International Journal on Education Insight
Vol. 7, No. 2, April 2026, pp. 299-308
e-ISSN: 2722-2691 p-ISSN: 2722-2683 DOI: 10.12928/ijei.v7i2.15483
REVIEW PAPER

From misconceptions to machine models: A decade review of conceptual and technological advances in probability and combinatorics learning

Siti Nur Baiti [1], Farida Nurhasanah [1,*], Triyanto [1]

[1] Universitas Sebelas Maret, Surakarta, Jawa Tengah, Indonesia
*Corresponding author

Abstract
Abstract concept in probability and combinatorics often conflict with students' intuitive reasoning, creating persistent challenges in teaching and learning. To investigate these challenges a systematic literature review (SLR) following the PRISMA framework was conducted of 50 peer-reviewed articles published between 2015 and 2025. The articles were retrieved through WATASE UAKE, an academic literature discovery platform that provide access to a curated collection of open access educational research published in Scopus Indexed journals across quartile Q1-Q4. This study identified three key findings. First, probability dominates 84% of the literature, yet instruction remains largely mechanistic, with modern approaches such as Bayesian reasoning underutilized especially in primary education. In addition, human-centered strategies such as multiple representations, contextual modeling, and game-based learning have proven effective in addressing misconceptions but are rarely systematized in curricula. Second, while 26% of studies involved technology (CAI, GeoGebra, AI), only 10% used modern AI, and none developed systems that diagnostically adapt to student misconceptions such as equiprobability bias. Third, because curricula treat probability's classical, frequentist, and subjective perspectives as disconnected, future research should pursue cross-cultural, design-based studies that adapt effective pedagogical strategies to local curricula, alongside teacher education programs that build diagnostic competence rather than content mastery alone. This reveals a critical gap: the absence of AI-based learning materials that address the cognitive structures behind errors. This review contributes to mathematics education research by mapping the disconnect between cognitive-pedagogical strategies and AI-based innovation, an integration that remains largely absent from existing research frameworks. It also proposes a cognition-aware AI model as a novel direction for future instructional design. The study calls for curricula that integrate classical, frequentist, and subjective perspectives, and teacher education programs that strengthen epistemological understanding of uncertainty.

Keywords: artificial intelligence; combinatorics; misconceptions; multiple representations; probability; systematic literature review

How to cite: Baiti, S.N., Nurhasanah, F., & Triyanto (2026). From misconceptions to machine models: A decade review of conceptual and technological advances in probability and combinatorics learning. *International Journal on Education Insight, 7*(2), 299-308. https://doi.org/10.12928/ijei.v7i2.15483

Article history: Received 30/12/2025, Accepted 17/08/2026, Published 21/08/2026

Correspondence address: Mathematics Education Department, Universitas Sebelas Maret, Surakarta, Jawa Tengah, Indonesia. E-mail: farida.nurhasanah@staff.uns.ac.id

INTRODUCTION

Probability and combinatorics are core components of mathematics curricula at all levels of education, yet they remain one of the most challenging domains due to their abstract nature and often counterintuitive nature. Contemporary research consistently identifies persistent misconceptions among students, such as equiprobability bias (assuming all outcomes are equally likely), confusion between permutations and combinations, and misunderstandings of conditional probability (Batanero & Álvarez-Arroyo, 2024; Rico & Ruiz-Hidalgo, 2022). Furthermore, the past decade has witnessed the rapid integration of artificial intelligence (AI)-based learning technologies such as generative models (ChatGPT), neural networks (deep learning), which promise data-driven adaptive support (Xuan et al., 2025; Liu et al., 2023).

Mastery of probability and combinatorics is not only essential for continuing mathematics studies but also serves as the foundation for data literacy and decision-making in an era of uncertainty (Batanero & Álvarez-Arroyo, 2024). In the context of Indonesia's Independent Curriculum, which emphasizes data literacy, contextual problem-solving, and computational thinking, probabilistic skills become increasingly crucial. However, the dominance of mechanistic approaches that focus on applying formulas without conceptual understanding has the potential to hinder the development of these competencies (Ollerton, 2015; Rico & Ruiz-Hidalgo, 2022).

