

Unpacking Data Literacy in Mathematics Education: A Systematic Review of Research Trends and Thematic Developments

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Abstract

Data literacy has become an essential skill in the digital era, yet its integration into mathematics education remains fragmented. As data-driven decision-making gains prominence in instructional practices, understanding how teachers engage with data literacy is crucial for enhancing student learning outcomes. This systematic review synthesizes research on data literacy in mathematics education from 2009 to 2024, employing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure a transparent and replicable study selection process. Bibliometric analysis was conducted using VOSviewer to map research trends, key themes, and collaborative networks in the field. The findings indicate a growing emphasis on teacher competency in data literacy, with studies highlighting its correlation with effective instructional strategies and improved learner engagement. Additionally, the review reveals that teachers' perceptions and confidence in utilizing data significantly influence their pedagogical approaches. The results also suggest that institutional support, professional development, and leadership play a critical role in fostering a data-literate teaching workforce. Despite an increasing body of research, gaps remain in understanding how data literacy directly impacts long-term student achievement. The study underscores the need to integrate data literacy within broader educational frameworks and policies to enhance mathematics instruction. Future research should further explore contextual challenges, intervention strategies, and the role of technology in strengthening data literacy among educators.

Keywords: Data literacy, mathematics education, systematic review, instructional decision-making, teacher competency, professional development

Introduction

Data literacy has emerged as a fundamental skill in the digital society (Carmi et al., 2020). The vast amount of data continuously generated in the digital world is only beneficial when individuals possess the necessary data literacy skills to access, collect, analyze, interpret, and use data effectively (Pangrazio & Sefton-Green, 2020). However, despite the rapid increase in data generation, the advancement of data literacy skills has not kept pace (Mosia et al., 2024; Henderson & Corry, 2021).

This gap in data literacy has significant implications for mathematics education, as it limits the effective use of data for decision-making and instructional improvement (Cowie & Cooper, 2017). Henderson and Corry (2021) emphasize that data literacy is crucial in mathematics education, particularly for teachers who require strong data literacy skills to enhance students' performance. Additionally, fostering a culture of data literacy is essential for both teaching and learning mathematics. As a result, the

recognition of the importance of improving data literacy skills, especially within mathematics education, is growing (Raffaghelli & Stewart, 2020). Early integration of data literacy skills into undergraduate teacher education programs has the potential to promote effective data management practices and enhance instructional quality (Womack, 2015; Pothier & Condon, 2019).

With the increasing acknowledgment of data literacy's role in mathematics education, a growing body of literature has emerged on the topic (Dodman et al., 2023; Egara & Mogege, 2024; Egara et al., 2025; Mosia et al., 2025a, 2025b, 2025c). Research on data literacy in mathematics education spans various educational contexts, including formal schooling, vocational training, higher education, and workplace learning. Despite this growing interest, challenges persist in effectively developing teachers' data literacy skills (Raffaghelli & Stewart, 2020). Teaching data literacy is further complicated by three

key factors: the continuous evolution of technologies and data sources, the shifting landscape of mathematics education, and the diverse contexts in which data literacy is applied.

Given these complexities, there is a pressing need to systematically examine the current state of data literacy in mathematics education. However, despite the increasing research interest, few systematic reviews have been conducted on this topic (Pinto et al., 2023). Therefore, this study aimed to provide a comprehensive systematic review based on a widely accepted framework to help educators and researchers better understand the current trends in data literacy in mathematics education and guide future teaching and research efforts.

Literature Review

Data literacy refers to teachers' ability to transform information into actionable instructional knowledge and practices by collecting, assessing, and interpreting various types of data, such as assessments, to guide instructional decisions (Mandinach & Abrams, 2022). Henderson and Corry (2021) argue that data literacy and technology are inseparable, as many teachers have access to both qualitative and quantitative data through school or district-level databases. Learning information systems, learning management systems, and online testing platforms are among the key technologies that teachers must navigate to extract data and interpret visualizations effectively.

Machine learning and artificial intelligence (AI) systems play increasingly significant roles in data-driven decision-making, offering recommendations based on extensive data collected from learner keystrokes, progress tracking, and performance outcomes in digital learning environments (Ahmad et al., 2020). Consequently, data literacy is seen as an essential skill, enabling teachers to make well-informed and meaningful educational decisions (Pinto, 2023). In mathematics classrooms, teacher data literacy not only enhances student performance but also fosters an effective culture of teaching and learning.

