

TRANSFORMATION OF MATHEMATICS EDUCATION WITH SITUATED COGNITION AND ARTIFICIAL INTELLIGENCE. A SCOPING REVIEW

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Abstract

Educational institutions play a prominent role in human development and must adapt to the transformative demands of a globalized world. One of the key challenges they face is integrating digital technologies and Artificial Intelligence (AI) tools into the educational process. Specifically, in mathematics education, it is essential to prepare students for this technological reality while maintaining effective teaching and learning strategies. This article presents, a scoping review has been carried out by adapting the PRISMA protocol of studies on situated cognition and the use of AI as a pedagogical tool in relation to the teaching of mathematics, whose activity, in addition to giving a perspective on the research background, offers epistemological foundations, methodological and operational methods to propose a pedagogical innovation strategy that confirms the effectiveness of ICT in mathematics teaching from situated cognition.

Introduction

Considering that it is in the Colombian context in which this research is developed, it is necessary to understand that the curriculum of the area of mathematics in the country's schools is based, in the first instance, on the General Education Law 115 of 1994, which dictates that mathematics is a compulsory and fundamental discipline. In its article 77 of chapter 2, Law 115 grants autonomy to educational institutions to build their Institutional Educational Project (PEI) and to adapt them to local environments. For this reason, educational institutions are also provided with the Curricular Guidelines (MEN, 1998) and the Basic Competency Standards (MEN, 2006), which were created to guide the teaching and learning processes for basic and secondary education.

What is stated in these official documents in relation to mathematical competence provides the guidelines with which a conception of mathematical knowledge is promoted as a primary instrument for the formation of critical and competent citizens, capable of analyzing and understanding their environment through the use of models, algorithms and logical reasoning and based on their orientations schools can design flexible and relevant curricular proposals. focused on the resolution of real problems and focused on situated, significant sociocultural contexts that respond to the needs of the environment.

Due to the globalized society, the age of knowledge, it is undeniable that the problems in reality are constantly evolving, and undoubtedly, education in the world has been affected by the advance of Information and Communication Technologies (ICT) which has impacted

the way in which teaching and learning are done. And mathematics is not exempt from this situation. The integration of digital tools, applications and online platforms has become a common and paramount practice to foster more interactive learning due, to a large extent, even more as a result of the COVID-19 pandemic, which not only acted as a catalyst for the adoption of educational technologies, but also accelerated the research and implementation of digital tools in teaching, adapting educational models to remote environments.

In the educational context of Colombia, there is a persistent concern about the difficulties of Colombian students to apply mathematical skills that reflect their ability to use the knowledge acquired during their training, since these are necessary to address everyday situations that require the interpretation of scenarios, the management of data and the support of conclusions. According to the national results of the Saber 11° tests of the Colombian Institute for the Evaluation of Education (ICFES, 2024) between 2017 and 2023, the average in mathematics for calendar A has remained without significant changes. Average scores have remained stable, except in 2021, when a decline was observed, possibly attributable to the pandemic.

The data for the last year analysed, 2023, further highlight the problem at the regional level (ICFES, 2024). In this sense, the Caribbean and Pacific regions presented the highest percentages of students in level 1 of performance in mathematics, with 15% and 13%, respectively. In particular, the Caribbean region, which includes the department of Magdalena where this research is carried out, exhibits a performance in mathematics below the national average, with a high proportion of students in levels 1 and 2, reaching 56%. On the other hand, the Central East region stood out by having the highest percentage of students in level 3 (58%) and level 4 (10%), which shows a notable gap in performance.

In the Colombian Caribbean, mathematics learning faces significant challenges derived from the socioeconomic and cultural context, such as the scarcity of resources, community beliefs, and institutional limitations that hinder the effective implementation of the curriculum (Feliciano-Semidei & Palencia, 2025). This situation has led to low educational coverage and quality, especially accentuated during the pandemic by inequality in access to digital technologies (Rhenals Ramos, 2021). Factors such as lack of family support, low cultural expectations, and technological limitations directly affect student motivation and performance. Although the use of ICT in mathematics teaching presents challenges, its potential to facilitate conceptual understanding through contextualized virtual environments is recognized (Grisales-Aguirre, 2018; Niño Merlo, 2023). However, there is still a disconnect between curricular approaches and actual pedagogical practice, characterized by traditional methods that limit the construction of meaningful learning (Višňovská & Cortina, 2025).

This problem is closely linked to the theory of situated cognition, which states that knowledge is developed through interaction in specific cultural and social contexts, following the foundations of Piaget, Vygotsky, Lave and Wenger. In the mathematical field, Greeno (1998) and Boaler (2000) highlighted how learning becomes more effective when it is integrated into real and collaborative situations, overcoming decontextualized approaches. In this framework, this study is developed in a public school in a municipality of the Colombian Caribbean, focusing on eighth-grade high school students. It is proposed to evaluate the effectiveness of an innovative educational program that articulates situated cognition strategies with technological tools, with the purpose of enhancing logical reasoning,

conceptual comprehension and mathematical problem solving, breaking with the traditional paradigm of transmissive teaching.

Mathematical skills—such as logical thinking, problem-solving, modeling, representation, and mathematical communication—are fundamental to the student's holistic development, enabling them to interpret and act in their environment. These competencies go beyond mechanical calculation, as they involve processes of analysis, synthesis and application of concepts in diverse contexts. From the perspective of situated cognition, learning is strengthened when it occurs in real and meaningful scenarios, which ensures that the knowledge acquired is useful and transferable to everyday situations.

At this point, situated cognition becomes important, which is based on various currents of constructivism, especially Piaget's (1972) cognitivism, which emphasizes the construction of knowledge based on individual experience, and Vygotsky's (2012) socioconstructivism, which highlights the importance of cultural context and social interaction in learning. It is also linked to the social constructionism of Berger and Luckmann (2001) and the postmodern perspectives of authors such as Potter (1998), who consider knowledge as a discursive and contextual construction, reinforcing the idea that learning is a collaborative process and situated in specific environments.

From this perspective, cognition is not reduced to an isolated mental process, but manifests itself as an activity situated in physical, social, and cultural contexts (Lave & Wenger, 1991). Knowledge, therefore, is generated through participation in communities of practice, mediated by tools, cultural practices, and social interactions (Greeno, 1998). Suchman (2007) deepens this vision by pointing out that knowledge is inseparable from the environment and the relationships that shape it, proposing a view that includes the interaction between humans and technologies. In the field of mathematics, this theory becomes relevant by proposing that problem solving must take place in authentic and collaborative scenarios, where understanding emerges from shared experience and the significant use of technological tools.

In this research, the use of digital technologies as a means to promote mathematical thinking in contextualized contexts is highlighted. However, although various studies have shown the potential of ICTs in this area, their impact does not depend only on their availability, but also on the way in which they are pedagogically integrated. Its effectiveness lies in generating interactive, challenging and relevant learning environments that promote student understanding, autonomy and self-regulation. Thus, rather than focusing on the technological tools themselves, a didactic design is required that enhances meaningful experiences. As the MEN (1998) points out, new technologies expand the possibilities of learning by enriching the curriculum with new ways of knowing and acting.

