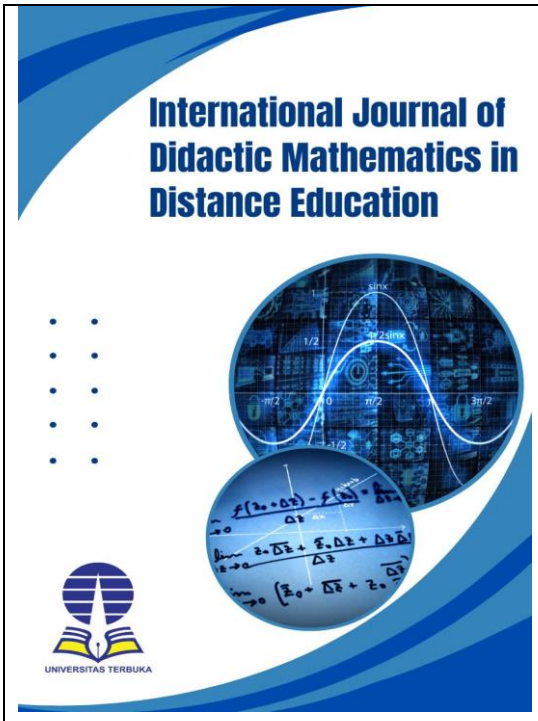
International Journal of Didactic Mathematics in Distance Education

Journal homepage: https://jurnal.ut.ac.id/index.php/ijdmde



Effective strategies for formulating and articulating a well-defined research problem: context in the field of mathematics education

Camilo Andrés Rodríguez-Nieto[1*], Flor Monserrat Rodríguez-Vásquez[2*], Benilda María Cantillo-Rudas[3*], Vicenç Font Moll[4*], Sudirman[5*]

[1*]Universidad de la Costa (CUC), Barranquilla/Atlántico, Colombia, crodrigu79@cuc.edu.co

[2]Universidad Autónoma de Guerrero, Chilpancingo/Guerrero, México, flor.rodriguez@uagro.mx

[3]Universidad de Panamá, Panamá, benilda-m.cantillo-r@up.ac.pa

[4]Universidad de Barcelona, Barcelona/Cataluña, España, vfont@ub.edu

[5]Universitas Terbuka, Jakarta, Indonesia, sudirman.official@ecampus.ut.ac.id

To cite this article:
Rodríguez-Nieto, C.A.R., Rodríguez-Vásquez, F.M., Cantillo-Rudas, B..M., Moll, V.F & Sudirman, S. (2025). Effective strategies for formulating and articulating a well-defined research problem: context in the field of mathematics education. *International Journal of Didactic Mathematics in Distance Education*, *2*(1), 16-31.

To link to this article:
https://jurnal.ut.ac.id/index.php/ijdmde

Published by:
Universitas Terbuka

IJDMDE

International Journal of Didactic Mathematics in Distance Education
Volume 2, Issue 1, pp. 16-31, E-ISSN: 3047-9207
https://jurnal.ut.ac.id/index.php/ijdmde

Effective strategies for formulating and articulating a well-defined research problem: context in the field of mathematics education

Camilo Andrés Rodríguez-Nieto[1*], Flor Monserrat Rodríguez-Vásquez[2*], Benilda María Cantillo-Rudas[3*], Vicenç Font Moll[4*], Sudirman[5*]
[1*]Universidad de la Costa (CUC), Barranquilla/Atlántico, Colombia, crodrigu79@cuc.edu.co
[2]Universidad Autónoma de Guerrero, Chilpancingo/Guerrero, México, flor.rodriguez@uagro.mx
[3]Universidad de Panamá, Panamá, benilda-m.cantillo-r@up.ac.pa
[4]Universidad de Barcelona, Barcelona/Cataluña, España, vfont@ub.edu
[5]Universitas Terbuka, Jakarta, Indonesia, sudirman.official@ecampus.ut.ac.id

*Correspondence: crodrigu79@cuc.edu.co

Abstract
This research offers an answer to the question: How to pose and write a research problem in Mathematics Education? To do so, a qualitative descriptive methodology was implemented, developed in four stages: first, it presents a general overview of the Theories in Mathematics Education and some articles where relevant studies have been reported; in the second stage, the means by which research can be disseminated or published are presented; in the third, meanings and ways to pose a research problem are shown and, finally, in the fourth stage, some theoretical reflections on the problem statement are presented. The results show that the writing and statement of the problem does not necessarily follow a structure, that depends on the type of research and the way in which the author reports his ideas or in which theoretical framework he frames his work, for example, research questions from the Onto-semiotic Approach and the Extended Theory of Connections are presented. However, a special path is suggested that has worked very well to be implemented in future research. In conclusion, for research to be successful, the problem and the issue must be well constructed and supported by the literature, which guides and invites reflection on the choice of theory (if possible), the methodology and the presentation of the results that can be theoretical and practical.

Article History
Received:
15 October 2024
Revised:
17 January 2025
Accepted:
01 February 2025
Published Online:
01 April 2025

Keywords:
Mathematics education;
Research problem;
Theories in Mathematics Education

1. Introduction

In the field of Mathematics Education there are various investigations where topics are addressed from multiple theories and methodologies such as the Onto-semiotic Approach (Godino, 2024; Godino et al., 2019; Font et al., 2016), the Extended Theory of Mathematical and Ethnomathematical Connections (Rodríguez-Nieto et al., 2023a; García-García & Dolores-Flores, 2018; Font & Rodríguez-Nieto, 2024; Rodríguez-Nieto et al., 2024), the APOS Theory and its cognitive part (Borji et al., 2024; Trigueros et al., 2024), mathematical modeling and its cycle (Ledezma et al., 2024), didactic suitability (Breda, 2021; Font et al., 2023), the Theory of Mathematical and Ethnomathematical Connections (García-García & Dolores-Flores, 2018; Font & Rodríguez-Nieto, 2024), Anthropological Theory of Didactics (Romo-Vázquez et al., 2024), Ethnomathematics and ethnomodeling (Aroca, 2022; D'Ambrosio, 2014; Rodríguez-Nieto, 2021a; Rodríguez-Nieto et al., 2023b; Rosa & Orey, 2021; Sudirman et al., 2024), mathematical argumentation (Cervantes-Barraza et al., 2024), problem posing and solving (Cai & Hwang, 2021; Santos-Trigo, 2021), among other methods of theoretical integration and methods for the analysis of mathematical activity, for

example, advances in networking of theories (Bikner-Ahsbahs, 2022; Cantillo-Rudas & Rodríguez-Nieto, 2024; Cantillo-Rudas et al., 2024; Rodríguez-Nieto, 2020, 2021b; Rodríguez-Nieto et al., 2022).

Just as important as articles, books and their chapters, conferences and other communications are, it is also relevant how these documents were written and what research problem they addressed to contribute to science, in such a way that they were of interest to the community of readers and researchers in Mathematics Education. It is known that many research projects that contribute to science and the teaching and learning of mathematics at different school levels are not being considered, but this is for reasons of scope. In this context, the communication of research results is an essential step in the research process. Frequently, peer-reviewed journals are the forum for such communication, however, many researchers are never taught how to write a publishable scientific article, a thesis or how to write a research problem (Busse & August, 2020).

