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Mathematical culture: Diagnosis of its development in Pinar del Río Secondary School

La cultura matemática. Diagnóstico de su desarrollo en la Secundaria Básica de Pinar del Río

A cultura matemática. Diagnóstico do seu desenvolvimento na Escola Secundária Básica de Pinar del Río

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ABSTRACT

The teaching and learning process of mathematics should contribute to the development of students' mathematical literacy, enabling them to understand and appreciate the usefulness of mathematics in life and school, as well as value its history and logical beauty with a critical attitude toward problems that can be solved through mathematical thinking. This article presents the results of a research project related to the diagnosis of the development of mathematical literacy in junior high schools in the province of Pinar del Río, Cuba. Empirical methods such as document analysis, interviews, observation, and pedagogical testing were used, along with mathematical and statistical methods that allowed for the processing of the data obtained. Among the main findings were the set

Translated from the original in Spanish

of variables through which the study could be developed, as well as their behavior after the application of the aforementioned methods. In this regard, it was found that the class does not have the expected impact on the students' sociocultural context, as teachers have a poor perception of the potential of the discipline's normative documents for developing mathematical literacy. This was evidenced by the lack of interdisciplinary contextualization of teaching tasks, the limited use of the history of mathematics as a resource to motivate students in the study of this science, and the weak integration of mathematical content with the skills developed by different social groups.

Keywords: culture; science; education; mathematics; history; interdisciplinary; social; technology.

RESUMEN

El proceso de enseñanza-aprendizaje de la Matemática debe contribuir a la formación de la cultura matemática de los educandos, para que puedan comprender y apreciar la utilidad de la Matemática en la vida y en la escuela, así como valorar su historia y belleza lógica con una actitud crítica frente a los problemas que pueden resolverse mediante el pensamiento matemático. En el artículo se exponen los resultados de una investigación relacionada con el diagnóstico del desarrollo de la cultura matemática en la Secundaria Básica de la provincia de Pinar del Río, Cuba. Para su desarrollo se emplearon métodos empíricos como el análisis documental, la entrevista, la observación y la prueba pedagógica, así como métodos matemático-estadísticos que permitieron el procesamiento de la información obtenida. Entre los principales hallazgos estuvieron el conjunto de variables a través de las cuales se pudo desarrollar el estudio, así como su comportamiento una vez aplicados los métodos señalados. En este sentido, se encontró que la clase no tiene el impacto en el contexto sociocultural esperado en los educandos, ya que los docentes presentan una pobre percepción sobre las potencialidades de los documentos normativos de la disciplina para el desarrollo de la cultura matemática. Esto se evidenció en la falta de contextualización interdisciplinar de las tareas docentes, el escaso uso de la historia de la Matemática como recurso para motivar a los educandos en el estudio de esta ciencia y la débil integración de los contenidos matemáticos con las habilidades creadas por diferentes grupos sociales.

Palabras clave: cultura; ciencia; formación; matemática; historia; interdisciplinar; social; tecnología.

RESUMO

O processo de ensino-aprendizagem da Matemática deve contribuir para a formação da cultura matemática dos educandos, para que possam compreender e apreciar a utilidade da matemática na vida e na escola, assim como apreciar a sua história e beleza lógica com uma atitude crítica em relação aos problemas que podem ser resolvidos através do pensamento matemático. No artigo são expostos os resultados de uma investigação relacionada com o diagnóstico do desenvolvimento da cultura matemática na Educação Secundária Básica da província de Pinar del Río, Cuba. Para o seu desenvolvimento foram utilizados métodos empíricos como a análise documental, a entrevista, a observação e o teste pedagógico, além de métodos estatísticos que permitiram o processamento da informação capturada. Entre os principais achados estiveram o conjunto de variáveis através das quais se pôde desenvolver o estudo, assim como o seu comportamento uma vez aplicados os métodos mencionados. Nesse sentido, constatou-se que a aula não tem o impacto no contexto sociocultural esperado nos educandos, uma vez que os docentes têm uma percepção pobre sobre as potencialidades dos documentos normativos da disciplina para o desenvolvimento da cultura matemática, o que se pôde perceber na falta de contextualização interdisciplinar das tarefas docentes, no escasso uso da história da matemática como recurso para motivar os educandos para o estudo desta ciência e na fraca integração dos conteúdos matemáticos com as habilidades desenvolvidas por diferentes grupos sociais.

