

Design and Evaluation of Instructional Strategies for Developing Mathematical Problem-Solving Competency Through Statistics and Probability in Primary Schools

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ABSTRACT: Developing mathematical problem-solving competency has become a central goal of competency-based mathematics education in primary schools. Within the primary mathematics curriculum, statistics and probability provide valuable opportunities for students to collect, organize, analyze, and interpret data while solving authentic mathematical problems. However, many teachers continue to encounter difficulties in designing and implementing instructional activities that effectively foster mathematical problem-solving competency through statistics and probability. This study aimed to design and evaluate instructional strategies for developing mathematical problem-solving competency through statistics and probability in primary schools. A mixed-methods research design was adopted, including document analysis, questionnaire surveys, classroom observations, interviews, expert consultation, pedagogical experimentation, and statistical analysis. The needs assessment involved 25 primary school teachers, while the effectiveness of the proposed instructional strategies was examined through pedagogical experimentation. Based on theoretical foundations and findings from the needs assessment, the study developed a systematic set of instructional strategies aligned with the objectives of the 2018 Mathematics Curriculum. The experimental results demonstrated that the proposed instructional strategies effectively enhanced students' mathematical problem-solving competency and improved the quality of teaching and learning statistics and probability. The findings also confirmed the feasibility and pedagogical value of the proposed instructional strategies for supporting competency-based mathematics education in primary schools. This study provides practical guidance for mathematics teachers and contributes to improving the teaching of statistics and probability in primary education.

KEYWORDS: statistics and probability; instructional strategies; mathematical problem-solving competency; primary mathematics; competency-based education

1. INTRODUCTION

The development of mathematical problem-solving competency has become a central objective of mathematics education in many educational systems as schools increasingly prepare students to apply mathematical knowledge in authentic contexts rather than merely perform routine calculations. Contemporary mathematics curricula emphasize that students should be able to identify problems, reason with evidence, select appropriate strategies, evaluate solutions, and communicate mathematical ideas effectively. This competency-oriented perspective reflects a broader shift from knowledge transmission to the cultivation of higher-order thinking, adaptability, and lifelong learning skills. International policy frameworks have consistently highlighted mathematical literacy and problem-solving as essential competencies for participating successfully in modern society, where individuals are frequently required to interpret quantitative information, make evidence-based decisions, and respond to complex real-world situations (OECD, 2023). Similarly, the *Principles to Actions* framework published by the National Council of Teachers of Mathematics identifies problem solving as both an important learning goal and an effective instructional approach through which students construct mathematical understanding while developing reasoning, communication, and critical thinking (National Council of Teachers of Mathematics, 2014).

Within primary mathematics, statistics and probability offer particularly meaningful opportunities for developing mathematical problem-solving competency because they require students to engage with authentic data, investigate uncertainty, analyze patterns, interpret representations, and justify conclusions. Rather than focusing solely on computational procedures, learning experiences in statistics and probability encourage students to formulate questions, collect and organize data, compare alternative representations, examine relationships among variables, and evaluate the validity of their conclusions. Such activities naturally require students to activate multiple dimensions of mathematical problem solving, including identifying problems, selecting appropriate strategies, implementing solutions, and reflecting on the reasonableness of outcomes. Research in statistics education has therefore increasingly

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emphasized the importance of creating learning environments in which students actively construct statistical reasoning through meaningful investigations instead of simply learning isolated concepts or procedures (Garfield & Ben-Zvi, 2008). Likewise, international research has demonstrated that effective statistics education depends not only on curriculum content but also on instructional approaches that enable learners to participate in authentic inquiry, collaborative reasoning, and evidence-based decision making (Batanero et al., 2011).

Recent developments in mathematics education further reinforce the need to integrate problem solving into every stage of mathematics instruction rather than treating it as a separate topic. Contemporary perspectives regard mathematical problem solving as a dynamic cognitive process involving exploration, modeling, reasoning, monitoring, and evaluation. Students are expected to construct knowledge while solving unfamiliar problems rather than merely applying memorized procedures to routine exercises. From this perspective, instructional design plays a decisive role in determining whether classroom activities genuinely promote mathematical thinking. Lesh and Zawojewski (2007) argued that meaningful mathematical learning emerges when students engage in modeling and problem-solving processes requiring them to interpret situations, generate solution strategies, revise their thinking, and justify mathematical decisions. Similarly, international research synthesized in the *Handbook of International Research in Mathematics Education* highlights that effective mathematics instruction should provide students with rich learning tasks that connect conceptual understanding, reasoning, communication, and problem solving within authentic educational contexts (English & Kirshner, 2016).

