



REVISTA

CÁTEDRA

July - December 2025

Vol. 8 Num. 2

Quito - Ecuador



Universidad Central del Ecuador
Facultad de Filosofía, Letras y Ciencias de la Educación



REVISTA

CÁTEDRA

Revista Cátedra, of the Facultad de Filosofía, Letras y Ciencias de la Educación of the Universidad Central del Ecuador is published every six months, the first month of each period from January-June, July-December. Director/Editors-in-Chief Ph.D. Sergio Lujan Mora, Ph.D. Verónica Simbaña Gallardo.

Location: Quito - Ecuador, belongs to the Faculty of Philosophy, Letters and Education Sciences of Universidad Central del Ecuador.

ISSN electrónico: 2631-2875

Digital Object identifier 

Web page: <http://revistadigital.uce.edu.ec/index.php/CATEDRA/index>

Revista Cátedra E-mail: revista.catedra@uce.edu.ec

Phone number: (+593) 2506-658 ext. 111 o 22904-760

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La Revista Cátedra, which belongs to the Faculty of Philosophy, Letters and Education Sciences of Universidad Central del Ecuador has been a means of communication since 1992; the academic voice of the professors was expressed through the bulletins, whose relevant objective was to improve the educational quality based on their experience, wisdom and knowledge as professors forming other educators. On May 2018, *Revista Cátedra* reemerges as a space that creates and disseminates articles oriented to the improvement of the educational process and its linkage with society.

OBJECTIVE

To disseminate multidisciplinary scientific unpublished articles, elaborated under the parameters of the research methodology, written with academic rigor and based on the teaching practice.

TOPICS

The topics covered are the theoretical bases of the Education Sciences in its different specialties and levels of the educational system. Priority will be given to papers describing pedagogical experiences, didactics used, innovation processes, and their relationship with new educational technologies.

TARGET AUDIENCE

The *Revista Cátedra* is directed to all the national and international researchers interested in publishing quality works that contribute to the improvement of the educational process.

From its origins, the *Revista Cátedra* was published in printed format. It is currently published in electronic format, using virtual environments to align to the needs of the revista s users and editors.

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Cátedra Journal, of the Universidad Central del Ecuador, Faculty of Philosophy, Letters and Educational Sciences, publishes scientific articles on various areas of knowledge related to Educational Sciences, based on the methodology of educational research and community service.

VISION

Vision

To be promoters in the publication of high quality scientific articles that, guided by research and from different areas of knowledge linked to the Educational Sciences, become the most prestigious reference in the understanding and improvement of the educational process.



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FOCUS AND SCOPE: Revista Cátedra has as its theoretical basis the Educational Sciences in its different specialties and levels of the educational system. Priority will be given to papers describing pedagogical experiences, didactics used, innovation processes, and their relationship with new educational technologies.

It disseminates scientific-academic articles constructed under the parameters of research methodology. It is open to national and international writers interested in contributing significantly to the solution of current educational problems.

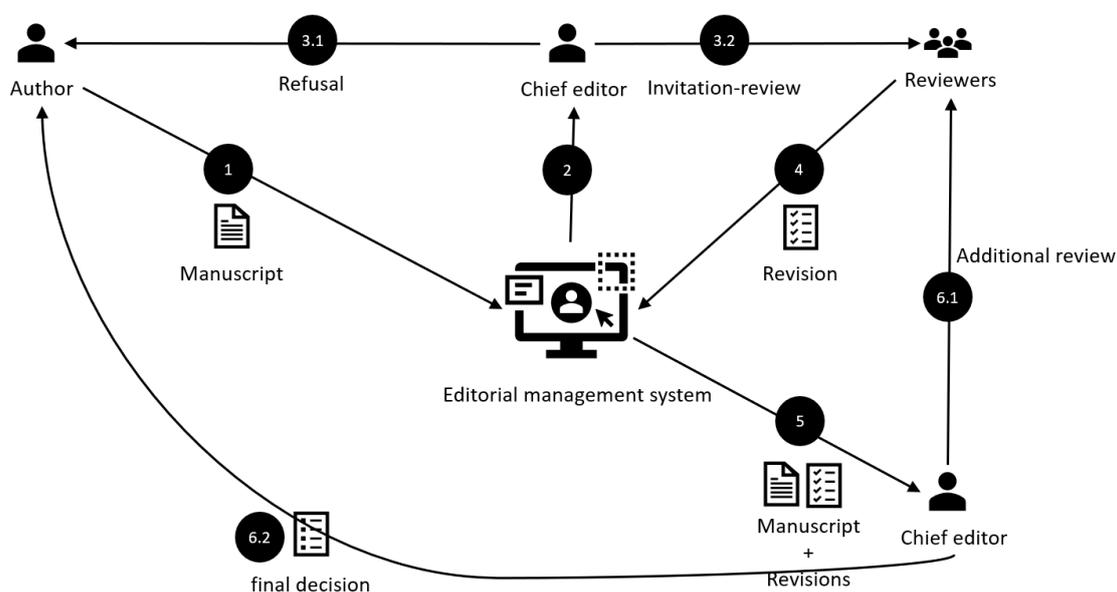
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The arbitration system for the articles received uses the double-blind peer review method, that is, the reviewers do not know the names or affiliation of the authors and the authors do not know the names or affiliation of the reviewers. As a minimum, each article is reviewed by two reviewers who are external national and international evaluators who do not belong to the internal team of the journal. The review process is confidential and participants agree not to disclose any information in the review.

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EDITORIAL

Cátedra Journal is honored to present its eighth volume, number two, in its electronic version. The topics covered have their theoretical foundations in the Educational Sciences across different specialties and educational levels. Thus, some relevant and outstanding aspects of each academic work are presented, addressing areas such as hospital pedagogy, education, and educational resources.

The content presented in this new issue is characterized by being developed under the parameters of research methodology. Furthermore, it is prepared with academic rigor under blind peer review and based on teaching practice and theory.

The issue consists of nine approved articles:

The first article, entitled *Mathematical teaching resources for hospital classrooms in Ecuador* was written by Ximena Pinos-Benavides. The main objective of this research was to highlight hospital classrooms, which are emerging as a vital solution, ensuring that academic training continues despite health adversities. However, teaching mathematics in this context presents unique challenges, requiring innovative teaching resources to maintain motivation and interest. The official Ecuadorian curriculum establishes learning standards that must be met even in these special environments, underscoring the urgent need for curricular adaptations that respond to the particular conditions of each student. This study used a qualitative and exploratory methodology and aimed to investigate precisely which teaching resources optimize mathematics learning in hospital classrooms. The findings are revealing: the teaching techniques that prevail and demonstrate the greatest effectiveness are those that engage the visual and motor channels. This is achieved through the use of graphic materials, pictorial representations, and body dynamics. These strategies transform abstract mathematics content into meaningful sensory experiences, enhancing learning and adapting to the diverse needs and cognitive styles of hospitalized students.

The second article, entitled *An overview of the dimensions of availability and accessibility of the right to education from 2014 to 2024* was authored by Alex Lucio-Paredes and Nadia Lucio-Paredes. This research focuses on an analysis of a fundamental duty of the State: guaranteeing the right to education. This study directly addresses the vital question of whether the Ecuadorian State is satisfactorily fulfilling the dimensions of availability and accessibility of education. The research, which covers the academic periods from 2013-2014 to 2023-2024, uses a mixed-method approach, and reveals alarming findings that demand our immediate attention. Regarding availability, the study shows that the number of educational institutions in the country has declined dramatically. Even worse, accessibility has also suffered significant blows. The authors conclude by emphatically stating that the Ecuadorian State is not guaranteeing the right to education in its dimensions of availability and accessibility.



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The third article, entitled *Relevance of the prioritized curriculum with emphasis on competencies: teachers' perspectives on the teaching of mathematics in Bachelor of Science*, is by Jhon Lima-Yarpaz, Ana Arias-Balarezo, and Franklin Molina-Jiménez. This academic work examines the relevance of the prioritized curriculum in the teaching and learning of Mathematics for second-year students of the Bachelor of Science Program in Quito during the 2023-2024 school year. This study, vital to the Ecuadorian educational context, focuses on how teachers perceive the development of communication, mathematical, digital, and socio-emotional competencies, as defined by the Ministry of Education, and the effectiveness of the Mathematics textbook provided. Its methodology used a qualitative and quantitative approach; the research included surveys of teachers from 22 Quito educational institutions and a content analysis of the textbook. The findings reveal that the curriculum demonstrates a high level of contextualization and relevance, achieving significant promotion of mathematical and socio-emotional skills. This is a clear indication that efforts to align education with students' current needs are bearing fruit. However, the study also identifies key areas for improvement. The development of digital skills in the classroom only reaches an average level of integration, suggesting a significant gap in students' preparation for the digital world. Furthermore, according to the authors, the analysis of the mathematics textbook revealed a notable omission: the study of the limit of a function, a fundamental concept at the science baccalaureate level.

The fourth article, entitled *The influence of academic stress on the performance of basic education students at the Central University of Ecuador* was authored by Jacqueline Díaz-Parra, Nadia Curipallo-Peralta, Héctor Rojas-Avilés, and Jenny Parra-Muñoz. This article focuses on a growing and silent problem that affects the heart of our higher education: academic stress. As noted by the United Nations Development Program, an alarming 77% of people worldwide experience moderate or severe stress. According to Moscoso and Barsallo (2018), this reality affects 43.2% of university students in Ecuador. The objective was to assess the stress level of in-person elementary school students. Using a non-experimental-descriptive methodology and a quantitative approach, the SISCO SV-21 Inventory was administered to 586 students from the Central University of Ecuador, selected in a stratified manner. The main stressors identified were homework overload and the type of work required, leading to consequences such as concentration problems and feelings of depression. Among the most significant findings is the need for higher education institutions to implement comprehensive and sustainable programs for academic stress management, specifically targeting students in the first semesters, who are in a critical adaptation stage, and those in advanced semesters, who face greater demands.

The fifth article, entitled *The quality of the infrastructure of early childhood education centers in the city of Quito-Ecuador* was authored by Luisa Soto-Duque, Edwin Panchi-Culqui, and Andrés Subía-Arellano. The purpose of this study was to evaluate the critical importance of infrastructure quality in early childhood education centers in the Metropolitan District of Quito. This recent study, which employed a mixed methodology with interviews and surveys with representatives of early childhood education institutions in the Metropolitan District of Quito, reveals a troubling reality: the current infrastructure does not comply with



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current regulations. It is imperative to invest in improving these spaces. Only in this way can truly quality education be ensured at this vital formative stage. Finally, the authors conclude that investment in early childhood education infrastructure is not an expense, but a direct investment in the future of children and, therefore, in the future of the city of Quito, Ecuador.

The sixth article, entitled *The influence of the ecuadorian education system on the development of critical thinking in Unified General Baccalaureate* is by Alexandra Patricia Chamba-Zarango and Floralba del Rocío Aguilar-Gordón. This research addresses a significant weakness in Ecuadorian education: our students' limited capacity to analyze and synthesize information, which hinders their ability to critically assess reality. This situation leads us to question: How is our educational system influencing the development of complex skills and, specifically, critical thinking? This research delves into the impact of the Ecuadorian educational system on the teaching-learning process in high school, proposing activities to foster critical thinking. Through analytical-synthetic and hermeneutic methods, which included analysis of the legal framework and interviews with teachers, the study reveals pedagogical perceptions and practices, as well as the challenges and opportunities in this vital area. Finally, the authors conclude that it is urgent to strengthen students' metacognitive skills and implement teaching strategies that provide them with lasting tools to identify truth criteria in discourses and formulate meaningful questions.

The seventh article, entitled *Development of historical thinking in the first year of high school: analysis of the activities in the History textbook* is by Erika Nasimba-Mera and Odalys Fraga-Luque. This research addresses a significant deficiency in history teaching: the poor development of historical thinking in students. This limitation restricts their ability to critically interpret the past and, instead, confines them to a mere accumulation of data. The research presented analyzed 121 activities from the first-year high school history textbook. This article used both quantitative and qualitative approaches for its respective data analysis. Likewise, the findings presented by the authors are revealing, given that the predominant activities in textbooks focus on first-order concepts and require a low or intermediate cognitive level. Finally, the authors conclude that there is an urgent need to diversify textbook activities to cultivate robust historical thinking, and that it is imperative to incorporate approaches that foster critical analysis, in-depth interpretation, and the reflective use of historical knowledge.

The eighth article, entitled *Problem-Based Learning and its incidence in the teaching-learning process of Chemistry* was authored by Víctor Castillo-Gaona and Grethy Quezada-Lozano. The objective of this research was to delve deeper into Problem-Based Learning (PBL) as an essential pedagogical strategy for the meaningful acquisition of knowledge and the development of competencies in students. The research highlights how PBL, when integrated into microcurricular planning, enables students to identify and address issues relevant to their context. This is achieved through collaborative group discussion, independent research, and synthesis of findings. The article employed a quantitative approach and a quasi-experimental design. The academic performance of two groups of



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Chemistry students at the Ciudad de Cuenca High School was compared during the 2023-2024 school year. The results revealed that, while the control group that used a traditional methodology showed performance considered "good," 100% of the experimental group, which implemented PBL, achieved a grade of "very good." Finally, the authors concluded that Problem-Based Learning not only improves academic performance in Chemistry, but also fosters the development of crucial disciplinary competencies in a collaborative environment.

