still concentrated on researchers and institutions from developed countries, especially the Anglo-Saxon region. There is a significant difference between the number of publications and the number of citations. Some countries (e.g. Germany) are productive but less impactful, while others (such as France) although not very much publicity are very influential but have a great influence. The contribution of developing countries, including Indonesia, has begun to be seen but is still limited and tends to be a single publication. This opens opportunities to expand international research collaboration networks so that they can increase the visibility and impact of research. A consistent research focus on education and assessment aspects opens up space for new innovations, especially the integration of learning technologies to improve students' literacy and statistical reasoning.

Conclusion

This bibliometric analysis confirms that research on *statistical reasoning, thinking, and literacy* is still dominated by authors and institutions from developed countries, with the United States, Australia, and France being the main centers both in terms of productivity and the impact of citations. Nevertheless, the emergence of contributions from developing countries, including Indonesia, shows a trend of expanding global participation. The implication of these findings is the importance of strengthening international collaboration networks so that research from developing countries is more visible and impactful in the global literature. In addition, the consistency of the research theme in the realm of education and assessment opens up opportunities for integration with digital technology and innovative learning approaches, so that the research results not only enrich academic treasures but also make a practical contribution in improving the quality of statistical learning in the digital era.

These bibliometric findings confirm the dominance of developed countries in *statistical reasoning, thinking, and literacy research*, but also show the contribution of developing countries that are starting to grow. To strengthen impact, cross-border and cross-disciplinary collaboration needs to be expanded. Thus, this study not only maps the research landscape, but also opens a strategic direction for the development of statistical research and learning practices in the future. This study provides a comprehensive mapping of the research landscape on statistical reasoning in education over the past two decades. By utilizing bibliometric techniques, the study reveals the intellectual structure of the field, identifies the most influential authors and collaborative networks, and highlights key thematic trajectories shaping current directions in statistical reasoning research. The findings underline the increasing emphasis on technology integration, active and project-based learning environments, and the development of students' statistical literacy to support informed decision-making in real-world contexts.

The contribution of this study lies in offering a structured and data-driven synthesis that enables educators, researchers, and policymakers to better understand how scholarly attention has evolved and where significant gaps remain. The results have important implications for instructional design and professional development, particularly in aligning pedagogical practices with the cognitive demands of contemporary statistics education.

Despite its strengths, this research has limitations that should be acknowledged. The analysis relied solely on the Scopus database, which may exclude some relevant publications indexed elsewhere. In addition, while thematic clustering reveals conceptual directions, this study did not include an in-depth quality assessment of the individual studies, nor did it directly evaluate how these trends translate into classroom practices.

Future research should therefore aim to incorporate a broader range of databases and perform more detailed methodological evaluations. Further inquiry into the alignment between bibliometric findings and real instructional outcomes, such as student reasoning processes, resilience in learning, and adaptability in data-driven problem solving, is also needed. Strengthening the linkage between theory and practice will ensure that continued growth in this field contributes meaningfully to statistical learning at all educational levels.

Overall, this review establishes a clearer foundation for advancing innovative pedagogical models and assessment approaches that foster robust statistical reasoning. By offering actionable insight into prevailing trends and emerging opportunities, the study can guide strategic efforts to enhance statistics education in response to evolving global needs.

Abbreviations

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses, RQs: Research Questions, SLR: Systematic Literature Review, SR: Statistical Reasoning, SRE: Statistical Reasoning in Education.

Acknowledgement

We thank LPPM UPH for the support that facilitated the smooth implementation of this research with the number of research of 110/SKR-UPH/VII/2025.