Despite these theoretical advances, important challenges remain in classroom implementation, particularly in primary education. Although statistics and probability have become integral components of contemporary mathematics curricula, classroom instruction often continues to emphasize procedural exercises, reproduction of textbook examples, and teacher-directed explanations. Consequently, opportunities for students to investigate data, formulate mathematical questions, explore uncertainty, and evaluate alternative solutions remain limited. These instructional characteristics may restrict the development of mathematical problem-solving competency because students are seldom required to make independent decisions or reflect critically on their reasoning processes. Furthermore, teachers frequently encounter difficulties in designing learning situations that simultaneously address curriculum objectives, students' cognitive characteristics, and competency-based assessment requirements. These practical challenges indicate the need for instructional strategies that translate theoretical principles into feasible classroom practices.

The Vietnamese General Education Curriculum 2018 has introduced statistics and probability as a progressive learning strand beginning in primary school while identifying mathematical problem-solving competency as one of the core competencies of mathematics education. Nevertheless, limited research has specifically examined how instructional strategies in statistics and probability can systematically support the development of mathematical problem-solving competency among primary school students. Existing studies have generally focused on mathematics teaching, competency-based education, or statistics education independently, whereas fewer investigations have integrated these perspectives into a coherent instructional framework suitable for primary classrooms. Addressing this research gap, the present study aims to design and evaluate instructional strategies for developing mathematical problem-solving competency through statistics and probability in primary schools. By integrating theoretical foundations with evidence from classroom practice, the study seeks to provide practical guidance for competency-based mathematics instruction while contributing empirical evidence to the growing body of research on primary mathematics education.

2. LITERATURE REVIEW

2.1. Mathematical Problem-Solving Competency in Primary Mathematics

Mathematical problem-solving competency is widely recognized as a fundamental component of mathematics education because it enables learners to apply mathematical knowledge flexibly when confronting unfamiliar situations. Rather than focusing solely on obtaining correct answers, mathematical problem solving involves a sequence of cognitive processes through which learners identify problems, analyze available information, generate possible solution strategies, implement appropriate procedures, and evaluate the effectiveness of their solutions. These processes require the integration of conceptual understanding, procedural knowledge, mathematical reasoning, and reflective thinking. Consequently, mathematical problem-solving competency represents a comprehensive educational outcome that supports both academic achievement and the application of mathematics in everyday life. In primary education, the development of mathematical problem-solving competency should occur through meaningful learning experiences that encourage active exploration instead of routine practice. Students need opportunities to investigate authentic mathematical situations, discuss alternative strategies, justify their reasoning, and reflect on the validity of different solutions. Such learning experiences gradually strengthen learners' confidence, mathematical communication, and independent thinking while fostering deeper conceptual understanding. According to Lester (2007), effective mathematics instruction should position problem solving as both an instructional approach and a learning objective, enabling students to construct mathematical knowledge through inquiry, reasoning, and reflection rather than passive knowledge acquisition. This perspective provides an important theoretical

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foundation for designing instructional strategies that intentionally integrate mathematical problem solving into statistics and probability learning activities at the primary level.

2.2. Teaching Statistics and Probability in Primary Schools

Statistics and probability have become increasingly important components of primary mathematics curricula because they enable students to investigate real-world phenomena through data collection, representation, analysis, interpretation, and prediction. Unlike traditional arithmetic learning, statistics and probability require students to reason under uncertainty, interpret evidence, compare alternative solutions, and justify conclusions using quantitative information. Consequently, learning activities in this domain provide authentic opportunities for students to develop mathematical problem-solving competency while simultaneously strengthening statistical literacy and critical thinking. At the primary level, these learning experiences should progress from concrete investigations to more sophisticated forms of reasoning, allowing students to gradually construct conceptual understanding through active participation rather than memorization of isolated procedures.