Palavras-chave: cultura; ciência; formação; matemática; história; interdisciplinar; social; tecnologia.

INTRODUCTION

The term culture comes from the Latin word *cultus*, which in turn derives from the word *colere*, meaning to tend the land or livestock. The term was used to designate a cultivated plot of land, the cultivation of the soil, or the care of livestock. By the mid-16th century, it had acquired a metaphorical connotation. When attempting to give a theoretical character to culture, somewhat limited interpretations emerged, such as the one that conceives of it as the collective result of human activity, including not only the results but also the activity itself; the one that maintains that it encompasses only its technological basis; or the one that considers it solely as creative activity.

From a scientific perspective, understanding science as a result of human activity necessitates considering the existence of scientific culture, viewed as the information related to scientific activities, including methods, research results, and the relationships these establish with other social activities. It is important to clarify that the concept of scientific culture is not exclusive to scientists, but also forms part of the general culture of individuals regarding the knowledge and activities of scientists (Torres-Gamarra, 2021).

Mathematics, as a science, is a cultural phenomenon. It is impossible to conceive of any culture without considering its role. The key lies in two ideas: first, the demonstration that in every culture, the processes of counting and measuring arise in one form or another; second, that regardless of the culture, the origin and subsequent theoretical development -even if created by other civilizations- are always consistent with any mathematical framework and incorporate that knowledge within them.

In turn, Euclid and Clavius, influenced by Platonic ideas, transformed mathematics into essential knowledge for the holistic development of the individual, enabling them to appreciate the beauty and order present in nature. Galileo and Descartes recognized it as an indispensable language and a key tool for deeply understanding natural phenomena and mastering the principles that govern their behavior. For their part, Newton, Leibniz, and Euler created a veritable symphony of infinity, manipulating limitless processes that led to significant advances in the natural sciences. Finally, mathematicians such as Bolzano, Cauchy, Weierstrass, and Cantor brought rigor and order to all mathematical constructions, which meant that, by the end of the 19th century, mathematics had become the most universally explained discipline.

In the search for an expression that fully encompasses the sociocultural phenomenon of "the knowledge with which each teacher approaches their work," the term "mathematical culture" emerges as the most fitting. Just as culture is inherent to every person from an anthropological perspective mathematical culture constitutes any mathematical perception or notion intimately linked to every human being living in society. The concept of mathematical culture has been approached from a perspective that goes beyond technical or academic knowledge of mathematics. It extends to the set of beliefs, attitudes, practices, and forms of communication that influence how people learn, teach, use, and value mathematics in social, cultural, and educational contexts.

Authors such as Martínez et al. (2022) explain that mathematical culture includes not only content, but also the norms, values, and forms of argumentation specific to the mathematical field. Similarly, Solares-Rojas (2021) points out that mathematical culture involves how mathematics is experienced in school and community contexts, integrating the cognitive, socio-emotional, and cultural aspects of mathematical learning.

From an ethnomathematical perspective, the concept of mathematical culture refers to the different ways in which diverse cultural groups develop, express, and apply mathematical knowledge within their social, economic, and productive contexts. This view recognizes that mathematics is not universal in its traditional academic form, but rather that multiple forms of mathematical reasoning exist that respond to the realities and needs of each culture.