Despite the recognized importance of data literacy, research suggests that many teachers lack confidence in their data literacy skills and do not perceive data-driven decision-making as useful. For example, a study conducted in the United States by Cowie and Cooper (2016) found that mathematics teachers were often uncomfortable with data literacy and hesitant to integrate data into their teaching practices, resulting in slow instructional improvement. In South Africa, Botha (2015) discovered that district-level decisions regarding interventions for underperforming schools

often exclude mathematics teachers, limiting their ability to analyze data, identify learning obstacles, and refine their instructional methods.

Developing teachers' data literacy skills requires structured professional development and collaboration. Henderson and Corry (2021) found that teachers' data literacy improves when they engage in Professional Learning Communities (PLCs) that facilitate collaboration with peers from different schools. Additionally, strong data cultures and supportive leadership have been linked to increased data literacy competency among educators. Beck and Nunnaley (2021) argue that teachers should receive training in data literacy, assessment literacy, and mathematics instruction. Effective professional development programs should challenge teachers' existing perspectives on data use, equipping them with the skills needed to integrate data-driven insights into their teaching. Similarly, Burres et al. (2020) emphasize the need for school districts to establish policies that not only promote data literacy but also enhance teacher-to-teacher communication to foster collaborative data use.

While existing literature highlights the significance of data literacy in mathematics education, there is limited research on how mathematics teachers specifically engage with data literacy in their instructional practices. To address this gap, this systematic review aims to consolidate existing research on data literacy within the context of mathematics teaching and learning. By evaluating and synthesizing findings from various studies, the review seeks to clarify the role of data literacy in instructional decision-making in mathematics education. Additionally, it aims to identify current research gaps and propose directions for future studies to enhance the effective integration of data literacy in mathematics instruction.

Research questions

The present study addressed the following research questions;

1. What are the publication trends in data literacy research within mathematics education from 2009 to 2024?
2. What are the common research aims, data analytics tools, participant demographics, variables, and methodological approaches in studies on data literacy in mathematics education?
3. How does data literacy influence teachers' instructional decision-making in mathematics classrooms?

Methods

This systematic review employed a rigorous approach to identify, select, and analyze relevant studies on data literacy in mathematics education. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Tricco et al., 2018) and incorporated bibliometric analysis to examine publication trends over time. The process involved defining inclusion and exclusion criteria, systematically searching databases using relevant keywords, screening and selecting studies, and categorizing findings based on key research themes.

Inclusion and Exclusion Criteria

A set of inclusion and exclusion criteria was applied to ensure the relevance of selected studies. Only peer-reviewed articles published in English between 2009 and 2024 were considered. Eligible studies explicitly addressed data literacy in mathematics education, including aspects such as data usage, data-driven decision-making, professional development, assessment, and school improvement. Studies focusing solely on higher education were excluded, as this review is concerned with primary school mathematics teaching and learning. Additionally, research that explored data literacy outside the context of mathematics education, as well as previous systematic reviews on related keywords, was excluded. After applying these criteria, 492 articles were selected for further analysis.

Search Strategy

A systematic search was conducted across multiple academic databases, including Scopus, Web of Science, and Google Scholar. The search focused on publications from 2009 to 2024 and utilized various keyword combinations, such as "data literacy" AND "mathematics" AND "primary school" OR "elementary school". The initial search yielded 303 articles. After removing duplicates and conducting a thorough screening process, a total of 492 papers were identified for full-text evaluation.

To answer Research Question 1, bibliometric analysis was conducted to examine publication trends, key research contributors, and dominant themes in data literacy research within mathematics education. VOSviewer, a specialized tool for bibliometric visualization, was employed to analyze co-authorship networks, citation patterns, and keyword co-occurrences across the selected studies. This helped identify the most influential research contributions and thematic clusters in the field.

Screening of Included Articles

A manual screening approach was employed to verify the relevance of selected studies. This involved a multi-step process, including title and abstract screening, followed by full-text review. The Revtools R package (Westgate, 2019) was used to eliminate duplicate bibliographic records and visualize article topics for efficient assessment. The PRISMA framework guided the screening process, and a PRISMA flow diagram was created to illustrate study selection, detailing included and excluded articles along with reasons for exclusion.

After applying all eligibility criteria, 14 studies were selected for final analysis. The included studies were categorized into two main themes: "Authors and titles of the articles" and "Study characteristics, including research aims, data analytics tools, common participants, methods, and key findings." This structured categorization provided a deeper understanding of how data literacy influences mathematics instruction (Moreno et al., 2018; Suyov-Vega et al., 2021).