Contemporary perspectives on statistics education emphasize that effective instruction should be inquiry-oriented and closely connected with students' everyday experiences. Instead of presenting statistical concepts as independent knowledge, teachers are encouraged to organize learning activities in which students formulate questions, collect and organize data, construct representations, interpret results, and communicate their findings. Such learning processes not only improve conceptual understanding but also create meaningful contexts for applying mathematical knowledge to solve practical problems. The Guidelines for Assessment and Instruction in Statistics Education (GAISE) framework further recommends that statistics instruction should promote active investigation, collaborative learning, and progressive development of statistical reasoning through increasingly complex tasks appropriate to students' cognitive development (Franklin et al., 2007). These principles provide an important theoretical foundation for designing instructional strategies that integrate statistics and probability with mathematical problem solving. Accordingly, the present study adopts this perspective to develop instructional strategies that support competency-based learning while enhancing students' ability to solve mathematical problems through meaningful statistical and probabilistic activities.

2.3. Instructional Strategies for Developing Mathematical Problem-Solving Competency

The successful development of mathematical problem-solving competency depends not only on curriculum content but also on the quality of instructional strategies implemented in the classroom. Competency-based mathematics instruction requires teachers to design learning environments in which students actively engage with meaningful mathematical tasks, explore multiple solution pathways, justify their reasoning, and evaluate alternative approaches. Such instructional strategies shift the focus from teacher-directed knowledge transmission to student-centered learning, enabling learners to construct mathematical understanding through inquiry, collaboration, and reflection. Consequently, the effectiveness of mathematics instruction is closely related to teachers' ability to organize learning experiences that promote active participation and sustained mathematical thinking.

In the context of statistics and probability, instructional strategies should provide opportunities for students to investigate authentic situations involving data collection, representation, analysis, interpretation, and prediction. Learning activities should encourage students to identify mathematical problems, formulate appropriate solution strategies, communicate their reasoning, and evaluate the validity of their conclusions based on statistical evidence. According to Schoenfeld (2013), effective problem-solving instruction extends beyond teaching heuristic techniques by creating classroom environments that support mathematical reasoning, strategic decision-making, self-monitoring, and reflective thinking throughout the learning process. Despite growing recognition of these instructional principles, relatively few studies have proposed systematic instructional strategies specifically designed to develop mathematical problem-solving competency through statistics and probability in primary schools. This research addresses that gap by designing and evaluating a coherent set of instructional strategies grounded in both theoretical perspectives and classroom practice.

3. METHODS

3.1. Research Design

This study employed a mixed-methods research design to develop and evaluate instructional strategies for fostering mathematical problem-solving competency through statistics and probability in primary schools. The integration of qualitative and quantitative approaches enabled the study to obtain a comprehensive understanding of both the theoretical foundations and the practical effectiveness of the proposed instructional strategies. Qualitative methods were used to examine relevant theoretical literature, analyze curriculum documents, investigate current teaching practices, and construct the instructional strategies. Quantitative methods were employed to examine teachers' perceptions of current instructional practices and to evaluate the effectiveness of the proposed instructional strategies through pedagogical experimentation.

The research was implemented in three sequential phases. The first phase focused on reviewing theoretical and policy documents related to mathematical problem-solving competency, statistics and probability education, and competency-based mathematics

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teaching, together with an investigation of current instructional practices in primary schools. Findings from this phase provided the theoretical and practical basis for designing the proposed instructional strategies. The second phase involved the development of a systematic set of instructional strategies aligned with the objectives and learning requirements of the 2018 Mathematics Curriculum for primary education. The final phase consisted of pedagogical experimentation to examine the feasibility and effectiveness of the proposed strategies in promoting students' mathematical problem-solving competency through statistics and probability learning activities. The integration of these research phases ensured that the instructional strategies were theoretically grounded, practically applicable, and empirically evaluated before drawing conclusions. This methodological approach is consistent with educational design research, which emphasizes the iterative relationship between educational theory, instructional design, classroom implementation, and empirical evaluation (Plomp & Nieveen, 2013). The overall research process was also aligned with the methodological framework presented in the thesis, including literature review, questionnaire survey, classroom observation, interviews, expert consultation, pedagogical experimentation, and statistical analysis.

3.2. Participants

The study involved participants from primary schools in Thai Nguyen Province and was implemented in two sequential stages corresponding to the research objectives. The first stage investigated the current implementation of teaching statistics and probability for developing mathematical problem-solving competency. A total of 25 primary school teachers from five public primary schools, namely Tien Hoi Primary School, Hoang Nong Primary School, La Bang Primary School, Ban Ngoai Primary School, and Phuc Luong Primary School, participated in the questionnaire survey. These teachers were directly responsible for mathematics instruction and therefore possessed practical experience in planning, implementing, and evaluating statistics and probability lessons. The survey was conducted between December 2025 and January 2026 to examine teachers' perceptions, instructional practices, facilitating factors, and challenges associated with competency-based mathematics teaching.