Saumell Marrero (2021) highlights those mathematical cultures, from an ethnomathematical perspective, allow for the appreciation of local knowledge and mathematical practices that are not traditionally considered within the formal school setting. Similarly, Moraes Conveição and Cardoso da Silva Neto (2025) recognize the influence of different cultures on how everyday situations and problems are addressed, as well as how explanations are offered for natural and social facts and phenomena. In general, they argue that understanding mathematical culture from an ethnomathematical perspective contributes to a more inclusive education that respects cultural diversity and recognizes mathematical knowledge that emerges in community, craft, or work contexts.

In this regard, Sepúlveda-Herrera and Huincahue (2024) highlight the importance of understanding how mathematics is present in different cultural communities. This reflects the relationships established between the reality of a cultural group and mathematics, which enriches the integration of mathematical modeling into initial teacher training and its teaching.

Regarding the aspects to consider when studying the behavior of mathematical culture in students, Campo-Fernández and Tovar-Aguirre (2025) emphasize the importance of considering the personal dimension, which includes constructs such as utility value, endogenous instrumentality, personal utility, and achievement value. These constructs indicate how classroom activities can be interpreted by students in terms of their usefulness in achieving personal, short-term, or future goals.

The development of mathematical literacy is a key educational process that aims to cultivate in students a deep understanding of mathematical concepts and their application in everyday life. Sánchez Fernández (2015) argues that the development of mathematical literacy, as a process, is characterized by the need to cultivate it within the classroom. He believes that identifying this development in teachers provides insight into their mathematical discourse in the classroom. Therefore, he considers the following dimensions of mathematical literacy: cognitive, historical, applicability, and formative.

Regarding the different perspectives on how to approach the development of mathematical culture, authors such as Terry et al. (2020) highlight the importance of mathematics teaching and the teacher's role as a guide. Their study offers a theoretical review of mathematical culture and its defining characteristics.

The process of developing mathematical culture in Basic Secondary Education needs to be analyzed from the new perspectives imposed by the current improvement of Cuban education, which proposes the reformulation of the comprehensive general culture of students, so that they can understand the processes that surround them and become involved in the transformation of reality.

This aspiration implies the need to delve deeper into the concept of culture from the teaching-learning process of mathematics, so the teacher of this subject cannot disregard the responsibility of specifying, as far as possible, the reasons why mathematics is taught and showing what this discipline is taught for.

The teaching and learning process of mathematics in Cuba is guided, fundamentally, by a set of guidelines, directives and programs for the subject in each grade, which reveal three essential elements: the value of mathematical knowledge for problem solving; the potential of learning mathematics to contribute to the development of thinking; and the contribution that the teaching of mathematics offers to the development of awareness and the education of new generations.

The guidelines or guiding ideas of the Mathematics discipline are resources that enhance the development of mathematical culture, since they guide the teacher to foster logical and critical reasoning skills, essential for solving complex problems, relating diverse areas of knowledge with mathematical content, presenting interesting challenges and problems that motivate students to explore mathematics and its relevance in everyday life, as well as providing methods and procedures that help students build their knowledge progressively and coherently.

On the other hand, the general conception of the discipline is based on guidelines that run through its course to ensure the continuity and systematization of the treatment of the contents around the conceptual cores, which reveals what is essential to achieve from the point of view of the objectives, the ordering of the contents and the didactic orientation for its treatment in the direction of the teaching-learning process.

Identifying guidelines related to mathematical knowledge, skills, and ways of thinking represents a significant advantage, as it enables the holistic development of students and refines skills, techniques, and competencies such as critical thinking and problem-solving. Mathematical thinking fosters a deeper understanding of concepts, leading to more meaningful learning. Its flexibility and adaptability to diverse contexts and students need allow for more personalized instruction, develop teamwork and communication skills, and promote a collaborative learning environment that enriches the educational experience. All of this leverages the existing potential of the current curriculum and improves the direction of the mathematics teaching and learning process.

Likewise, they create the necessary conditions for the conception and application of all the elements involved in the formation of mathematical culture, which allows working with the different components that include Formal Education, History and Tradition, Social Practice, Community Interaction, Aesthetic Appreciation and Technology and Media, based on their conceptualization and contextualization.