Search Results

The PRISMA flow diagram (Figure 1) summarizes the selection process, highlighting the number of articles included and excluded at each stage. The primary objective of this systematic review is to identify and analyze studies that examine the role of data literacy in mathematics instruction and its influence on teachers' instructional decisions.

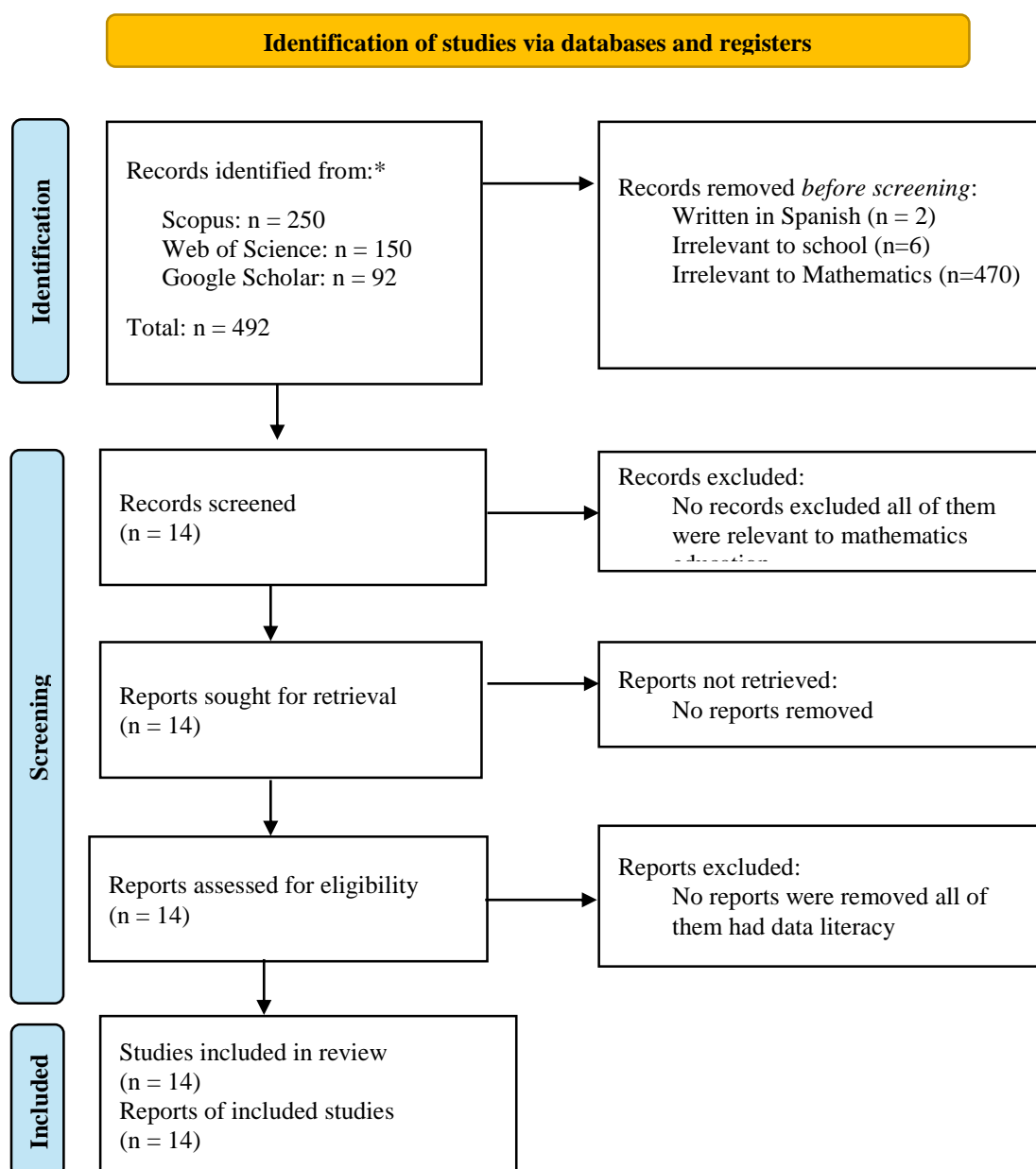


Figure 1. PRISMA Flow Diagram of Study Selection Process

Results

This section presents the findings of the systematic review in alignment with the research questions. The results are organized into two key areas: (1) Authors and titles of the articles, which provide an overview of the publication trends in data literacy research within mathematics education from 2009 to 2024, and

(2) Study characteristics, which analyze research aims, data analytics tools, participant demographics, methodological approaches, and key findings. By structuring the results in this manner, we aim to offer insights into the evolving landscape of data literacy in mathematics education and its impact on teachers' instructional decision-making.