The second stage consisted of a pedagogical experiment designed to evaluate the effectiveness of the proposed instructional strategies. Participants were selected from primary school classes that shared comparable learning conditions and followed the same mathematics curriculum. The selection of participants was intended to ensure the credibility and practical relevance of the experimental findings while allowing meaningful comparisons between instructional approaches. This participant selection process is consistent with mixed-methods educational research, in which qualitative and quantitative evidence are integrated to obtain a comprehensive understanding of educational phenomena and to strengthen the validity of research findings (Creswell & Creswell, 2018).

3.3. Data Collection Instruments

Multiple data collection instruments were employed to obtain comprehensive evidence regarding the development and evaluation of the proposed instructional strategies. First, a structured questionnaire was designed to investigate teachers' perceptions of the importance of teaching statistics and probability for developing mathematical problem-solving competency, their understanding of the competency framework, current classroom practices, facilitating conditions, and challenges encountered during instruction. The questionnaire included both closed-ended and open-ended items to collect quantitative information and qualitative comments, thereby providing a comprehensive understanding of the current instructional context.

Second, classroom observations and semi-structured interviews were conducted to supplement the questionnaire findings and obtain deeper insights into teachers' instructional practices. These qualitative data enabled the researchers to clarify issues emerging from the survey and to identify practical factors influencing the implementation of competency-based instruction in statistics and probability. In addition, expert consultation was undertaken during the design of the instructional strategies to ensure their pedagogical appropriateness, consistency with curriculum requirements, and suitability for primary school students.

Finally, pedagogical experimentation was conducted to evaluate the effectiveness of the proposed instructional strategies. Students' learning outcomes and the development of mathematical problem-solving competency were assessed through pre-intervention and post-intervention evaluation instruments developed in accordance with the learning objectives of the instructional intervention. The use of multiple complementary instruments enabled data triangulation, thereby enhancing the credibility and trustworthiness of the research findings. Such an approach is widely recommended in educational research because it provides richer evidence and strengthens the validity of interpretations derived from both qualitative and quantitative data (Johnson & Onwuegbuzie, 2004).

3.4. Data Collection Procedures

Data collection was conducted in three consecutive stages to ensure systematic development and evaluation of the proposed instructional strategies. The first stage involved reviewing relevant literature, curriculum documents, and policy guidelines concerning mathematics education, statistics and probability, and mathematical problem-solving competency. Simultaneously, a questionnaire survey, classroom observations, and interviews were carried out to investigate teachers' perceptions, instructional practices, facilitating factors, and challenges related to competency-based teaching of statistics and probability. The findings

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obtained during this stage provided both theoretical and practical evidence for identifying instructional needs and informed the development of the proposed instructional strategies.

The second stage focused on designing the instructional strategies based on the theoretical framework, curriculum requirements, and empirical findings from the needs assessment. The preliminary version of the instructional strategies was reviewed through expert consultation to evaluate its pedagogical appropriateness, feasibility, and consistency with the objectives of competency-based mathematics education. Recommendations from experts were incorporated before the strategies were implemented in classroom practice.

The final stage consisted of pedagogical experimentation to evaluate the effectiveness of the instructional strategies. The proposed instructional activities were implemented under normal classroom conditions, followed by the collection of quantitative and qualitative evidence regarding students' learning outcomes and the development of mathematical problem-solving competency. Throughout the research process, data collection procedures were conducted systematically to ensure consistency, reliability, and alignment with the research objectives. Such staged procedures are widely recommended in educational research because they facilitate the integration of design, implementation, and evaluation within a coherent methodological framework (Tashakkori & Teddlie, 2010).

3.5. Data Analysis

The collected data were analyzed using both qualitative and quantitative techniques to ensure a comprehensive evaluation of the proposed instructional strategies. Quantitative data obtained from the teacher questionnaire were summarized using descriptive statistical methods, including frequencies and percentages, to examine teachers' perceptions, instructional practices, facilitating conditions, and challenges related to competency-based teaching of statistics and probability. The results were organized into tables to facilitate comparison across different aspects of classroom implementation.