Therefore, this article offers an exploratory bibliographic tour through a scope review, which integrates the search, selection, evaluation, and rigorous synthesis using predefined criteria (Mena Orejuela, 2022) provides this study with the existing scientific evidence on the incidence of technologies in the educational act. This scoping review, in addition, is a support for decision-making, becoming a powerful instrument to examine what researchers are doing, determine gaps in the study and promote meta-analysis. Therefore, the scoping review as a method of documentary research is justified on the theoretical, methodological and practical level of the study in that it allows answering what epistemological, methodological and operational foundations are required to structure a

program based on situated cognition, using educational mobile applications powered by AI as mediators of mathematical learning.

Method

According to Abdallah (2024), an exhaustive review of the literature delimits the scope of the research, placing the study within a broader intellectual context, demonstrating the competence of the researcher in the field and clearly establishing the direction for his research, in this sense, this research work was carried out following the methodological route of search, selection and systematization and analysis of the review.

Selection and exclusion criteria

- The first criterion was thematic, for which three fundamental aspects were addressed in the research: mathematics, situated cognition and Artificial Intelligence.
- The second criterion of inquiry was scientific documents, theses, articles and essays whose interest, as far as possible, was the mixture of the aforementioned elements or related terms. For example: "mathematical skills", "mathematical thinking", "mathematical reasoning" and "situated learning", "contextualised teaching" "ICT", "digital tools", among others.
- The other criteria corresponded to the academic databases, the languages and the specific time range in which they were published. The documents were extracted from: ProQuest, ERIC, RedALyC, SciELO, Dialnet, ResearchGate, Google Scholar, Academia. Some institutional and Open Access repositories such as Arxiv and Amelica, which should have been published between 2020 and 2025, in three languages: Spanish, English and Portuguese, were also examined.
- As a consequence, any papers outside the selection criteria were excluded from the review.

Search equation

In order to parameterize approximately the percentage of significant texts found, the following equation was formulated:

Search Accuracy = $\frac{\text{Número de documentos relevantes recuperados}}{\text{Total de documentos recuperados}} \times 100$

Next, as proposed by Mejía (2019), for the documentary review, the search engines used, the dates of inquiry, the search equations, the number of results obtained, the number of relevant results, the accuracy of the search and, finally, the titles of the documents with their corresponding authors and dates, as specified in Table 1, an example of how the search was carried out is offered.

Table 1.
Example of the search protocol for findings in Dialnet

Search Engine	Dialnet
Search Date	16/06/2025

Search equation	"mathematics" ("mathematical competencies" OR "mathematical thinking" OR "mathematical reasoning") AND "situated cognition" ("situated learning" OR "contextualized teaching") AND "ICT" and Artificial Intelligence ("ICT" OR "digital tools") "mathematics" ("mathematical competencies" OR "mathematical thinking" OR "mathematical reasoning") AND "situated cognition" ("situated learning" OR "contextualized teaching") AND "ICT" AND Artificial Intelligence ("ICT" OR "digital tools") "mathematics" ("mathematical competencies" OR "mathematical thinking" OR "mathematical reasoning") AND "situada cognição" ("situada learning" OR "contextualized teaching") AND "TIC" AND Artificial Intelligence ("ICT" OR "digital tools")
Number of documents recovered	10
Number of relevant documents	6
Search accuracy	60%
Relevant results	2021. Cubillo, M. R., del Castillo Fernández, H., & Martínez, B. A. The use of mobile applications in mathematics learning: a systematic review. 2022. Márquez, I. E. L., & Lozano, M. I. Á. Development of mathematical logical thinking of students from 7 to 8 years old application of an Escape Room. 2023. Merlo, C. A. N. Teaching Mathematics Mediated by ICT. 2023. García-Cartagena, Y., & Olivares-Petit, C. Educational Technology: Review and Perspectives for Curricular Innovations in Chile. 2024. Muñoz-Potosi, A. F., Castro-García, M. E., Valdivieso-González, L. G., Rodríguez-Montero, P., & Tepichín-Rodríguez, E. Strengthening of mathematical competencies in children between 10 and 13 years of age using didactic sequences mediated by ICTs. 2024. Carrasco-Ruiz de Valdivia, M. E., Mallén Pascualvaca, P., & Albanese, V. Local practices and contextualized mathematical tasks from Andalusia, Spain.

Source: Own elaboration
The individual matrix of each relevant study was recorded according to Table 2.

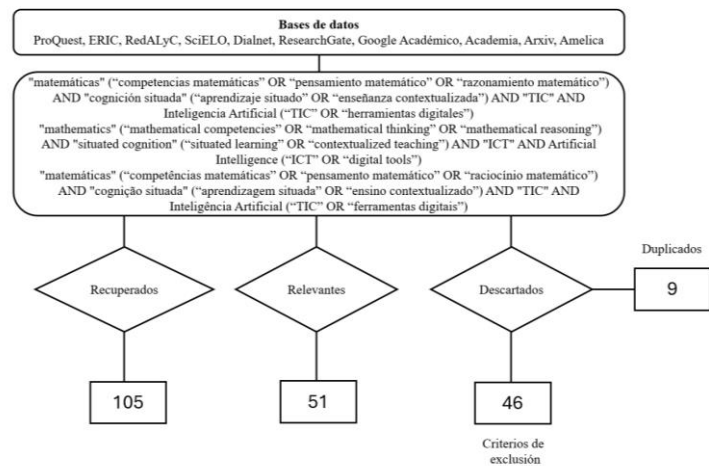
Table 2.
Example of the matrix of findings by relevant study

Search Engine	Unimagdalena Repository
Title	Mathematical Thinking and Problem Solving promoted by a didactic strategy mediated by ICT.
Author	Guete D.
Year of publication	2021
Place of publication	Colombia
Post Type	Dissertation
Language	Spanish
URL/DOI	https://repositorio.unimagdalena.edu.co/handle/123456789/21348
Elements	Strengthening the teaching-learning process of algebraic concepts through an ICT-mediated didactic strategy for students of Mathematical Reasoning and Representation. Use of the development of algebraic reasoning supported by pedagogical strategies and use of information and communication technologies. Mixed research university students. The ICT-mediated didactic strategy improved students' comprehension and functionality of algebraic concepts.

Source: Own elaboration

Additionally, a flow chart of the selection of the generalized search was made. See Figure 1.

Figure 1.
Systematic Review Protocol, article selection flowchart adapted for scoping review.



Source: Own elaboration. In original language: Spanish

Results

In order to have an overview of the research background in relation to georeference, the information extracted from the documents was organized into four tables showing the International Studies of the Old World (Table 3); Latin America and the Caribbean (Table 4); National (Table 4) and regional (Table 5).