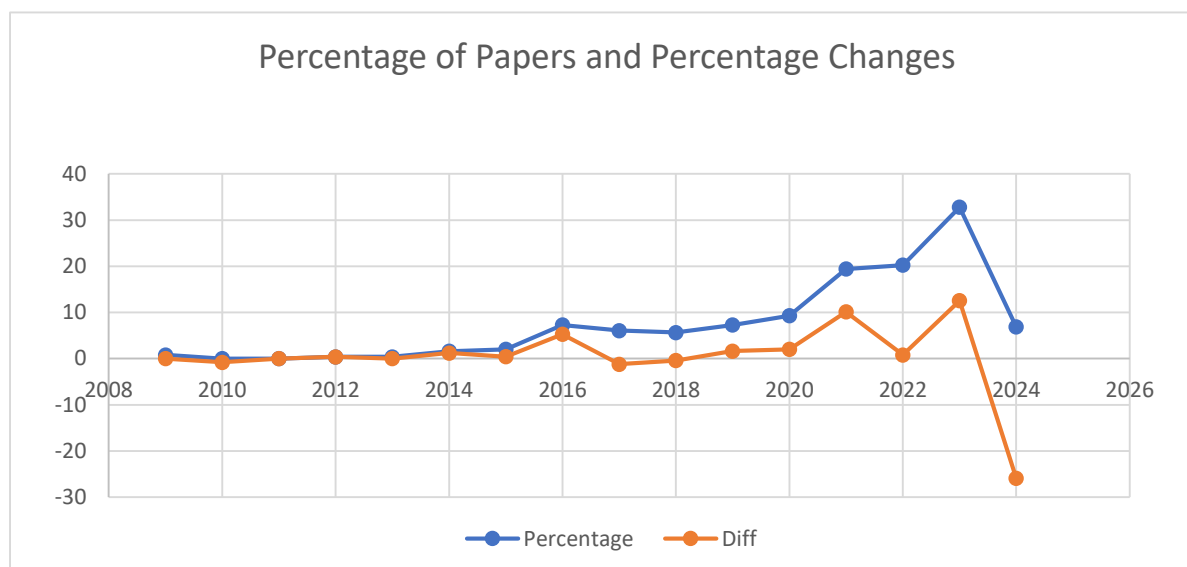
Data Overview

Table 1 presents the authors and titles of studies included in this review. These studies focus on various aspects of data literacy in mathematics education, ranging from data-driven instructional practices to teacher preparation and decision-making processes.

Table 1. Authors and titles of studies

Authors	Research Title
Benita et al. (2021)	A smart learning ecosystem design for delivering Data-driven Thinking in STEM education
Carlson et al. (2017)	A Multistate District-Level Cluster Randomized Trial of the Impact of Data-Driven Reform on Reading and Mathematics Achievement
Wu et al. (2021)	Research on the data analysis knowledge assessment of pre-service teachers from China based on cognitive diagnostic assessment.
Reeves and Honig (2015)	A classroom data literacy intervention for pre-service teachers
Means et, al. (2011)	Teachers' Ability to Use Data to Inform Instruction: Challenges and Supports
Van Geel et al. (2016)	Assessing the Effects of a School-Wide Data-Based Decision-Making Intervention on Student Achievement Growth in Primary Schools
Vahey (2012)	A cross-disciplinary approach to teaching data literacy and proportionality
Cowie and Cooper (2019)	Exploring the challenge of developing student teacher data literacy
Schildkamp and Kuiper (2010)	Data-informed curriculum reform: Which data, what purposes, and promoting and hindering factors.
Schildkamp et al. (2017)	Factors promoting and hindering data-based decision making in schools
van der Scheer and Visscher (2016)	Effects of an intensive data-based decision making intervention on teacher efficacy
Staman et al. (2017)	Effects of a data-based decision making intervention on student achievement
Hoogland et al. (2016)	Prerequisites for data-based decision making in the classroom: Research evidence and practical illustrations
Schramm-Possinger and Harris (2021)	Investigating Teacher's Practices and Beliefs of Data Literacy to Enhance Pre-service Teacher Education