A systematic review by Batanero and Álvarez-Arroyo (2024) revealed that current research remains fragmented into two separate streams. The first stream focuses on in-depth analysis of student reasoning and the development of theory-based pedagogical strategies emphasizing constructivist, sociocultural, and didactic approaches (e.g., multiple representations, modeling, games) that have been shown to be effective in addressing misconceptions (Iversen & Nilsson, 2019; Post & Prediger, 2024). The second stream explores the implementation of AI for evaluation or instructional support, ranging from generative models like ChatGPT to neural network-based approaches for teaching reform and CNN-based pedagogical applications, but rarely integrates cognitive diagnosis of how students reason (Xuan et al., 2025; Liu et al., 2023; Qu et al., 2021; Ma et al., 2024). Furthermore, modern probabilistic approaches such as Bayesian and frequentist remain marginal in classroom practice, particularly at the elementary and secondary levels (Batanero & Álvarez-Arroyo, 2024; Ollerton, 2015).

Facing this fragmentation, this systematic literature review (SLR) aims to synthesize findings from 50 peer-reviewed articles to map the current research landscape, identify critical gaps between learning theory and technology, and formulate holistic future development directions. This SLR is guided by the following three research questions: (1) What are the main current research trends in probability and combinatorics education, particularly regarding conceptual understanding, technological innovation, and pedagogical design?; (2) What are the main gaps in our understanding of how students learn probability and combinatorics, particularly in integrating cognitive theory with emerging technologies such as AI?; (3) How can future research better support curriculum development and teacher education to promote modern probabilistic thinking at all levels of education?

RESEARCH METHOD

This study uses a Systematic Literature Review (SLR) approach to identify, analyze, and synthesize current findings on probability and combinatorics learning in modern educational contexts. The SLR process follows general guidelines adapted from Tranfield, Denyer, and Smart (2003) and Kitchenham & Charters (2007), with adjustments for the context of mathematics and information technology education.

The primary source of literature in this study is WATASE UAKE, a curated collection of Scopus-indexed scientific journal articles (quartiles Q1–Q4). This source selection was based on the academic credibility of Scopus as a globally reputable database, as well as the availability of articles on a range of relevant topics. The publication period was limited to 2015 to 2025 to capture contemporary trends in probability pedagogy, technological innovation, and curriculum design following global reforms.

The search was conducted through a systematic exploration of the WATASE UAKE collection using a combination of the following keywords with Boolean operators.