Author Contributions

Tanti Listiani: conceptualization, methodology, investigation, data collection, managed software, data curation, coordinated project administration and resources, drafting the original manuscript, preparing visualizations, performing validation, editing, Dhoriva Urwatul Wutsqa: conceptualization, supervision, formal analysis, supported validation, reviewing the manuscript, Kuswari Hernawati: supervision throughout the research process, validation of results, participated in critical review of the manuscript, Wahyu Setyaningrum: supervision, validation of the methodology, findings, reviewing the manuscript, Heri Retnawati: supervision of the study, validation of the analysis and interpretation, review and refinement of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Declaration of Artificial Intelligence (AI) Assistance

The authors declare that Artificial Intelligence (AI) tools, specifically ChatGPT developed by OpenAI, were used to support the writing process of this manuscript. The AI assistance was limited to improving language clarity, generating wording suggestions, and enhancing the overall readability. The authors independently reviewed, verified, and are fully responsible for the accuracy and integrity of the content presented in this paper.

Ethics Approval

This study did not involve human participants or animals; therefore, ethical approval was not required.

Funding

The research project is funded by the internal university grants of 110/SKR-UPH/VII/2025 from the LPPM Universitas Pelita Harapan.

References

1. Griffin RJ, Dunwoody S. Chair support, faculty entrepreneurship, and the teaching of statistical reasoning to journalism undergraduates in the United States. Journalism. 2016;17(1):97–118.
2. Rahmatina D, Nusantara T, Parta IN, *et al*. Statistical Reasoning Process of Students in Decision Making Using Commognitive Framework. Acta Sci. 2022;24(3):63–88.
3. Sukoriyanto S, Khurin'in K. Statistical reasoning of junior high school students in solving central tendency problems mean, median, and modus. AIP Conference Proceedings. 2023;2569:040020. https://doi.org/10.1063/5.0112343
4. White BJ, Larson RL, Theurer ME. Interpreting statistics from published research to answer clinical and management questions. J Anim Sci. 2016;94(11):4959–71.
5. Jauhari ALR, Ariany RL, Fardillah F, *et al*. Profile of students' statistical reasoning capabilities in introductory social statistics courses. J Phys Conf Ser. 2021;1764:012118. https://iopscience.iop.org/article/10.1088/1742-6596/1764/1/012118/pdf
6. Rufiana SI, Sa'Dijah C, Susanto H, *et al*. Statistical reasoning levels of students in prediction tasks. J Phys Conf Ser. 2019. https://ui.adsabs.harvard.edu/abs/2019JPhCS1315a2075S/abstract
7. Setianingsih R, Rahmah DA. Procedural Reasoning, an advanced level where students can apply statistical procedures to solve problems. J Phys Conf Ser. 2020;1569;042064. https://doi.org/10.1088/1742-6596/1569/4/042064
8. Saidi SS, Siew NM. Assessing secondary school students' statistical reasoning, attitudes towards statistics, and statistics anxiety. Stat Educ Res J. 2022;21(1):1–19.
9. Chan SW, Ismail Z, Sumintono B. A refined technology-based statistical reasoning assessment tool in descriptive statistics. Adv Sci Lett. 2015;21(7):2352–5. https://doi.org/10.1166/asl.2015.6273
10. Sabbag A, Garfield J, Zieffler A. Assessing Statistical Literacy and Statistical Reasoning: The REALI Instrument. Stat Educ Res J. 2018;17(2):141–60.
11. Hamid AHA, Cui Z. Data analysis skills in teaching leadership: A strategic study to improve student learning outcomes and digital literacy. Int J Instr

Cases. 2024;8(1):309–29. https://ijicases.com/menuscript/index.php/ijicases/article/view/146/99