Writing a research problem in mathematics education presents multiple challenges that many researchers and students struggle with. One of the most common difficulties is the lack of clarity in problem delimitation, where researchers often formulate overly broad or ambiguous problems, making it hard to establish clear and specific objectives. This is frequently caused by an unclear relationship between the variables involved, leading to confusion. Additionally, insufficient theoretical foundation is another major issue, as some researchers fail to conduct an adequate literature review, resulting in problems that are either redundant or lack novelty. Without a strong theoretical grounding, the significance of the research problem within the mathematics education context may be poorly justified.

Another recurring difficulty is the confusion between the problem and its objectives, where researchers mistakenly equate the research problem with research questions or objectives, leading to redundancy and a lack of precision. Many also struggle with contextualizing the research problem, often overlooking important factors such as the educational level, student characteristics, or mathematical content being studied. Additionally, the lack of educational impact in some research problems results in minimal practical applicability, as they fail to address real needs in mathematics teaching and learning. This absence of relevance weakens the contribution of the study to improving educational practices.

Furthermore, formulating specific and well-structured research questions remains a challenge, as many questions tend to be too general or misaligned with the main research problem. Researchers also face difficulties in using appropriate technical language, with many relying on colloquial or informal terms that may not be suitable for an academic audience. Moreover, there is often a disconnection between the research problem and the methods, where researchers do not adequately consider how to approach the problem from a methodological standpoint, leading to complications during the study's implementation. Given these challenges, the research question emerges: How can a research problem in Mathematics Education be effectively posed and written? Addressing this question is crucial, as it reflects a widespread concern in both national and international research contexts, highlighting the need for clear guidance in developing well-structured research problems.

2. Methods

This qualitative descriptive research progresses through four main stages (Cohen et al., 2018), each aimed at constructing a comprehensive understanding of Mathematics Education research theory, dissemination practices, problem identification, and the implications of well-defined research problems. These stages are designed to offer both a foundation and a reflective pathway for academics, educators, and researchers engaged in Mathematics Education. Basically, this research was carried out using a content analysis method where the data is the literature available on the Internet on the statement of the problem.

Stage 1: Overview of Theories in Mathematics Education and Review of Related Studies

The initial stage of this research focuses on presenting a broad overview of influential theories in Mathematics Education. This includes foundational theories such as constructivism, socio-cultural theory, and cognitive developmental theories, each of which has shaped how mathematics is taught and understood. Constructivist theory, for example, which posit that learners actively construct knowledge, has guided educators to promote discovery-based and inquiry-oriented learning environments. Socio-

cultural theory, pioneered by Vygotsky, emphasizes on the social and cultural dimensions of learning, suggesting that mathematics learning is not only individual but also a product of collaboration and cultural interaction.

In addition to theoretical foundations, this stage highlights specific studies that have explored various educational frameworks, instructional strategies, and student outcomes in Mathematics Education. For instance, research examining the use of technology in mathematics classrooms has provided valuable insights into how digital tools, like dynamic geometry software, can enhance student engagement and understanding of complex mathematical concepts. Other studies have explored cognitive load theory in mathematics, offering guidance on structuring lessons that do not overwhelm students' cognitive resources. By synthesizing these studies, this stage offers a foundation for understanding current trends, gaps, and debates in Mathematics Education research.

Stage 2: Dissemination and Publication of Research in Mathematics Education

The second stage of this research addresses the avenues through which Mathematics Education research can be disseminated and shared with the broader academic and educational communities. Dissemination is critical as it ensures that research findings are accessible to practitioners who can implement them in classroom settings and contribute to ongoing scholarly discussions. This stage emphasizes the importance of selecting appropriate journals and conferences specific to Mathematics Education.

In terms of publication, specialized journals like the Journal of Mathematics Teacher Education, Educational Studies in Mathematics, and the International Journal of Science and Mathematics Education are dedicated to publishing rigorous research in Mathematics Education. These journals offer a platform for both empirical and theoretical contributions, making them ideal for sharing innovations, evaluations, and theoretical discussions within the field. Conferences, such as the International Congress on Mathematical Education (ICME) and the Psychology of Mathematics Education (PME) conference, are also highlighted as valuable forums where researchers can present their work, engage in discussions, and receive feedback that can refine and enhance their studies. This stage underscores that understanding the publication landscape is essential for academics who aim to reach the right audience and maximize the impact of their work.

Stage 3: Defining and Refining Research Problems in Mathematics Education

The third stage dives into the process of defining a research problem, a crucial step that set the direction for any scholarly inquiry. In Mathematics Education, research problems can vary widely, from exploring cognitive processes involved in mathematical reasoning to assessing the effectiveness of instructional strategies or technological interventions. To effectively define and refine research questions, researchers are encouraged to start by identifying gaps in the existing literature or addressing pressing educational challenges observed in practice.

Methods for refining research questions include conducting a thorough literature review to identify specific areas that require further exploration, using theoretical frameworks to narrow down the scope of inquiry, and applying feasibility considerations to ensure that the research problem can be addressed within practical constraints. For example, a researcher interested in understanding how students develop geometric thinking might begin by reviewing the literature on Van Hiele's model of geometric thought and then narrow down the focus to a specific age group or instructional method. This stage provides tools and guidance for posing precise, manageable research questions that contribute meaningfully to the field.

Stage 4: Theoretical Reflections on Problem Statements and Implications

The final stage involves theoretical reflections on the significance of well-articulated problem statements. This stage recognizes that defining a research problem is not merely a methodological step but a reflection of the researcher's underlying assumptions and values about teaching and learning mathematics. The formulation of a research problem can have far-reaching implications, both for educational practice and for future research. A well-defined problem statement serves as a guide for the researcher, ensuring that the study remains focused and relevant. Moreover, it has implications for how findings are interpreted and applied in real-world educational contexts.

For instance, a study that addresses how students understand abstract mathematical concepts can inform teachers on instructional methods that foster deeper conceptual understanding. On a broader level, the problem statement may prompt future researchers to investigate additional variables, apply different methodologies, or test the research findings across diverse populations. Theoretical reflections at this stage are intended to help researchers consider the broader impact of their work and how it can contribute to both immediate instructional improvements and the long-term development of Mathematics Education as a discipline.

3. Results and Discussion

In this section, the results are shown in terms of the methodological stages and then the discussion, providing detailed insights into the data analysis process, the key findings, and their implications for future research and practical applications within the field.