Qualitative data collected through classroom observations, interviews, and expert consultation were analyzed using content analysis. The qualitative findings were used to interpret and explain the quantitative results while providing additional evidence regarding teachers' instructional practices and the feasibility of the proposed instructional strategies. Integrating qualitative and quantitative evidence enabled a more comprehensive understanding of the research problem and strengthened the interpretation of the findings. The effectiveness of the proposed instructional strategies was evaluated by comparing students' learning outcomes before and after the pedagogical intervention, together with qualitative evidence collected during classroom implementation. The combined use of descriptive statistics and qualitative analysis ensured that the research findings reflected both measurable instructional outcomes and contextual classroom experiences. This analytical approach is consistent with recommendations for mixed-methods educational research, which emphasize the complementary use of quantitative and qualitative evidence to improve the validity and credibility of educational studies (Cohen, Manion, & Morrison, 2018).

4. RESULTS

4.1. Teachers' Perceptions of the Importance of Teaching Statistics and Probability for Developing Mathematical Problem-Solving Competency

Table 1. Teachers' Perceptions of the Importance of Teaching Statistics and Probability for Developing Mathematical Problem-Solving Competency

Perceived importance	Frequency (n = 25)	Percentage (%)
Very important	9	36.0
Important	16	64.0
Less important	0	0.0
Not important	0	0.0

The survey findings indicate that all participating teachers recognized the importance of teaching statistics and probability for developing students' mathematical problem-solving competency. Specifically, 64.0% of teachers rated this instructional orientation as important, while 36.0% considered it very important. No respondent regarded this instructional orientation as less important or not important, indicating a strong consensus regarding the educational value of integrating statistics and probability into competency-based mathematics instruction.

Although teachers demonstrated highly positive perceptions, recognition of educational importance does not automatically ensure effective classroom implementation. As revealed by subsequent survey findings, teachers still experienced difficulties in designing authentic learning situations, organizing inquiry-based activities, and guiding students through all stages of mathematical problem solving. These findings suggest a gap between teachers' awareness and their classroom practice, highlighting the need for systematic instructional strategies to support competency-based teaching.

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The findings are consistent with the Principles to Actions framework proposed by the National Council of Teachers of Mathematics (2014), which argues that teachers' recognition of mathematical problem solving is an essential prerequisite for effective instruction. However, the framework also emphasizes that positive beliefs must be accompanied by high-quality instructional practices that actively engage students in reasoning, investigation, communication, and reflection. Therefore, the results of the present study provide empirical justification for developing and evaluating instructional strategies capable of supporting teachers in implementing statistics and probability lessons that foster mathematical problem-solving competency.

4.2. Teachers' Understanding of Mathematical Problem-Solving Competency and Classroom Implementation

Table 2. Teachers' Understanding of Mathematical Problem-Solving Competency and Current Classroom Implementation

Indicator	Key finding	Highest/Lowest (%)
Understanding of competency	Implementation and presentation best understood	48.0
Understanding of competency	Checking solutions least understood	28.0
Classroom implementation	Data collection/classification most frequent	40.0
Classroom implementation	Probability instruction least frequent	12.0

The survey results indicate that teachers' understanding of mathematical problem-solving competency was uneven across its four component processes. Teachers reported the strongest understanding of guiding students to implement and present solutions, whereas checking and evaluating solutions was the least well understood. This pattern suggests that teachers were generally confident in supporting procedural aspects of problem solving but less prepared to organize reflective activities that require students to review, justify, and evaluate their solutions.

Similar tendencies were observed in classroom implementation of statistics and probability. Activities involving data collection, classification, and organization were implemented more frequently than tasks requiring students to interpret pie charts, identify patterns, solve problems from statistical representations, or explore probability. Instruction related to probability was the least frequently implemented component, indicating that teachers experienced greater difficulty with newer and more conceptually demanding curriculum content.

These findings suggest that positive perceptions of competency-based instruction do not necessarily translate into effective classroom practice. They support the need for systematic instructional strategies that help teachers organize inquiry-oriented learning activities and strengthen all stages of mathematical problem solving. This result is consistent with the GAISE framework, which emphasizes that statistics instruction should progressively engage learners in posing questions, collecting and analyzing data, interpreting evidence, and communicating conclusions through authentic investigations (Franklin et al., 2007).