Finally, the ninth article, *Active learning through projects in mathematics: a strategy for effective implementation of curriculum design* by María Arias-Albuja, Milton Coronel-Sánchez, and Luis Logacho-Morocho, is presented. This study addresses the pressing need to transform mathematics teaching in Ecuador. The research focused on upper basic education and high school levels, exploring Project-Based Learning (PBL) as an active teaching strategy. Its objective was to overcome memorization and foster meaningful learning, in addition to enhancing the development of essential competencies in students. The article used a mixed-method approach to evaluate the impact of PBL in the Ecuadorian curricular context. It also identified relevant activities and proposed a methodological guide for teachers. To gather information, a survey was administered to 160 students and 30 teachers in the city of Quito. Finally, the authors concluded that it is essential to develop the ability to contextualize and make mathematical learning relevant, integrating content with real-life problems.

Cátedra Journal thanks all the authors and reviewers who made the publication of this issue possible. It also invites the national and international academic community to submit their research related to Educational Sciences in its various specialties and educational levels.

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REVISTA

CÁTEDRA

Mathematical teaching resources for hospital classrooms in Ecuador

Recursos didácticos para la enseñanza de la Matemática en aulas hospitalarias de Ecuador

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(Received on: 16/06/2025; Accepted on: 30/06/2025; Final version received: 26/07/2025)

Suggested citation: Pinos-Benavides, X. (2025). Mathematical teaching resources for hospital classrooms in Ecuador. *Revista Cátedra*. 8(2), 19-37.

Abstract

Children and young people facing chronic or long-term illnesses often find their academic education interrupted. To address this need, hospital classrooms have emerged as an alternative that guarantees continuity of learning. Mathematics is one of the most complex disciplines and faces several challenges, requiring adaptation to innovative teaching resources that maintain student motivation and interest. Ecuador's official curriculum establishes learning standards that must be met even in hospital settings. This highlights the need for curricular adaptations to respond to students' unique conditions. The purpose of this study is to investigate which teaching resources support mathematics learning. This is an exploratory qualitative study, supported by the empirical method, that is, the researcher's direct experience. The results obtained from the interview script indicate that among the teaching techniques applied in the hospital setting, the visual and motor channels prevail, through the use of graphic materials, pictorial representations, and body dynamics. These techniques allow the abstract contents of Mathematics to become meaningful sensory experiences, enhancing learning and adapting to cognitive needs and styles.

Keywords

Hospital classrooms, teaching, Mathematics, teaching resources.



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Resumen

Niños y jóvenes que enfrentan enfermedades crónicas o prolongadas suelen ver interrumpida su formación académica. Para responder a esta necesidad han surgido las aulas hospitalarias como una alternativa que garantiza la continuidad del aprendizaje. La Matemática es una de las disciplinas más complejas y tiene varios desafíos, pues, necesita adaptarse a recursos didácticos innovadores que mantengan la motivación y el interés del estudiante. El currículo oficial de Ecuador establece estándares de aprendizaje que deben cumplirse incluso en contextos hospitalarios. Esto resalta la necesidad de realizar adaptaciones curriculares para responder a las condiciones particulares de los estudiantes. El propósito de este estudio es indagar sobre cuáles son los recursos didácticos que favorecen el aprendizaje de la Matemática. Es una investigación de enfoque cualitativo exploratorio, apoyado en el método empírico, es decir, la experiencia directa de la investigadora. Los resultados obtenidos a partir del guion de la entrevista señalan que entre las técnicas de enseñanza aplicadas en el contexto hospitalario prevalecen el canal visual y motriz mediante el uso de materiales gráficos, representaciones pictóricas y dinámicas corporales. Estas técnicas permiten que los contenidos abstractos de la Matemática se conviertan en experiencias sensoriales significativas, potenciando el aprendizaje y adaptándose a necesidades y estilos cognitivos.

Palabras clave

Aulas hospitalarias, enseñanza, Matemática, recursos didácticos.

1. Introduction

The right to education is fundamental for the development of children and adolescents, but those facing chronic or long-term illnesses often find their academic education interrupted. To respond to this need, hospital classrooms have emerged as an alternative that guarantees continuity of learning by adapting pedagogical strategies to the students' conditions. In Ecuador, these classrooms are part of the inclusive education model promoted by the Ministry of Education, which establishes the guidelines for the development of this modality. Their objective is to ensure that students receive an education adapted to their needs, based on various approaches, including rights-based, inclusive, comprehensive care, well-being, and ecological-contextual approaches. These approaches seek to ensure that education in hospital settings is accessible, flexible, and of high quality. It is recognized that students in this condition require personalized methodologies, innovative pedagogical strategies, and adequate materials to maintain their academic development.

One of the main challenges of hospital education is the teaching of mathematics, given that this subject requires continuity, abstraction, and constant practice. Despite efforts to ensure equitable education, the implementation of specific strategies for teaching mathematics in these settings remains a challenge. There are limitations regarding teacher training in adapted methodologies, the availability of appropriate teaching resources, and the curricular integration of these students. Therefore, the main objective of this research is to analyze teaching resources that promote mathematics learning in a hospital setting.

Regarding methodology, this study adopts an exploratory qualitative approach based on the empirical method, that is, the researcher's direct experience. A semi-structured interview technique was used to collect information; the data collected using the instrument allowed



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for the establishment of the following categories: methodology, strategy, technique, topics, student age, and student satisfaction scale.

The article is structured into six sessions: the second session presents the state of the art and a brief review of other research related to the topic. The third session provides a conceptual overview of the teaching resources used for mathematics learning. The fourth session addresses a curricular analysis based on the National Model for Hospital and Home Educational Management and Care in Ecuador. The fifth session presents the methods and materials used for this study. The sixth session presents the results of the research and explains which teaching resources maintain educational continuity, reduce anxiety, and promote mathematics learning in a hospital setting.

2. State of the art

In 2016, in Ecuador, the Ministry of Education and the Ministry of Public Health implemented the National Model for Hospital and Home Educational Management and Care. The goal was to guarantee access, retention, and learning for students experiencing illness through comprehensive, high-quality educational care. The model was built on principles of equity, inclusion, and rights, incorporating flexible, personalized, and fun methodologies to facilitate the educational process in hospital or home settings. Its results include the consolidation of an inter-institutional public policy that allows for the implementation of the program in several hospitals across the country, benefiting thousands of children and adolescents. The conclusions highlight the importance of coordinating the health and education sectors and recognizing the specific needs of hospitalized students. The goal is to promote a pedagogy that fosters both the academic development and emotional well-being of students and their families

In 2017, in Paris, UNESCO published the Guide to Ensuring Inclusion and Equity in Education, a study that, while not focused exclusively on hospital classrooms, provides key foundations for inclusive education that encompass non-conventional settings such as these. Among its findings, the report identifies the urgent need to adapt teaching resources to diverse contexts, including those marked by prolonged medical conditions that prevent regular attendance in traditional classrooms. The guide concludes that ensuring equitable and inclusive education involves developing policies that integrate all students, including those in vulnerable situations due to health reasons, and ensuring that educational resources effectively respond to their learning needs.

In 2017, in Bogotá, Colombia, a study entitled "Design and Implementation of Teaching Resources in Mathematics Classes for a Hospital Classroom," prepared by Salgado and Castro, was conducted. This research arose in response to the need to guarantee the right to education for hospitalized children and young people. Among its results, it was evident that the use of manipulative materials and games as teaching aids enabled patient students to acquire meaningful learning. Furthermore, it strengthened socio-mathematical skills and maintained a positive attitude toward mathematics. In conclusion, the study highlights the importance of a flexible and contextualized pedagogical approach, in which teaching resources foster the understanding of mathematical concepts and promote social interaction and emotional well-being in hospitalized settings.

In 2018, a study titled "Implementation of Teaching Resources for Mathematics: An Experience in a Hospital Classroom" was conducted in Bogotá, Colombia, by Salgado and



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Castro. This study arose from a lack of adequate teaching materials for teaching mathematics to hospitalized students. Through a collaboration between the Francisco José de Caldas District University and the LeBeM curriculum project, students designed and donated various teaching resources, such as the neutralizer, the egg tangram, the factoring dominoes, and Papy's minicomputer. These resources were implemented and adapted to the conditions of the clinical setting. The results showed a positive change in students' attitudes toward the subject, increased interest and motivation for learning, and improvements in socio-mathematical skills. The conclusions highlight that the use of teaching resources designed using the Universal Design for Learning (UDL) approach promotes educational inclusion. It addresses diversity and improves access to knowledge in unconventional settings such as hospital classrooms.

In 2021, Bolívar and Galindo conducted a study titled "Implementation of Resources and Strategies to Generate Learning Environments in Hospital Classrooms Regarding Mathematics Teaching" in Bogotá, Colombia. The objective was to improve mathematics teaching and learning processes in a hospital classroom through the use of inclusive teaching resources and pedagogical strategies. The results showed that resources designed as math games, manipulatives, and interactive activities generated a positive and motivating environment for hospitalized students. The conclusions indicated that teaching resources, when appropriate to the physical, cognitive, and emotional conditions of patients, facilitate learning and positively impact their emotional state and overall well-being.

3. Related concepts

3.1 Teaching resources for teaching mathematics

The resources used in educational settings are essential for promoting the acquisition of new knowledge in mathematics. According to Lugo et al. (2019), "in the learning process, logical-mathematical concepts constitute a fundamental and useful tool, because through them children express their knowledge every day in each of their educational training experiences" (p. 20). Therefore, a resource is understood to be anything that accompanies and facilitates the implementation of pedagogical strategies, such as games, songs, visual representations, and teaching materials.

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3.2 Mathematical role-playing games

Mathematical role-playing is a teaching strategy that allows students to apply mathematical concepts in real-life situations by playing different roles. According to Salgado and Castro (2017), "the use of teaching resources in the mathematics classroom can be achieved through play, which is why one of the aspects to consider is that of play as a teaching device" (p. 1). This methodology promotes the understanding of numbers and operations through social interaction and contextualized problem-solving. In a hospital classroom, learning should be flexible; role-playing offers a fun and meaningful way to enhance both academic and emotional levels. Within mathematical role-playing, various dynamics can be employed,



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such as shopping simulations. Students assume the roles of sellers and buyers to practice addition, subtraction, and calculating change. Material distribution activities can also be designed, in which children must distribute objects in equal parts or according to certain criteria, promoting the learning of fractions and proportions. A complementary strategy has been observed to involve the use of negotiation games, where students propose agreements and solve mathematical problems through reasoning and dialogue. These activities strengthen numerical skills while promoting critical thinking and conflict resolution.

3.3 Painting and mathematics

Painting is a teaching resource that combines art with mathematics teaching, allowing students to visualize and understand abstract concepts creatively. According to Vallejo (2011), “the artistic dimension of mathematics is reflected in numerous pictorial works; such that contemplating and working on them can serve to strengthen basic and more complex elements of mathematics” (p. 76). Therefore, this strategy is especially useful in hospital classrooms. Through the use of color, shapes, and artistic composition, children can represent mathematical relationships without having to rely solely on numbers and symbols. Furthermore, painting encourages individual expression, concentration, and emotional well-being, which contributes to more meaningful learning.

Various painting activities can be developed within painting, such as representing symmetries, where students create figures reflected on an axis to understand the concepts of balance and proportion. Likewise, it is possible to work with geometric patterns and sequences, in which children must identify and reproduce series of shapes and colors to reinforce mathematical logic. An effective strategy is the use of fractions in painting, in which students divide canvases or drawings into proportional sections to visually represent fractions and percentages. These activities stimulate students' creativity and spatial perception in inclusive education contexts.

3.4 Modeling with plasticine or clay

Modeling with plasticine or clay is a didactic tool that allows students to manipulate and create three-dimensional figures, favoring the understanding of geometric and spatial concepts in a concrete manner. According to Bolaños and Mogro, (2004).

Modeling is the most beautiful expression of giving shape with your own hands, with easy-to-handle materials, for example, plasticine, dough, clay, etc. With modeling, it is possible to create great things like fantastic works of existing forms, thus educators lead children to understand the value, meaning and representative nature of manipulating the material (p. 68).

In this sense, this strategy is particularly effective in hospital classrooms where teaching must be adaptable and provide a practical approach for students. By modeling objects, children can tangibly experiment with mathematical concepts such as volume, shape, proportions, and symmetry, which facilitates the abstraction of these concepts. Furthermore, the modeling process fosters fine-motor coordination, creativity, and problem-solving, which in turn contributes to students' emotional well-being.