12. Tsai YC. Empowering students through active learning in educational big data analytics. Smart Learn Environ. 2024;11(1):14. https://doi.org/10.1186/s40561-024-00300-1
13. Krüger J, Lausberger C, von Nostitz-Wallwitz I, *et al*. Search. Review. Repeat? An empirical study of threats to replicating SLR searches. Empir Softw Eng. 2020;25(1):627–77.
14. Aleu FG, Flores F, Perez J, *et al*. Assessing systematic literature review bias: Kaizen events in hospitals case study. In: Proceedings of the International Conference on Industrial Engineering and Operations Management. School of Engineering and Technology, Universidad de Monterrey, San Pedro Garza Garcia, NL, 45000, Mexico: IEOM Society; 2020:3086–91. https://doi.org/10.46254/AN10.20200223
15. Boiarskii B, Lyude A, Boiarskaia A, *et al*. Bibliometric analysis of the Japan-Russia scientific cooperation networks using R bibliometrix. J Infrastructure Policy Dev. 2024;8(8):6155. https://doi.org/10.24294/jipd.v8i8.6155
16. Donthu N, Kumar S, Mukherjee D, *et al*. How to conduct a bibliometric analysis: An overview and guidelines. J Bus Res. 2021;133:285–96. https://doi.org/10.1016/j.jbusres.2021.04.070
17. Supian S, Ismail N. Mapping in the topic of mathematical model in paddy agricultural insurance based on bibliometric analysis: A systematic review approach. Computation. 2022;10(4):50. https://doi.org/10.3390/computation10040050
18. Echchakoui S. Why and how to merge Scopus and Web of Science during bibliometric analysis: the case of sales force literature from 1912 to 2019. J Mark Anal. 2020;8(3):165–84.
19. Moher D, Altman DG, Tetzlaff J. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). In: Guidelines for Reporting Health Research: A User's Manual. Ottawa Hospital Research Institute, Ottawa, ON, Canada: Wiley Blackwell. 2014:250–61. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118715598
20. Wang CW. Writing systematic reviews. In: English for Medical Communication: A Guide to Course Design. Centre for Applied English Studies, University of Hong Kong, Hong Kong: Taylor and Francis; 2025: 219–38. https://doi.org/10.4324/9781003375654-11
21. Mateo S. A procedure for conduction of a successful literature review using the PRISMA method. Kinesitherapie. 2020;20(226):29–37.
22. Pote JY, Sediyono E, Iriani A. Conceptual model of quality improvement gamification framework. In: AIP Conference Proceedings. Department of Computer Science, Universitas Kristen Satya Wacana, Central Java, Salatiga City, Indonesia: American Institute of Physics; 2024. https://pubs.aip.org/aip/acp/article-pdf/doi/10.1063/5.0210541/19965075/030002_1_5.0210541.pdf
23. Galli F. Manuscript Selection in a Literature Review: "Free-Full-Text-or-Next" as a New Criterion. Int Rev Res Open Distrib Learn. 2025;26(1):258–60.
24. Chen H, Tsang YP, Wu CH. When text mining meets science mapping in the bibliometric analysis: A review and future opportunities. Int J Eng Bus Manag. 2023;15: 18479790231222349. https://journals.sagepub.com/doi/pdf/10.1177/18479790231222349
25. Gómez MCS, García JLC, Castro SV, *et al*. Research Methods in the Educational Field: Bibliometric Analysis - A Comparative Study between Scopus and WoS. Rev Esp Educ Comp. 2025;(46):141–72.
26. Marvi R, Foroudi MM. Bibliometric analysis: Main procedure and guidelines. In: Researching and Analysing Business: Research Methods in Practice. Aston Business School, United Kingdom: Taylor and Francis; 2023:43–54. https://www.taylorfrancis.com/chapters/edit/10.4324/9781003107774-4/bibliometric-analysis-reza-marvi-mohammad-foroudi
27. Knapczyk A, Francik S, Pedryc N, *et al*. Bibliometric analysis of research trends in engineering for rural development. In: Engineering for Rural Development. University of Agriculture, Krakow, Poland: Latvia University of Agriculture; 2018:23–25. https://www.iitf.lbtu.lv/conference/proceedings2018/Papers/N389.pdf

How to Cite: Listiani T, Wustqa DU, Hernawati K, Setyaningrum W, Retnawati H. Mapping the Research Landscape of Statistical Reasoning in Education using PRISMA: A Bibliometric Analysis. Int Res J Multidiscip Scope. 2026; 7(1): 648-666. DOI: 10.47857/irjms.2026.v07i01.08191