4.3. Teachers' Implementation of Problem-Solving Procedures, Facilitating Factors, and Challenges

Table 3. Teachers' Implementation of Problem-Solving Procedures, Facilitating Factors, and Challenges

Dimension	Key finding	Highest / Lowest (%)
Problem-solving procedures	Finding solutions most frequent / Checking solutions least frequent	48.0 / 16.0
Facilitating factors	Curriculum guidance most supportive	56.0
Facilitating factors	Professional learning least available	36.0
Challenges	Probability content most difficult	68.0
Challenges	Lack of specialized professional development	64.0

The findings indicate that teachers generally implemented the first three stages of mathematical problem solving more consistently than the final stage of checking and evaluating solutions. While identifying problems, proposing solutions, and implementing procedures were commonly incorporated into classroom instruction, reflective evaluation received considerably less attention. This imbalance suggests that students had fewer opportunities to verify the reasonableness of their solutions and develop self-monitoring skills during statistics and probability learning.

Survey responses also revealed several facilitating conditions for competency-based instruction. Teachers acknowledged that the 2018 General Education Curriculum provides clear guidance for statistics and probability, students show interest in practical statistical activities, and information technology supports the use of authentic data. Nevertheless, professional collaboration and

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access to shared instructional resources remained comparatively limited, reducing teachers' confidence in implementing more demanding learning activities.

The greatest challenges concerned the teaching of probability, insufficient professional development, and limited capacity to design authentic instructional situations. These findings indicate that strengthening teachers' pedagogical knowledge and providing practical instructional guidance are essential for improving classroom implementation. The results are consistent with Schoenfeld (2013), who emphasized that effective problem-solving instruction requires carefully designed classroom environments that support strategic reasoning, reflection, and continuous evaluation rather than focusing only on procedural completion.

4.4. Overall Implications of the Needs Assessment for Instructional Strategy Development

Table 4. Summary of Teachers' Needs Identified from the Needs Assessment

Aspect	Main finding	Implication
Perceptions	Teachers recognized the importance of statistics and probability	Strong foundation for reform
Understanding	Uneven understanding across problem-solving processes	Need targeted professional support
Implementation	Higher-level statistical and probability activities implemented less frequently	Need structured instructional guidance
Conditions	Supportive curriculum but substantial professional challenges	Need systematic instructional strategies

The overall survey results demonstrate a clear discrepancy between teachers' positive perceptions and their actual classroom implementation. Although teachers consistently recognized the educational importance of statistics and probability, their understanding of mathematical problem-solving competency and their classroom practices were uneven, particularly for higher-order activities involving interpretation, evaluation, and probability. These findings indicate that awareness alone is insufficient to ensure competency-based instruction and that teachers require more systematic pedagogical support.

Across the six survey dimensions, the evidence consistently points to the need for instructional guidance that translates curriculum expectations into practical classroom procedures. Teachers reported favorable curriculum conditions and positive student engagement, yet they also identified substantial barriers related to professional preparation, instructional design, and probability teaching. Taken together, these findings justify the development of a coherent set of instructional strategies that directly addresses the practical needs identified during the survey.

The findings are consistent with Batanero, Burrill, and Reading (2011), who argued that successful statistics education depends not only on curriculum reform but also on teachers' pedagogical knowledge, instructional resources, and opportunities for sustained professional learning. Therefore, the needs assessment provides a strong empirical foundation for the instructional strategies proposed in this study and establishes the rationale for the subsequent pedagogical intervention.

5. DISCUSSION

5.1. Teachers' Positive Perceptions and the Gap Between Awareness and Classroom Practice

The findings of this study demonstrate that primary school teachers generally recognize the educational importance of teaching statistics and probability for developing students' mathematical problem-solving competency. All surveyed teachers considered this instructional orientation to be either important or very important, indicating a strong level of professional awareness regarding the role of competency-based mathematics education. Nevertheless, the subsequent survey results revealed that positive perceptions did not consistently translate into effective classroom practice. Teachers reported uneven understanding of the different components of mathematical problem-solving competency and encountered considerable challenges when organizing higher-order learning activities, particularly those requiring students to evaluate solutions, interpret statistical evidence, and engage with probability concepts. These findings suggest that teachers' recognition of educational goals alone is insufficient to ensure successful implementation unless it is supported by appropriate pedagogical knowledge and practical instructional guidance.

This finding is consistent with the study by Sánchez-Mendías et al. (2024), which reported that teachers' positive attitudes toward mathematics education are closely associated with instructional quality but emphasized that effective classroom practice depends on adequate professional competence and continuous professional development. Similarly, Broza et al. (2025) found that both in-service and pre-service teachers expressed favorable perceptions of interdisciplinary mathematics instruction while simultaneously identifying difficulties in translating innovative educational ideas into everyday teaching practice. These studies collectively suggest that positive beliefs provide an essential foundation for instructional improvement but cannot independently produce meaningful changes in students' learning experiences without sustained pedagogical support.

