

Analysis of mathematical competencies in regular basic education: A systematic review

Análisis de las competencias matemáticas en la educación básica regular: una revisión sistemática

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Abstract

The purpose of this study was to analyze the development of mathematical competencies in regular basic education through a systematic literature review. To do so, the PRISMA protocol was applied, selecting 20 relevant articles published between 2017 and 2025 from recognized databases such as Scopus, SciELO, and WoS. The temporal distribution of the articles reveals that the year 2025 accounts for the largest number of publications, with a total of six articles, representing 30% of the total. Based on the analysis of the different thematic categories, it was found that active teaching strategies that foster critical thinking, meaningful learning, and collaborative interaction among students significantly contribute to strengthening mathematical competencies at this educational level. Furthermore, the incorporation of technological tools and the implementation of contextualized assessment were identified as factors that favor student motivation and deepen content understanding. On the other hand, innovative pedagogical approaches, adapted to the specific characteristics of each context, require ongoing professional development for teachers. This highlights the fundamental role they play as learning facilitators, promoting more dynamic and effective educational environments. In conclusion, the study underscores the importance of combining active methodologies, technology, and relevant assessments to optimize the mathematics teaching-learning process in basic education.

Keywords: learning, mathematical competencies, teachers, basic education, students.

Resumen

El presente estudio tuvo como propósito analizar el desarrollo de las competencias matemáticas en la educación básica regular mediante una revisión sistemática de la literatura. Para ello, se aplicó el protocolo PRISMA, seleccionando 20 artículos relevantes publicados entre 2017 y 2025, provenientes de reconocidas bases de datos como Scopus, SciELO y WoS. La distribución temporal de los artículos revela que el año 2025 concentra el mayor número de publicaciones, con un total de seis artículos, que representan el 30 % del total. A partir del análisis de las distintas categorías temáticas, se constató que las estrategias didácticas activas que fomentan el pensamiento crítico, el aprendizaje significativo y la interacción colaborativa entre estudiantes contribuyen significativamente al fortalecimiento de las competencias matemáticas en este nivel educativo. Asimismo, la incorporación de

herramientas tecnológicas y la implementación de una evaluación contextualizada se identificaron como factores que favorecen la motivación estudiantil y profundizan la comprensión de los contenidos. Por otro lado, los enfoques pedagógicos innovadores, adaptados a las características específicas de cada contexto, exigen un desarrollo profesional continuo para los docentes. De esta manera, se destaca el rol fundamental que éstos desempeñan como facilitadores del aprendizaje, promoviendo ambientes educativos más dinámicos y efectivos. En conclusión, el estudio subraya la importancia de combinar metodologías activas, tecnología y evaluaciones pertinentes para optimizar el proceso de enseñanza-aprendizaje de las matemáticas en la educación básica.

Palabras clave: aprendizaje, competencias matemáticas, docentes, educación básica, estudiantes.

Introduction

Students who enhance their mathematical competencies have greater opportunities to access better living conditions and explore new fields of study, as well as to engage in scientific, technological, cultural, and economic domains (Percial, 2025; Cedeño & Sáez, 2024). However, traditionally, mathematics education has favored routine and low-impact methods, neglecting more complex skills such as reasoning, strategy formulation, procedural justification, and the use of analytical and reflective judgment (Barrionuevo et al., 2025; Alvarado, 2024). Therefore, it is necessary to implement heuristic methods and active, transformative strategies that enable learners to understand context, construct new meanings, and strengthen mathematical skills (Soledispa & Parra, 2024; Hänze & Leiss, 2022).

Internationally, it is increasingly evident in curricula, educational policies, and global assessments that the development of mathematical competence in basic education is a priority (Bolaño et al., 2024; Gutiérrez & Yanchaguano, 2025; Beltrán-Pellicer & Alsina, 2022). Instruments such as PISA and TIMSS have established themselves as benchmarks for measuring mathematical skills in students, revealing significant regional disparities (Zhu, 2018; Herrera, 2020). Notably, Asian countries such as Japan, Singapore, and South Korea stand out, with their success attributed—among other factors—to well-structured curricula, highly trained educators, and a culture that values mathematical education from an early age (Himeji-Ken, 2025).