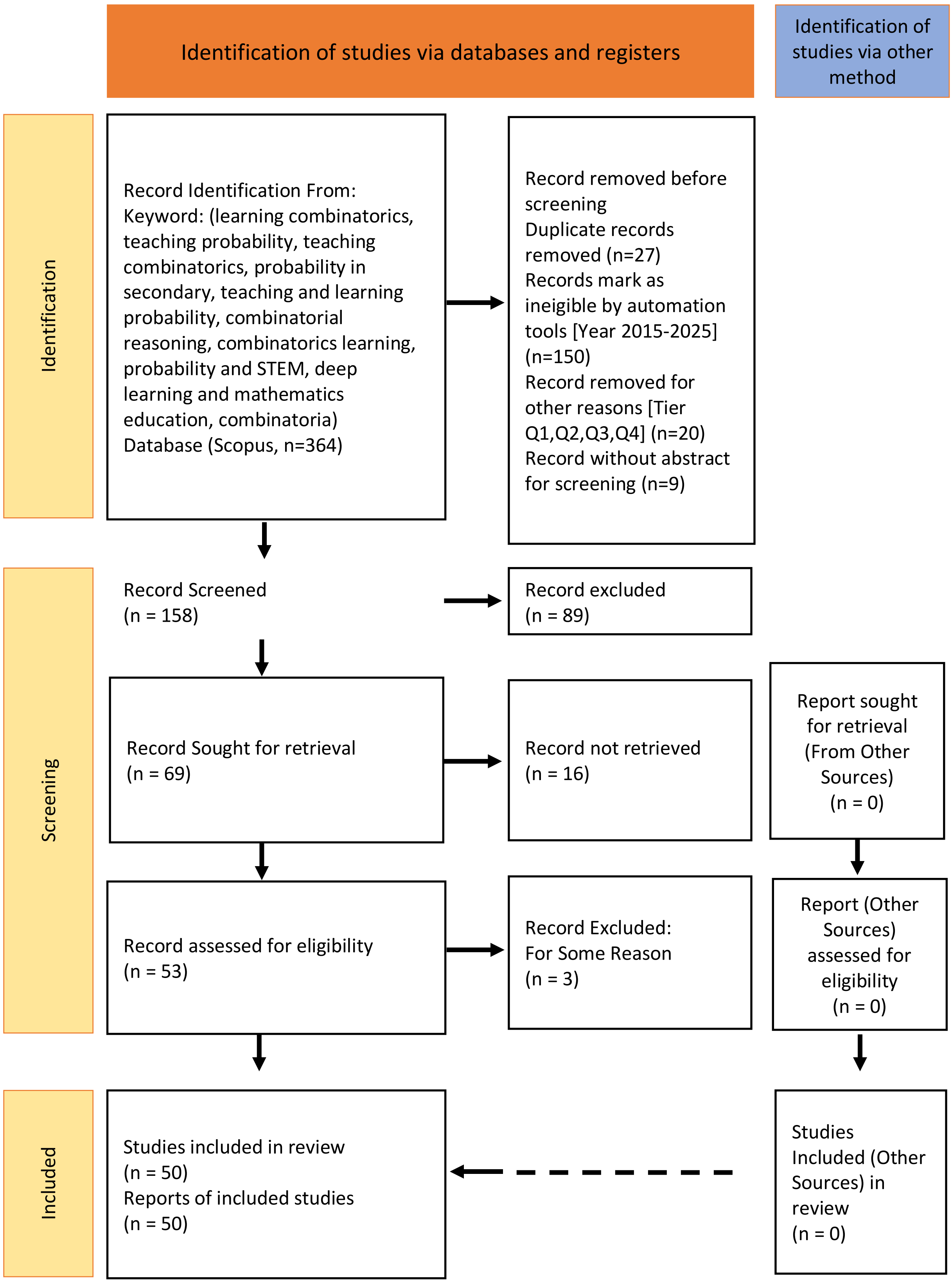

Figure 1. PRISMA flow diagram of the article selection process

(“learning combinatorics” OR “teaching probability” OR “teaching combinatorics” OR “probability in secondary” OR “teaching and learning probability” OR “combinatorial reasoning” OR “combinatorics learning” OR “probability and STEM” OR “deep learning and mathematics education“ OR “probability and combinatorics” OR “probability thinking” OR “mathematis education in high school”)

Inclusion criteria: (1) Peer reviewed and Scopus indexed articles (Q1 – Q4), (2) Published between 2015 - 2025, (3) Focus on probability and/or combinatorics learning (4) involve analysis of students, teachers, curriculum, textbooks, or educational technology systems, (5) Available in English. Exclusion criteria: (1) non-peer reviewed articles (blogs, theses, theses that have not undergone external peer review, etc.), (2) articles outside the 2015-2025 timeframe, and (3) focus on other mathematical topics without probability/combinatorics integration.

The selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework process in three stages. First is identification. The initial search yielded 364 articles. Among these 364 articles, 27 were duplicates, 150 were flagged as ineligible by the automated tool, 20 were removed for other reasons, and 9 articles lacked abstracts for screening, leaving 158 articles. Second is screening. Titles and abstracts were independently reviewed by researchers. Irrelevant articles were eliminated. Of the 158 identified articles, 89 were found to be irrelevant, leaving 69 articles. Of these 69 articles, 53 were deemed suitable for use. Third is sligibility. The full texts of the 53 articles were analyzed in depth based on the inclusion criteria. Of the 53 articles, 3 were in foreign languages and were eliminated, leaving 50 eligible articles for further analysis. The complete PRISMA flow diagram detailing article inclusion/exclusion at each stage is presented in Figure 1.

Data analysis used thematic analysis (Braun & Clarke, 2006). The analysis process consisted of four stages: familiarization, initial coding (6 dimensions: topic, level, approach, focus, technology, theory), revision and critical reflection, and thematic mapping. Coding was conducted using a digital spreadsheet (Google Sheets), and every analytical decision was transparently documented to ensure auditability and credibility of the findings.