Within modeling, activities can be developed focused on the construction of three-dimensional geometric figures. In this approach, students create shapes such as cubes, spheres, pyramids, and cylinders using different materials. Through this process, they are able to identify the properties of each figure and understand aspects such as the number of



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faces, vertices, and edges. This experience also strengthens skills such as fine-motor coordination, spatial perception, and logical reasoning applied to geometry.

One educational activity involves creating fraction models, where children divide clay into equal parts to represent fractions of a whole, allowing them to visualize abstract concepts in a concrete way. Shape composition exercises can also be developed, in which students combine different shapes to create more complex objects.

3.5 Mathematical narratives and stories

Mathematical storytelling is a teaching resource that integrates mathematics into narrative contexts, facilitating the understanding of abstract concepts through engaging and creative stories. According to Sánchez et al. (2013):

The ability to express any topic, no matter how abstract, in a story, whether spoken or written, opens the door for teachers to use different representative strategies to explain difficult mathematical content. For example, assigning to concepts that are not perceptible or real (such as the magnitudes of the forces or energies they measure and that are not visible to the human eye (p. 20).

Therefore, in hospital classrooms, this approach allows students to face mathematical challenges within a story, making learning more accessible and relevant. Narrative captures children's attention and encourages the development of logical thinking and problem-solving skills, as students must apply their mathematical knowledge to follow the story and solve situations within it. Within mathematical stories, activities such as solving addition and subtraction problems can be included within a narrative in which characters face situations such as sharing resources or dividing objects. Multiplication and division problems can also be included as characters need to divide something among several or calculate the total of elements in different groups.

An interesting activity involves solving equations through mathematical puzzles integrated into a story or plot. This strategy encourages the use of logic and strengthens algebraic skills by presenting problems in an engaging context. Furthermore, it allows students to develop reading comprehension, creativity, and the ability to solve situations reflectively and independently.

3.6 Body Expression and Mathematics

Body language as a teaching resource in mathematics teaching allows students to learn through movement, using their bodies to represent and explore mathematical concepts. According to Fernández-Díez and Arias-García (2013):

The starting point of all learning in children is in the body. This body is located at a point or position in space that provides a series of pieces of information that will be completed with the creation of spatial relationships motivated by movement. Without adequate observation of this position and movement, spatial relationships will be unproductive for spatial cognitive development and, by extension, mathematical development (p. 160).

Therefore, this strategy is especially useful in contexts such as hospital classrooms, where it is essential to maintain student interest through meaningful and active experiences. Through body language, children connect abstract thinking with physical action, which



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strengthens memory, comprehension, and psychomotor development. It also allows for the incorporation of play, coordination, and collaborative work, all of which are key aspects for emotional well-being in sensitive educational environments.

Among the activities proposed by this resource is the representation of geometric figures using the body as a means of expression. Students form triangles, circles, or rectangles in space, either individually or in teams, with the goal of identifying and understanding the basic properties of each figure. This dynamic promotes kinesthetic learning, stimulates body coordination, and promotes collaborative work in the classroom. A complementary activity is the simulation of sequential movements or rhythmic patterns. In this activity, students perform a series of steps that imitate mathematical sequences, such as counting by twos or fives. This activity promotes the recognition of regularities and patterns, in addition to strengthening number sense and motor memory. It also promotes active learning by integrating the body into the construction of mathematical thinking.

Similarly, dramatization of operations can be used, where students "act out" addition, subtraction, or group distribution, allowing them to experience the operations in a concrete and fun way. This type of activity combines mathematical learning with physical education, generating multisensory experiences that strengthen both knowledge and the student's overall development.

3.7 Music and mathematical rhythms

Music and mathematical rhythms as teaching resources promote mathematics learning by linking sound patterns with numerical concepts. This strategy is beneficial in hospital classrooms. It promotes a cheerful environment, stimulates auditory memory, and reduces stress, which can interfere with the educational process. According to Alsina et al. (2022):

The relationship between music and mathematics and the interest this topic arouses are aspects that have been studied and researched throughout the history of music and mathematics. As a result of this trajectory, some teachers have been considering for years now extending this relationship to the educational field to observe and clarify the repercussions of music education for mathematical learning and vice versa (p. 2).

Therefore, by integrating music into math activities, students develop counting, sequencing, pattern recognition, and logical reasoning skills, all within a single environment. Putting music into learning also improves concentration and internal rhythm, which supports both mathematical understanding and emotional self-regulation.

Within this resource, activities such as using songs to practice multiplication tables can be used. Students memorize operations to the rhythm of catchy melodies, facilitating their retention. Also, activities can be carried out with clapping or percussion instruments, in which children create rhythmic patterns that represent numerical sequences (for example, clapping every two numbers or marking a beat with multiples of three), promoting the understanding of regularities.

Likewise, fractional rhythms can be used, where a piece of music is divided into equal parts to understand the concepts of fractions and proportions. These strategies help consolidate mathematical knowledge and, in turn, generate enthusiasm, participation, and well-being in students. These aspects are essential for learning in hospital settings.



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3.8 Board games

According to Remón and Manero, board games represent an effective teaching resource for teaching mathematics, especially in sensitive contexts such as hospital classrooms, where the playful component is highly relevant for maintaining student motivation. The use of games contributes to strengthening problem-solving skills, facilitates the acquisition of knowledge and intellectual abilities similar to those developed in other educational settings, and increases motivation, interest, and class attendance. It also has a significant influence on affective learning and promotes socialization. It can be used as a means to assess students' values, attitudes, and behaviors (Remón and Manero, 2018).

Through these games, children can practice basic operations, develop logical thinking, improve their concentration, and work as a team, all within a relaxed and enjoyable environment. "Play constitutes a fundamental preparation for children to develop their activities throughout adult life" (Carmona and Cardeñoso, 2019, p. 60). Furthermore, games allow mathematical content to be adapted to each student's pace and level, making them a flexible and inclusive tool for meaningful learning. Among the activities that can be implemented with this resource is the use of numerical dominoes. In this approach, students match pieces containing the results of operations or numerical equivalences, allowing them to reinforce mental calculations in a playful way. This dynamic stimulates agility in mathematical reasoning, improves attention, and encourages participation through play.

Another teaching option is the use of puzzles with geometric or arithmetic content. In these types of activities, students must match pieces according to certain mathematical properties, such as shape, area, or the result of an operation. This resource not only promotes the understanding of key concepts but also stimulates logical thinking, concentration, and the ability to solve problems strategically. Together, these games contribute to strengthening various mathematical skills in a dynamic and participatory way.

3.9 Manipulative materials

Manipulative materials are essential teaching resources in mathematics teaching. They allow students to physically interact with concrete objects to build their understanding of abstract concepts. This methodology is effective in hospital classrooms, as it requires more visual, tactile, and dynamic learning experiences. The most basic level of thinking development lies in the ability to identify a specific characteristic of an object (Novo-Martín, 2021). By using materials that can be touched, moved, and combined, children develop logical and mathematical skills.

"Manipulation is essential in early childhood education, as it helps children acquire knowledge and build mental representations" (Berga-Espona, 2013, p. 65). Among the most effective manipulative materials are the abacus, ideal for representing units, tens, and hundreds, facilitating the understanding of the decimal number system. Cuisenaire rods, meanwhile, allow for exploring the relationship between numbers, operations, and fractions in a visual or colorful way. This allows students to internalize the concepts of addition, subtraction, and equivalence. They can also work with the tangram, a geometric puzzle that encourages shape recognition, the composition and decomposition of figures, and spatial thinking. All of these materials make learning mathematics more accessible and meaningful. They also stimulate creativity and active exploration, fundamental elements in the educational process in hospital settings.



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4. Curricular connection

This study is part of the mathematics area, coordinating with the cross-cutting theme of inclusive education and attention to diversity, as established by the National Curriculum of Ecuador. The proposal responds to the need to guarantee the right to education for children and young people in vulnerable situations, especially those receiving educational services in hospital classrooms. In this sense, it is directly linked to the problem-solving theme, by promoting the development of logical-mathematical thinking through the use of teaching resources adapted to non-conventional contexts.

The use of teaching resources in teaching Mathematics in hospital classrooms is supported by the National Model for Hospital and Home Educational Management and Care of Ecuador, whose purpose is to guarantee access, retention, and learning for children and adolescents who, due to medical conditions, cannot attend their educational institution regularly. This model promotes quality, flexible, and adapted education through methodological strategies that respond to the needs of students who are ill, hospitalized, undergoing treatment, or are on prolonged medical leave. Within this framework, the use of playful, flexible, personalized, and innovative proposals is proposed to maintain educational continuity, reduce anxiety, and promote students' emotional, social, and cognitive development.

This approach aligns with the mathematics standard, which establishes that students solve everyday problems by applying observation processes to events in their immediate environment (Ministry of Education of Ecuador, 2016). This criterion is appropriately adapted to hospital settings, where meaningful learning must be developed through real-life situations that are understandable to students. Through teaching resources such as role-playing games, mathematical stories, manipulative materials, modeling, and body language, educational experiences are created that connect Mathematics with students' daily lives. From an inclusive and interdisciplinary approach, the teaching of Mathematics is articulated with areas such as Language and Literature (through storytelling), Cultural and Artistic Education (through music, painting, and body expression), and Citizenship Education (through cooperative play), promoting the understanding of abstract concepts through concrete and adapted experiences. This allows students not only to solve numerical or spatial problems, but also to observe and represent information from the hospital environment in which they find themselves.

Finally, it responds to the principles of the Ecuadorian National Curriculum: inclusion, participation, relevance, and flexibility, seeking to guarantee the right to a meaningful education for all students, especially those with health conditions that limit their presence in the conventional classroom. This fosters the development of exit profile competencies such as problem-solving, collaboration, autonomy, and the application of knowledge in real-life contexts.

5. Methods and materials

This exploratory qualitative study is based on an empirical method based on the researcher's direct experience. The steps followed for the study are described below:

- Location of the study area. The research focused on the pediatrics department of the Carlos Andrade Marín Hospital in Quito, Ecuador.
- Sample selection. 42 instructors from the Mathematics and Physics program at the Faculty of Philosophy of the Central University of Ecuador participated. They applied the Hospital Classrooms project to 58 children admitted to the pediatrics department of the Carlos Andrade Marín Hospital.



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- Design and application of the research instruments. Data collection was carried out using semi-structured interviews. It should be noted that this instrument was validated by experts in the area of Pedagogy of the Experimental Sciences of Mathematics and Physics and experts in the area of psychopedagogy from the Faculty of Philosophy of the Central University of Ecuador. The data collected using the instrument subsequently allowed for the establishment of the following categories: methodology, strategy, technique, topics, student age, and student satisfaction scale.
- Data processing. The interview was transcribed for data processing. Subsequently, based on the previously established categories, the main codes (which were extracted from the quotes) were identified using Atlas ti. Furthermore, with this program, the codes and quotes were recorded in a matrix, and a semantic network was created for each category to establish the relationship between the codes.
- Analysis and discussion of results. Using the matrix of relevant codes, semantic networks, and the research framework, the results were theorized and discussed, leading to the final conclusions of the study.

6. Results

Table 1 presents a summary of the categories: teaching methodologies, teaching strategies, teaching techniques, topics covered, age and student satisfaction, in the field of Mathematics teaching in hospital classrooms in Ecuador, with their codes and frequencies of rooting derived from the study. The most relevant aspects for the aforementioned categories are then described through the representation of semantic networks.

Category	Code	Frequency
Methodology	Experience-Based Learning	3
	Skill-Based Learning	1
	Game-Based Learning	19
	Problem-Based Learning	11
	Cooperative Learning	3
	Gamification	11
Strategy	Active Learning	2
	Experiential Learning	2
	Cooperative Learning	4
	Detecting and Adapting to Student Needs	3
Technique	Guided Practice	1
	Rewards	3
	Problem-Solving	12
	Challenge-Solving Through Games	28
	Motor Skills Learning	9
	Games	7
	Brainstorming	1
	Teaching Materials (Graphic Worksheets, Math Worksheets, Drawings, Crossword Puzzles)	5
	Visual	29



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Topic	Sets and Subsets	2
	Equations	8
	Geometric Figures	6
	Basic Operations	22
	Operations with Fractions	2
Student Ages	1 year	1
	10 years	2
	11 years	4
	12 years	9
	13 years	2
	14 years	6
	15 years	1
	5 years	7
	6 years	4
	7 years	2
Student Satisfaction Scale	8 years	3
	9 years	4
	Totally satisfied	42

Table 1. Summary of categories: Teaching methodologies, teaching strategies, teaching techniques, topics to be covered, age and student satisfaction in the field of teaching Mathematics in hospital classrooms

From the frequency analysis in Table 1, it can be seen that there are patterns in teaching practices and teaching resources used by teachers in the context of hospital classrooms in Ecuador. Below is a detailed analysis for each category studied, contrasted with its semantic network and frame of reference:

6.1 Teaching methodology

In this category, it is observed that game-based learning or gamification (with a rooting frequency of 30) is positioned as the most used central methodology, followed by problem-based learning, with a rooting frequency of 11 records. Likewise, methodologies such as cooperative learning and experience-based learning were identified with a lower rooting frequency (3), which suggests that these strategies take a complementary and not a primary role.