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The present study extends these findings by demonstrating that the discrepancy between teachers' awareness and classroom implementation is particularly evident in statistics and probability education at the primary level. While teachers appreciated the educational significance of this learning domain, they experienced difficulties in designing authentic statistical investigations, organizing inquiry-based activities, and guiding students through the complete mathematical problem-solving process. These findings provide empirical support for the development of systematic instructional strategies that not only strengthen teachers' professional competence but also provide practical classroom guidance for implementing competency-based statistics and probability instruction. Such support is likely to narrow the gap between educational intentions and classroom practice while promoting more effective development of students' mathematical problem-solving competency.

5.2. Challenges in Teaching Statistics and Probability for Developing Mathematical Problem-Solving Competency

The findings of this study indicate that the challenges encountered by primary school teachers extend beyond individual teaching skills and reflect broader issues related to curriculum implementation, professional preparation, and instructional resources. Although teachers demonstrated positive perceptions of competency-based mathematics education, they reported considerable difficulties in teaching statistics and probability, particularly when designing authentic learning situations, selecting appropriate instructional approaches for probability, and organizing activities that require students to analyze data, justify mathematical reasoning, and evaluate alternative solutions. In addition, many teachers identified insufficient professional development opportunities and a lack of specialized instructional materials as significant barriers to implementing competency-oriented teaching effectively. These findings suggest that the successful development of students' mathematical problem-solving competency depends not only on curriculum reform but also on sustained support for teachers' professional learning and instructional capacity.

The present findings are consistent with those reported by Batanero, Burrill, and Reading (2011), who argued that statistics education presents distinctive pedagogical challenges because teachers must integrate statistical reasoning, data interpretation, and inquiry-based learning within authentic classroom contexts. Their work emphasizes that teachers frequently require additional professional preparation to confidently teach statistical concepts and design meaningful investigations that move beyond procedural instruction. Similarly, Garfield and Ben-Zvi (2008) highlighted that effective statistics instruction requires teachers to create learning environments in which students actively construct statistical understanding through data exploration, discussion, and evidence-based reasoning. Without adequate pedagogical support and instructional resources, classroom practice tends to emphasize routine exercises rather than opportunities for higher-order mathematical thinking.

The results of the present study reinforce these international findings by demonstrating that similar challenges remain evident in primary mathematics classrooms. Teachers experienced particular difficulty when implementing probability-related activities and guiding students through the later stages of mathematical problem solving, especially evaluating and reflecting on solution strategies. These findings provide a strong empirical rationale for developing systematic instructional strategies that translate curriculum expectations into practical classroom procedures. By supporting teachers in designing authentic statistical investigations and problem-solving activities, such strategies can strengthen both instructional quality and students' mathematical problem-solving competency, thereby facilitating the effective implementation of competency-based mathematics education.

5.3. Implications for Instructional Strategy Development

The needs assessment conducted in this study provides a clear empirical foundation for the development of instructional strategies that support mathematical problem-solving competency through statistics and probability. Although teachers demonstrated positive perceptions of competency-based mathematics education, the survey findings revealed inconsistencies in their understanding of the different stages of mathematical problem solving, uneven implementation of statistics and probability content, and persistent challenges in designing authentic learning activities. These findings indicate that effective instructional improvement requires more than increasing teachers' awareness of educational reform. Instead, teachers need practical pedagogical guidance that systematically translates curriculum objectives into classroom practices and supports the organization of meaningful learning experiences.

The present findings are consistent with the perspective of McKenney and Reeves (2021), who argued that educational design research should generate practical instructional solutions grounded in both theoretical principles and authentic educational problems. Rather than proposing abstract pedagogical recommendations, educational design research emphasizes the iterative development, implementation, evaluation, and refinement of instructional interventions capable of addressing real classroom needs. Likewise, Plomp and Nieveen (2013) highlighted that instructional design should be informed simultaneously by curriculum requirements, empirical evidence, and classroom realities to ensure both educational effectiveness and practical feasibility. These perspectives strongly support the methodological approach adopted in the present study, in which the proposed instructional strategies were developed directly from the needs identified through the teacher survey and aligned with the objectives of competency-based mathematics education.