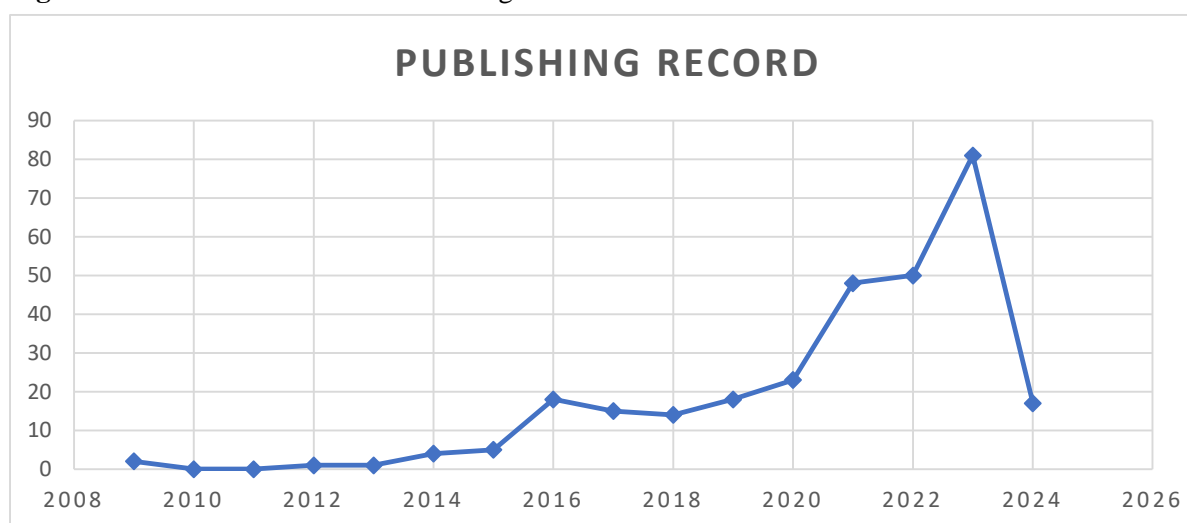
Trends in Publications on Data Literacy in Mathematics Education (2009–2024)



To examine the publication trends on data literacy in mathematics education, we analyzed articles published between 2009 and 2024. The results are presented in Figure 2 and Figure 3.

Figure 2. Publication Trend - 2009 - 2024

Figure 1. Publication Growth in Percentage



The analysis reveals that there were no publications on data literacy between 2010 and 2011. This absence aligns with the relatively recent rise in scholarly interest in data literacy, which is closely linked to advancements in artificial intelligence (Michos et al., 2023). However, from 2016 onward, there has been a noticeable upward trend in publications, peaking in 2023 with 81 papers. This period (2016–2023) saw the publication of 200 papers on data literacy, indicating sustained research interest. The red line in Figure 2, labeled “Diff,” represents the year-over-year percentage change in publications. Notably, there was a 10.12% increase in 2021 and a 12.55% increase in 2023, demonstrating growing scholarly engagement with data literacy research. Interestingly,

2024 shows a decline in publications, suggesting a potential research gap in data literacy and mathematics education that future studies could explore. Therefore, this analysis answers part of Research Question 1 by highlighting the volume and trend of publications on data literacy. The findings show a steady growth in research interest, peaking in 2023, but with a subsequent decline in 2024, signaling areas for further investigation.

Research Aims, Data Analytics Tools, Participants, and Methods

This section presents findings addressing Research Questions 2 and 3. Research Question 2 examines research aims, data analytics tools, participant



demographics, and methodologies in studies on data literacy in mathematics education. Research Question 3 explores the impact of data literacy on teachers' instructional decision-making. The findings are structured into themes corresponding to each question

for clarity (see Table 2). Table 2 summarizes the reviewed studies, including their research aims, data analytical tools, common participants, methods, and key findings.