Table 3
Summary of Asian, African, Oceania, and European International Studies on ICT, Mathematical Competences, and Situated Cognition (2020-2025)

Count ry	Year	Authors	Title	Method	Key finding
Russia	2020	Soboleva, E. V. Chirkina, S. E. Kalugina, O. A. Shvetsov, M. Y. Kazinets, V. A. Pokaninova, E. B.	<i>Didactic potential of using mobile technologies in the development of mathematical thinking.</i>	Mixed	The experimental group that developed mobile applications significantly improved their level of mathematical thinking and mathematical literacy compared to the control group
China	2024	Huang, X.	<i>Application of artificial intelligence APP in quality evaluation of primary school science education.</i>	Quantitative	Promoting the assessment of STEM curriculum learning in elementary school, to improve STEM teaching
Egypt	2024	Mohamed, M. A. et al.	<i>Applications of artificial intelligence in teaching mathematics for the second preparation year in Egyptian official language schools.</i>	Quantitative	Artificial intelligence (AI) topics in mathematics education were divided into categories such as benefits and disadvantages, conceptual understanding, factors, role, suggestion of ideas, strategies, and effectiveness.
Ghana	2024	Henkel, O. Horne- Robinson, H. Kozhakhme	<i>Effective and scalable math support: Evidence on the impact of an AI-tutor on</i>	Quantitative	Chat-based tutoring that leverages AI provides a cost-effective and operationally efficient

Country	Year	Authors	Title	Method	Key finding
		tova, N.Lee, A.	<i>math achievement in Ghana</i>		approach to improving student learning outcomes.
Singapore	2021	Tay, L. Y., Lee, S. S.Ramachandran, K.	<i>Implementation of online home-based learning and students' engagement during the COVID-19 pandemic: A case study of Singapore mathematics teachers.</i>	Qualitative - Exploratory	The COVID-19 pandemic and lockdowns forced teachers in Singapore to design online math and evidence-based learning classes.
Australia	2022	Burke, P. F.Kearney, M.Schuck, S.Aubusson, P.	<i>Improving mobile learning in secondary mathematics and science: Listening to students.</i>	Qualitative	Participants experienced a significant improvement in their learning through collaboration in digital environments.
Austria	2020	Weinhandl, R. Lavicza, Z.Hohenwarter, M.Schallert, S.	<i>Enhancing flipped mathematics education by utilising GeoGebra.</i>	Qualitative - Grounded Theory	Students are key elements in task definition, feedback, and learning contexts when using GeoGebra in flipped education.
France	2023	Outhwaite, L. A.Early, E. Herodotou, C.Van Herwegen, J.	<i>Understanding how educational maths apps can enhance learning: A content analysis and qualitative comparative analysis</i>	Qualitative	Math apps are most effective when they combine programmatic leveling, explanatory feedback, and motivational feedback.
Spain	2024	Carrasco-Ruiz De Valdivia, M. E. Mallén Pascualvacap.	<i>Local practices and mathematical tasks contextualized from Andalusia, Spain.</i>	Qualitative - ethnographic	She integrated contextualized local practices (traditional sewing and Sevillian dance) into the teaching of geometry to establish meaningful connections between everyday

Country	Year	Authors	Title	Method	Key finding
		Albanese, V.			knowledge and academic mathematics
Spain	2023	Merlo, A. N.	C. Teaching Mathematics Mediated by ICT.	Systematic review	The mediation of ICT in mathematics teaching has transformed learning by making it more accessible, interactive and effective, improving problem-solving and fostering collaboration between teachers and students
Spain	2021	Cubillo, M. R. Del Castillo Fernández, H. Martínez, B. A.	The use of mobile applications in mathematics learning: systematic review.	Systematic review	Positive impact on performance and motivation after the use of educational mobile applications in the mathematics classroom.
Portugal	2021	Costa, C.Cabrita, I.ML Martins, F.Oliveira, R.Bernardi no Lopes, J.	<i>What is the role of digital artifacts in the teaching and learning of mathematics?</i>	Systematic review	Digital artifacts enhance mathematical interaction, exploration, and understanding, as long as they are consciously integrated into well-founded teaching strategies.
England	2021	Gulliford, A.Walton, J.Allison, K.Pitchford, N.	<i>A qualitative investigation of implementation of app-based maths instruction for young learners.</i>	Qualitative	Learning math with Apps was enhanced when they combined personalized programmatic leveling, explanatory feedback on correct or incorrect answers, and motivational feedback such as praise

Source: Own elaboration

Table 3, in consideration of location, ordered the studies carried out in Asia, Africa, Oceania and Europe, in chronological order from the most recent, the authors, the title of the document, the methodology implemented to approach the research and the key findings to facilitate comparison and analysis.

Table 4

Summary of North America, Latin America, and Caribbean Studies on ICT, Mathematical Competencies, and Situated Cognition (2020-2025)

Country	Year	Authors	Title	Method	Key finding
Canada	2020	Dubé, A. K. Kacmaz, G. Wen, R. Alam, S. S. Xu, C.	<i>Identifying quality educational apps: Lessons from 'top' mathematics apps in the Apple App store.</i>	Qualitative	The lack of transparency and relevant educational information in the descriptions makes it difficult for parents and educators to identify quality Apps.
United States	2023	Sun, Y. Nambiar, R. Vidyasagar, V.	<i>Gamifying math education using object detection</i>	Qualitative	Mobile system with real-time audiovisual feedback, improvement in geometric learning.
Mexico	2024	Mártir Rodríguez, A. L.	Situated Didactic Situations: A Methodological Adjustment in Additive Problem Solving with Second Grade Primary School Students	Educational Action Research	Theory of didactic situations improve the development of mathematical logical thinking to solve different types of problems and establish a practical relationship between their learning in school and their daily life.
Mexico	2023	Bourbon, C. V.	Situated learning for the development of critical thinking in order to solve mathematical problems with students in the third grade of primary school.	Qualitative - holistic	The intervention allowed students to develop critical thinking through situated learning for the understanding of mathematical concepts.
Mexico	2021	Feliciano Morales, A., Cuevas Valencia, R. E.	Use of ICT in the learning of mathematics at the higher level	Quantitative Quasi-experimental	20% improvement in solving differential equations using ICT.

Countr y	Yea r	Authors	Title	Method	Key finding
Panama	2024	Forero-Corba, W., & Bennasar, F. N.	Techniques and applications of <i>Machine Learning</i> and Artificial Intelligence in education: a systematic review	Systematic review	The most widely used machine learning techniques in education are supervised learning, especially Random Forest and K-Nearest Neighbors, mainly applied for the prediction of academic performance and the detection of school dropout.
Dominican Republic	2023	Liriano López, A.	Collective Construction of a Community of Practice in a Secondary Institution in the Dominican Republic: Links with the Situated Learning Theory of Jean Lave and Etienne Wenger	Participatory Action Research	The formation of a community of practice significantly strengthened teachers' competencies in the pedagogical use of digital technologies, promoting a transformation in their educational practices.
Ecuador	2021	Semanate-Semanate, D. E., & Robayo-Jácome, D. J.	Didactic strategy based on ICT to improve academic performance in the area of Mathematics	Quantitative	the didactic strategy based on ICT benefited the appropriation of mathematical knowledge, critical reasoning capacity, intellectual curiosity, cognitive improvement, content acquisition through theory, practice and experience,
Ecuador	2022	Urquizo, D. Z. Correa, K. M. Velasco, J. C. Correa, G. M.	ICT and the strengthening of mathematical competencies in students of mathematics teaching pedagogy.	Quantitative Quasi-experimental	Evidence of the impact of ICT on future teachers in formal mathematical competences.