Similarly, identifying guidelines related to more general mathematical skills, abilities, and habits offers potential for developing mathematical literacy, as it promotes logical thinking, problem-solving, and critical reasoning all fundamental to mathematical learning and its application in diverse contexts. It also encourages perseverance, attention, and organization, contributing to a positive attitude toward learning mathematics; supports the acquisition of skills that extend beyond purely mathematical concepts, such as communication, collaboration, and independent learning; and facilitates students' connection of mathematics to real-world situations, strengthening their mathematical literacy and their capacity to make informed decisions.

Therefore, the Mathematics curriculum in Basic Secondary Education has potential that contributes to the development of mathematical culture in students, such as the development of critical and logical thinking in problem-solving that fosters the ability to analyze, formulate, and resolve situations; the introduction of tools for evaluation and decision-making; the practical application of mathematical concepts in daily life and in various areas of knowledge; the promotion of creativity in problem-solving; the introduction of mathematical games that stimulate interest and curiosity; the development of social skills such as teamwork; mathematical communication seen as the ability to express ideas and solutions clearly and coherently; and the construction of a mathematical culture that promotes the appreciation of mathematics as an essential tool in science, technology, and everyday life.

Furthermore, it includes historical and philosophical aspects of learning to understand the development of mathematical thinking over time, identifies competencies that demonstrate mathematical skills as essential for technological development, and promotes a positive attitude towards continuous learning and self-education.

Accordingly, the Mathematics program in Basic Secondary Education not only focuses on the acquisition of technical knowledge, but also seeks to develop individuals with a solid mathematical culture, enabling them to face the challenges of today's world effectively and contribute to society in a comprehensive way.

In general, the goal is for students to acquire skills in problem-solving, logical reasoning, and applying mathematical concepts in diverse contexts; to foster the ability to analyze, evaluate, and create mathematical arguments; to promote the relationship between mathematics and other areas of knowledge; to integrate technologies and digital resources into teaching; to stimulate interest through challenging problems; and to adopt methodologies that promote collaborative and participatory environments. Likewise, the development of mathematical literacy should include the responsible use of mathematics in society and its impact on daily life, understood as a cultural and social production focused on the sociocultural context. The assumptions established in these initial pages have allowed the authors to conduct research related to the behavior of the most essential aspects that characterize the development of mathematical literacy in students at junior high schools in the province of Pinar del Río, the results of which are presented below in this article.

MATERIALS AND METHODS

For the study of the process of development of mathematical culture in the junior high schools of the province of Pinar del Río, the following operationalization of the variable was used:

Dimension I. Actions developed by the teacher for the development of mathematical culture in the Mathematics class in Basic Secondary Education.

Indicators:

a) Taking advantage of the guidelines offered by the normative documents of the Mathematics discipline for the formation of mathematical culture from the classroom.
b) Utilizing the history of mathematics as a science, as a resource to develop mathematical culture.
c) Use of technological resources in the formation of mathematical culture from the mathematics class.
d) Leveraging the links between mathematical content and other areas of science in the development of mathematical culture.
e) Taking advantage of social practices close to the student related to the use of mathematical content.
f) Taking advantage of the interaction with the different conceptions about mathematical content created historically by the social groups that make up the community.

Dimension II. Results in the formation of mathematical culture achieved by the students.

Subdimension 1: Mastery by the students of the fundamental historical references in the development of the content studied.

Indicators:

a) Mastery of the fundamental elements related to the historical development of the mathematical content studied.
b) Handling of technological resources used in mathematics throughout its history (abacus, calculator, calculation assistants, etc.).
c) Knowledge about the social practices related to the use of the mathematical content studied, historically used in their immediate environment.

Subdimension 2: Recognition by students of the applicability of the mathematical content studied.

Indicators:

a) Solving problems related to other areas of science using the mathematical content studied.
b) Solving problems related to their daily practice using the mathematics learned.