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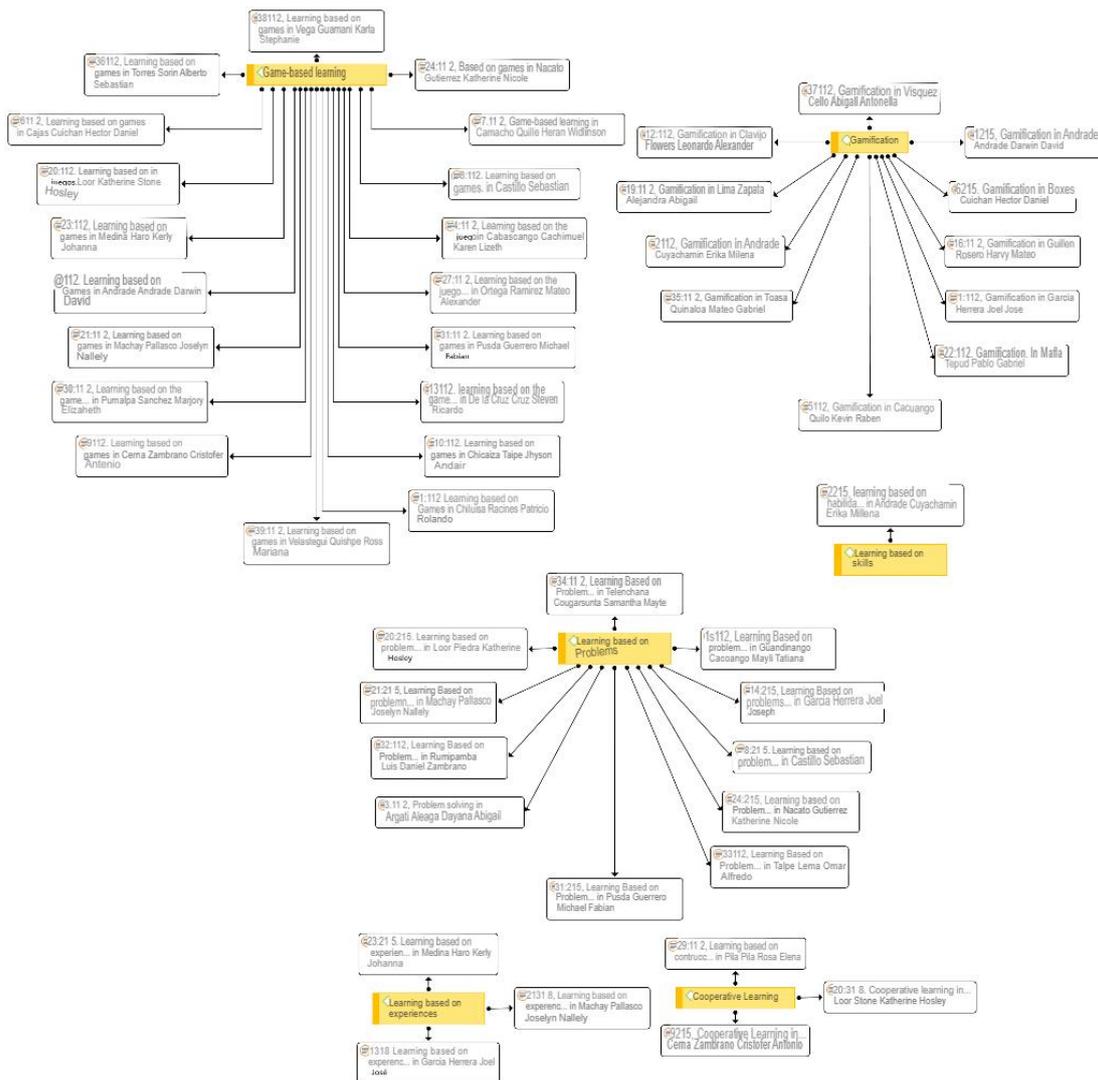


Figure 1. Semantic network category Teaching methodology

When comparing the data in Table 1 with the semantic network in Figure 1, which belongs to the Teaching Methodology category, a preference for the use of active methodologies is evident, emphasizing gamification and problem-solving. The use of these methodologies is highlighted because they facilitate the teaching of Mathematics in clinical contexts, allow adjustment to the emotional and physical situation of students, and maintain student interest, ensuring meaningful learning.

6.2 Teaching strategies

Regarding teaching strategies, the use of fun challenges with mathematical challenges (rooting frequency of 31) stands out as a central teaching strategy for learning. Subsequently, problem-solving appears as a second central strategy, indicating a tendency to work from logical reasoning and contextual analysis. Finally, other strategies such as cooperative learning (frequency 4) and personalized adaptation (frequency 3) show a concern for social interaction and the individual needs of students.



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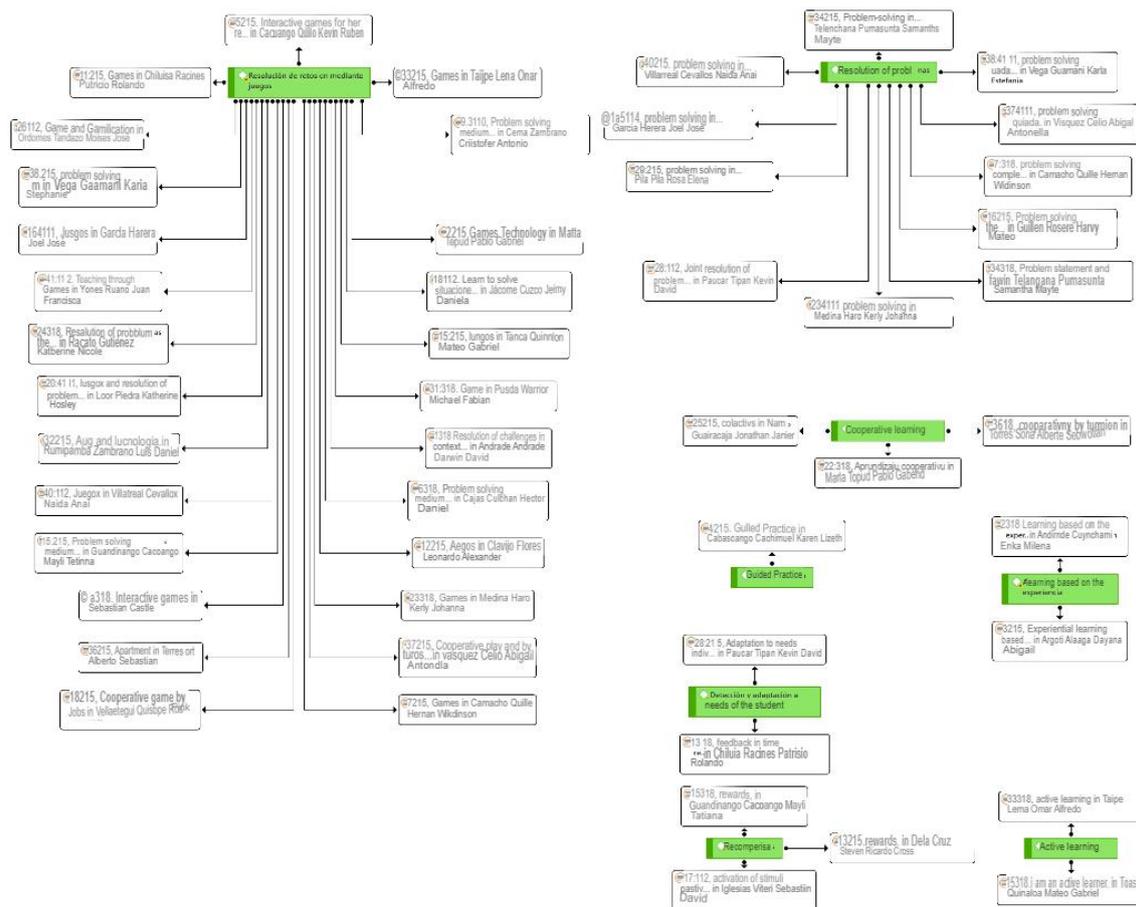


Figure 2. Semantic network category Teaching strategies

By comparing the information with the semantic network in Figure 2, it can be seen that the use of playful, flexible, and emotionally stimulating proposals coincides with what has been proposed in specialized literature on hospital pedagogy. In this sense, authors such as Ochoa et al. (1999) state that "educational resources should be adapted to the student's health status, allowing each student to progress at their own pace" (p. 2); and authors such as Alsina et al. (2022) highlight the importance of "integrating environmental elements such as play, art, or music to generate meaningful learning experiences" (p. 211).

Finally, it is important to mention that the National Model for Hospital and Home Educational Management and Care (Ministry of Education and Ministry of Health, 2016) emphasizes the importance of proposing comprehensive pedagogical care approaches centered on people and not solely on content, thus validating the use of flexible, student-centered strategies and methodologies.

6.3 Teaching techniques applied by teachers:

Regarding teaching techniques, it can be observed that visual techniques (graphics, drawings, etc.), with a frequency of 29 mentions, are predominant in the context of hospital classrooms. Also notable are motor learning and games with a frequency of 16 mentions, as well as the use of structured teaching materials (graphic cards, crossword puzzles, etc.)



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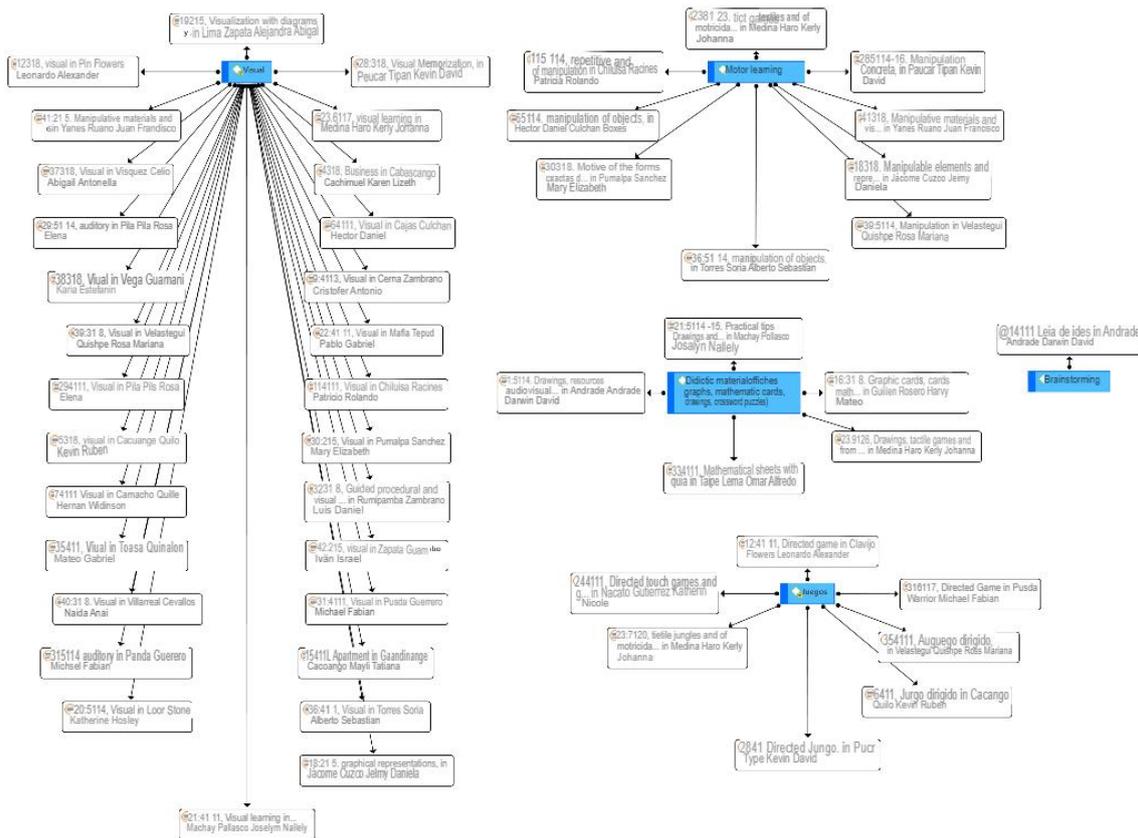


Figure 3. Semantic network category Teaching techniques applied by teachers

When comparing the analysis of the category teaching techniques applied by teachers with its semantic network (Figure 3), it is evident how visual and motor techniques are predominant in the hospital context. Thus, visual techniques allow learning to be facilitated through images, diagrams or graphic representations. And motor learning reinforces the active and corporal dimension of learning. In this regard, authors such as Vallejo (2011) "highlight the importance of graphic materials in the teaching process, stating that images allow mathematics to be visualized from a more creative, understandable and meaningful approach" (p. 75).