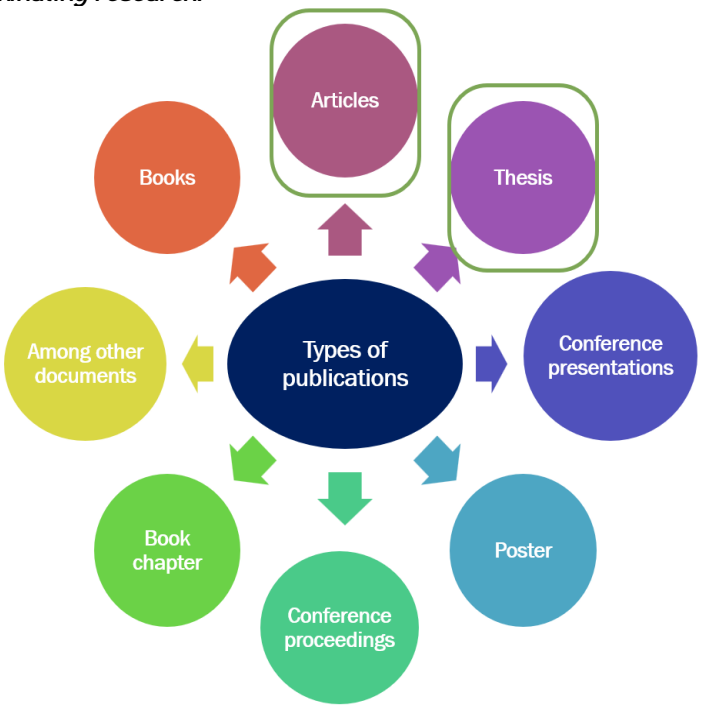
3.1 Results

3.1.1. Means of communicating research

There are various means of disseminating, publishing, and communicating the results of research, each with its specific benefits. Academic journals are a traditional and prestigious option, as they offer peer review and visibility in the scientific community. Conferences and congresses allow results to be presented in person, facilitating feedback and networking. Institutional repositories and academic social networks, such as ResearchGate or Academia.edu, are platforms that broaden the reach, by offering open access to a wider audience. In addition, having a personal blog or website allows results to be explained in an accessible way while collaborating with media outlets ensures greater dissemination among the general public. The articulation of traditional and digital media optimizes the visibility, projection, and impact of research works, enhancing the accessibility of the knowledge generated, where many authors feel grateful for obtaining and downloading the studies of interest. Figure 1 shows some of these means.

Figure 1

Some means of disseminating research.



It was then exemplified with two of the means presented in Figure 1, such as the thesis and the scientific article, highlighting their key features and differences. The thesis was usually more extensive and covers a comprehensive analysis, while the scientific article typically presented concise findings (see Table 1).

Table 1
Structure of a thesis for obtaining a bachelor's degree in mathematics

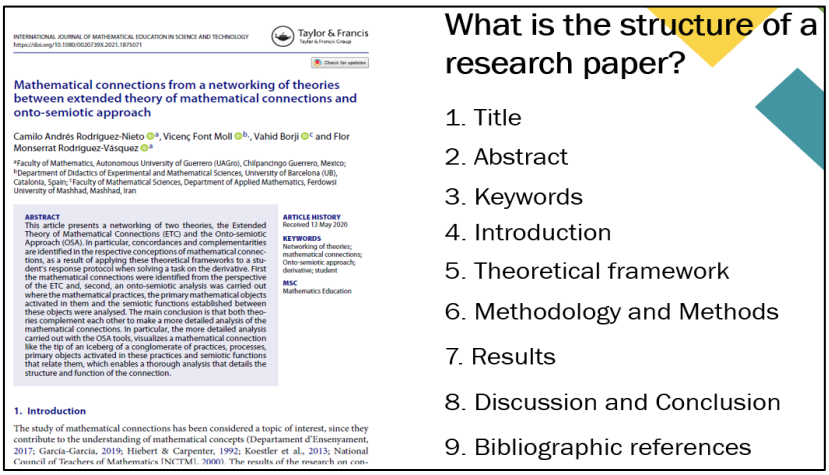
Structure of the degree project tdg of bachelor's degree in mathematics
The formative research conducted in the Bachelor's Degree in Mathematics program at the Faculty of Education Sciences of the University of Atlántico is revealed in the following Structure for degree projects as a mandatory requirement: • **Preliminary Pages:** • Cover page. • Back cover. • Approval sheet (must include the names of evaluator 1 and evaluator 2 for their signatures) • Acknowledgment (one page for the entire group) • Dedication (one page for the entire group) • Table of contents (if applicable, include a table of figures, list of tables, and list of appendices) • Abstract (250 words) and keywords • Abstract and keywords (in English) • Introduction **CHAPTER I PROBLEM STATEMENT** 1.1. Description of the problem. 1.2. Problem formulation. 1.3. Justification. 1.4. Objectives: 1.4.1. General Objective 1.4.2. Specific Objectives **CHAPTER II REFERENCE FRAMEWORK** 2.1. Background 2.2. Theoretical framework **CHAPTER III METHODOLOGICAL DESIGN** 3.1. Research Design and Methodology 3.2. Population and sample 3.3. Techniques and instruments **CHAPTER IV ANALYSIS AND INTERPRETATION OF RESULTS** 4.1. Data collection or information production (implementation of the proposal or didactic intervention) 4.2. Analysis and interpretation of the information (description of the analysis of activities, moments, documents, etc.) **CHAPTER V CONCLUSIONS AND RECOMMENDATIONS** 5.1. Conclusions (viewed from the objectives and achieved results) 5.2. Recommendations: (from the conclusions, the contributions to new research based on the results obtained in this study) **BIBLIOGRAPHIC REFERENCES** **APPENDICES** **PROPOSAL** *(only if applicable to the project and should be included as an appendix)* • Title of the Proposal • Execution Period: Start and End Dates • Introduction • Justification • Objectives: 5.5.1. General Objective 5.5.2. Specific Objectives • Pedagogical actions • The final report should have an average of 90 pages of content and up to 10 pages of appendices, with a total maximum of 100 and a minimum of 90.

The scientific article may vary depending on the type of journal to which you wish to submit the article, but also the type of article, whether it is a review, research, or reflection. Figure 2 shows the

structure of an article published by Rodríguez-Nieto et al. (2022). Generally, most journals have specific guidelines for article format, including sections such as the abstract, introduction, methodology, results, and discussion (Busse & August, 2020). In addition to these core sections, articles often include references, acknowledgments, and supplementary materials when needed. The precise structure and length can vary based on the journal's standards (e.g., 5.000, ..., 10.000 words maximum) and the nature of the research presented.

Figure 2

Structure of a research article.



After presenting some means of communicating research, it is important to highlight that it is not enough to recognize the various means available, but rather, what do I communicate regarding all the significant results obtained in a study and what is the research problem that I effectively solved or attempted to give a plausible answer to? This consideration is crucial for ensuring that the research contributes meaningfully to the existing body of knowledge and addresses the questions that matter most in the field.

3.1.2. The research problem

The research problem is in some cases difficult to find, but in other cases very simple and everything is due to the depth of reading and understanding of the subject, that is, how familiar the reader or researcher is with the subject to be addressed. In this line, the research problem is a prior knowledge of the unknown, an unknown in science that requires research. The solution reached must contribute to the transformation of the object of study, to the enrichment of knowledge, to the achievement of the desired state and the development of science (López, 2008). The research problem has been characterized by different authors (see Table 2).