In contrast, Latin America faces a particularly complex scenario (Demarchi, 2020). Students in regular basic education often achieve low results in mathematics on national and international assessments (Näslund-Hadley & Alonzo, 2024). According to reports from the Inter-American Development Bank (Arias et al., 2023; Banco Interamericano de Desarrollo et al., 2024), this issue is related to poorly contextualized curricula, a lack of pedagogical resources, insufficient continuous teacher training, and a disconnect between mathematical content and students' everyday lives (Zumba et al., 2024; Cáceres-Mesa et al., 2025). In response to this reality, several countries have initiated curricular reforms that promote critical thinking, collaborative work, and the resolution of real problems through mathematics (Ansina, 2021; Meza-Holguín et al., 2024).

Specifically, in Peru, significant changes have been made to the curriculum, teaching methods, and assessment tools applied to regular basic education (Olivares & Peinado, 2024). According to the national curricular design, competencies such as modeling situations, argumentation, the use of technology in mathematical processes, and result communication are prioritized (Ministerio de Educación, 2010). Thus, the development of mathematical thinking should begin with meaning construction and problem-solving (Bracho et al., 2023).

In this context, fostering logical, critical, and analytical thinking in students is one of the essential objectives of mathematics education in basic education (Saavedra-Pizarro, 2024; Núñez-Lira et al., 2020). Therefore, acquiring mathematical competencies is fundamental in today's complex and digital environment, as it contributes not only to facing academic and professional challenges but also to understanding and interacting with social realities (Ureña-Villamizar et al., 2024; Montes, 2024). Moreover, by approaching mathematics from this perspective, the discipline ceases to be abstract and isolated, becoming a useful language that enables individuals to understand the world, make informed decisions, and actively participate in democratic life (López-Bermúdez et al., 2024). Thus, the necessity arises to replace traditional methods with more holistic, inclusive, and contextualized approaches that analyze the evolution of mathematical competencies throughout regular basic education (Romero et al., 2024; Rosado, 2023).

Finally, it is crucial to sustain pedagogical practices that recognize student diversity, value real-world experience in mathematical teaching, and consider the teacher as an active mediator of knowledge (Pelcastre-Benítez & Cáceres-Mesa, 2025). Therefore, it is not only relevant but ethically essential to consider existing mathematical competencies, underlying theories, and best practices at various levels, in order to ensure accessible and high-quality education for all (Chanel, 2024). From this premise arises the research question: What

is the current state of the literature on mathematical competencies in regular basic education? Consequently, the objective of this study is to analyze these competencies through a systematic review of the literature.