Table 2: Summary of Studies Investigating Data Literacy in Mathematics

Study	Country	Objectives	Design	Analytic tools	Common participants	Findings
Benita et al., 2021	Singapore	The study aims at constructing a generalizable large-scale smart learning ecosystem that involves effective and efficient support (e.g., guidance, feedback, or tools) in the context of children and adolescent STEM education	Case study	ModStore	More than 90,000 students from primary school (ages 7 to 12), secondary school (13 to 16), and pre-university (17 and 18) from 129 different schools around the country.	Adoption of data-driven thinking encourages problem-solving, collaborative learning and analytic skills
Carlson et al 2017	USA	To determine the impact of data-driven reform on learners mathematics achievement by providing teachers with extensive training on interpreting and use of data reform in their classroom	Experimental study	Multilevel modeling	60 school districts, containing 500 school teachers	Learners achievement significantly improves
Cowie and Cooper 2018	USA	To explore teachers views of data literacy	Mixed Method	Thematic analysis	lecturer, student teacher and school leader	Findings suggest a concern and opportunity to develop data literacy as this calls on mathematical understanding
Reeves and Honig 2015	USA	To investigate pre-service teachers' perceptions of the impact of a 6-hour data literacy intervention which involved scoring classroom assessment and analysing, interpreting and making decisions based in the data	Mixed Method	Descriptive statistics (statistical software R and ANOVA)	64 pre-service teachers	Participant reports suggest that the intervention increased the pre-service teachers' knowledge and skills related to data literacy
Van de Scheer and Visscher 2016	The Netherlands	The study aimed to investigate the effect of an intensive Data Based Decision-Making intervention on teachers' efficacy	Experimental design	Item response theory (IRT) model	62 teachers	The findings shows that a teacher's sense of efficacy regarding instructional strategies and student engagement improved



Study	Country	Objectives	Design	Analytic tools	Common participants	Findings
						significantly by means of an intensive intervention
Means et al 2011	USA	The study examined both the implementation of student data systems and the broader set of practices involving the use of data to improve instruction, regardless of whether or not the data are stored in and accessed through an electronic system.	Exploratory sub study	Atlas.ti, a qualitative data analysis program	180 teachers and 35 administrators or specialists (such as data coaches).	Teachers likelihood of using data in decision making is affected by how confident they feel about their knowlegde and skills in data analysis and interpretation
Van Geel 2016	The Nertheland	Assessing the effect of school wide data-based decision making intervention on learners achievement in primary school	Linear mixedmethod	Linear mixed models using the differential effect	learners from 53 primary schools	Learners achievement improved especially those from low-socio economic status schools
Schildkamp and Kuiper 2010	The Nertheland	To explore how school leaders and teachers in the Netherlands use data	qualitative research methodology	Random intercept	six best-practice Dutch schools for upper secondary education	Teachers use data to change their classroom instructions and monitor learners progress
Wu et al., 2021	China	This study aimed to construct a cognitive model of teachers' data analysis knowledge and develop an instrument for its measurement, while also exploring the reliability and model fit of the assessment.	Exploratory study	Cognitive diagnostic model	531 Chinese pre-service teachers	Teachers with the same attributes have differences in attribute mastery and knowledge status
Staman et al 2017	The Nerthalands	To evaluate whether the focus intervention that was meant to equip teachers and schools for DBDM was effective in terms of accomplishing higher levels of student achievement than a	Quantitative study	The behavioural cohort	Teachers, principals, and academic coaches from 42 schools	Teachers experience difficulties in translating student progress data into adaptive instruction in the classroom.



Study	Country	Objectives	Design	Analytic tools	Common participants	Findings
		control group which was not trained for DBDM.				
Vahey et al 2012	USA	A set of four 2-week, sequential modules for cross-disciplinary implementation in seventh-grade classrooms was designed and evaluated	Quantitative approach	Proportional Assessment, Disciplinary Evaluation, Feedback Mechanism Data Literacy Metrics	Reasoning Cross- Module Teacher and educational Growth Students, curriculum researchers administrators	teachers, student data literacy was increased designers, through the focused integration of and mathematics.
Schildkamp, 2017	The Netherlands	To study the extent to which school organizational characteristics, data characteristics, user and collaboration influenced data use for (1) accountability, (2) school development, and (3) instruction	Qualitative methodology	Hierarchical linear model	1,073 teachers	teachers appear to score relatively high on data use for accountability and school development.
Schramm-Possinger & Harris (2021)	USA	This study assesses K-12 teachers' beliefs, contextual supports, and actual uses of student data	Quantitative methodology	Correlation-based PCA	Teachers administrators	Results showed that teachers' beliefs, school environments, and engagement in substantive data-driven analyses are associated with their use of periodic and classroom-based data to inform their instruction and communications with instructional coaches, students and their parents.
Hoogland et al. (2016)	The Netherlands	The study aims to identify prerequisites of data-based literature review	Systematic review	Atlas-ti	Teachers	Collaboration among teachers and their attitudes toward data use, as well as contextual variables such



Study	Country	Objectives	Design	Analytic tools	Common participants	Findings
		decision making implementation.	successful and Qualitative study			as the degree to which they are supported by school administrators, were all factors in a teacher's use of data to make decisions.