Table 2

Diverse perspectives on the research problem based on the literature review

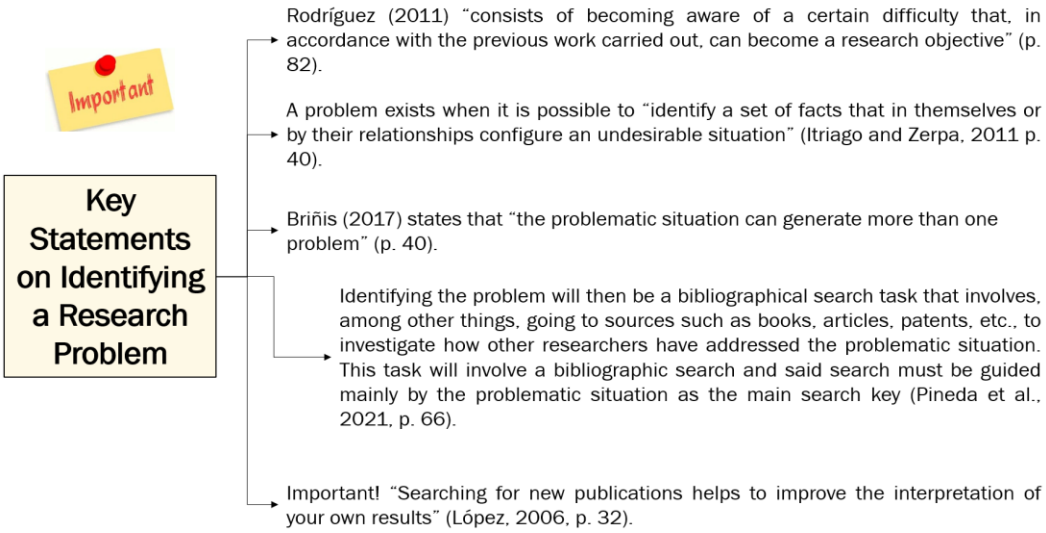
Perspective	Description
1	It is the starting point of a scientific investigation, it constitutes and directs the element from which other essential components of the investigative process Will be determined, such as the theoretical framework, and the methodology, among others (Corona et al., 2017).
2	"To state the problem is nothing more than to refine and structure the research idea more formally" (Hernández et al., 2014, p. 36).
3	For Cresswell (2014), the choice of a research problem is manifested from two fundamental aspects: "the nature of the problem and the experience of the researcher" (p. 31).
4	It represents a specific issue of a research topic, which generates dissatisfaction, misunderstanding or difficulty that requires being explained or solved by a scientific community and which is expressed in the form of a question (Barboza et al., 2018).
5	The step from the idea to the statement of the problem can be immediate or take a considerable time; it depends on how familiar the researcher is with the subject of his

Perspective	Description
	study, the complexity of the idea itself, the existence of previous studies, the commitment of the researcher and his skills (Hernández et al., 2014, p. 36).

Subsequently, Figure 3 shows key elements and practical methods to effectively identify the research problem comprehensively.

Figure 3

Keys to finding the research problem



As it is already known what a research problem was, various paths to pose a research problem was presented below. These paths included identifying gaps in existing literature, consulting with experts in the field, considering societal needs, and reflecting on personal interests or experiences (Briñis, 2017; Busse & August, 2020). Each method provides a unique lens through which researchers can explore critical questions, ensuring their studies contribute valuable insights to their respective disciplines.

3.1.3. Paths to follow to raise the research problem

Thanks to the literature review, it was possible to identify various paths to raise the question of writing a research problem, highlighting some authors. Figure 4 explains some key elements proposed by (Busse & August, 2020), considering path 1.

Figure 4

Main elements of the introduction section of an original research article (Busse & August, 2020).

Specifically, "your research objective should address the gap you identified. Make sure to add enough background information to allow readers to understand your study" (Busse and August, 2020, p.

2). It is known that, in most studies, the research problem is located in the introduction section and it is essential to know some aspects in order to avoid making mistakes or writing errors (see Table 3).

Table 3
Common mistakes and recommendations in the introduction section (Busse and August, 2020).

Cheats or errors	Recommendation
The introduction is too generic, not written for specific readers of a designated journal.	Choose a target journal and write to its readers. Visit your target journal's website and research the journal's readership. If you're writing for a magazine with a more general readership, such as , you should include more background information.
The citations are inadequate to support the claims.	Cite all statements that could be challenged. If a claim can be debated, it should be supported by one or more citations. To find articles relevant to your research, consider using open access journals, which are available for anyone to read for free.
The objective of the research is vague.	Include enough key information to allow readers to imagine the analysis. Make sure your research objective contains essential details such as setting, population/sample, study design, time point, dependent variable, and independent variables. Using such details, the reader should be able to imagine the analysis you have conducted.

Path 2 is guided by the American Psychological Association (APA) (2020), where all people, teachers, and researchers from any field of knowledge are cordially invited to read this special book. Therefore, it is necessary to frame the problem or question and its context where the applicable literature must be reviewed, critiqued, and synthesized to identify key problems/debates/theoretical frameworks in the relevant literature to clarify barriers, knowledge gaps, or practical needs. Then, guidelines for reviewers are requested to be considered, and case examples, personal narratives, vignettes, or other illustrative material examples can be included in the introduction.

Path 3 is suggested by Davidson and Delbridge (2011) who state that the introduction together with the research problem is made up of:

(a) The purpose of the introduction is to explain to the reader what the research question is, how original it is, what importance it has, and to succinctly describe how the study aims to answer it.
(b) It is essential that the document begins with a brief introduction to the topic, clearly describing how and why the research question arose.
(c) Provide adequate background information using relevant literature to familiarize readers with the topic, but do not include a detailed literature review.
(d) Explicitly state the importance of your research, as the reader may not necessarily make the leap in logic that is obvious to you.
(e) The introduction should end with clearly stated objectives. If the study addresses a hypothesis, then the hypothesis should also be stated here (p. 62 - 63).

For its part, path 4 is proposed by Cresswell (2014) where the following must be taken into account:

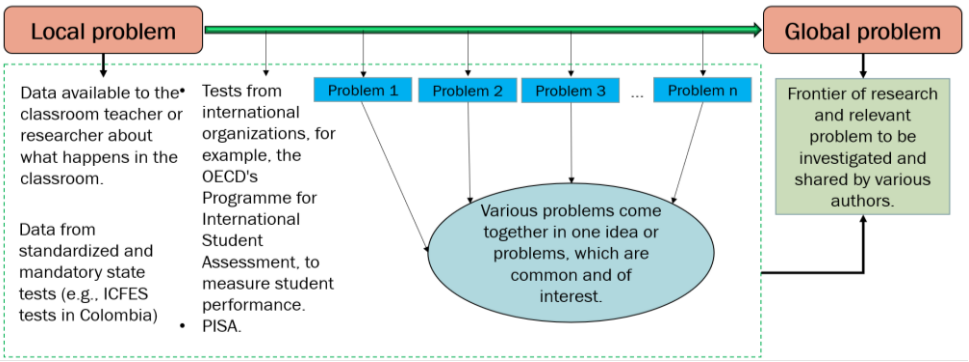
(a) Review the literature.
(b) Identify gaps in the literature (on our problem).
(c) Identify an audience and match the significance of the problem with the interests of that audience.
(d) Clearly state the purposes of the research.