Subdimension 3: Development achieved by the students in the critical analysis of the surrounding reality using the mathematical content studied.

Indicators:

a) Interpretation of situations based on mathematical information.
b) Making estimates based on mathematical information.
c) Decision-making supported by data and quantitative information.
d) Perception of the beauty of mathematics as a science through patterns and symmetries.

The sampling process for the teachers was carried out using cluster sampling. The population, consisting of 132 mathematics teachers from the province of Pinar del Río, was grouped into 11 clusters (one per municipality). Two of these clusters were randomly selected: the municipalities of Pinar del Río and Consolación del Sur. The sample consisted of 22 teachers (11 from each municipality), selected based on more than 10 years of teaching experience.

For students in Basic Secondary Education, the population consisted of 16,021 students. The selected sample comprised 37 students from the Development Project for Direct Admission to the Pre-University Vocational Institute of Exact Sciences of Pinar del Río. This sample included students from all municipalities in the province, thus ensuring territorial representativeness. This group is considered an extreme group, given that it includes students who have won medals in provincial competitions in science subjects, whose criteria contribute significant elements to the understanding of mathematical culture. The general methodological approach for the diagnostic study of the development of mathematical culture was based on the use of methods at the empirical level of knowledge, such as:

- Document review: the teachers' lesson plans were analyzed in order to assess the handling of the variables under study.
- Observation: The way in which teachers conduct the process in the classroom was verified. This observation was non-participant, systematic, and regulated, using a structured instrument that allowed for standardized measurement of variables and ensured the objectivity of the data.
- Unstructured group interview: of a qualitative nature, applied with the purpose of obtaining in-depth answers about teachers' perceptions and experiences related to mathematical culture.

- Pedagogical test: applied to the 37 students in the sample, to evaluate the development achieved in the indicators related to mathematical culture.

In total, 22 ninth-grade math classes were observed, and the lesson plans of the 22 participating teachers were reviewed. Data processing was carried out by calculating an index for each indicator (I) and an index for each dimension. This index allowed the total score achieved in the sample to be related to the overall possible score, classifying the results into four categories:

1. Inadequate: $I \leq 0.25$
2. Not suitable: $0.25 < I \leq 0.50$
3. Suitable: $0.50 < I \leq 0.75$
4. Very suitable: $0.75 < I \leq 1$

RESULTS

Empirical results that characterize the state of the variable in the province of Pinar del Río

Regarding the state of the actions developed by the teacher for the formation of mathematical culture in the Mathematics class in Basic Secondary Education, the results of the observation of classes and the review of the lesson plans are presented (Table 1).

Table 1. Relationship between classroom observation and lesson plan review

			IDIIOC		Total
			2	3	
IDIIPC	2	Count	11	9	20
		% within IDIIOC	100.0%	81.8%	90.9%
	3	Count	0	2	2
		% within IDIIOC	0.0%	18.2%	9.1%
Total		Count	11	11	22
		% within IDIIOC	100.0%	100.0%	100.0%

Source: Own elaboration

As shown in table 1, both classroom observations and lesson plan reviews identified 11 teachers (50%) with a rating of *"inadequate"* in this dimension. Similarly, 9 teachers (81.8%) presented lesson plans that were inadequate for the development of mathematical literacy, even though the observed lesson was evaluated as *adequate.* Furthermore, in the 11 lessons rated as *inadequate,* the lesson plan did not show any improvement. The overall results obtained from the observations and lesson plan reviews, according to the defined indicators, are presented below (Table 2).