6.4 Topics covered

According to the analysis of Table 1 and the semantic network (Figure 4), it was determined that the curriculum focuses heavily on teaching basic mathematical operations (addition, subtraction, etc.), with a rooting frequency of 22 mentions. Subsequently, recurring topics appear such as elementary geometry (rooting frequency 12) and applied problems (rooting frequency 12).



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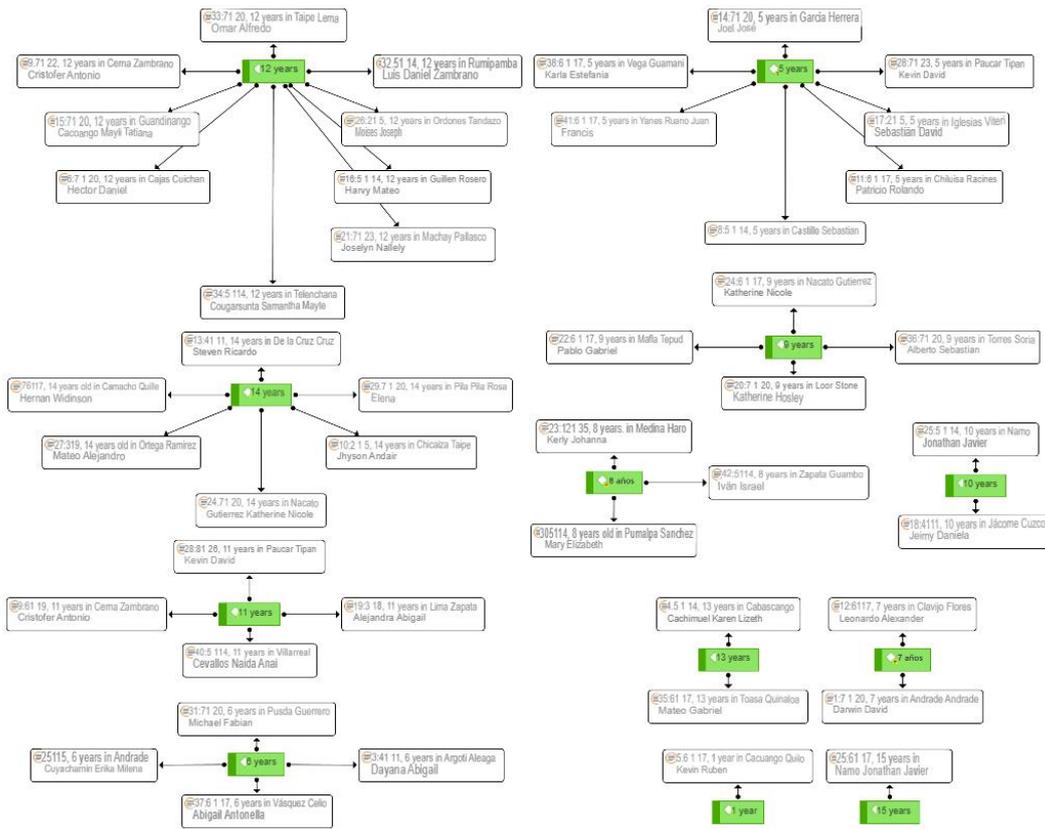


Figure 5. Semantic network category Student ages

6.6 Student satisfaction

From the analysis of Table 1 and the semantic network (Figure 6) it is evident that all students are "totally satisfied" with the pedagogical interventions carried out in the hospital classrooms. These results demonstrate the human quality of the educational process by the participating teachers, since they provided emotional support, containment and motivation to the students.



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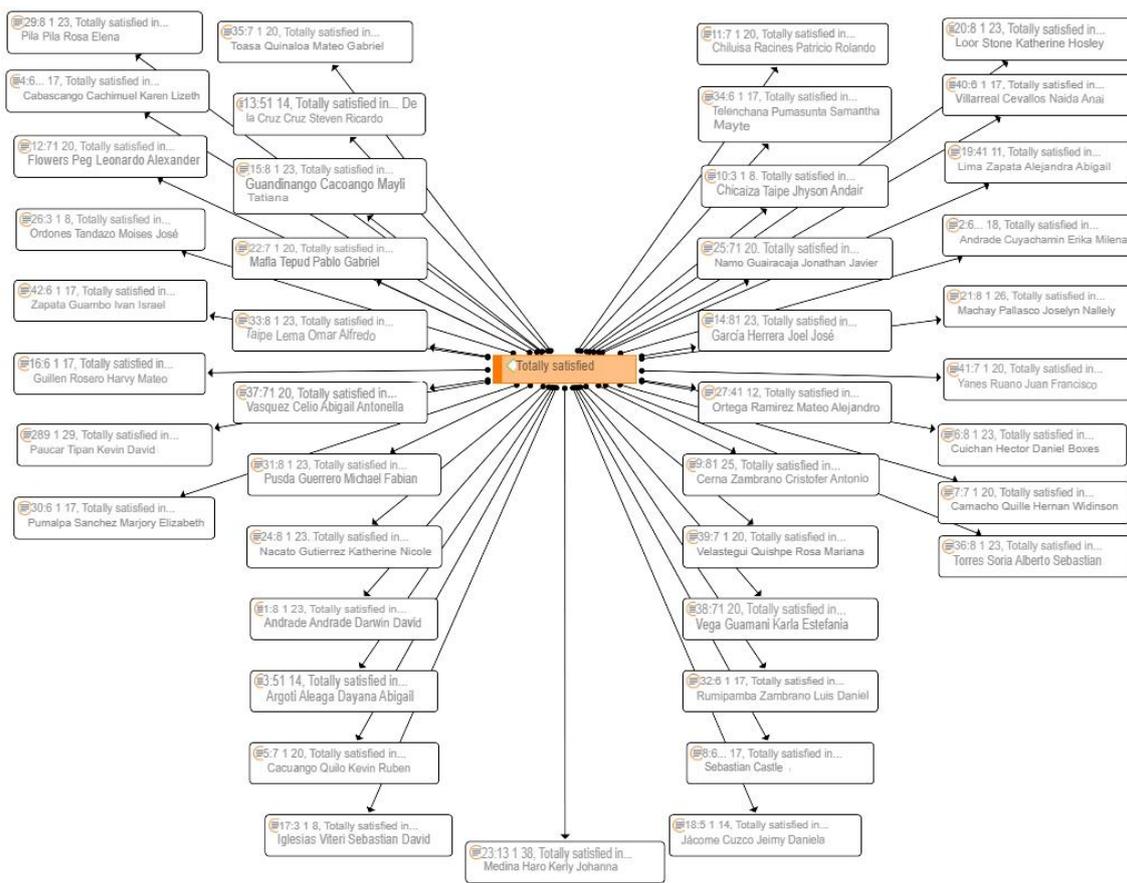


Figure 6. Semantic network category Student satisfaction

7. Conclusions

By comparing the qualitative and quantitative data, as well as the framework of this study, it is established that mathematics teaching in hospital classrooms in Ecuador should be based on active, inclusive, and adaptive practices; and that the use of concrete materials and playful methodologies should be fundamental pillars of mathematics teaching in hospital classrooms.

Regarding teaching methodologies, it was established that active methodologies such as gamification (game-based learning) are effective in the hospital setting because they encourage participation and motivation, and maintain student interest, ensuring meaningful learning. Regarding teaching strategies, it was determined that student-centered strategies, such as the use of manipulative materials and personalized teaching, are highly effective in generating lasting learning in the hospital classroom. Teaching strategies in the hospital classroom context should foster student motivation and participation. In this regard, the application of strategies such as playful challenges, logical reasoning, and cooperative learning and personalized adaptation are suggested to ensure individual attention tailored to the needs of students.

Regarding the teaching techniques applied in the hospital setting, visual and motor channels prevail through the use of graphic materials, pictorial representations, and body dynamics. These techniques allow abstract mathematical content to become meaningful sensory



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experiences for students, enhancing their learning and adapting to their needs and cognitive styles. Finally, it is important to mention that the age diversity of the student body (5 to 14 years) represented a significant challenge for teachers, as it was necessary to develop flexible and differentiated teaching plans for each program beneficiary. In this context, it is essential to continue researching and designing strategies that strengthen the teaching of mathematics in these settings. This guarantees the right to an equitable and inclusive education for hospitalized students.

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REVISTA

CÁTEDRA

An overview of the dimensions of availability and accessibility of the right to education from 2014 to 2024

Una radiografía a las dimensiones de disponibilidad y accesibilidad del derecho a la educación desde el 2014 al 2024

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(Received on: 19/02/2025; Accepted on: 27/03/2025; Final version received on: 04/07/2025)

Suggested citation: Lucio-Paredes, A. & Lucio-Paredes, N. (2025). An overview of the dimensions of availability and accessibility of the right to education from 2014 to 2024. *Revista Cátedra*, 8(2), 38-54.

Abstract

One of the State's obligations is to effectively guarantee the right to education. This requires state services through goods and services—both private and non-public. However, each good or service satisfies a specific dimension of education. The guiding question of this study is: Does the State satisfactorily guarantee the availability and accessibility of education? This study is important because it allows us to uncover the status of educational availability and accessibility through the analysis of the number of institutions and the gross enrollment ratio from the 2013-2014 academic period to the 2023-2024 academic year. The



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work adopts a mixed approach; the research design was the nested or embedded concurrent dominant model because quantitative and qualitative data were collected simultaneously. The paper concludes by stating that the State does not guarantee the right to education in the availability dimension because the number of educational institutions varies negatively between the years studied. In the 2013-2014 school year, there were 24,573 institutions, while in the 2023-2024 school year, there was a reduction equivalent to 34% of the total number of educational establishments present in 2013-2014. In the accessibility dimension, the State also fails to guarantee the right to education because the enrollment rate decreased considerably at two points in time. In the 2015-2016 school year, there was a reduction of 100,636 students. Then, in the 2020-2021 school year, there was a decrease of 92,253 students. At both points in time, accessibility to the educational system was affected for material, economic, and discrimination reasons.

Keywords

Accessibility, availability, education, educational institutions, educational enrollment.

Resumen

Un deber del Estado es garantizar efectivamente el derecho a la educación. Para esto se requiere de prestaciones estatales a través de bienes y servicios -propios e impropios-. Sin embargo, cada bien o servicio satisface una dimensión específica de la educación. La pregunta que guía este estudio es, ¿el Estado garantiza satisfactoriamente la disponibilidad y la accesibilidad de la educación? El estudio es importante porque nos permite develar la situación de la disponibilidad y accesibilidad de la educación a través del análisis del número de instituciones y la tasa bruta de matrícula desde el periodo académico 2013-2014 hasta el 2023-2024. El trabajo tiene un enfoque mixto; el diseño de la investigación fue el anidado o incrustado concurrente de modelo dominante porque se recolectó simultáneamente datos cuantitativos y cualitativos. El trabajo finaliza exponiendo que el Estado no garantiza el derecho a la educación en la dimensión de disponibilidad porque el número de instituciones educativas varía negativamente entre los años estudiados. En el 2013-2014 hay 24573 instituciones, mientras que, al 2023-2024 existe una reducción equivalente al 34 % del total de establecimientos educativos presentes en el 2013-2014. En la dimensión de accesibilidad el Estado tampoco garantiza el derecho a la educación porque la tasa de matrícula disminuye considerablemente en dos momentos. En el periodo lectivo 2015-2016 existe una reducción de 100636 estudiantes. Luego, en el periodo 2020-2021 existe una disminución de 92253 estudiantes. En ambos momentos la accesibilidad al sistema educativo se afecta por motivos materiales, económicos y, de discriminación.

Palabras clave

Accesibilidad, disponibilidad, educación, instituciones educativas, matrícula educativa.

1. Introduction

The explanation for the importance of guaranteeing the right to education is not unique. However, both human capital theories and signaling theories agree in attributing to education the ability to prepare students for their entry into the workforce and improve their economic well-being (Castellar-Uribe, 2006; Kido-Cruz and Kido-Cruz, 2015). Other positions, critical of the aforementioned, state that "education should not only assist in the development of basic skills, but also in the development of a child's personality" (Ruiz-



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Muñoz, 2014, p. 3). We observe that the explanation of the purpose of education depends on the theoretical perspective used for the analysis.

Although there are theoretical debates about its purposes, there is broad consensus on the fundamental importance of education for the development of societies. In fact, its relevance is such that it was enshrined as a human right in the 1948 UN Universal Declaration. This recognition was furthered years later by the Committee on Economic, Social and Cultural Rights, which in its General Comment No. 13 defined its four essential characteristics: availability, accessibility, acceptability, and adaptability. This study will analyze the dimensions of availability and accessibility of the right to education through educational indicators that reflect the number of educational institutions and the gross enrollment rate of the National Education System in public, municipal, fiscomisional, and private settings.

This research moves away from a fragmented view of the characteristics of education and invites us to understand that there is an interrelationship between the characteristics of the right to education. In this regard, some specialized literature has also distinguished between educational indicators and indicators of the right to education. Consequently, this paper attempts to overcome this limitation by establishing the relationship between educational indicators and dimensions of the right, considering that educational indicators "allow us to demonstrate the extent to which the State fulfills its obligations to respect, protect, and promote the right to education" (Pérez, 2015, p. 92). In this sense, the educational indicator that shows the number of institutions allows us to understand the right in its dimension of availability; while the educational indicator of the gross enrollment rate allows us to approach the dimension of accessibility.