RESULTS AND DISCUSSION

Results

Analysis of 50 articles yielded the following quantitative and thematic findings, organized into three parts that correspond to the study's three research questions (See Table 1).

Current trends in probability and combinatorics education

A total of 84% of articles focused on probability learning. The most dominant misconceptions were equiprobability bias (appearing in 22 articles), errors in conditional probability (14 articles), and the dominance of mechanistic approaches (18 articles). Articles such as Gürbüz et al. (2018) and Nguyen et al. (2025) demonstrate that these misconceptions persist across cultures and educational levels.

In terms of pedagogical design, the most frequently reported effective strategies were human-centered: multiple representations (17 articles), game-based learning (9 articles) that reported the use of spinners, dice, or simulations to develop empirical intuition (Iversen & Nilsson, 2019; Sharma, 2015) and the Realistic Mathematics Education (RME) approach (5 articles). Socio-constructivist and interactional strategies, such as revoicing, have also been shown to support students' probabilistic reasoning (Eckert & Nilsson, 2015). Research has demonstrated the efficacy of tree diagrams and truth tables in addressing misconceptions. (Post & Prediger, 2024; Satake & Vashlishan Murray, 2015). In terms of technological innovation, only 26% of articles involved any form of technology, and within that group, modern AI (LLM, deep learning, CNN) was used in just 10% of the total corpus, indicating that despite growing interest, technology adoption in probability and combinatorics education remains the exception rather than the norm.

Table 1. Distribution of 50 articles based on analysis dimensions

Dimension	Category	Number of Articles	Percentage
Mathematics Topic	Probability	42	84 %
	Combinatorics	6	12 %
	Others	2	4 %
Educational Level	Higher Education	18	36 %
	Senior High School	12	24 %
	Junior High School	9	18 %
	Pre-service/In-service Teachers	8	16 %
	Elementary School	3	6 %
Instructional Approach	Multiple Representations	17	34 %
	Game-Based Learning	9	18 %
	Contextual Modeling	8	16 %
	Textbook/Curriculum Analysis	7	14 %
	Collaborative/Peer Instruction	5	10 %
	Others	4	8 %
Educational Technology	Yes (AI, CAI, GeoGebra, etc.)	13	26 %
	No	37	74 %
Type of Technology	Modern AI (LLM, Deep Learning, CNN)	5	10 %
	CAI / Simple Simulations	5	10 %
	GeoGebra / Mathematics Software	3	6 %
Focus	Misconceptions and Learning Difficulties	22	44%
	Pedagogical Strategies	17	34%
	Attitudes and Beliefs	8	16%
	Curriculum and Needs	5	10%

Gaps in integrating cognitive theory with AI

Although 26% of articles involved technology, the integration was shallow. CAI and simulations have been shown to be more effective than traditional learning in addressing misconceptions, but they are not adaptive to individual responses (Gürbüz et al., 2018). Modern AI (Xuan et al., 2025; Liu et al., 2023; Qu et al., 2021; Ma et al., 2024) is used primarily for evaluating instructional systems or pedagogical effectiveness, not for diagnosing the cognitive structures behind errors. No articles developed Natural Language Processing (NLP)-based systems to analyze students' written explanations of probability. Key Finding: A key gap is the lack of AI-based instructional materials that integrate misconception diagnosis with adaptive pedagogical feedback.

Implications for curriculum and teacher education

Of the 50 articles, several explicitly addressed curriculum needs and gaps. Martin et al. (2022) and Ollerton (2015) critiqued curricula for treating classical, frequentist, and subjective probability as disconnected rather than complementary perspectives; Basaran et al. (2015) identified a mismatch between the probabilistic reasoning skills expected by higher education and what secondary curricula actually deliver; and Voit and Bathke (2015) found inconsistent implementation of probability curricula across classrooms even within a single education system. Textbook-level analyses reinforce this concern: Rico and Ruiz-Hidalgo (2022) identified systematic conceptual errors in Spanish statistics and probability textbooks, including confusing random experiments with events and treating representativeness as automatic, cautioning that such errors risk being inherited from textbooks to teachers to students. Similarly, Yang and Sianturi (2019), comparing introductory probability textbooks in Singapore, the US, and Indonesia, found that Indonesian materials relied on a single frequentist approach with predominantly low-level cognitive demands, unlike Singapore's emphasis on higher-order procedure-with-connection tasks. On the teacher education side, studies in this SLR predominantly focused on content mastery rather than diagnostic competence, the ability to systematically identify and respond to students' probabilistic misconceptions.