Countr y	Yea r	Authors	Title	Method	Key finding
Ecuador	2022	Márquez, I. E. L., & Lozano, M. I. Á.	Development of mathematical logical thinking of students from 7 to 8 years old application of an Escape Room.	Quantitative	He proposed a didactic proposal for Escape Room, in 8 missions or steps for the development of mathematical logical thinking,
Brazil	2024	Felipe Barros, J. E. Dias de Abreu, J.	<i>Artificial Intelligence in Mathematics Education: What has been researched. With the word, the teacher,</i>	Qualitative	Generative AI, such as ChatGPT, encouraged teacher reflection and improved collaborative mathematical problem solving.
Brazil	2024	Rimes, I. O. M.	<i>Digital Security and Artificial Intelligence: New Paths for Mathematics Teaching.</i>	Qualitative	He revealed that teacher training is oriented towards a deeper understanding of the role of the pedagogical observer, promoting reflective practices focused on the aesthetic dimension of the classroom.
Brazil	2023	De Melo, G. S. De Sousa, L. O.	<i>Dynamic Platform for Teaching Mathematics on Digital Whiteboard</i>	Systematic review	Mathigon proved to be versatile, attractive and interactive for students and teachers, although its pedagogical effectiveness depends on an adequate design of the didactic actions
Venezuela	2023	Buitrago, J. M.	Teaching mathematics and cognitive processes: realities, meanings and experiences, with an impact on learning.	Qualitative - Phenomenological	A pedagogical base model emerged from the cognition and learning of mathematics considering the educational context and reality.

Country	Year	Authors	Title	Method	Key finding
Venezuela	2021	Mantilla, G.	Development of mathematical competences through information and communication technologies (ICT) in secondary education.	Qualitative - ethnographic	Although several teachers incorporate ICT in their classes, deficiencies persist in their application and some do not use them fully, which generates disadvantages for students and maintains their demotivation towards learning
Venezuela	2020	Perera, D.Fernández, M.Urdaneta C., Izquierdo, S.	Network tool and development of mathematical skills.	Qualitative	The implementation of the digital tool significantly favored the acquisition of mathematical skills, by promoting interaction, autonomy and critical thinking of students in virtual environments.
Peru	2024	Vega Espinoza, M. E.Pretel Sifuentes, A	Vega Espinoza, M. E.Pretel Sifuentes, A.	Quantitative - applied	The use of artificial intelligence tools had a positive impact on the development of mathematical competencies, improving the performance, conceptual comprehension and motivation of students in the fifth year of secondary school.
Peru	2022	Castro, M. Y. T. Yataco, P. V. Valdivia, M. I. V. López, G. S. L.	Development of mathematical skills in virtual environments. A systematic review	Systematic review	Virtual environments that integrate educational software and technologies such as virtual and augmented reality enhance cognitive skills, problem-solving, and critical thinking in the teaching of mathematics, although their effectiveness

Country	Year	Authors	Title	Method	Key finding
					depends on infrastructure, teacher training, and equity in access.
Peru	2021	Hilario Bacilio, G. M.	ICT-mediated project-based learning to develop mathematical competencies in secondary school students.	Quantitative -applied	The application of ICT-mediated PBL significantly strengthened students' mathematical competencies by encouraging collaborative work, real problem solving, and autonomous use of technological tools.
Argentina	2020	Pezzatti, L. Edelsztejn, V.Hermida, M. J.	<i>The learning of mathematics in Argentina and its association with the cognitive sciences: opportunities and challenges</i>	Qualitative	It exposes the current state of scarce connection between research in cognitive sciences and mathematics education
Argentina	2020	Adrogué, C. Orlicki, M. E.	Access to and use of information and communication technologies (ICTs) in secondary school in different socioeconomic contexts in Argentina.	Qualitative - Phenomenological	Students perceived that practice-based teaching fosters a deeper and more meaningful understanding of the content addressed
Chile	2023	García-Cartagena, Y.Olivares-Petit, C.	Educational Technology: Review Perspectives Curricular Innovations in Chile.	Systematic review	Innovations in technological education in Chile focus on integrating programming and robotics through project-based approaches, although there are tensions in the development of

Countr y	Yea r	Authors	Title	Method	Key finding
					computational thinking and critical debates about biases and curricular integration

Source: Own elaboration

In the case of the New World studies, Table 4 grouped the American and Caribbean studies, also ordered in chronological order, the place where the study was carried out, the authors, the title of the document, the methodology of approach, as well as the key findings to facilitate the comparison and analysis where recurrence was found in Brazil. Ecuador, Peru and Venezuela for their interest in the study of innovation in digital tools with special attention to mathematics.

Table 5
Summary of National Studies on ICT, Mathematical Competences and Situated Cognition (2020-2025)

City	Year	Authors	Title	Method	Key finding
Bogota	2021	Córdoba Melgarejo <i>et al.</i>	Inclusive ICT-mediated didactic strategy to improve mathematical problem-solving competence: A case study.	Qualitative - Case Study	ICT + Polya method in students with cognitive deficits, improve motivation and solution structure.
Cali	2020	Guamanga, M. H.	Formal logic, critical thinking and situated cognition.	Systematic review	Formal logic, in terms of the development of essential critical thinking skills, must be framed in situational teaching (or situated cognition)
Tumaco	2022	Parra-Vallejo, M. J.	Application of ICT, b-Learning and Computational Thinking Strengthen Mathematical Competencies	Quantitative, to quasi-experimental	Motivation and improvement in mathematical problem solving via gamification and blended learning.

City	Year	Authors	Title	Method	Key finding
Pitalito	2022	Castañeda Castañeda, C. C.	Didactic strategy mediated by ICT to strengthen mathematical competencies in the concept of relationships between natural numbers in the sixth grade of the Criollo Municipal Educational Institution, main headquarters of the municipality of Pitalito–Huila.	Action Research Educational	Increased interest and motivation towards learning new mathematical concepts through digital board, web 2.0 platform, Geogebra and Kahoot from meaningful learning.
Manzanares	2024	Bolaños, H. A. Dueñas, A. T. Ordoñez, Y. Ramírez, S. Y. Herrera, J. A. E.	Game-Based Learning and the Integration of GeoGebra Mathematical Software as a Strategy for the Strengthening of Algebraic Thinking in Eighth Grade Students of the Nuestra Señora del Rosario Educational Institution, Manzanares, Caldas	Mixed	Increasing student motivation and engagement through gamification and Geogebra software
Bucaramanga	2024	Muñoz-Potosi, A. F. Castro-García, M. E. Valdivieso-González, L. G. Rodríguez-Montero, P. Tepichín-Rodríguez, E.	Strengthening of mathematical competencies in children between 10 and 13 years of age using didactic sequences mediated by ICTs.	Quantitative	Positive impact of the proposal because students went from a Basic to a Higher level of performance.

City	Year	Authors	Title	Method	Key finding
Bucaramanga	2023	Acosta-Guarnizo, L. M., Valdivieso-González, L. G. Muñoz-Potos, A. F.	Pedagogical strategy mediated by ICT to strengthen mathematical reasoning competence in sixth grade students.	Quantitative Quasi-experimental	Significant increase in numerical and spatial reasoning through a virtual playful strategy.
Bucaramanga	2021	Bueno Díaz, M. V.	ICT as didactic mediators in the teaching-learning processes of the area of mathematics in the basic primary school of the La Laguna Educational Institution in the Municipality of Los Santos.	Qualitative-pragmatic	Didactic support in digital educational applications and tools as dynamic elements for the development of mathematical skills and competencies.
Medellin	2023	Jaramillo López, C.M. Sánchez Sánchez, J. D. Londoño Cano, R.A.	Integration of ICT into the evaluation practices of school mathematics.	Systematic review	It emphasizes formative assessment and effective feedback in real context.
Medellin	2023	Parra Sánchez, J. S.Torres Pardo, I. D. Martínez de Meriño, C. Y.	Personalization of resources for university mathematics teaching using artificial intelligence	Quantitative	The review allowed AI to be recognized as a strategy to obtain an early warning about those students who have a low level.
Grass	2024	Rosero Yepes, R. M.	ICTs, dynamizers of mathematical learning, with students from the Los Pastos Educational Institution.	Action Research Educational	the use of ICT significantly boosted mathematical learning by increasing student motivation and participation.