The results of this systematic review were grouped into three clusters. The first cluster comprises studies focused on teachers' competency in data literacy. The second cluster includes studies examining the impact of data-driven decision-making interventions in the teaching and learning of mathematics. The final cluster consists of studies investigating teachers' perceptions and attitudes toward data literacy and its use in education.

Cluster 1: Teachers' Competency in Data Literacy

The review revealed that teachers' competency in data literacy varies widely. Wu et al. (2021) assessed 531 pre-service teachers and found significant differences in their abilities to extract, represent, and interpret data. Similarly, Reeves and Honig (2015) reported that a six-hour intervention on data literacy led to measurable improvements in teachers' skills. Means et al. (2011) highlighted that confidence in data literacy influences teachers' ability to integrate data-driven decision-making into their instruction. Overall, the findings suggest that while some teachers have strong data literacy skills, many require targeted professional development to improve their competency.

Cluster 2: Influence of Data Use on Instructional Decisions

Teachers' data literacy significantly influences their instructional decisions. Studies by Benita et al. (2021) and Carlson et al. (2017) found that data-driven decision-making improves problem-solving, collaborative learning, and analytical skills among students. Van Geel et al. (2016) demonstrated that structured data-driven instructional approaches resulted in higher student achievement in mathematics. Furthermore, Vahey et al. (2012) emphasized that teachers who integrate data literacy into lesson planning and classroom practices enhance student engagement and performance. These findings indicate that teachers with strong data literacy skills make more informed instructional decisions, ultimately benefiting student learning outcomes.

Cluster 3: Teachers' Views on Data Use

Teachers' perceptions and attitudes toward data literacy play a crucial role in their instructional practices. Schildkamp and Kuiper (2010) found that teachers in the Netherlands actively use data to refine instructional strategies and track student progress. Schramm-Possinger and Harris (2021) reported that teachers' positive beliefs about data literacy, along with supportive school environments, encourage data-driven teaching. However, Cowie and Cooper (2018) noted that pre-service teachers often struggle with data literacy due to limited mathematical proficiency. Hoogland et al. (2016) emphasized the importance of collaboration and administrative

support in fostering positive attitudes toward data use in instruction. These findings suggest that while many teachers recognize the value of data literacy, continuous training and institutional support are needed to enhance their confidence and effectiveness in applying data-driven practices.

Discussion

Publication Trends in Data Literacy Research in Mathematics Education (2009–2024)

Our systematic review reveals a significant increase in research on data literacy in mathematics education over the past decade, particularly from 2016 onward, reflecting a growing scholarly emphasis on data-driven instructional practices. The observed peak in 2023 (81 publications) suggests heightened academic and policy interest, likely driven by the integration of artificial intelligence and data-based decision-making frameworks in educational settings (Michos et al., 2023). However, the absence of publications between 2010 and 2011 indicates that data literacy only recently emerged as a central research focus.

The fluctuations in publication volume, particularly the notable increases in 2021 (10.12%) and 2023 (12.55%), suggest a sustained interest and investment in data literacy research. However, the decline in 2024 raises critical questions about whether research momentum is slowing or if new challenges—such as methodological limitations, funding constraints, or shifts in research priorities—are emerging. Future studies should investigate whether this decline is a temporary fluctuation or signals a saturation of research themes that require new theoretical and empirical directions.

Furthermore, our findings highlight geographical disparities, with a dominance of Western contexts (e.g., the United States and the Netherlands) in data literacy research, while African and South American regions remain significantly underrepresented. This gap underscores the need for regionally contextualized studies that examine how data literacy is developed, perceived, and applied within diverse educational ecosystems. Without broader geographic representation, current research risks reinforcing Western-centric frameworks that may not fully address localized educational challenges and policy needs.

Common Research Aims, Data Analytics Tools, and Methodological Approaches

The review identified several recurring themes in research objectives. Most studies focused on (1) assessing teachers' knowledge and perceptions of data literacy, (2) evaluating interventions designed to enhance teachers' data literacy, and (3) examining the

impact of data literacy on instructional decision-making.