Discussion

Interpreting current trends

The dominance of human-centered pedagogical strategies, such as multiple representations, game-based learning, and RME, confirms that cognitively grounded approaches remain the primary lever for addressing misconceptions. However, these strategies are rarely systematized into curricula and instead persist as isolated interventions. This points to a need for frameworks such as Ollerton's (2015) unifying model, which integrates classical, frequentist, and subjective perspectives, to be adopted more broadly rather than treated as auxiliary teaching resources.

Interpreting the cognition AI gap

These findings confirm the tension between cognition-based pedagogical strategies and the promise of AI-based technologies. The implication is that mathematics learning needs to shift from a mechanistic approach to a design that fosters cognitive conflict, in line with the principles of RME and TDS.

Potential innovative solutions include: (1) Digital Didactic Design (DDD) that combines technology and pedagogical depth. (Nopriana et al., 2023); (2) game-based and narrative approaches such as Alice in Randomland (Flavio Guiñez et al., 2021); (3) integration of three probability lenses (Classical, frequentist, Bayesian) (Ollerton, 2015). However, AI still operates as a “black box,” limiting its pedagogical explainability and understanding. The future of innovation lies in the development of cognitively aware AI.

Implications for curriculum and teacher education

In the Indonesian context, these findings are relevant to the Independent Curriculum (Kurikulum Merdeka), which emphasizes data literacy. Teacher education needs to be strengthened in misconception analysis and representation-based task design. Digital platforms like Rumah Belajar (Learning House) can adopt the DDD principle for interactive modules.

Future research should prioritize five interconnected directions. First, cognition-aware AI systems that combine Natural Language Processing (NLP) with schema theory could analyze students' written probabilistic reasoning to detect misconceptions such as equiprobability bias in real time. Building on generative AI applications already piloted in mathematics classrooms (Xuan et al., 2025), such systems would move beyond current recommendation-only or evaluation-only functions toward genuine diagnostic feedback grounded in cognitive theory. Second, Bayesian reasoning interventions at the junior secondary level remain almost entirely unexplored in this corpus, despite evidence that alternative representations such as truth tables can make Bayes' rule more accessible than symbolic formulas even for novice learners (Satake & Vashlishan Murray, 2015). Design-based research is needed to test whether such representations allow Bayesian concepts to be introduced earlier than current curricula typically permit, rather than being reserved for advanced or tertiary instruction. Third, cross-cultural studies comparing how multiple representations, such as tree diagrams, spinners, and two-way tables, function across different curricular traditions would clarify which pedagogical strategies are broadly transferable versus context-dependent. This is particularly urgent given that comparative textbook analyses have already revealed substantial differences in cognitive demand and conceptual approach across countries (Yang & Sianturi, 2019), and given that most instructional strategies identified in this review originate from Western contexts. Fourth, integrating computational or programming-based approaches with combinatorial reasoning offers a promising bridge between computational thinking curricula and probabilistic literacy. Lockwood and De Chenne (2019) demonstrated that having students write loops and conditional statements in Python to enumerate outcomes can enrich their combinatorial reasoning; extending this approach to probability instruction, and evaluating its effectiveness across educational levels, remains an open area. Fifth, longitudinal studies tracking students' retention of probabilistic understanding after intervention are notably absent from the reviewed literature. Without such studies, it remains unclear whether the gains reported by human-centered and technology-assisted strategies alike are durable or merely short-term, which limits the field's ability to determine which interventions deserve wider curricular adoption.