Source: Own elaboration

Similarly, for the national studies shown in Table 4, the studies were also classified following the same pattern. It was observed that in Bucaramanga notable studies are being carried out in the field of ICT and mathematics.

Table 6
Summary of Regional Studies of the Colombian Caribbean Coast on ICT, Mathematical Competencies and Situated Cognition (2020-2025)

Montería	2022	Hoyos Prioló, V. J.	Mathematical modelling with the use of ICT: evaluation of a didactic-mathematical knowledge training programme for teachers	Mixed Sociocriticism	- Mathematical Education, made it possible to link the teaching of mathematics with social and political contexts.
Barranquilla	2024	Romero Caballero, S.	Theoretical methodological model for the development of generic competencies from challenge-based learning	Qualitative - constructive	- The proposed model demonstrates that challenge-based learning, structured in its dimensions and components, is effective in enhancing transversal competences
Barranquilla	2023	Escorcía et al.	<i>Specialised Knowledge of the Mathematics Teacher to Teach through Modelling using ICTs.</i>	Mixed	- They point to specialized teaching knowledge to teach modeling with ICT.
Barranquilla	2023	Henao Rivas, L.Herrera Lozano, V.Bolaño Truyol, J.	Didactic strategies mediated by adaptive educational technologies for personalized learning in basic and secondary education	Mixed - non-experimental	- Strategies based on adaptive educational technologies made it possible to adjust teaching processes to the individual needs of students

Santa Marta	2021	Guete García, D.	Mathematical Thinking and Problem Solving promoted by a didactic strategy mediated by ICT.	Mixed	The Didactic strategy with the mediation of ICT strengthens the Teaching-Learning process of mathematics, especially in the understanding of concepts associated with the development of algebraic reasoning.
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Source: Own elaboration

In the Colombian Caribbean region, the concern to inquire about ICT and mathematics is notable, with a predominance in Barranquilla, as can be seen in Table 6.

The scoping review resulted in significant epistemological, methodological, and operational contributions to support the design of the proposal for pedagogical intervention of situated cognition and the use of AI applications for the development of competencies. Therefore, the theoretical preeminence will be presented initially, then the methodological, then the technological and will end with the key findings conglomerates

Thematic preeminence

Mathematical skills. Most of the studies reviewed highlight that problem-solving is the mathematical competence most addressed and favored through the use of ICTs, since these technologies strengthen mathematical thinking by facilitating the contextualization of new learning and improving teaching-learning processes (Romero Caballero, 2024). From an early age, the use of digital tools is essential to promote logical thinking and critical problem-solving skills.

Various authors (Perera et al., 2020; Bueno Díaz, 2021; Urquizo et al., 2022) agree that well-applied technological strategies enhance key skills such as logical reasoning. In turn, studies such as those by Hilario Bacilio (2021) and Mantilla (2021) show that ICT-mediated projects and contextualized methodologies strengthen logical-mathematical thinking in secondary school. This research insists that mathematical competences must go beyond the technical domain of algorithms, integrating complex and contextualized cognitive processes.

On the other hand, authors such as Vega Espinoza and Pretel Sifuentes (2024) and Muñoz-Muñoz-Potosi et al. (2024) underline the effectiveness of the design of technological didactic sequences that promote active learning, adjusted to the cognitive and age characteristics of students. Also, Castro et al. (2022) state that well-designed virtual environments not only provide interactive resources, but also promote critical reflection, crucial in the construction of mathematical knowledge. Thus, it is proposed to rethink

pedagogical practices from a competency-based approach, overcoming the mechanical repetition of procedures.

Technological tools. Regarding digital tools, the review shows a significant diversity that includes tablets, computers, mobile devices and educational software. Researchers such as Soboleva et al. (2020), Cubillo et al. (2021) and Burke et al. (2022) show that mobile technologies offer personalized and flexible learning environments, which contribute to better mathematical understanding. For their part, Merlo (2023) and Costa et al. (2021) argue that these tools not only transmit content, but also transform educational interactions, favoring autonomous and meaningful learning.

The incorporation of artificial intelligence (AI) represents a growing trend. Mohamed et al. (2024), Henkel et al. (2024) and Parra Sánchez et al. (2023) show that AI-based applications make it possible to adapt teaching to the student's level and offer immediate feedback, which facilitates more personalized and effective learning. Along these lines, Rimes (2024) and Huang (2024) highlight how smart environments optimize both the assessment and personalization of the training process, expanding access to quality educational experiences.

Situated learning. Research backgrounds coincide in pointing out that situated learning is a key pedagogical alternative to develop mathematical thinking in real and meaningful contexts. Inspired by Lave and Wenger, Liriano López (2023) proposes to form communities of school practice that integrate mathematical knowledge with collective experiences. Likewise, Carrasco-Ruiz de Valdivia et al. (2024) propose the use of contextualized tasks as a link between local culture and school curriculum, generating more critical and relevant learning.

Borbonio (2023) and Mártir Rodríguez (2024) highlight that skills such as critical thinking and problem-solving are strengthened when didactic situations are anchored in real contexts of the student environment. From the perspective of situated cognition, Guamanga (2020) argues that logical reasoning and mathematical understanding develop more effectively when they are connected to specific social scenarios. Taken together, these studies highlight that situated learning not only improves the understanding of concepts, but also gives them a new meaning from the student's cultural experience.

Methodological preeminence

Quantitative studies. A significant portion of the studies used quantitative methodologies to measure the impact of digital technologies on mathematical learning by analyzing numerical data. Among them are: Huang (2024); Mohamed et al. (2024); Henkel et al. (2024); Semanate-Semanate and Robayo-Jácome (2021); Márquez and Lozano (2022); Muñoz-Potosi et al. (2024); Parra Sánchez et al. (2023); Vega Espinoza and Pretel Sifuentes (2024); and Hilario Bacilio (2021). Some studies specify the quasi-experimental nature of its approach, such as those of Feliciano Morales and Cuevas Valencia (2025); Urquizo et al. (2022); Parra-Vallejo (2022); and Acosta-Guarnizo et al. (2023), which allowed them to examine causal relationships in real educational contexts.

Qualitative studies. An even greater number of investigations were based on qualitative methodologies, which allowed exploring the experiences of students and teachers, as well as the pedagogical strategies employed and the digital resources used. Several studies limited themselves to classifying their approach as general qualitative (Burke et al., 2022; Outhwaite et al., 2023; Gulliford et al., 2021; Dubé et al., 2020; Sun et al., 2023; Felipe

Barros and Dias de Abreu, 2024; Rimes, 2024; Perera et al., 2020; Pezzatti et al., 2020), while others, such as Tay et al. (2021), specified an exploratory approach.

Some studies delved deeper into their designs, such as ethnographic ones (Carrasco-Ruiz De Valdivia et al., 2024; Mantilla, 2021), phenomenological (Adrogué & Orlicki, 2020; Buitrago, 2023), those based on grounded theory (Weinhandl et al., 2020), and the case study of Córdoba Melgarejo (2021).