Both paths (3 and 4) emphasize the importance of being clear and concise when communicating the purpose and relevance of a study, although from different perspectives. While Davidson and Delbridge (2011) focus on contextualizing the research and establishing clear objectives from the outset, Cresswell (2014) emphasizes the need to understand the literary framework and the specific audience to achieve a greater impact. These paths complement each other and can be integrated into the creation of a comprehensive introduction that provides a solid framework and addresses the reader's interests, while firmly situating the research within its academic context.

It is worth mentioning that, from my perspective as a researcher, I propose path 5 to identify and

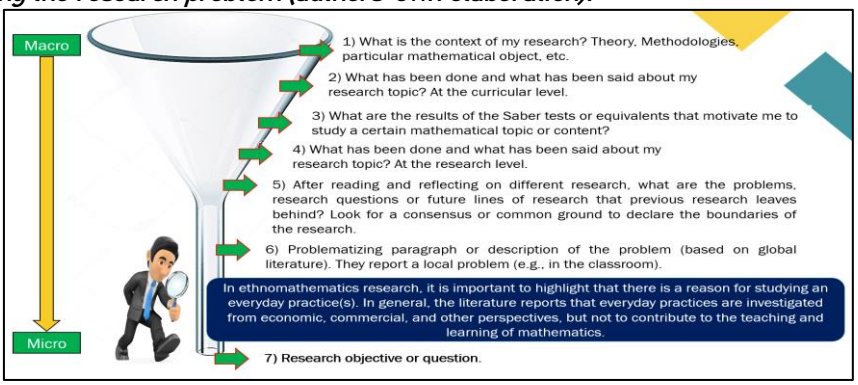
write the research problem (see Figures 5 and 6).

Figure 5
Preliminary aspects for identifying the research problem.



Based on the information in Figure 5, path 5 revealed in Figure 6 is constructed with examples.

Figure 6
Path 5 for writing the research problem (authors' own elaboration).



3.1.4. Guiding questions for the statement of the problem

Whenever a person wants to do research, he or she must have an idea of what he or she wants to do, that is, he or she will have a local problem created in his or her mind by his or her personal interest or, alternatively, he or she will be experiencing it with his or her students in the classroom. However, to address a global problem that is related to the research frontier, the questions described in Table 4 must be answered.

Table 4
Key questions for writing the research problem.

Question type	Characterization
Describe the problematic situation	What is happening? How is this happening? How long has this been happening? Where is it happening? Who has investigated this? What are the consequences of this happening?
Identify the problem	Why does what is described happen? What is problematic about the situation described? For whom or what entity is this a problem? Who has researched it? What factors are associated with the problem?

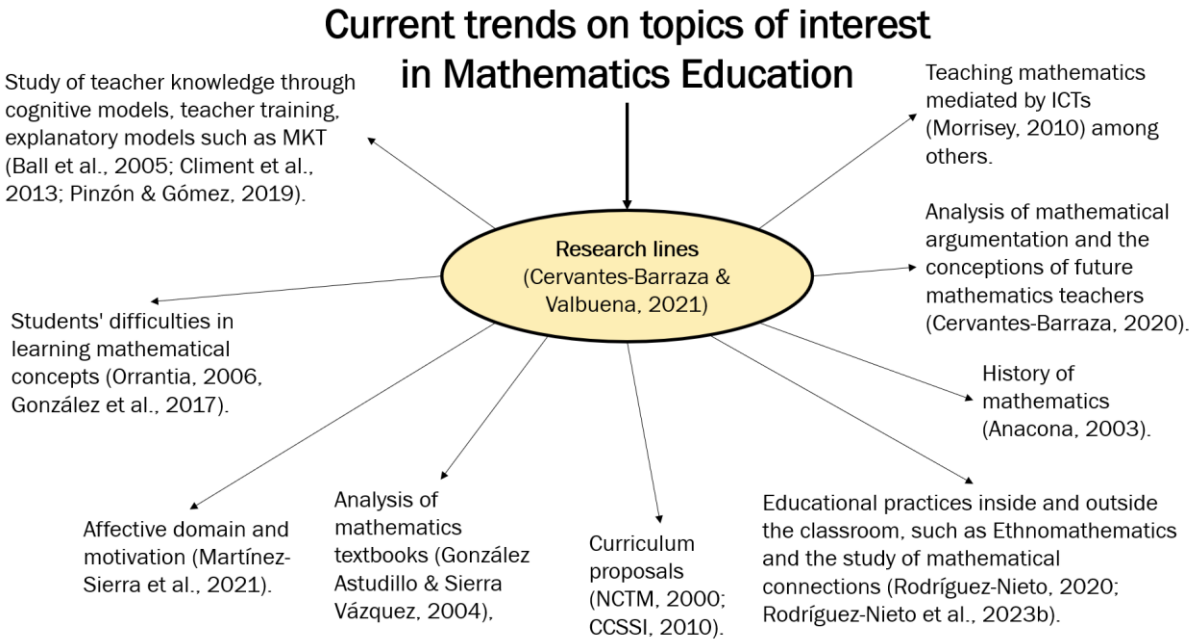
Question type	Characterization
Formulate the problem	What could be done to solve the problem? What could be the solution strategy for the problem? What theory, which explains the problem, offers solutions for it? To what extent can the strategy solve the problem?

3.1.5. Current trends in research in Mathematics Education

The research shows a great effort made by several authors where trends to investigate Mathematics Education are visualized, for example, use of technology in the classroom involving digital artifacts and artificial intelligence; learning based on problems and projects, taking into account the contextualization of the contents and collaborative learning; inclusive mathematics education considering diversity, equity and special education; computational thinking in the classroom and its connection with data science; neuroscience and cognitive mathematical processes that give rise to neuromathematics; teacher training and professional development; evaluation strategies, among others. Other authors have highlighted trends or future lines of research (see Figure 7).

Figure 7

Research trends in Mathematics Education



In addition to the main trends, areas such as mathematical connections, ethnomathematics, and neuro-mathematics are currently being explored and analyzed in recent studies (Rodríguez-Nieto et al., 2024; Cantillo-Rudas et al., 2024). Ethnomathematics focuses on how different cultures understand and use mathematics in their specific contexts, while neuromathematics examines the neurological bases of mathematical processes. Another relevant approach is the analysis of mathematical activity from an onto-semiotic perspective. The Onto-semiotic Approach (OSA) is presented as an inclusive theory that allows studying mathematical phenomena from different dimensions, and poses its research questions (see below). This theory considers mathematical practices as a combination of objects, meanings, and representation systems, allowing a comprehensive and multidimensional analysis of how mathematical competencies are developed in various educational contexts and environments.

In the Onto-semiotic Approach (OSA) there are the following research problems (Godino et al., 2019).

1. *Epistemological Problem*
   Key Question (QE1): How does mathematics emerge and develop?
2. *Ontological Problem*
   Key Question (QO1): What is a mathematical object? What types of objects are involved in mathematical activity?