This paper analyzes the percentages of educational institutions and the gross enrollment rate of the National Education System from the 2013-2014 school year to the 2023-2024 school year to evaluate compliance with state obligations to guarantee the effectiveness of the right to education in the dimensions of availability and accessibility. The paper begins with the question: Does the State satisfactorily guarantee the availability and accessibility of education? The purpose of this study is to describe the state of the right to education in terms of availability and accessibility by analyzing the number of educational institutions and the gross enrollment rate in the National Education System between the 2013-2014 and 2023-2024 school years.

The article consists of six sections. The first section provides an introduction, and the second presents a literature review. The third section presents the methodology, while the fourth section presents the results and a discussion. The fifth section presents the study's conclusions.

2. Literature review

2.1 Approximation and distinction of human rights

For Marín, human dignity is the fundamental value of human rights. However, the definition and characterization of the concept of human dignity is difficult to address because it is a diffuse notion that requires multiple disciplines for its explanation. Although the notion of dignity emerged during the transition from the Middle Ages to the modern age and was reinforced by the natural law theory of law, the positivization of human rights is the work of international intergovernmental organizations in the exercise of the renewed post-war international law (Marín, 2007, p. 3).



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Reviewing some of the prominent doctrine, we can affirm that human rights are "supranational rights that apply and are validated for all without distinction, and they are above any particular legal system" (Rodríguez and García, 2019, p. 1602). Human rights, unlike constitutional rights, "have universal validity; they are attributed equally to all people in the world. To this extent, they take priority over positive law, as they represent a measure of the latter's legitimacy" (Borowski, 2003, p. 31).

Since 1948, a comprehensive international legal framework has been developed to recognize, protect, and promote the right to education (Right to Education Initiative, 2015). The cornerstone of this framework is the Universal Declaration of Human Rights, which was not only the first instrument to recognize education as a right but also established it as a fundamental means for respecting other human rights. This framework was subsequently strengthened by the International Covenant on Economic, Social and Cultural Rights, adopted by the UN General Assembly in 1966. To monitor the implementation of this Covenant, the Committee on Economic, Social and Cultural Rights was established in 1985. Its establishment was formalized by Resolution 1985/17 of the United Nations Economic and Social Council (ECOSOC).

In 1999, the Committee on Economic, Social and Cultural Rights adopted General Comment No. 13. General Comment No. 13 states that the right to education in all its forms and levels must have four characteristics or dimensions. The Royal Spanish Academy (RAE) defines a characteristic as "a quality that gives character or serves to distinguish someone or something from their peers" (RAE, 2014). However, the characteristics that the Committee assigns to education should not be considered the only qualities that exclude others, but rather as reference frameworks for States parties to the Covenant to more effectively fulfill their obligations regarding the right to education. Taking General Comment No. 13 as a reference, the characteristics or dimensions of the right to education are availability, accessibility, acceptability, and adaptability. 2.2 Structure of the Right to Education

Our Constitution places education in the catalog of rights to good living. Drawing a parallel with other forms of classification, the rights to good living are equivalent to second-generation rights, also classified as Economic, Social, and Cultural Rights (ESCR) or rights to something. Professor Robert Alexy explains the structure of rights to something. In this regard, the author argues that "the right to something can be conceived as a triadic relationship whose first member is the bearer or holder of the right (a), its second member is the recipient of the right (b), and its third member is the object of the right (G)" (1993, p. 187).

The obligation of the right to something will always consist of an action on the part of the recipient. This allows us to classify rights to something into rights to negative actions and rights to positive actions. Within the rights to positive actions, we specifically find rights to benefits (Alexy, 1993, p. 196). The right to education is guaranteed through positive and negative actions; however, in this paper, we will only address the positive actions that the State must take to ensure the availability and accessibility of the right to education. Following the proposed structure, the holder of the right to education is the human being. The recipient is the State, primarily through the Ministry of Education, but not exclusively. The obligation consists of the positive action inherent in the provision of public goods and services to guarantee coverage, access, and other obligations that are not the subject of this paper.



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2.3 National Education System

The 2008 Ecuadorian Constitution establishes that the National Education System (SNE) is composed of educational levels, modalities, and supports, as well as the institutions, policies, plans, programs, services, resources, and actors of the educational process (Art. 344). An educational modality refers to "the specific way of offering an educational service in relation to administrative procedures, learning strategies, and teaching aids" (Barroso, 2006, p. 6). The SNE modalities are formal education and non-formal education. Formal education is classified into three levels. The levels that comprise formal education are early childhood education, basic general education, and high school. The school enrollment age for the first level starts at 3 years old and ends at 5 years old. The theoretical enrollment age for basic education starts at 5 years old and ends at 14 years old. For high school, however, the schooling age begins at 15 and ends at 17 years of age. Comparing our classification of educational levels with the reference framework developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in its International Standard Classification of Education (ISCED 2011), the initial level corresponds to ISCED Level 0 – Early Childhood Education; the basic education level corresponds to ISCED Level 1 – Primary Education and ISCED Level 2 – Lower Secondary Education; while high school corresponds to ISCED Level 3 – Upper Secondary Education (UNESCO Institute for Statistics (UIS), 2013, pp. 27–61).

Each level can be present in different educational levels. For Silva-Beltrán et al. (2005), educational level,

It summarizes all the resources allocated by the country to the maintenance of educational services and can be divided into two sources: public resources administered by the government and those directly contributed by individuals to pay for their children's schooling (p. 240).



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In Ecuador, there are four pillars that define the legal nature of an institution, which may be a public, municipal, fiscomisional, or private educational establishment. Beyond the legal nature of the educational institution, the LOEI mandates that no establishment shall be for-profit. However, this provision is far from being fulfilled and is therefore an open discussion that leads us to the commercialization of education and its privatization, but which is not the subject of this work.

2.4 State duties and the right to education

From a normative perspective, Ecuador is a constitutional state with duties, not rights (Judgment No. 282-13-JP/19, 2019). The state's duties can be "positive or negative obligations" (Ferrajoli, 2013, p. 558). The Ecuadorian state's highest duty is to "guarantee, without any discrimination, the effective enjoyment of the rights established in the Constitution and in international instruments, particularly education" (Constitution of the Republic of Ecuador, 2008, Art. 3, No. 1). The reasons that give meaning to the Constitution's prescriptions for the state are rooted in philosophical and political foundations. For Professor Cortés, the constitutional state rests on the theses of social liberalism, which is characterized by endowing the state with the function of "protecting the vital needs of people through their recognition as fundamental human rights and by establishing a system of guarantees that includes prohibitions of harm (negative) and obligations to provide services (positive)" (2012, p. 191). In contrast, for Ramiro Ávila, the foundation of the constitutional state is distributive egalitarianism, which is characterized by its emphasis on a collective and supportive human being, entitled to multiple rights necessary for individual and social life, particularly economic and social rights (2025, p. 6). Both positions are complementary. They recognize that the role of the constitutional state is to guarantee rights; however, to achieve this goal, the state has a set of positive obligations that it must fulfill.

Professor Luigi Ferrajoli (2013), based on a formal legal systematization, indicates that all rights are expectations, although not all expectations contemplate the same correlations and obligations. For example, following the liberal classification of rights, freedom rights such as privacy entail negative expectations of non-injury, consisting of no impediment or disturbance to the exercise of the right. Meanwhile, economic, social, and cultural rights such as education entail positive expectations of provision, consisting of the action of the obligated party to guarantee the right (pp. 144-145). However, each right requires, to a different extent, both negative and positive expectations for its fulfillment.

For the right to education to be effective, the State must develop a complex system of negative and positive guarantees. Positive guarantees are "the obligations corresponding to positive expectations" (Ferrajoli, 2006, p. 25). In this case, they are the actions that the State must adopt to make the right to education effective. But we must remember that guarantees are not implemented in the abstract, but rather are materialized through public goods and services, whether their own or improper.

According to our Constitution (2008), the State promotes and guarantees the right to education through the National Education System and the Higher Education System (Art. 343 and 350). It is interesting how the constituent, when drafting the regulations relating to the S.N.E. and S.E.S., appears to have done so under the conception of Niklas Luhmann's systems theory, which understands society as a complex social system that, given its complexity, requires subsystems, each of which "observes society from its own function" (Urteaga, 2009, p. 308). If we analyze the purposes that the constituent attributed to each



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system, we can identify that it falls within Luhmann's conceptions of the educational system, this function being the:

The transformation of individual psychic systems so that they are capable of participating in any form of communication. It becomes necessary for society when socialization fails to ensure appropriate behavior. The peculiarity of the educational system, therefore, is that its effects manifest themselves, unlike other functional subsystems, outside the social system (Urteaga, 2009, p. 310).

The right to education at the initial, basic, and high school levels is guaranteed through the goods and services offered by the National Education System. The purpose of this system is to develop the individual and collective capacities and potential of the population. Finally, the National Education System must be coordinated with the Higher Education System, the Health System, the Economic and Social Inclusion System, and other systems.

The right to education, as a positive expectation of action, is effective through the provision of goods and services. In this sense, the Constitution of the Republic of Ecuador (2008) recognizes and guarantees to people "the right to access quality public and private goods and services, with efficiency, effectiveness, and fair treatment, as well as to receive adequate and truthful information about their content and characteristics" (Art. 66, No. 25). According to the doctrine of Administrative Law, the concept of public service is defined as:

Any technical activity intended to satisfy, in a uniform and continuous manner, a need of a general nature, subject to a mutable legal regime that is exorbitant to ordinary law, either through public administration or through individuals empowered to do so by the competent authority, for the indiscriminate benefit of all persons (Fernández, 2010, p. 14).

If the service is provided directly by the State or by a private entity under delegation, concession, or other legal entity, the service is called a public service. Conversely, if the service is provided neither by the State nor by a private entity under delegation, but said activity satisfies a general need, the service is called an improper public service. Based on the proposed division, education will always be guaranteed through public services, even more so since the Constitution of the Republic of Ecuador (2008) stipulates that education "shall respond to the public interest and shall not be at the service of individual and corporate interests" (Art. 26). However, with the advent of neoliberalism and the theory of contestable markets, the notion of a public service mutated due to "voices that raised the need to deregulate the providers of such services and subject them to the rules of a competitive market" (Rozas and Hantke, 2013, p. 20).

In the country, neoliberal policies began to be implemented from 1981 until 2007. This period was characterized by economic stabilization through monetary policy, fiscal policy, and trade policy, and a drastic reduction in public investment. Since the country's fiscal policy during this period was primarily oriented toward meeting international credit obligations rather than financing public goods and services, the consequence was a drastic reduction in state participation in social policy, resulting in political, economic, and social instability.

Salgado (2008) reviews Ecuador's constitutional history and argues that "the idea of convening a constituent assembly has always been present, especially when political and institutional problems appear to have no other solution because the facts exceed the legal



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framework" (p. 205). Consequently, the constitutional process that began on April 15 with the entry referendum was a space for discussion, confrontation, and agreement among representatives of the various political forces and social movements of the time, who expressed their views and interests in the Fundamental Law. In this regard, the 2008 Constitution, for example, recognizes and guarantees free education up to the third level, creates the National Education System, establishes financing rules for said system, and generally prescribes the obligations of the State to guarantee the right to education. The Ecuadorian State, by constitutional mandate, has the ultimate duty to guarantee the right to education, which is possible through the provision of public goods and services.

2.5 Dimensions of the right to education

From a prescriptive perspective, education as a right has a triple nature: it is simultaneously a constitutional right, a fundamental right, and a human right. General Comment No. 13 established that the characteristics of the right to education are availability, accessibility, acceptability, and adaptability. Availability implies that "there must be sufficient educational institutions and programs available." (Committee on Economic, Social and Cultural Rights, 1999, p. 3). Other authors equate availability with affordability, defining it as the obligation of States to "ensure that free and compulsory education is available for all children of primary school age" (Tomasevski, 2008, p. 350). Using an overly simplistic analogy, availability is also equivalent to the coverage of educational institutions provided by the National Education System.

Accessibility means that "educational institutions and programs must be accessible to all, without discrimination" (Committee on Economic, Social and Cultural Rights, 1999, p. 3). No one should be left out of the education system. Accessibility guarantees entry to the system without discrimination, and affirmative action policies promote access for people belonging to historically excluded groups. However, Observation No. 13 itself has stated that the dimension of full accessibility without restriction is applicable only up to secondary education—following the national typology, full accessibility is up to high school. The Constituent Assembly incorporated the accessibility component and enshrined it in the Constitution of the Republic of Ecuador (2008), which provides that "Universal access, permanence, mobility, and graduation shall be guaranteed without discrimination, and compulsory education at the initial, basic, and high school levels or their equivalent" (Art. 28).