The implications of the present study therefore extend beyond identifying existing instructional challenges. The findings demonstrate the necessity of designing coherent instructional strategies that explicitly guide teachers through each stage of the

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teaching process, from creating authentic problem situations and facilitating data investigation to encouraging mathematical reasoning, reflection, and evaluation. Such strategies provide practical support for teachers while promoting greater consistency in classroom implementation across different topics within statistics and probability. Consequently, the instructional strategies proposed in this study may serve not only as pedagogical resources for primary mathematics teachers but also as useful references for professional development activities aimed at strengthening competency-based mathematics instruction in primary education.

5.4. Educational Implications for Competency-Based Mathematics Teaching

The findings of this study have several important implications for competency-based mathematics education in primary schools. First, the results indicate that improving students' mathematical problem-solving competency requires systematic changes in classroom instruction rather than isolated modifications to individual lessons. Although teachers generally recognized the importance of statistics and probability within the mathematics curriculum, the survey revealed that effective implementation remained constrained by uneven pedagogical understanding, limited professional preparation, and insufficient instructional resources. These findings suggest that competency-based curriculum reform should be accompanied by structured instructional guidance that enables teachers to transform curriculum expectations into meaningful classroom practice.

The present findings are consistent with the recommendations of Darling-Hammond et al. (2020), who emphasized that meaningful learning occurs when students actively construct knowledge through inquiry, reasoning, collaboration, and reflection within supportive instructional environments. Likewise, the OECD Learning Compass 2030 (OECD, 2019) highlights that competency development requires learning experiences connecting disciplinary knowledge with authentic contexts, enabling students to apply knowledge flexibly while developing higher-order thinking and responsible decision-making. These international perspectives reinforce the argument that statistics and probability should not be taught merely as isolated mathematical content but should instead serve as meaningful contexts through which students investigate real-world situations, interpret evidence, and solve practical problems.

Building upon these perspectives, the present study demonstrates that carefully designed instructional strategies can bridge the gap between curriculum expectations and classroom implementation. By providing teachers with coherent pedagogical procedures, authentic learning tasks, and opportunities to engage students in all stages of mathematical problem solving, the proposed instructional strategies may contribute to more effective competency-based mathematics instruction in primary schools. Beyond improving the teaching of statistics and probability, the findings also suggest broader implications for teacher professional development, curriculum implementation, and instructional design in primary mathematics education. Consequently, the instructional framework proposed in this study may serve as a practical reference for teachers, teacher educators, and curriculum developers seeking to strengthen competency-oriented mathematics teaching and foster students' mathematical problem-solving competency in authentic learning environments.

6. CONCLUSION

This study was conducted to design and evaluate instructional strategies for developing mathematical problem-solving competency through statistics and probability in primary schools. Grounded in the competency-based orientation of mathematics education, the research combined theoretical analysis with an empirical investigation of current teaching practices to identify instructional needs and establish a practical foundation for instructional design. The survey findings demonstrated that primary school teachers generally recognized the educational importance of teaching statistics and probability for developing mathematical problem-solving competency. However, the results also revealed considerable disparities between teachers' positive perceptions and their classroom implementation. Teachers experienced difficulties in understanding all components of mathematical problem-solving competency, organizing higher-order statistical and probabilistic learning activities, implementing reflective evaluation during problem solving, and teaching probability concepts. These findings indicate that strengthening teachers' awareness alone is insufficient to improve instructional quality without systematic pedagogical support and practical instructional guidance.

Based on the identified needs, the study provides empirical evidence supporting the development of instructional strategies that integrate statistics and probability with competency-based mathematics teaching. Rather than focusing solely on mathematical content, the proposed instructional approach emphasizes authentic problem situations, active student engagement, statistical investigation, mathematical reasoning, communication, reflection, and evaluation throughout the learning process. Consequently, the study contributes both theoretically and practically by demonstrating how instructional design can bridge the gap between curriculum expectations and classroom implementation while supporting the development of mathematical problem-solving competency in primary education.

Despite these contributions, the study has several limitations. The needs assessment was conducted with teachers from a limited number of primary schools within one province, and the findings therefore should be interpreted within this educational context. Future research may extend the implementation of the proposed instructional strategies across different educational settings, examine their long-term effectiveness, and investigate how digital technologies and emerging instructional approaches can further

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enhance the teaching of statistics and probability for developing mathematical problem-solving competency. Overall, the findings provide valuable implications for curriculum implementation, teacher professional development, and competency-based mathematics education while offering practical guidance for improving the quality of statistics and probability instruction in primary schools.

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