3. *Semiotic-Cognitive Problem*
   Key Question (QSC1): What does it mean to know a mathematical object? What does the object signify for a subject at a given moment and under given circumstances?
4. *Ecological Problem*
   - *Description: Analyze the diversity of factors and norms that condition the teaching and learning processes.*
   - *Key Question (QEC1): What factors support and condition the development of instructional processes, and what norms regulate them?*
5. *Educational-Instructional Problem*
   - *Description: Studies the teaching and learning processes within didactic institutions to optimize them.*
   - *Key Questions:*
     - *QE1: What is teaching? What is learning? How are they related?*
     - *QE2: What types of interactions should be implemented to optimize learning?*
6. *Optimization of the Instructional Process Problem*
   - *Description: Focuses on improving learning through didactic suitability criteria.*
   - *Key Question (QOA1): What types of actions and resources should be implemented to optimize mathematical learning?*

Also, ETC has research questions that help it to be developed and applied in various problematic phenomena:

(a) What connections are made when studying a particular mathematical object?
(b) What practices, processes, objects, and semiotic functions constitute a mathematical connection? (Rodríguez-Nieto et al., 2021).
(c) How do we generate a new typology of mathematical connections?
(d) How to use two or more theoretical frameworks to analyze mathematical connections?
(e) What is the quality of mathematical connections?
(f) What mathematical knowledge do artisans, merchants, or anyone else use when developing their daily practice?
(g) What universal activities do artisans from a certain community use when developing their daily practice?
(h) What ethnomathematical connections are evident between the mathematics used by people in their daily practice and institutionalized or public mathematics? (Rodríguez-Nieto, 2021).
(i) It is necessary to build and validate a reference framework to study mathematical understanding based on connections (García-García, 2019).
(j) What practices, processes, objects and semiotic functions constitute a mathematical connection and what is their role in understanding mathematical concepts? (Rodríguez-Nieto et al., 2021).
(k) What mathematical connections does a mathematics teacher make and how do they influence the mathematical activity of students?
(l) What universal activities are promoted in the activation of an ethnomathematical connection of a craftsman or person when carrying out their daily practice? (Rodríguez-Nieto et al., 2022).

3.2. Discussion

The construction of the research problem is one of the most fundamental aspects in the development of any academic project. At this stage, not only is the direction of the research defined, but it simultaneously ensures coherence between the different sections of the project. For example, it is the guiding thread for the theoretical framework, methodology, results, discussion, and conclusions. It ensures that, when a research problem is well stated, it connects all the sections of the research, facilitating the logical flow of the study and preventing the initial idea of the research from being lost or confused (Busse & August, 2020).

Furthermore, a well-defined research problem helps the researcher discuss and compare the results obtained and highlight the novelty of his or her project. If the research problem is clear and specific, it guides the researcher towards obtaining results that not only answer the question posed, but also offer novel contributions to the area of study. This increases the originality of the findings and the

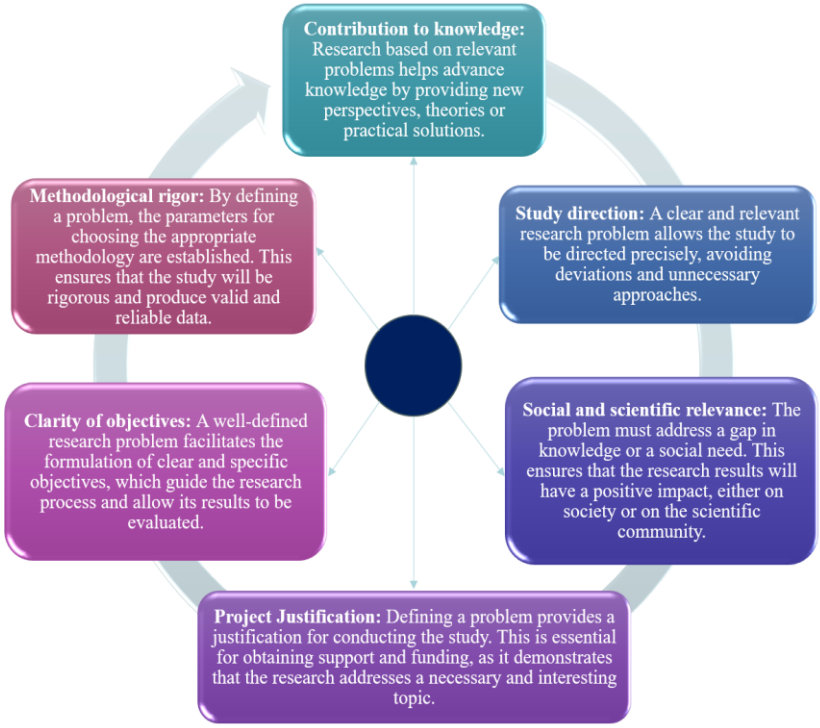
value of the work, contributing to the development of knowledge in the field investigated (APA, 2020; Corona et al., 2017).

In any research work, a problem statement based on global and local literature (see Figures 5 and 6) allows obtaining adequate results to address a problem. By consulting various sources (in specialized or non-specialized journals), the researcher acquires a deep knowledge of the topic, becoming a special expert on the subject, which makes it easier to identify gaps and define a problem that contributes to the field of study and write more fluently. In addition, an introduction section with an exhaustive literary review places the work in a broad context, showing how it relates to previous research and responds to specific needs by connecting theory with practice, proposing well-argued solutions (Cresswell, 2014; Hernández et al., 2014).

Finally, the importance of the research problem lies in the fact that it is the beginning of any scientific study. It should be noted that a well-defined and written research problem allows the authors of a project to identify the areas of knowledge that need greater understanding and/or immediate attention, propose solutions to specific challenges and contribute to the advancement of knowledge in a discipline, in this case mathematics. Some key aspects that highlight its importance are presented in Figure 8.

Figure 8

Summary of the benefits of the research problem.



4. Conclusion

The diagram presented in Figure 8 highlights the key elements of the research process. It highlights the importance of defining a research problem to ensure methodological rigor, clarity of objectives, direction of the study, and social and scientific relevance. Each of these components is fundamental to contributing to knowledge and justifying the project. Together, they promote effective research that can generate practical solutions and advance understanding in diverse areas. This structure encourages critical reflection and ensures that research is aligned with the real needs of society.

Acknowledgments

To the people who have addressed this issue and participants in various conferences that I have given to improve the writing of the research problem.

Author Contribution

Author 1: Conceptualization, Writing - Original Draft, Editing and Visualization; Formal analysis, and Methodology.
Author 2: Conceptualization, Writing - Original Draft, Editing and Visualization; Formal analysis, and Methodology.
Author 3: Conceptualization, Writing - Original Draft, Editing and Visualization; Formal analysis, and Methodology.
Author 4: Conceptualization, Writing - Original Draft, Editing and Visualization; Formal analysis, and Methodology.
Author 5: Conceptualization, Writing - Original Draft, Editing and Visualization; Formal analysis, and Methodology.

Funding Statement

This study is part of the projects: Teaching project coded by DOC.100-11-001-18 (Universidad de la Costa) & Grant PID2021-127104NB-I00 funded by MICIU/AEI/10.13039/501100011033 and by "ERDF A way of making Europe".

Conflict of Interest

The author declares no conflict of interest.