Accessibility involves "ensuring that everyone within a jurisdiction has the opportunity to participate in educational processes without being discriminated against or excluded" (Köster, 2016, p. 37). Ensuring accessibility entails overcoming the barriers that impede entry into the National Education System. Accessibility consists of three subdimensions: 1) non-discrimination; 2) material accessibility; 3) economic accessibility. The three subdimensions are interrelated.

The subdimension of non-discrimination implies that entry into the National Education System must be open to all, with emphasis on groups that have historically been discriminated against. Therefore, no one can be prevented from accessing the Education System due to a suspicious status. To eliminate factors that promote discrimination in access, the State must act immediately; these actions are not implemented gradually nor are they subject to the availability of government resources.

Material accessibility involves overcoming the geographical and technological barriers that hinder entry into the System. For example, no one should be excluded from the National



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Education System (SNE) because they live in a rural area of the country or because they lack internet service. Economic accessibility ensures that no one is excluded from the education system due to economic vulnerability. Consequently, the State must implement free education. General Observation No. 13 clarifies that it is the State's obligation to guarantee free primary education and gradually implement free education up to third level. In Ecuador, based on the struggles and tensions among social movements focused on defending education, the 2008 Constitution recognized and guaranteed free education up to third level.

The acceptability of education implies that “the form and substance of education, including curricula and teaching methods, must be acceptable (e.g., relevant, culturally appropriate, and of good quality) to students and, where appropriate, parents” (Committee on Economic, Social and Cultural Rights, 1999, p. 3). The acceptability of education is often associated with the criterion of educational quality, and at the same time, educational quality is attempted to be measured through the number of students passing; however, this position is restricted because acceptability “implies a new design of education, based on the human rights of all the main actors: students, their parents, and teaching staff” (Tomasevski, 2008, p. 374).

The adaptability of education means that it “must have the flexibility to adapt to the needs of changing societies and communities and to respond to the needs of learners in diverse cultural and social contexts” (Committee on Economic, Social and Cultural Rights, 1999, p. 3). Therefore, institutions, regardless of their funding source, “have the obligation to educate students, taking into account the unique context of each student in order to maximize their learning, without their social environment affecting their cognitive development” (Constitutional Court of Ecuador, 2024, p. 50). The constituent adopted the adaptability criterion and established it in Articles 27 and 28 of the Constitution.

In short, adaptability entails recognizing the diversity of the members of the National Education System and implementing the necessary guarantees so that all, taking into account their diversity, can effectively exercise their rights in the SNE. To guarantee the effective enjoyment of the right to education, the articulated exercise of all dimensions of the right must be promoted. However, measuring the degree of satisfaction of the right implies rethinking and overcoming the segmented vision that marks a clear distinction between educational indicators and indicators of the right to education. Tomasevski has proposed the 4As (affordability or availability, accessibility, availability, acceptability) as indicators of the right to education (2008, pp. 349-350), while the Committee on Economic, Social and Cultural Rights has used the 4As as dimensions of the right to education; on the other hand, the Organization of American States (OAS) (2015) has constructed “a model composed of quantitative indicators and qualitative progress indicators, organized according to three types of indicators: structural, process, and results; organized under three conceptual categories” (p. 19).

To measure the right to education and other ESCR, we observe that there is no single proposal to understand, evaluate, or measure the dimensions of the right to education. There are several ways. However, we believe that we can analyze availability through the number of educational institutions, and we can evaluate accessibility through the enrollment rate.

Analyzing the number of enrolled students through the Gross Enrollment Ratio allows us to briefly address access to education. The Gross Enrollment Ratio Enrollment rate (hereinafter GER) is the “number of students enrolled in a given level of education, regardless of age, expressed as a percentage of the population of the theoretical age group



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corresponding to that level of education" (UNESCO Institute for Statistics, 2009, p. 7). Through the Gross Enrollment Rate we can quantify the access of people to the National Education System. The GER is obtained by dividing the total number of students enrolled in the National Education System by the total population that is of the official age to integrate the National Education System, the result of the division is multiplied by one hundred.

3. Methods and materials

The work adopted a mixed-method approach. The research design was based on the dominant concurrent embedded model because quantitative and qualitative data were collected simultaneously (Hernández et al. 2014, pp. 560-561). The information review was conducted using official documents from the Ministry of Education and specialized literature on the topic. Based on educational indicators such as the number of educational institutions and the Gross Enrollment Rate, the dimensions of availability and accessibility of the right to education were analyzed. This work describes the status of availability and accessibility of the right to education in Ecuador from the 2013-2014 academic period to the 2023-2024 academic period.

4. Results

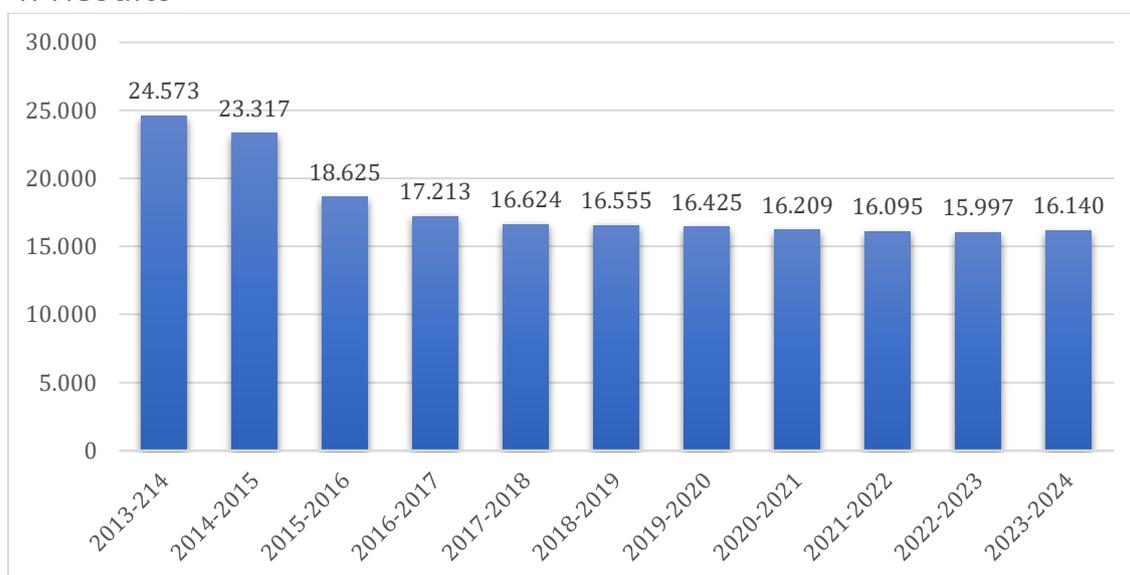


Figure 1: Historical number of educational institutions in Ecuador. Adapted from: (Ministry of Education, 2024)

In the 2013-2014 school year, there were 24,573 institutions, while in the 2023-2024 school year, there were 16,140 institutions. Therefore, from the first year analyzed to the last year, there was a decrease of 8,433 institutions, equivalent to 34% of the total number of educational establishments. In the 2015-2016 school year, there was an abrupt change in the number of educational establishments, remaining at 18,625; since that year, the decline has been stable. In the years 2022-2023, the lowest number of educational institutions will be recorded, reaching 15,997 establishments.

The distribution of educational institutions according to support could be summarized as "the number of educational institutions with fiscal support historically represents more than 70% compared to other supports, private around 20%, fiscomisional 4% and municipal 1%." (Ministry of Education, 2024, p. 27). In the years 2013-2014 the number of



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institutions with municipal support was 283, fiscomisional support 979, private support 5024; fiscal support 18287, however, after ten years, that is, for the 2023-2024 school year, the number of institutions is: municipal support 112, fiscomisional support 617, private support 3022, fiscal support 12389. Therefore, after ten years, in municipal support there is a decrease of 60.42%, in fiscomisional support there is a reduction of 39.90%, in private support it decreased by 39.84% and in fiscal support it decreased by 32.25%. The educational support that has the greatest decrease in educational establishments is the municipal one, while the support with the smallest reduction is the fiscal one.

In the 2013-2014 school year, of the 24,573 institutions, 13,815 were located in urban areas, while 10,758 were in rural areas. This means that of the 100% of institutions, 43.77% were located in rural areas and 56.22% in urban areas. In contrast, for the years 2023-2024, there were 16,140, distributed: 7,477 in rural areas and 8,663 in urban areas. This means that during these years, 46.22% of the institutions were located in rural areas and 53.67% in urban areas. Comparing the first school year (2013-2014) with the last school year (2023-2024), there was a 2.5% decrease in urban establishments, while establishments in rural areas increased by 2.5%.

During the period analyzed, there was a quantitative decline in the number of educational establishments. The number of institutions is directly related to the dimension of availability. At first glance, the decrease in establishments would affect availability and, therefore, there is a regression of the right to education. However, the regression of the right to education is not only defined by the decrease in institutions, unless this decrease affects other dimensions of the right, such as the accessibility and quality of education.

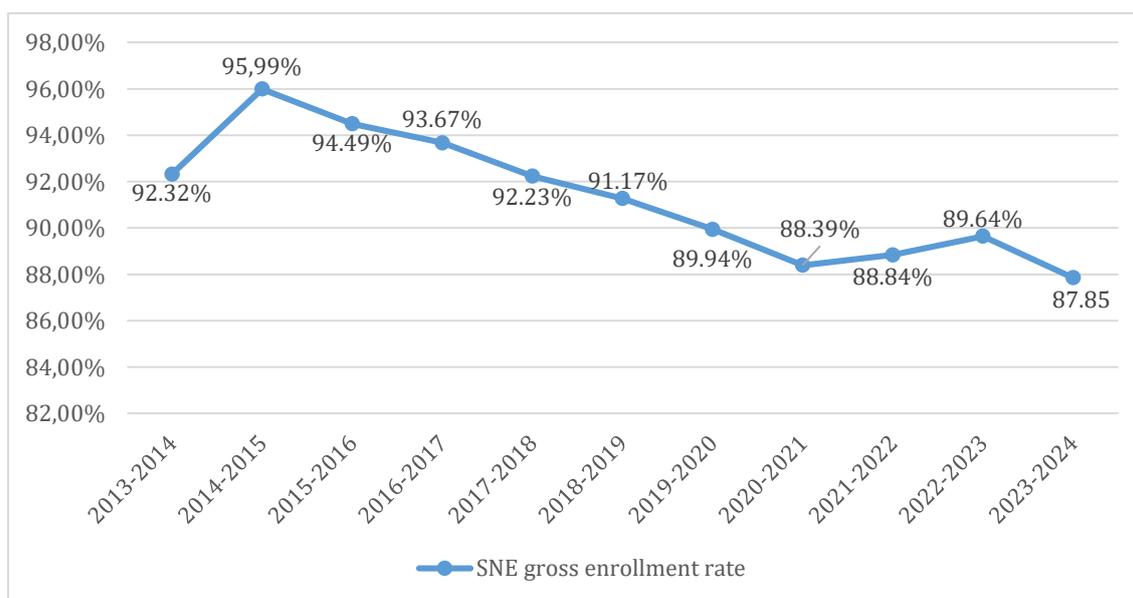


Figure 2: SNE gross enrollment rate. Adapted from: (Ministry of Education, 2024)

Analyzing enrollment numbers using the Gross Enrollment Ratio (GER) provides a brief overview of access to education. The gross enrollment ratio (GER) is the "number of students enrolled in a given level of education, regardless of age, expressed as a percentage of the population in the theoretical age group corresponding to that level of education" (UNESCO Institute for Statistics (UIS), 2013, p. 10). Using the GER, we can quantify people's access to the National Education System. The GER is obtained by dividing the total number



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of students enrolled in the National Education System by the total population of the official age to join the National Education System, and multiplying the result by one hundred.

The Gross Enrollment Ratio (GER) decreased from 2014 to 2024. In the 2013-2014 school year, the GER was 92.32%. In the 2014-2015 school year, the GER reached its highest percentage in the last ten years, with 95.99% of enrollment. However, after that year, the GER began to decline, reaching 88.39% in the 2020-2021 school year, the year in which the state of emergency was declared due to the COVID-19 pandemic. The Ministry of Education attributed the decline in the GER in 2020-2021 to the COVID-19 pandemic, although, as we can see, the decline has been sustained since 2016. In the 2021-2022 and 2022-2023 cycles, there is a very slight recovery in student enrollment compared to the lowest year of the GER; however, in 2023-2024, the GER falls again.