Multiple studies based on systematic reviews (Merlo, 2023; Cubillo et al., 2021; Costa et al., 2021; Forero-Corba & Bennasar, 2024; De Melo and De Sousa, 2023; Castro et al., 2022; García-Cartagena & Olivares-Petit, 2023; Guamanga, 2020; Jaramillo et al., 2023), useful for building theoretical frameworks and supporting the inclusion of ICT in mathematics teaching and situated learning.

In addition, there was interest in educational action research-type approaches (Mártir Rodríguez, 2024; Castañeda Castañeda, 2022; Rosero Yepes, 2024) and participatory research (Liriano López, 2023), which seek to improve teaching practices through active collaboration with students.

Mixed studies. Some works integrate both quantitative and qualitative methods, combining the measurement of technological impact with the exploration of educational experiences. Examples of this mixed methodology are: Soboleva et al. (2020); Bolaños et al. (2024); Guete García (2021); Hoyos Prioló (2022); Escorcía et al. (2023); and Henao Rivas et al. (2023). This methodological integration allows them to approach digital education from a broader and more comprehensive perspective.

Significant findings in the scoping review

The documentary review shows that, although ICTs bring numerous benefits to mathematics education, there are structural limitations that affect their implementation, such as the digital divide, poor connectivity and lack of teacher training. The urgent need to train educators not only in technological use, but also in active methodologies appropriate to digital environments is pointed out.

Likewise, it is warned that the design of technological tools must be culturally relevant, considering the sociocultural context of the students to guarantee their effectiveness.

An evolution in the research is observed: from an initial stage focused on validating the basic use of ICTs, progress has been made towards the analysis of their pedagogical integration and the consideration of emotional and motivational aspects (such as anxiety, satisfaction or parental perception), giving rise to a more holistic vision of learning in digital contexts.

Finally, pending lines of research are identified, including the need to delve into how ICT can be integrated in a contextualized way into school curricula, maintaining the link between situated learning, mathematical skills and technology. This reinforces the relevance of the research problem that articulates these three fundamental axes.

Discussion

The findings of the scoping review highlighted the importance of problem-solving as a core mathematical competency, driven by the use of digital technologies, especially mobile applications with artificial intelligence (AI). These tools not only facilitate access to mathematical content, but also encourage the development of logical and critical thinking in contexts that are meaningful to students. The combination of emerging technologies and

active pedagogical approaches suggests that mathematics learning can be transformed by anchoring itself in relevant situations, promoting a more active teaching-learning process connected to the sociocultural context of the students.

However, the review also identified important limitations that should be considered in the implementation of an educational program based on situated cognition and mediated by mobile applications with AI. Among these barriers are the digital divide that affects access to devices in vulnerable contexts, the lack of teacher training in active methodologies and the small number of studies that explicitly integrate mathematical skills, situated cognition and AI technologies in real classroom environments. In addition, the need for a pedagogical design that considers cultural relevance is underlined, avoiding homogeneous approaches that do not adjust to the particularities of the school environment.

Conclusion

The scoping review presented here supports the relevance of an educational proposal that articulates situated cognition with the use of mobile applications based on artificial intelligence (AI) for the development of mathematical competencies in secondary school students. The findings show that the most promoted competence through digital technologies is problem solving, since it allows activating complex cognitive processes such as logical thinking, critical reflection and contextualized decision-making. It is also highlighted that technological tools, especially mobile and smart ones, offer personalized, interactive and flexible environments that favor more meaningful, autonomous and motivating learning. It is also relevant to consider that mixed methodological approaches allow assessing both the quantitative results and the qualitative experiences of students and teachers.

In general terms, the implementation of programs based on situated cognition with the support of mobile technologies and artificial intelligence implies rethinking teaching practices, promoting training in active methodologies and moving towards a more flexible, contextualized and relevant curriculum, which leads to addressing the structural limitations identified, such as the digital divide and the need for teacher training. to guarantee the effectiveness and sustainability of these educational innovations.

References

- Abdallah, M. (2024). The Role and Function of Literature Review in Educational Research Studies: A Pragmatic Perspective. . *Assiut University*, 1-13. Obtenido de <https://eric.ed.gov/?id=ED660561>
- Acosta-Guarnizo, L., Valdivieso-González, L., & Muñoz-Potos, A. (2023). Pedagogical strategy mediated by ICT to strengthen mathematical reasoning competence in sixth grade students. *Scientific Journal*, 13(24), 13-24. doi:10.14483/23448350.19758
- Adrogué, C., & Orlicki, M. (2020). Access to and use of information and communication technologies (ICTs) in secondary school in different socioeconomic contexts in Argentina. *Praxis educativa*, 24(3), 1-12. doi:10.19137/praxiseducativa-2020-240308
- Berger, P., & Luckmann, T. (2001). *The social construction of reality*. BBAA. Argentina: Amorrortu.
- Boaler, J. (2000). Exploring situated insights into research and learning. *Journal for Research in Mathematics Education*, 31(1), 113-119. doi:10.2307/749822
- Bolaños, H., Dueñas, A., Ordoñez, Y., Ramírez, S., & Herrera, J. (2024). *Game-Based Learning and the Integration of GeoGebra Mathematical Software as a Strategy for*

- the Strengthening of Algebraic Thinking in Eighth Grade Students of the Nuestra Señora del Rosario Educational Institution, Manzanares [Thesis].* Colombia: University of Cartagena. Retrieved from <https://repositorio.unicartagena.edu.co/server/api/core/bitstreams/b691a96a-e91e-4215-b2fa-334b1a6627e6/content>
- Borbonio, E. (2023). *Situated learning for the development of critical thinking in order to solve mathematical problems with students in the third grade of primary school.* Mexico: National Pedagogical University. Retrieved from <http://rixplora.upn.mx/jspui/bitstream/RIUPN/143680/1/UNP304MEBVAEN2023.pdf>
- Bueno Díaz, M. (2021). *ICT as didactic mediators in the teaching-learning processes of the area of mathematics in the basic primary school of the La Laguna Educational Institution in the Municipality of Los Santos.* Colombia: Universidad Pontificia Bolivariana. Retrieved from https://repository.upb.edu.co/bitstream/handle/20.500.11912/11611/280_1%20%281%29.pdf?sequence=4&isAllowed=y
- Buitrago, J. (2023). *Teaching mathematics and cognitive processes: realities, meanings and experiences, with an impact on learning [Thesis].* Venezuela: Universidad Pedagógica Experimental Libertador. Retrieved from <https://www.espacio.digital.upel.edu.ve/index.php/TD/article/view/624/564>
- Burke, P., Kearney, M., Schuck, S., & Aubusson, P. (2022). Improving mobile learning in secondary mathematics and science: Listening to students. *Journal of computer assisted Learning*, 38(1), 137-151. doi:10.1111/jcal.12596
- Carrasco-Ruiz de Valdivia, M., Mallén Pascualvaca, P., & Albanese, V. (2024). Local practices and mathematical tasks contextualized from Andalusia, Spain. *Latin American Journal of Ethnomathematics Sociocultural Perspectives of Mathematics Education*, 15(Special), 1-22. doi:10.22267/relatem.22151.90
- Castañeda Castañeda, C. (2022). *Didactic strategy mediated by ICT to strengthen mathematical competencies in the concept of relationships between natural numbers in the sixth grade of the Criollo Municipal Educational Institution, main headquarters of the municipality of Pitalito–Huila.* Colombia: Universidad Autónoma de Bucaramanga. Retrieved from <https://repository.unab.edu.co/handle/20.500.12749/17596>
- Castro, M., Yataco, P., Valdivia, M., & López, G. (2022). Development of mathematical skills in virtual environments. A systematic review. *Alpha Centauri*, 3(2), 46-59. doi:10.47422/ac.v3i2.80
- Congress of the Republic of Colombia. (1994). Law 115 of February 8, 1994. By which the General Law of Education is issued. Colombia: Congress of the Republic of Colombia. Retrieved from https://www.mineducacion.gov.co/1621/articles-85906_archivo_pdf.pdf
- Costa, C., Cabrita, I., M. L. Martins, F., Oliveira, R., & Bernardino Lopes, J. (2021). What is the role of digital artifacts in the teaching and learning of mathematics? *Mathematics with life*, 29-44. Obtained from https://www.researchgate.net/profile/Fernando-Martins-20/publication/357225930_Qual_o_papel_dos_artefactos_digitais_no_ensino_e_na_