5. References

Anacona, M. (2003). La historia de las matemáticas en la educación matemática. *Revista EMA*, *8*(1), 30-46. https://funes.uniandes.edu.co/funes-documentos/la-historia-de-las-matematicas-en-la-educacion-matematica/

Aroca, A. (2022). Un enfoque didáctico del programa de Etnomatemáticas. Tecné, Episteme Y Didaxis: TED, (52), 211–248. https://doi.org/10.17227/ted.num52-13743

American Psychological Association [APA]. (2020). *Publication Manual of the American Psychological Association* (7th ed.). American Psychological Association.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator*, 14–22. http://hdl.handle.net/2027.42/65072

Barboza, M., Ventura J., & Gaycho, T. (2018). Consideraciones en relación con el problema de la investigación. *Revista Cubana de Información en Ciencias de la Salud*, *29*(1), 89-91. https://www.medigraphic.com/pdfs/acimed/aci-2018/aci181h.pdf

Bikner-Ahsbahs, A. (2022). Adaptive teaching of covariational reasoning: Networking "the way of being" on two layers. The Journal of Mathematical Behavior, 67, 100967. https://doi.org/10.1016/j.jmathb.2022.100967

Borji, V., Martínez-Planell, R., & Trigueros, M. (2024). Students' Understanding of Riemann Sums and Double Integrals: The Case of Task Design in APOS Theory. *International Journal of Research in Undergraduate Mathematics Education*, 1-29. https://doi.org/10.1007/s40753-024-00250-6

Breda, A. (2021). Valoración y rediseño de una unidad sobre proporcionalidad, utilizando la herramienta Idoneidad Didáctica. *Uniciencia*, *35*(1), 38-54. http://dx.doi.org/10.15359/ru.35-1.3

Briñis, A. (2017). *La investigación social. Cuaderno metodológico*. El Salvador: Talleres Gráficos UCA.

Busse, C., & August, E. (2021). How to write and publish a research paper for a peer-reviewed journal. *Journal of Cancer Education*, *36*(5), 909-913. https://doi.org/10.1007/s13187-020-01751-z

Cai, J., & Hwang, S. (2021). Teachers as redesigners of curriculum to teach mathematics through problem posing: conceptualization and initial findings of a problem-posing project. *ZDM Mathematics Education,* **53**, 1403–1416. https://doi.org/10.1007/s11858-021-01252-3

Cantillo-Rudas, B. M., & Rodríguez-Nieto, C. A. (2024). Relaciones entre la Neurociencia y la Educación Matemática: un estado del arte. *Caminhos da Educação Matemática em Revista (Online)*, *14*(1), 33-50. https://periodicos.ifs.edu.br/periodicos/caminhos_da_educacao_matematica/article/view/1626

Cantillo-Rudas, B. M., Rodríguez-Nieto, C. A., Font, V., & Rodríguez-Vásquez, F. M. (2024). Mathematical and neuro-mathematical connections activated by a teacher and his student in the geometric problems-solving: A view of networking of theories. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(10), 1-23. https://doi.org/10.29333/ejmste/15470

Cervantes-Barraza, J. (2020). Concepciones de futuros profesores de matemáticas en el contexto de la argumentación. Academia y virtualidad, *13*(1), https://doi.org/10-22. 0000-0002-7000-4977

Cervantes-Barraza, J. A., Salgado, S. J., & Peluffo, R. J. T. (2024). Promoviendo la participación y la argumentación de los estudiantes en clase de matemáticas: el caso del m-learning. *Sophia*, *20*(2), 1-17. https://doi.org/10.18634/sophiaj.20v.2i.1215

Cervantes-Barraza, J., & Valbuena Duarte, S. (2021). Preguntas de investigación en Educación Matemática, una mirada desde las concepciones de los futuros profesores. *Encuentros*, 19(02). https://doi.org/10.15665/encuen.v19i02.2522

Climent, N., Romero-Cortés, J. M., Carrillo, J.; Muñoz-Catalán, M. C., & Contreras, L. C (2013). ¿Qué conocimientos y concepciones movilizan futuros maestros analizando un vídeo de aula? *Revista Latinoamericana de Investigación en Matemática Educativa*, *16*(1), 13-36. https://www.scielo.org.mx/scielo.php?pid=S1665-24362013000100002&script=sci_abstract&tlng=pt

Common Core State Standards Initiative (CCSSI). (2010). Common core state standards for mathematics. Washington, DC: National Governors Association Center for Best Practices and Council of Chief State School Officers. Retrieved from http://www.cores tanda rds.org/wp-conte nt/uploa ds/Math_Stand ards.pdf

Corona, M., Fonseca, H. M., & Corona, F. (2017). Algunos apuntes generales sobre el problema de investigación. *Medisur*, *15* (3), 426-431. http://scielo.sld.cu/scielo.php?pid=S1727-897X2017000300018&script=sci_arttext

Cresswell, J. W. (2014). *Research Design, quantitative, qualitative and mixed methods approaches*. SAGE Publications, Inc. Thousand Oaks, California.

D'Ambrosio, U. (2014). Las bases conceptuales del Programa Etnomatemática. *Revista Latinoamericana de Etnomatemática Perspectivas Socioculturales de la Educación Matemática*, *7*(2), 100-107. https://www.revista.etnomatematica.org/index.php/RevLatEm/article/view/126

Davidson, A. & Delbridge, E. (2011). How to write a research paper. Paediatrics and Child Health, 22(2), 61–65.

Font, V., Calle, E., & Breda, A. (2023). Uso de los criterios de idoneidad didáctica y la metodología Lesson Study en la formación del profesorado de matemáticas en España y Ecuador. *Paradigma*, *44*(2), 376-397. https://doi.org/10.37618/PARADIGMA.1011-2251.2023.p376-397.id1424

Font, V., & Rodríguez-Nieto, C. A. (2024). Naturaleza y papel de las conexiones en la enseñanza y el aprendizaje de las matemáticas. *Avances de Investigación en Educación Matemática*, (25). 1-7. https://doi.org/10.35763/aiem25.6777

Font, V., Trigueros, M., Badillo, E., & Rubio, N. (2016). Mathematical objects through the lens of two different theoretical perspectives: APOS and OSA. *Educational Studies in Mathematics*, *91*(1), 107-122. https://doi.org/10.1007/s10649-015-9639-6

García-García, J. (2019). Escenarios de exploración de conexiones matemáticas [Scenarios for exploring mathematical connections]. *Números: Revista de didáctica de las matemáticas*, 100, 129-133.

García-García, J., & Dolores-Flores, C. (2018). Intramathematical connections made by high school students in performing calculus tasks. *International Journal of Mathematical Education in Science and Technology*, *49*(2), 227-252. https://doi.org/10. 1080/0020739X.2017.1355994

Godino, J. D. (2024). Enfoque ontosemiótico en educación matemática Fundamentos, herramientas y aplicaciones. Aula Magna. McGraw-Hill Interamericana de España S.L.

Godino, J. D., Batanero, C., & Font, V. (2019). The onto-semiotic approach: implications for the prescriptive character of didactics. *For the Learning of Mathematics*, *39* (1), 37- 42.