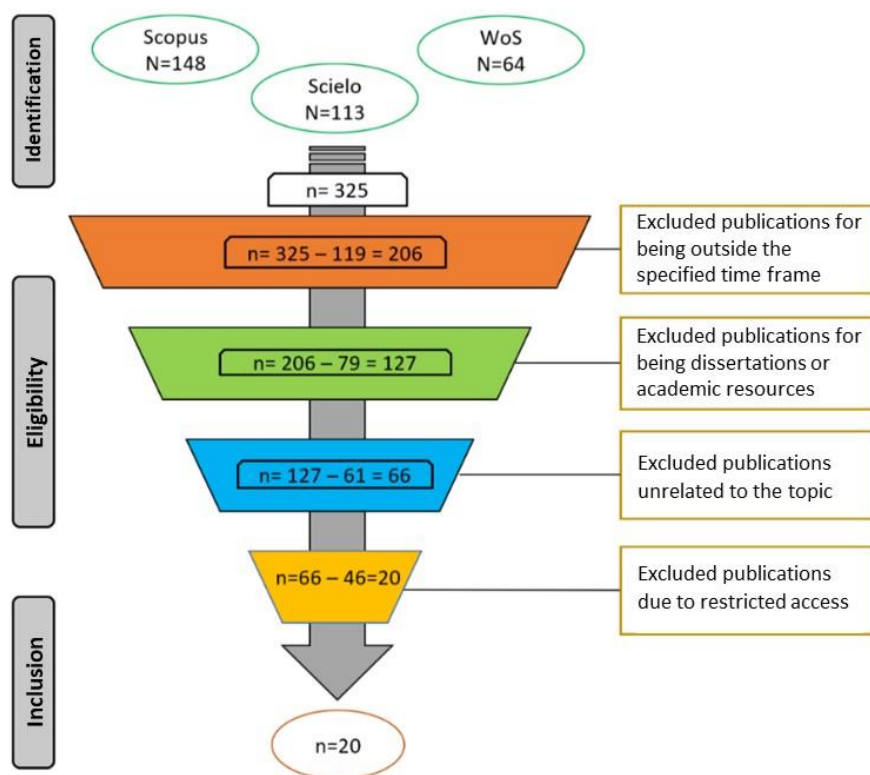
Methodology

This study is based on a systematic literature review, strictly following the guidelines established in the PRISMA protocol. According to Page et al. (2021), this protocol represents a rigorous method for searching, analyzing, evaluating, and extracting relevant data from a broad set of studies related to a specific theme, phenomenon, or research question. The procedure employed to conduct this systematic review is detailed below.

Regarding inclusion criteria, publications between 2017 and 2025 were selected, consisting of original research articles and reviews published in Spanish, English, or Portuguese. Conversely, exclusion criteria limited the elimination of dissertations, books, publications outside the stipulated time frame, articles with restricted access, and those whose themes were not related to the object of study.

The search was conducted in the databases Scopus, SciELO, and Web of Science (WoS), using Boolean operators in Spanish and English, such as “competencias matemáticas” and “mathematical competencies.” Initially, 325 potentially relevant publications were identified. However, after the rigorous application of exclusion criteria and the corresponding filtering through the PRISMA flow diagram, the study concluded with a final selection of 20 articles (see Figure 1).

Figure 1
Flow diagram for systematization of information (PRISMA)



Results and discussion

From a total of 325 reviewed articles, 20 studies were ultimately selected that address mathematical competencies in regular basic education. Their main characteristics are summarized in Table 1, which details the frequency of publications by year and the most relevant findings.

Table 1
Results of the analysis of mathematical competencies

Year	Author(s)	Findings / Conclusions
2024	Tovalino et al.	Teacher efforts to reinvent themselves and enhance their technical skills, as well as to develop innovative tactics, contributed to academic success during the pandemic.
2021	Poma et al.	More research is needed to provide educators with the necessary knowledge to guide mathematical learning and enhance competency development.
2025	Ramos	Insufficient use of technology, ineffective communication, and lack of engaging materials limit the development of mathematical competencies, which remain at an average level.
2025	Maguiña & Padilla	The use of technologies such as smartphones and applications can significantly enhance learning in mathematics, especially in distance education, where autonomy is key.
2023	Quispe et al.	Success in developing mathematical competencies is closely linked to the presence of strong cognitive skills and problem-solving ability.
2025	Vaca-De la Cruz et al.	It is essential to promote training programs centered on heuristic techniques and ensure continuous support for students during practical application.
2024	Moreno & Moreno	Formative assessment, based on recognizing achievements, self-assessment, and peer evaluation, positions the student as the protagonist in their mathematical learning.
2025	Ponce-Altamirano et al.	Mathematical competencies are better developed using culturally sensitive approaches, gamification, active learning, contextualization, and technology, which also foster motivation and teamwork.
2022	Guisvert & Lima	Gamification enhances the teaching of mathematics, motivating students both in the classroom and in their independent study through popular technological tools.
2019	Alsina et al.	Adapting methodologies to specific contexts facilitates the implementation of educational procedures aligned with modern demands.
2023	Yupanqui	Strategies such as mathematical modeling, the Pólya technique, problem-based learning, and ethnomathematics improve problem-solving teaching.
2019	Rivera & Ahumada	The Singapore Method proves effective in improving mathematical thinking according to current curricular standards.
2025	Vaca-De la Cruz et al.	It is recommended to encourage teachers to promote problem generation, stimulating students to create and solve comprehensive mathematical situations.
2017	Velásquez et al.	Contextualized assessment seeks to improve quality through formative processes involving improvement strategies supported by teachers.
2022	Farfán-Pimentel et al.	Pedagogical approaches that promote collaborative work contribute to improving teaching practices and learning outcomes in mathematics.
2024	Arévalo-Duarte et al.	The development of problem-solving competency is enhanced through procedures that integrate cognitive and contextual actions.
2021	Ramos & Ramos Vera	Gamification motivates students to overcome challenges and take initiative, favoring the development of mathematical competencies in an engaging manner.
2025	Díaz & Gastello	Methodologies such as ludification, problem-based learning, projects, and flipped classrooms are successful for developing mathematical competencies.
2019	Vilca	The use of problem-solving strategies and collaborative work in pairs enhances learning and competency development in secondary students.