- aprendizagem_de_matematica/links/61c21befabfb4634cb3372fa/Qual-o-papel-dos-artefactos-digitais-no-ensino-e-na-aprendizagem-d
- Cubillo, M., Del Castillo Fernández, H., & Martínez, B. (2021). The use of mobile applications in mathematics learning: a systematic review. [Essay]. *Journal of the Faculty of Education of Albacete*, 36(1), 17-34. Retrieved from <http://www.revista.uclm.es/index.php/ensayos>
- De Melo, G., & De Sousa, L. (2023). Dynamic Platform for the Teaching of Mathematics on Digital Whiteboard. *Ibero-American Journal of Humanities. Science and Education*, 9(10), 5274-5282. doi:10.51891/rease.v9i10.11954
- Dubé, A., Kacmaz, G., Wen, R., Alam, S., & Xu, C. (2020). Identifying quality educational apps: Lessons from ‘top’ mathematics apps in the Apple App store. *Education and Information Technologies*, 25, 5389-5404. doi:10.1007/s10639-020-10234-z
- Escorcia, I., Rincón, J., & Montes, M. (2023). Specialised Knowledge of the Mathematics Teacher to Teach through Modelling using ICTs. *Acta Scientiae*, 25(1), 160-195. doi:10.17648/acta.scientiae.7363
- Feliciano-Semidei, R., & Palencia, K. (2025). Rural context of the Colombian Caribbean described by secondary school mathematics teachers. *Revista Colombiana de Educación*(95), 1-19. doi:10.17227/rce.num95-19016
- Felipe Barros, J., & Dias de Abreu, J. (2024). Artificial Intelligence in Mathematics Education: What has been researched. *With the Word, the Teacher*, 9(25), 283–304. Retrieved from <http://revista.geem.mat.br/index.php/CPP/article/view/1092>
- Forero-Corba, W., & Bennasar, F. (2024). Techniques and applications of Machine Learning and Artificial Intelligence in education: a systematic review. *RIED-Ibero-American Journal of Distance Education*, 27(1), 209-253. doi:10.5944/ried.27.1.37491
- García-Cartagena, Y., & Olivares-Petit, C. (2023). Educational Technology: Review and Perspectives for Curricular Innovations in Chile. *Chilean Journal of Scientific Education*, 24(1), 36-55. Retrieved from <https://revistas.umce.cl/index.php/RChEC/article/view/2772>
- Greeno, J. (1998). The situativity of knowing, learning, and research. *American Psychologist*, 53(1), 5-26. doi:10.1037/0003-066X.53.1.5
- Grisales-Aguirre, A. (2018). Use of ICT resources in mathematics teaching: challenges and perspectives. *Enramada*, 14(2), 198214. doi:10.18041/1900-3803/entram.2.4751
- Guamanga, M. (2020). Formal logic, critical thinking and situated cognition. *Polysemy*, 16(30), 117-132. doi:10.26620/uniminuto.polysemy.16.30.2020.117-132
- Guete García, D. (2021). *Mathematical Thinking and Problem Solving promoted by a didactic strategy mediated by ICT. [Thesis]*. Colombia: Universidad del Magdalena. Retrieved from <https://repositorio.unimagdalena.edu.co/handle/123456789/21348>
- Gulliford, A., Walton, J., Allison, K., & Pitchford, N. (2021). A qualitative investigation of implementation of app-based maths instruction for young learners. *Educational & Child Psychology*, 38(3), 90-108. doi:10.1111/bjet.13339
- Henao Rivas, L., Herrera Lozano, V., & Bolaño Truyol, J. (2023). *Didactic strategies mediated by adaptive educational technologies for personalized learning in basic and secondary education*. Colombia: Corporación Universidad de la Costa. Retrieved from <https://hdl.handle.net/11323/10595>

- Henkel, O., Horne-Robinson, H., Kozhakhmetova, N., & Lee, A. (2024). Effective and scalable math support: Evidence on the impact of an AI-tutor on math achievement in Ghana. *arXiv preprint*, 1-10. Obtenido de <https://arxiv.org/pdf/2402.09809>
- Hilario Bacilio, G. M. (2021). ICT-mediated project-based learning to develop mathematical competencies in secondary school students. *Ciencia Latina Revista Científica Multidisciplinar*, 5(4), 5617-5646. doi:10.37811/cl_rcm.v5i4.711
- Hoyos Prioló, V. (2022). *Mathematical modeling with the use of ICT. evaluation of a didactic-mathematical knowledge training program for teachers of basic, secondary and secondary education*. Colombia: RUDECOLOMBIA - Universidad del Magdalena. Retrieved from <https://repositorio.unimagdalena.edu.co/handle/123456789/20824>
- Huang, X. (2024). Application of artificial intelligence APP in quality evaluation of primary school science education. *Educational Studies*, 50(6), 1215-1235. doi:10.1080/03055698.2022.2066462
- ICFES. (2024). *National report on the results of the Saber 11° exam 2023*. Bogotá: ICFES. Retrieved from https://www.icfes.gov.co/wp-content/uploads/2025/04/Informe_Saber11_2023.pdf
- Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. (G. Winchler, Ed., M. Espíndola, & C. Alfaro, Trans.) Madrid: Paidós.
- Liriano López, A. (2023). *Collective construction of a community of practice in a secondary school in the Dominican Republic: Links with the theory of situated learning by Jean Lave and Etienne Wenger [Thesis]*. Dominican Republic: University open to adults. Retrieved from <https://rai.uapa.edu.do/bitstream/handle/123456789/2368/TESIS%20DOCTORAL%20ANYELI%20LIRIANO.pdf?sequence=1&isAllowed=y>
- Mantilla, G. (2021). *Development of mathematical competences through information and communication technologies (ICT) in secondary education. [Thesis]*. Venezuela: UPEL. Retrieved from <https://espacio.digital.upel.edu.ve/index.php/TGM/article/view/321>
- Márquez, I., & Lozano, M. (2022). Development of mathematical logical thinking of students from 7 to 8 years old application of an Escape Room. *Mastery of the Sciences*, 8(3), 48. doi:10.23857/dc.v8i3
- Mártir Rodríguez, A. (2024). *Situated didactic situations: a methodological adjustment in the resolution of additive problems with students in the second grade of primary school. [Thesis]*. Mexico: Universidad Autónoma de Zapatecas. Retrieved from <http://ricaxcan.uaz.edu.mx/jspui/handle/20.500.11845/3732>
- Mejía, J. (2019, September 19). How to search for scientific articles - search log. [Video]. Youtube. <https://www.youtube.com/watch?v=w-714rsx3TA&t=257s>
- MEN. (1998). *Curricular Guidelines*. Colombia: Ministry of National Education. Retrieved from https://www.mineducacion.gov.co/1621/articles-89869_archivo_pdf9.pdf
- MEN. (2006). *Basic Standards of Competencies in Mathematics*. Ministry of National Education. Retrieved from https://www.mineducacion.gov.co/1759/articles-340021_recurso_1.pdf
- MenaOrejuela, V. (2022). Systematic review: evaluation process in Colombian classrooms of basic, secondary and secondary education. *Science & Society*, 4(2), 131-143.