González Astudillo, M., & Sierra Vázquez, T. (2004). Metodología de análisis de libros de texto de matemáticas. Los puntos críticos en la enseñanza secundaria en España durante el siglo xx. Enseñanza de las ciencias, 22(3), 389–408.

González, I., Benvenuto, G., & Lanciano, N. (2017). Dificultades de Aprendizaje en Matemática en los niveles iniciales: Investigación y formación en la escuela italiana. Psychology, Society, & Education, 9(1),135-145. https://dialnet.unirioja.es/servlet/articulo?codigo=6360204

Hernández, R., Fernández, C., & Baptista, P. (2014). *Metodología de la investigación*. México: McGraw-Hill.

Itriago, M., & Zerpa, C. E. (2011). El planteamiento del problema en el proyecto de investigación en ingeniería. *Revista de la Facultad de Ingeniería Universidad Central de Venezuela*, 26(3), 39-54.

Ledezma, C. A., Rodríguez Nieto, C. A., & Font, V. (2024). The role played by extra-mathematical connections in the modelling process. *Avances de investigación en educación matemática*. (25), 81-103. https://doi.org/10.35763/aiem25.6363

López, L. B. (2006). La búsqueda bibliográfica: Componente clave del proceso de investigación. DIAETA, 31-37.

López, J. (2008). *Investigación educativa: en preguntas y respuestas. Curso de metodología para el post grado*. La Habana: Universidad de Ciencias Pedagógicas "Héctor Alfredo Pineda Zaldívar.

Martínez-Sierra, G., Cervantes-Barraza, J., & Jiménez-Sandoval, L. (2021) Experiences of Mexican teenage students when choosing a math degree: A mathematical narrative identity study. Uniciencia, 35(1), 245-264. http://dx.doi.org/10.15359/ru.35-1.15

Morrisey, J. (2010). El uso de TIC en la enseñanza y el aprendizaje. Cuestiones y desafíos. Disponible en: http://coleccion.educ.ar/coleccion/CD30/co ntenido/pdf/morrisey.pdf

National Council of Teachers of Mathematics (NCTM). (2000). Principles and standards for school mathematics. Reston, VA: Author

Orrantia, J. (2006). Dificultades en el aprendizaje de las matemáticas: una perspectiva evolutiva. Revista Psicopedagogia, 23(71), 158-180. https://pepsic.bvsalud.org/pdf/psicoped/v23n71/v23n71a10.pdf

Pineda B., E., Lizcano D., A. R., & Parra V., J. A. (2021). Planteamiento del problema de investigación en educación: algunas orientaciones para profesores que investigan en el aula. Plumilla Educativa, 28 (2), 57-79. https://doi.org/10.30554/pe.2.4300.2021

Rodríguez-Nieto, C. A. (2020). Explorando las conexiones entre sistemas de medidas usados en prácticas cotidianas en el municipio de Baranoa. *IE Revista de Investigación Educativa de la REDIECH*, 11, e-857. https://doi.org/10.33010/ie_rie_rediech. v11i0.857

Rodríguez-Nieto, C. A. (2021b). *Análisis de las conexiones matemáticas en la enseñanza y aprendizaje de la derivada basado en un networking of theories entre la teoría de las conexiones y el enfoque ontosemiótico [Analysis of mathematical connections in the teaching and learning of the derivative based on a networking of theories between the theory of connections and the onto-semiotic approach]* [Unpublished doctoral dissertation] Universidad Autónoma de Guerrero.

Rodríguez-Nieto, C. A. (2021a). Conexiones etnomatemáticas entre conceptos geométricos en la elaboración de las tortillas de Chilpancingo, México [Ethnomatematical connections between geometric concepts in the making of tortillas from Chilpancingo, Mexico]. *Revista de Investigación Desarrollo e Innovación [Journal of Research, Development and Innovation]*, *11*(2), 273-296. https://doi.org/10.19053/20278306.v11.n2.2021.12756

Rodríguez-Nieto, C. A., Cabrales, H. A., Arenas-Peñaloza, J., Schnorr, C. E., & Font, V. (2024). Onto-semiotic analysis of Colombian engineering students' mathematical connections to problems-solving on vectors: A contribution to the natural and exact sciences. *EURASIA Journal of Mathematics, Science and Technology Education*, *20*(5), 1-24. https://doi.org/10.29333/ejmste/14450

Rodríguez-Nieto, C. A., Escobar-Ramírez, Y., Font, V., & Aroca, A. (2023b). Ethnomathematical and mathematical connections activated by a teacher in mathematical problems posing and solving. *Acta Scientiae. Revista de Ensino de Ciencias e Matemática, 25*(1), 86-121. https://doi.org/10.17648/acta.scientiae.7356

Rodríguez-Nieto, C. A., Font, V., Borji, V., & RodríguezVásquez, F. M. (2022). Mathematical connections from a networking theory between extended theory of mathematical connections and onto-semiotic

approach. *International Journal of Mathematical Education in Science and Technology*, *53*(9), 2364-2390. https://doi.org/10.1080/0020739X.2020.1799254

Rodríguez-Nieto, C. A., Rodríguez-Vásquez, F. M., & Font, V. (2023a). Combined use of the extended theory of connections and the onto-semiotic approach to analyze mathematical connections by relating the graphs of f and f'. *Educational Studies in Mathematics*, *114*(1), 63-88. https://doi.org/10.1007/s10649-023-10246-9

Rodríguez-Nieto, C. A., Rodríguez-Vásquez, F. M., & García-García, J. (2021). Pre-service mathematics teachers' mathematical connections in the context of problem-solving about the derivative. *Turkish Journal of Computer and Mathematics Education*, *12*(1), 202-220. https://doi.org/10.16949/turkbilmat.797182

Rodríguez, W. (2011). *Guía de investigación científica*. Lima: Fondo Editorial UCH.

Romo-Vázquez, A., Barquero, B., & Bosch, M. (2020). La profesionalización docente en la modalidad online y la implementación de los REI: aciertos y desafíos. *Educação Matemática Pesquisa, 22*(4), *772-786*. https://doi.org/10.23925/1983-3156.2020v22i4p772-786

Rosa, M., & Orey, D. C. (2021). An ethnomathematical perspective of STEM education in a glocalized world. *Bolema: Boletim de Educação Matemática*, *35*(70), 840-876. https://doi.org/10.1590/1980-4415v35n70a14

Santos-Trigo, M. (2021). Resolución de Problemas Matemáticos y Tecnologías Digitales: agenda de Investigación y desarrollos. *FPIEM: Formación del Profesorado e Investigación en Educación Matemática*, (13), 205-222. https://dialnet.unirioja.es/servlet/articulo?codigo=8344100

Sudirman, Rodríguez-Nieto, C. A., & Bonyah, E. (2024). Integrating ethnomathematics and ethnomodeling in Institutionalization of school mathematics concepts: A study of fishermen community activities. *Journal on Mathematics Education, 15*(3), 835-858. http://doi.org/10.22342/jme.v15i3.pp835-858

Trigueros, M., Badillo, E., Sánchez-Matamoros, G. *et al.* Contributions to the characterization of the Schema using APOS theory: Graphing with derivative. *ZDM Mathematics Education* (2024). https://doi.org/10.1007/s11858-024-01615-6