2024	Castro	The incorporation of augmented reality increases conceptual understanding, interest, and creativity in students' learning of mathematics.
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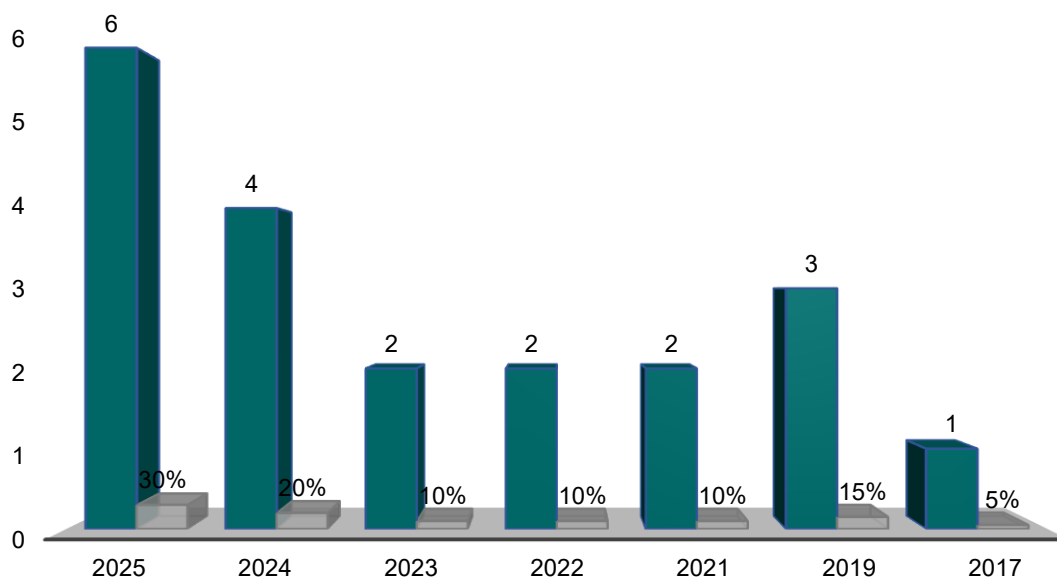
For the analysis and interpretation of the results, the studies were categorized according to the year of publication. Additionally, they were organized based on their context and analyzed across four major thematic dimensions: teaching strategies, problem-based learning (PBL), assessment of mathematical competency, and technological innovation.

Frequency of publications by country

Regarding the year of publication, as shown in Figure 2, the year 2025 records the highest number of publications, with a total of six articles representing 30% of the total. It is followed by 2024, with 20%, and then 2019, with 15%. In the fourth position are the years 2021, 2022, and 2023, each accounting for 10% of the scientific publications related to the studied area. Finally, 2017 presents the smallest proportion, with 5% of the reviewed articles.

Figure 2

Distribution of articles by year of publication



Teaching strategies for the development of mathematical competencies

For students to acquire solid mathematical competencies, it is essential to implement effective teaching strategies. These competencies encompass not only the memorization of data and concepts but also the ability to solve problems, reason logically, and communicate mathematical ideas clearly. According to Yupanqui (2023), teaching strategies should enhance students' skills in solving mathematical problems, promoting contextualized, active, and collaborative learning. In this regard, Guisvert & Lima (2022) and Ramos & Ramos Vera (2021) agree that gamification has proven to be a powerful tool for creating a more engaging, interactive, and student-centered learning environment, both in basic and secondary education.