Table 2. Results of classroom observation and study of teachers' lesson plans

<table>
<tr><th>Indicator</th><th>Ia</th><th>Ib</th><th>Ic</th><th>Id</th><th>Ie</th><th>If</th><th>Index</th><th>Category</th></tr>
<tr><td>Lesson Plan (Index)</td><td>0.37</td><td>0.50</td><td>0.56</td><td>0.48</td><td>0.10</td><td>0.28</td><td rowspan="2">0.38</td><td rowspan="2">2</td></tr>
<tr><td>Lesson plan (Category)</td><td>2</td><td>2</td><td>3</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td>Class observation (Index)</td><td>0.39</td><td>0.56</td><td>0.56</td><td>0.48</td><td>0.15</td><td>0.27</td><td rowspan="2">0.40</td><td rowspan="2">2</td></tr>
<tr><td>Class observation (Category)</td><td>2</td><td>3</td><td>3</td><td>2</td><td>1</td><td>2</td></tr>
</table>

Source: Own elaboration

As shown in table 2, both observation and review of lesson plans indicate that the dimension related to teaching actions for the development of mathematical literacy in lower secondary education reaches an overall index of less than 0.40, which qualifies the teachers' work as *inadequate*.

The analysis by indicators reveals the greatest impact on the following:

- Ia: making use of the guidelines provided by the normative documents of the discipline of Mathematics.
- Id: leveraging the links between mathematical content and other areas of science.
- Ie: making use of social practices close to the student.
- If: taking advantage of the interaction with historical conceptions about mathematical content.

All of them show indices below 0.50, indicating insufficient development. The remaining indicators, although with slightly better results, do not exceed 60% of the possible score.

Results in the development of mathematical culture achieved by students

Regarding students' understanding of the fundamental historical references in the development of the studied content, the interviews revealed a limited knowledge of the main historical milestones in mathematics. They reported using textbooks and internet searches to research the contributions of prominent scientists. However, they lacked clarity on what technological resources specific to the discipline are available or how to use them, only mentioning measuring instruments and calculators.

Their knowledge of social practices related to the use of mathematical concepts in their immediate environment was also poor. Although they mentioned examples of measurement used by farmers and carpenters, they were unable to incorporate them as tools for problem-solving.

Regarding the recognition of the applicability of the mathematical content studied, the results (Table 3) corroborate that 21 out of 37 students (56.8%) have limitations in solving problems related to other areas of science, and 22 out of 37 (59.9%) show difficulties in applying mathematical knowledge in situations of their daily life.

Table 3. Recognition of the applicability of the mathematical content studied

Indicators	Students with difficulties	%
a. Solving problems related to other areas of science using the mathematical content studied.	21	56.8
b. Solving problems related to their immediate practice using the mathematics studied.	22	59.9

Source: Own elaboration

Regarding the critical analysis of the surrounding reality based on the mathematical content studied, the results (Table 4) reveal that more than 50% of the students are unable to interpret situations, estimate, or make decisions based on mathematical information. The most affected indicator was the perception of the beauty of mathematics as a science, where 33 students (89.2%) showed significant limitations in appreciating patterns or symmetries.

Table 4. Critical analysis of the surrounding reality using the mathematical content studied

Indicators	Students with difficulties	%
a. Interpret situations using mathematical information.	21	56.8
b. Make estimates using mathematical information.	19	51.4
c. Make decisions based on the information they have.	20	54.1
d. Perception of the beauty of mathematics as a science through patterns and symmetries.	33	89.2

Source: Own elaboration

DISCUSSION

Accordingly, regarding the development of mathematical culture, we agree with Sánchez Fernández (2015), who considers that it should be fostered in the classroom, taking into account the cognitive, historical, applicability, and formative dimensions. Therefore, for the study presented in this article, a dimension has been proposed to evaluate the actions teachers take to develop mathematical culture.

Regarding the indicators of this dimension, the theoretical analyses conducted have revealed points of agreement with authors such as Martínez et al. (2022), who emphasize the importance of content, norms, values, and forms of argumentation in their concept of mathematical culture; as well as with Solares-Rojas (2021), who highlights the importance of leveraging how mathematics is experienced in the school and community context to integrate the cognitive, socio-emotional, and cultural aspects of mathematical learning. There is also agreement with Saumell Marrero's (2021) ethnomathematical perspective, which aims to help students and teachers value local knowledge and mathematical practices that are not typically taught within the school setting.