Regarding methodologies, our findings highlight that quantitative approaches dominated (e.g., survey-based studies, experimental interventions), while qualitative investigations (e.g., case studies, ethnographic research) were relatively limited. This suggests a gap in in-depth, contextualized understanding of how teachers interact with data in real classroom settings. Additionally, studies varied significantly in terms of participant demographics, with most focusing on in-service teachers, while pre-service teachers and school administrators were underrepresented. Addressing these gaps could provide a more holistic view of data literacy in mathematics education.

The Role of Data Literacy in Instructional Decision-Making

The review confirmed that data literacy plays a crucial role in shaping teachers' instructional decisions, particularly in adapting lessons based on student performance data. Studies such as those by Means et al. (2011) and Van de Scheer and Vissecher (2016) found that teachers who received training in data-driven instruction were better equipped to modify teaching strategies and improve student outcomes.

However, not all findings were consistent. While some interventions led to significant improvements in teaching efficacy (Van de Scheer & Vissecher, 2016), others found no measurable impact on student achievement (Statman et al., 2017). This discrepancy suggests that simply training teachers in data literacy may not be sufficient—additional factors, such as school support structures, access to user-friendly data tools, and teachers' pre-existing beliefs about data use, may play a critical role in determining the effectiveness of data-driven instruction.

Teacher-Related Variables and Challenges in Data Literacy

Our findings also highlight key teacher-related variables influencing data literacy development. Many studies (e.g., Reeves & Honig, 2015; Cowie & Cooper, 2018) reported significant gaps in teachers' foundational knowledge of data analytics, particularly among pre-service teachers. Additionally, studies revealed that teachers often struggle with interpreting complex data sets, limiting their ability to apply data-driven insights effectively. These findings underscore the urgent need for targeted professional development programs that go beyond basic statistical training to include practical, hands-on experiences with real classroom data. Moreover, research indicates that teachers' attitudes toward data literacy—whether they perceive data use

as beneficial or burdensome—can significantly influence their willingness to engage with data tools. Addressing these perceptual barriers through ongoing support and mentorship could enhance the sustained adoption of data-driven practices in mathematics classrooms.

Implications for Educational Practice and Policy

The findings of this systematic review highlight the importance of data literacy as a key component of effective mathematics instruction. Teachers who engage with data-driven decision-making demonstrate greater adaptability in their instructional approaches, which, in turn, enhances student participation and achievement. Schools should consider integrating data literacy training into professional development programs, emphasizing practical applications in mathematics classrooms to build teachers' confidence and competence in using data.

Additionally, the review underscores the influence of data literacy interventions on teachers' willingness to engage with data-driven problem-solving. Educators who receive targeted support in data literacy are more likely to adjust their instructional strategies based on student performance insights. To sustain these improvements, policymakers should prioritize funding for teacher training programs that focus on data interpretation, common misconceptions, and best practices for integrating data into mathematics instruction.

Moreover, equitable access to data-driven resources remains a critical issue. Schools in disadvantaged communities often lack access to digital tools and training opportunities that facilitate effective data use. To bridge this gap, policymakers should allocate targeted funding to support under-resourced schools in implementing data-driven teaching strategies, ensuring that all learners benefit from advancements in educational data science.

Future Research Directions

Although this review provides valuable insights, several gaps remain in the literature. First, most studies relied on self-reported data, which may introduce biases in measuring teachers' actual data literacy skills. Future research should incorporate longitudinal studies tracking how teachers' data literacy evolves over time and how sustained engagement with data impacts student learning outcomes.

Second, while quantitative studies dominated the field, there is a need for more qualitative and mixed-methods research to explore how teachers and students interact with data-driven instruction in real classroom settings. Further investigations should also examine how contextual factors—such as school

culture, access to technology, and administrative support—moderate the effectiveness of data literacy interventions.

Finally, more research is needed in underrepresented regions, particularly in Africa, South America, and Asia, where educational data literacy remains understudied. Expanding the scope of research will provide a more comprehensive understanding of how data literacy practices can be adapted to different educational contexts worldwide.

Conclusion

This systematic review highlights the growing significance of data literacy in mathematics education, particularly in shaping teachers' instructional decisions and improving student outcomes. Despite its potential, data literacy remains an emerging field with limited empirical research, particularly in non-Western educational contexts. To address the existing gaps, future studies should focus on long-term impacts, diverse methodological approaches, and regional disparities in data literacy adoption. Advancing data literacy education as a structured research domain will be essential in ensuring that teachers and students can fully benefit from data-informed instructional strategies in mathematics.

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