These findings align with the observations of Rivera & Ahumada (2019) and Vaca-De la Cruz et al. (2025), who emphasize the importance of prioritizing active, student-centered approaches, such as Pólya's strategies or the Singapore Method, in conventional curricula to strengthen mathematical understanding. The combination of both approaches could offer a comprehensive strategy for enhancing mathematical competencies.

Problem-Based Learning

On the other hand, Arévalo-Duarte et al. (2024) and Vilca (2019) agree that problem-solving and problem-based learning are effective pedagogical approaches for enhancing mathematical skills in primary and secondary

students. These methodologies promote collaborative work and contextualized learning, which are fundamental for strengthening problem-solving capabilities.

Furthermore, Farfán-Pimentel et al. (2022) and Ponce-Altamirano et al. (2025) emphasize the value of collaborative learning as a key strategy that encourages active student participation and strengthens meaningful relationships among peers. However, to maximize outcomes, it is advisable to combine this technique with other methods that consider the particularities of each classroom and individual learning styles.

Assessment of mathematical competence

Regarding assessment, Moreno & Moreno (2024), along with Alsina et al. (2019) and Velásquez-Luna et al. (2017), argue that linking mathematics instruction with real-life situations, promoting personal reflection among students, and providing continuous feedback constitute a formative and contextualized approach that fosters the deep development of mathematical competence. In this way, students are better prepared to face standardized assessments and to assimilate mathematical concepts meaningfully throughout their lives.

Additionally, Poma et al. (2021) and Vaca-De la Cruz (2025) concur that the incorporation of active and innovative practices, which encourage critical thinking and autonomy, promotes the growth of mathematical competencies in basic education classrooms. Consequently, it is essential to adopt a comprehensive strategy that encompasses teacher training, the educational environment, and methodological diversity, emphasizing continuous innovation and adaptation of teaching strategies to facilitate deeper and more meaningful learning.

Moreover, Ramos (2025) highlights that to achieve more relevant learning, it is necessary to reform educational practices, emphasizing the role of the teacher as a facilitator, improving teaching materials, and promoting the use of technological tools. In alignment with this, Díaz & Gastello (2025) and Quispe et al. (2023) advocate for moving away from traditional teaching methods. While Quispe et al. stress the importance of building a solid cognitive foundation, Díaz & Gastello underline the need to implement interactive approaches to apply that knowledge. Thus, combining cognitive enhancement with active methodologies presents a promising avenue for strengthening mathematical competencies.

Technological innovation and mathematical competence

Finally, according to the reviewed studies, emerging technologies hold great potential for enriching mathematics instruction in basic education. The use of augmented reality (Castro, 2024), virtual education platforms (Tovalino et al., 2024), and digital tools (Maguiña & Padilla, 2024) contribute to the development of mathematical competencies, increase intrinsic motivation, and facilitate a deeper conceptual understanding. However, challenges such as the need for more specialized teacher training and limitations in interaction on certain platforms have been identified. Overall, the results indicate that for technology to positively impact learning, an appropriate pedagogical implementation, continuous teacher training, and coherent contextualization with the educational environment are essential.

Conclusions

The reviewed studies demonstrate that approaches such as problem-based learning, gamification, and collaborative exercise resolution are highly effective in promoting autonomy, critical thinking, and a deep understanding of mathematical concepts in students. Furthermore, it is crucial to consider the student's context when assessing their development, implementing continuous feedback mechanisms that enhance their learning, efficiency, performance, and comprehension.

Consequently, teaching strategies that highlight active student participation, collaborative work, and the practical application of knowledge are indispensable for strengthening mathematical competencies. Similarly, the appropriate use of electronic resources and technologies, managed by trained teachers, can significantly enhance the learning process.

In summary, the results support the need for a paradigm shift in mathematics instruction, oriented towards greater creativity, adaptability, and contextualization. In this renewed model, the incorporation of technology, the mediating role of the teacher, and the implementation of innovative pedagogical tactics become key elements in fostering the meaningful and lasting acquisition of mathematical concepts by students.

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