On the other hand, while the position of Terry et al. (2020), which prioritizes the teacher's role in developing mathematical culture, is considered valuable, it is important to highlight the relevance, in this regard, of the student's relationship with the history of mathematics as a science. This includes the use of technological resources in mathematics, the connection of mathematical content with other areas of science and practical applications relevant to the student, as well as interaction with the diverse conceptions of mathematical content historically developed by the social groups that make up the community. These approaches aim to ensure that students master the fundamental historical references in the development of the content, not only recognize its applicability but also critically analyze the surrounding reality. Consequently, the proposed operationalization of the variable under study is presented.

Therefore, in the proposed indicators for the dimension related to the teacher's work in developing mathematical culture, the following aspects must be taken into account: the use of the guidelines offered by the normative documents of the Mathematics discipline for the formation of mathematical culture in the classroom; the use of the history of mathematics as a science; the use of technological resources; the links between mathematical content and other areas of science in the formation of mathematical culture; the use of social practices close to the student related to the use of mathematical content; and the use of conceptions about mathematical content created historically by the social groups that make up the community.

However, the behavior of these indicators is not adequately reflected in teachers' practices, as they have a poor understanding of the potential of the normative documents of the Mathematics discipline for fostering mathematical literacy. These documents focus primarily on elements of mathematical knowledge and neglect other important aspects, such as creativity, the beauty of mathematics, the contribution of the history of mathematics and social practices, and practical application. Teaching practices lack elements that would allow teachers to leverage interdisciplinary and socio-historical relationships established around mathematical content. Classes fail to achieve a contextualized, interdisciplinary, and integrative approach to instructional and educational content that connects the material to other areas of knowledge. Most classes do not incorporate the analysis of situations related to the history of mathematics as a science, nor do they include resources for developing mathematical literacy, nor do they address the socio-historical relationships established within the community regarding mathematical content. The class lacks the use of didactic and technological resources that would facilitate more dynamic and engaging learning, limiting students' opportunities to explore mathematical concepts practically. Mathematics and science are taught in isolation, without integrating other fields of knowledge, which limits the understanding students need to tackle complex problems. The teacher fails to recognize the relevance of mathematics in students' daily lives and cultural context; likewise, they do not integrate mathematical content with the problem-solving skills developed by different social groups.

In determining the variables for studying the development of mathematical culture in students, we have concurred with Sepúlveda-Herrera and Huincahue (2024), Moraes Conveição and Cardoso da Silva Neto (2025), and Campo-Fernández and Tovar-Aguirre (2025) regarding the importance of establishing a personal dimension that includes constructs such as utility value, endogenous instrumentality, personal utility, and achievement value. For this reason, we have proposed subdimensions that allow us to explore students' mastery of the fundamental historical references in the development of the mathematical content studied, their recognition of the applicability of mathematical content, and their ability to critically analyze the surrounding reality using the mathematical content they have studied.

The theory put forward by the different authors is sound and we agree with it; however, the authors do not highlight the importance of emphasizing the knowledge, skills and attitudes of the conceptual cores of mathematics as utilitarian resources for life, as a source of historical knowledge and beauty.

The dimension related to the results achieved by students in developing mathematical literacy led to the conclusion that they possess knowledge of the fundamental elements related to the historical development of the mathematical content studied, based solely on the references provided by the textbook. Their use of technological resources employed in mathematics throughout history is evident in their use of drawing instruments, calculators for complex calculations, and cell phones for information searches; however, they do not utilize mathematical software. For the most part, they are unfamiliar with the conceptions of mathematical content historically developed by the social groups within their community, as well as with the various social practices related to the use of mathematical content for problem-solving. They have a limited view of the applicability of the mathematical content studied, which hinders their ability to solve problems related to their everyday lives, and they have a low perception of the beauty inherent in the use of mathematical content, for example, in the use of patterns and symmetries.

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Conflict of interest

Authors declare no conflict of interests.

Authors' contribution

The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.