CONCLUSION

A systematic literature review of 50 articles confirms that probability and combinatorics learning still faces a tension between human cognitive understanding and the promise of modern educational technology. Four key findings reinforce this position: (1) probability dominates the literature (84%), yet instruction remains largely mechanistic; human-centered pedagogical strategies, such as multiple representations and game-based learning, are the most effective approach identified, though rarely systematized into curricula; (2) AI integration remains superficial, with no system capable of diagnosing the cognitive structures behind misconceptions such as equiprobability bias; and (3) addressing curricula that treat probability's classical, frequentist, and subjective perspectives as disconnected rather than complementary requires future research on cross-cultural, design-based approaches that adapt effective pedagogical strategies to local contexts, alongside teacher education programs that build diagnostic competence rather than content mastery alone.

The primary contribution of this SLR is the identification of a critical gap: no AI system capable of diagnosing equiprobability bias and providing adaptive feedback based on learning theory exists. Building on this gap, future research should pursue three concrete directions. First, researchers should prioritize developing cognition-aware AI systems that integrate NLP-based analysis of students' written reasoning with schema theory, moving beyond the recommendation-oriented and evaluation-oriented systems identified in this review toward genuine diagnostic capability. Second, because most human-centered pedagogical strategies identified here originate from Western educational contexts, cross-cultural design-based research is needed to determine which strategies, such as multiple representations and game-based learning, transfer effectively to curricula such as *Indonesia's Independent Curriculum*, and which require substantial contextual adaptation. Third, longitudinal studies are needed to establish whether gains from human-centered or technology-assisted interventions alike are retained over time, since the durability of these approaches remains untested in the reviewed literature. These findings have direct implications for development research in Indonesia, particularly in the context of the Independent Curriculum, where integrating cognitively grounded AI tools with locally relevant pedagogical strategies could substantially advance probability and combinatorics education at scale. The future of probability learning is not a choice between technology and pedagogy, but rather a judicious integration of both, with technology that is not only “smart” but also “pedagogical.”

DECLARATION

Author contribution

All authors contribute in the research and/or writing the paper, and approved the final manuscript.

Siti Nur Baiti	Conceptualized the research, designed the methodology, conducted the investigation, collected and analyzed the data, interpreted the findings, and wrote the original manuscript.
Farida Nurhasanah	Provided supervision throughout the research, guided the research design and manuscript development, reviewed and revised the methodology and analysis, and critically reviewed the manuscript.
Triyanto	Provided academic guidance, reviewed and revised the manuscript, contributed constructive suggestions to improve the quality of the paper, and approved the final version of the manuscript.

Funding

This research did not receive any funding.

Conflict of interest

All authors declare that they have no competing interests.

The use of artificial intelligence

We do not use any generative AI tools to write any part of this paper.

Additional information

Not available.

Ethics declaration

We as authors acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that we have obtained the permission from the relevant institutes when collecting data. We support the International Journal on Education Insight (IJEI) in maintaining the high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

REFERENCES

Batanero, C., & Álvarez-Arroyo, R. (2024). Teaching and learning of probability. *ZDM – Mathematics Education*, *56*(1), 5–17. https://doi.org/10.1007/s11858-023-01511-5

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Eckert, A., Nilsson, P. (2015). Introducing a symbolic interactionist approach on teaching mathematics: the case of revoicing as an interactional strategy in the teaching of probability. *Journal of Mathematics Teacher Education,* 20, 31–48. https://doi.org/10.1007/s10857-015-9313-z

Flavio Guiñez, F., Vásquez, C., Brito, C., & Martínez, S. (2021). Alice in randomland: a resource for improving attitudes towards probability and its teaching. *Statistics Education Research Journal*, *20*(2), 14. https://doi.org/10.52041/serj.v20i2.410

Gürbüz, R., Dede, Y., & Doğan, M. F. (2018). The role of computer-assisted instruction in the teaching of probability. *Hacettepe University Journal of Education*, 1–18. https://doi.org/10.16986/HUJE.2018036943

Iversen, K., & Nilsson, P. (2019). Lower secondary school students' reasoning about compound probability in spinner tasks. *The Journal of Mathematical Behavior*, *56*, 100723. https://doi.org/10.1016/j.jmathb.2019.100723

Kitchenham, B., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. *EBSE Technical Report* (EBSE-2007-01). *Keele University and Durham University*.