- Retrieved from
<https://cienciaysociedaduatf.com/index.php/ciesocieuatf/article/view/128>
- Merlo, C. (2023). Teaching Mathematics Mediated by ICT. *Multidisciplinary Scientific Journal*, 7(5), 8796-8812. doi:10.37811/cl_rcm.v7i5.8455
- Mohamed, M., Said, A., Hassan, H., El Sayed, M., Abdelhamid, M., Shehata, M., & Ali, Y. (2024). Applications of artificial intelligence in teaching mathematics for the second preparation year in Egyptian official language schools. *Basic Sciences Sector, The Department of Mathematics*, 1, 77-94. Obtenido de https://journals.ekb.eg/article_368292_b5b963a192ad515d7b7b2d68e9b3976f.pdf
- Muñoz-Potosi, A., Castro-García, M., Valdivieso-González, L., Rodríguez-Montero, P., & Tepichín-Rodríguez, E. (2024). Strengthening of mathematical competencies in children between 10 and 13 years of age using didactic sequences mediated by ICTs. *Eduweb*, 18(1), 48-65. doi:10.46502/issn.1856-7576/2024.18.01.4
- Niño Merlo, C. (2023). Teaching Mathematics Mediated by ICT. *Ciencia Latina Revista Científica Multidisciplinar*, 7(5), 87968812. doi:10.37811/cl_rcm.v7i5.8455
- Outhwaite, L., Early, E., Herodotou, C., & Van Herwegen, J. (2023). Understanding how educational maths apps can enhance learning: A content analysis and qualitative comparative analysis. *British Journal of Educational Technology*, 54(5), 1292-1313. doi:10.1111/bjet.13339
- Parra Sánchez, J., Torres Pardo, I., & Martínez de Meriño, C. (2023). Personalization of resources for teaching university mathematics using artificial intelligence. *Inter-American Journal of Research, Education and Pedagogy*, 16(1), 319-340. doi:10.15332/25005421.7904
- Parra-Vallejo, M. (2022). Application of ICT, b-Learning and Computational Thinking for the Strengthening of Mathematical Competencies. *Revista Tecnológica-Educativa Docentes 2.0*, 14(2), 29-41. doi:10.37843/rtd.v14i2.313
- Perera, D., Fernández, M., Urdaneta, C., & Izquierdo, S. (2020). Network tool and development of mathematical skills. *Digital Journal Information Society*, 45, 1-7. Retrieved from <http://sociedadelainformacion.com/45/herramienta.pdf>
- Pezzatti, L., Edelsztejn, V., & Hermida, M. (2020). The learning of mathematics in Argentina and its association with the cognitive sciences: opportunities and challenges. *Studies in Psychology*, 41(2), 348-372. doi:10.1080/02109395.2020.1749496
- Potter, J. (1998). *Representing reality: Discourse, rhetoric and social construction*. LDN. England: Sage.
- RhenalsRamos, J. (2021). Socio-educational inequalities in the Colombian context: perspectives for pedagogical transformation in times of crisis. *Revista Docentes 2.0*, 10(1), 5-11. doi:10.37843/rtd.v10i1.186
- Rimes, I. (2024). *Digital Security and Artificial Intelligence: New Paths for Mathematics Teaching [Tesis]*. Brazil: State University of Rio de Janeiro. Obtained from <https://www.bdtd.uerj.br:8443/bitstream/1/23483/2/Tese%20-%20Ighor%20Opiliar%20Mendes%20-%20Rimes%20-%202024%20-%20Completa.pdf>
- Romero Caballero, S. (2024). *Theoretical methodological model for the development of generic competencies from challenge-based learning [Thesis]*. Colombia: Corporación Universidad de la Costa. Retrieved from <https://hdl.handle.net/11323/13681>

- Rosero Yepes, R. (2024). ICTs, dynamizers of mathematical learning, with students from the Los Pastos Educational Institution. *Ciencia Latina Revista Científica Multidisciplinar*, 8(6), 784-817. doi:10.37811/cl_rcm.v8i6.14802
- Semanate-Semanate, D., & Robayo-Jácome, D. (2021). Didactic strategy based on ICT to improve academic performance in the area of Mathematics. *Koinonia*, 4(8), 379-403. doi:10.35381/e.k.v4i8.1384
- Soboleva, E., Chirkina, S., Kalugina, O., Shvetsov, M., Kazinets, V., & Pokaninova, E. (2020). Didactic potential of using mobile technologies in the development of mathematical thinking. *Eurasia Journal of Mathematics, Science and Technology Education*, 16(5), 1-20. doi:10.29333/ejmste/118214
- Suchman, L. (2007). *Human-machine reconfigurations: Plans and situated actions*. NY. USA: Cambridge University Press.
- Sun, Y., Nambiar, R., & Vidyasagaran, V. (2023). Gamifying math education using object detection. *arXiv preprint*, 1-6. Obtenido de arXiv:2304.06270.
- Tay, L., Lee, S., & Ramachandran, K. (2021). Implementation of online home-based learning and students' engagement during the COVID-19 pandemic: A case study of Singapore mathematics teachers. *The Asia-Pacific Education Researcher*, 30(3), 299-310. doi:10.1007/s40299-021-00572-y
- Urquizo, D., Correa, K., Velasco, J., & Correa, G. (2022). ICT and the strengthening of mathematical competencies in students of mathematics teaching pedagogy. *Horizontes*, 5(21), 1363-1374. Retrieved from <http://repositorio.cidecuador.org/jspui/handle/123456789/1108>
- Vega Espinoza, M., & Pretel Sifuentes, A. (2024). *Artificial intelligence and the progress of mathematical skills in students in the fifth year of secondary school, school period 2024. [Thesis]*. Peru: Universidad Nacional José Faustino Sánchez Carrión. Retrieved from <https://repositorio.unjfsc.edu.pe/bitstream/handle/20.500.14067/10540/TESIS.pdf?sequence=5>
- Višňovská, J., & Cortina, J. (2025). Curriculum and mathematical coherence: exploring the tensions in teaching and learning number. *ZDM – Mathematics Education*, 57, 125–142. Obtenido de <https://link.springer.com/article/10.1007/s11858-025-01706-y>
- Vygotsky, L. (2012). *The development of higher psychological processes*. (S. Furió, Trans.) Madrid: Austral.
- Weinhandl, R., Lavicza, Z., Hohenwarter, M., & Schallert, S. (2020). Enhancing flipped mathematics education by utilising GeoGebra. *International Journal of Education in Mathematics, Science and Technology*, 8(1), 1-15. Obtenido de <https://files.eric.ed.gov/fulltext/EJ1240531.pdf>
- Wenger, E. (2002). *Communities of practice*. Spain: Paidós.