Liu, B., Han, T., Qi, L., & Ji, F. (2023). Incorporating multidimensional data analysis methods for probability theory and mathematical statistics teaching reform and practical exploration. *Applied Mathematics and Nonlinear Sciences*, *9*(1), 1–19. https://doi.org/10.2478/amns.2023.2.01310

Lockwood, E., De Chenne, A. (2019). Enriching students' combinatorial reasoning through the use of loops and conditional statements in python. *International Journal of Research in Undergraduate Mathematics Education, 6*, 303–346. https://doi.org/10.1007/s40753-019-00108-2

Martin, V., Thibault, M. & Homier, M. (2022). Convergence and divergence in probability teaching in elementary and secondary school in Québec: A closer look at eight teachers' self-reported practices. *Canadian Journal of Science Mathematics and Technology Education, 22*, 659–678. https://doi.org/10.1007/s42330-022-00241-2

Ma, J., Liu, Q., Zhang, Z., & Gu, P. (2024). Research on personalized recommendation of teaching resources based on joint probability matrix decomposition model and CNN improvement algorithm. *Applied Mathematics and Nonlinear Sciences*, *9*(1), 20240543. https://doi.org/10.2478/amns-2024-0543

Nguyen, Q. A., Dao, N. H., Hoa, T. A., & Nguyen, N.-G. (2025). Teaching conditional probability in grade 12 using realistic mathematics education theory. *Journal on Mathematics Education*, *16*(2), 603–632. https://doi.org/10.22342/jme.v16i2.pp603-632

Nopriana, T., Herman, T., & Martadiputra, B. A. P. (2023). Digital didactical design: The role of learning obstacles in designing combinatorics digital module for vocational students. *International Journal of Interactive Mobile Technologies* (iJIM), *17*(2), 4–23. https://doi.org/10.3991/ijim.v17i02.34293

Ollerton, R. L. (2015). A unifying framework for teaching probability event types. *International Journal of Mathematical Education in Science and Technology*, *46*(5), 790–794. https://doi.org/10.1080/0020739X.2015.1005702

Post, M., & Prediger, S. (2024). Teaching practices for unfolding information and connecting multiple representations: The case of conditional probability information. *Mathematics Education Research Journal*, *36*(1), 97–129. https://doi.org/10.1007/s13394-022-00431-z

Qu, G., Hu, W., Jiao, W. & Jin, J. (2021). Application of deep learning-based integrated trial-error + science, technology, reading/writing, engineer, arts, mathematics teaching mode in college entrepreneurship education. *Frontiers in Psychol*ogy, *12*, 739362. https://doi.org/10.3389/fpsyg.2021.739362

Rico, N., & Ruiz-Hidalgo, J. F. (2022). Errors concerning statistics and probability in Spanish secondary school textbooks. *Applied Sciences*, *12*(24), 12719. https://doi.org/10.3390/app122412719

Satake, E., & Murray, A. V. (2015). An alternative teaching method of conditional probabilities and Bayes' rule: An application of the truth table. *Teaching Statistics*, *37*(3), 89–95. https://doi.org/10.1111/test.12080

Sharma, S. (2015). Teaching probability: A socio-constructivist perspective. *Teaching Statistics*, *37*(3), 78–84. https://doi.org/10.1111/test.12075

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, *14*(3), 207–222. https://doi.org/10.1111/1467-8551.00375

Voit, W., & Bathke, A. (2015). Statistics and probability at secondary schools in the Federal State of Salzburg: an empirical study. *Austrian Journal of Statistics*, *44*(1), 17-24. https://doi.org/10.17713/ajs.v44i1.12

Xuan, S. H., Nguyen, A. T., Nguyen, T., Nguyen, L., Nguyen, H., Pham, N., Phung, T., Ngo, B., Nguyen, V., Nguyen, M., Tran, T., Le, T., Nguyen, K., & FNU, P.. (2025). Evaluating the impact of generative AI in mathematics education: A comparative study in Vietnamese high schools, *Human Behavior and Emerging Technologies*, 8886206. https://doi.org/10.1155/hbe2/8886206

Yang, D. C., & Sianturi, I. A. J. (2019). The earliest teaching and learning of probability in Singapore, the US, and Indonesia from the perspectives of textbooks analysis. *Irish Educational Studies*, *38*(4), 535–559. https://doi.org/10.1080/03323315.2019.1664313

This page is intentionally left blank.