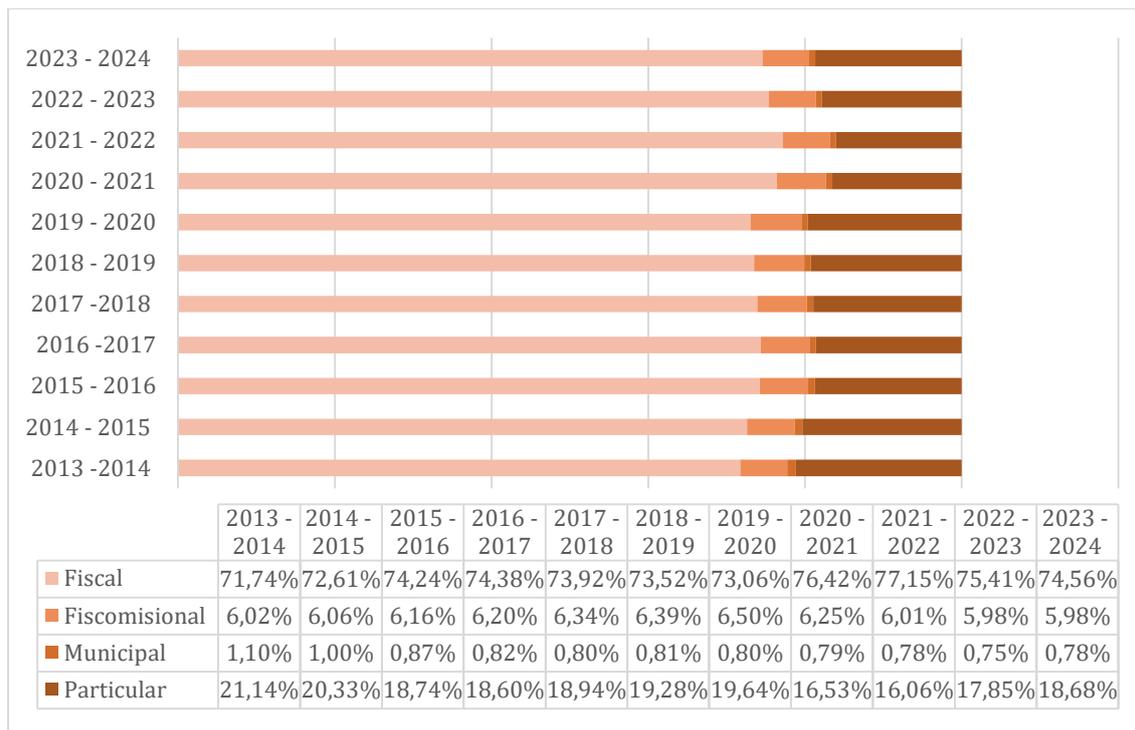


Figure 3: Students by support. Adapted from: (Ministry of Education 2024, p. 50)

In the 2013-2014 school year, enrollment distributed by educational support system shows that 71% corresponds to fiscal support, followed by 21.14% to private support, 6.02% to fiscomisional support, and 1.10% to municipal support. For the years 2023-2024, the total enrollment is distributed as follows: 74.56% to fiscal support, 18.68% to private support, 5.98% to fiscomisional support, and 0.78% to municipal support. The largest percentage of enrollment is distributed between fiscal and private support systems. Since 2013-2014, the percentage of students enrolled in public support has grown slightly and steadily, reaching 74% in the 2016-2017 school year. It then dropped to 73%, where it remained stable and with minimal variations until the 2019-2020 period.

Beginning in the 2020-2021 school year, the percentage of students enrolled has seen a positive change compared to previous years, reaching 76.42%. Private support in 2013-2014 recorded its highest percentage at 21.14%. The percentage of students enrolled subsequently declined, reaching its lowest point in 2021-2022 at 16.06%. In 2021-2022, there was a significant change in both fiscal and private support. There is a migration of



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students from private support to fiscal support. This phenomenon can be answered by the data from the 2021 National Employment, Unemployment, and Underemployment Survey (ENEMDU), which states that "As of December 2021, national poverty stood at 27.7% and extreme poverty at 10.5%. In urban areas, poverty reached 20.8% and extreme poverty at 5.9%. Finally, in rural areas, poverty reached 42.4% and extreme poverty at 20.3%." (National Institute of Statistics and Census (INEC), 2021, p. 8). We can observe that poverty increased, people lost purchasing power to access goods and services, and one manifestation of this phenomenon is the migration from private support to fiscal support.

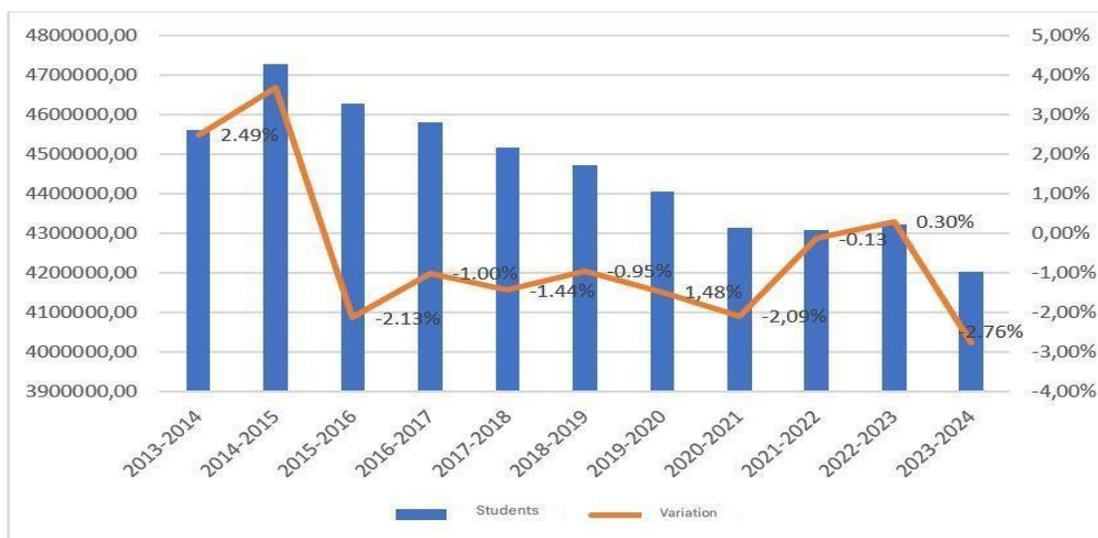


Figure 4: Evolution of enrollment at the national level. Adapted from: (Ministry of Education, 2024, p. 47).

In the 2013-2014 school year, 4,560,138 students were enrolled in the National Education System, while in the 2023-2024 school year, 4,202,798 were enrolled. The highest enrollment rate was 4,728,582 in the 2014-2015 school year, while the lowest rate was recorded in the 2023-2024 school year. Comparing the school year with the highest enrollment rate to the school year with the lowest enrollment rate, there is an 11% decrease in students. Analyzing all the years studied, there are two significant negative variations. The first occurs between the years 2014-2015 and 2015-2016, where there is a decrease of 100,636 students. The decrease coincides with the reduction in the number of educational institutions as a result of the closure of one- and two-teacher schools.

The second negative variation occurred between the 2019-2020 and 2020-2021 school years, where there was a decrease of 92,253 students, marking the year with the greatest decline in the enrollment rate. This information is corroborated by the work carried out by the United Nations Children's Fund (UNICEF), where the results indicated that in 2021 in Ecuador, "around 90,000 students are already outside the education system and around 15% of students report not having had regular contact with their teachers in the last two weeks" (UNICEF, 2021, p. 4). The GER decreased dramatically in 2020-2021 due to the social and economic impacts derived from the global health crisis.

During this period, unemployment and rising poverty caused 3% of students to migrate from the private system to the public system. There are several justified criticisms of state



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responses for being late and ineffective in ensuring student retention during the pandemic. However, fiscal support made it possible to guarantee the right to education for some—but not all—children and adolescents whose legal guardians lost the purchasing power to pay for private education. However, more than 90,000 children were ultimately excluded by an education system that failed to provide timely responses. However, as of 2023-2024, 4.1% of children and adolescents do not have access to education. Therefore, there is a further decline in the number of enrolled students, which opens the need to address the underlying causes, possibly due to the increase in migration of Ecuadorians due to the growing economic and security crisis.

The State has not guaranteed access to education, and the dropout rate from the education system is profound at two points in time. In 2015-2016, full access was hindered by geographical reasons (material accessibility) and economic conditions (economic accessibility). However, in 2020-2021, full access was hindered by material reasons—the digital divide—derived from economic and social issues (economic accessibility).

5. Conclusions

The State does not guarantee the right to education in terms of availability. The number of educational institutions varies negatively. In the 2013-2014 school year, there were 24,573 institutions, while in the 2023-2024 school year, there were 16,140 institutions. Therefore, in the last school year analyzed, there was a reduction equivalent to 34% of the total number of educational establishments present in 2013-2014.

The State does not guarantee the right to education in terms of accessibility. The enrollment rate dropped considerably at two points. In the 2015-2016 school year, there was a decrease of 100,636 students who did not enroll. The decrease coincides with the reduction in the number of educational institutions resulting from the closure of one-teacher and two-teacher schools. Then, in the 2020-2021 period, there was a decrease of 92,253 students, coinciding with the increase in poverty and unemployment due to the COVID-19 pandemic. At both times, accessibility to the education system was affected in the dimensions of material accessibility (geographical and digital reasons) and economic accessibility (scarce economic resources to access goods and services) and non-discrimination.

In the 2023-2024 school year, there was again a drop in the number of enrolled students. This coincides with the increase in migration, with 2023 being the year with the highest number of people who did not return to the country and 2024 the year with the second highest numbers. In future research, the challenge is to establish cause-and-effect relationships between the aforementioned factors to determine whether they have led to the regression of the right to education. Possible causes include the closure of single- and two-teacher educational institutions, the increase in unemployment and poverty, and the migration of Ecuadorians for security and economic reasons.

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Declaration of authorship-CRediT

ALEX LUCIO-PAREDES: State of the art, related concepts, data analysis, organization and integration of collected data, conclusions, final draft, and editing.

NADIA LUCIO-PAREDES: State of the art, related concepts, data analysis, organization and integration of collected data, conclusions, final draft, and editing.



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REVISTA

CÁTEDRA

Relevance of the prioritized curriculum with emphasis on competencies: teachers' perspectives on the teaching of mathematics in Bachelor of Science

Pertinencia del currículo priorizado con énfasis en competencias: perspectivas docentes sobre la enseñanza de matemáticas en Bachillerato en Ciencias

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(Received on: 27/05/2025; Accepted on: 15/06/2025; Final version received on: 25/07/2025)

Suggested citation: Lima-Yarpaz, J., Arias-Balarezo, A. & Molina-Jiménez, V. (2025). Relevance of the prioritized curriculum with emphasis on competencies: teachers' perspectives on the teaching of mathematics in Bachelor of Science. *Revista Cátedra*, 8(2), 55-76.



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Abstract

This article analyzes the relevance of implementing the prioritized curriculum in the teaching and learning of mathematics among second-year science baccalaureate students during the 2023-2024 academic year. This article focuses on the development of communication, mathematical, digital, and socioemotional competencies, as defined by the Ministry of Education. This research, based on teachers' perceptions of their classes and their use of the mathematics textbook provided to students, focuses on qualitative and quantitative approaches. The research combines documentary analysis with a field study, conducting surveys with teachers from 22 educational institutions in Quito. A worksheet was used for text analysis. The results show a high level of contextualization and relevance in the implementation of the curriculum, as well as a significant promotion of mathematical and socioemotional competencies. However, the development of digital competencies shows a medium level of integration. Regarding the text analysis, it was determined that the limit of a function is not studied. It is concluded that, although there is an effort to incorporate these competencies into the teaching-learning process, it is necessary to strengthen training in the use of digital tools and improve textbooks to ensure more effective implementation of the prioritized curriculum.

Keywords

Communicational competencies, digital competencies, mathematical competencies, socio-emotional competencies, prioritized curriculum.

Resumen

El presente artículo analiza la pertinencia de la aplicación del currículo priorizado en la enseñanza y aprendizaje de las matemáticas en estudiantes de segundo año de bachillerato en Ciencias durante el año lectivo 2023-2024, con énfasis en el desarrollo de competencias comunicacionales, matemáticas, digitales y socioemocionales, definidas por el Ministerio de Educación, con base en la percepción de los docentes en el desarrollo de sus clases y en la utilización del texto de Matemática entregado a los estudiantes. La investigación, de enfoque cualitativo y cuantitativo, combina el análisis documental con un estudio de campo, a través de la aplicación de encuestas a docentes de 22 instituciones educativas de la ciudad de Quito y para el análisis del texto se empleó una ficha de análisis de contenido. Los resultados evidencian un alto nivel de contextualización y pertinencia en la implementación del currículo, así como un fomento significativo de las competencias matemáticas y socioemocionales. No obstante, el desarrollo de competencias digitales presenta un nivel medio de integración. En cuanto al análisis del texto se determinó que no se estudia el límite de una función. Se concluye que, aunque existe un esfuerzo por incorporar estas competencias en el proceso de enseñanza-aprendizaje, es necesario fortalecer la formación en el uso de herramientas digitales y mejorar los libros de texto para garantizar una implementación más efectiva del currículo priorizado.

Palabras clave

Competencias comunicacionales, competencias digitales, competencias matemáticas, competencias socioemocionales, currículo priorizado.

1. Introduction

The education system faces global challenges, including the need to adapt education to technological advances, constant social change, and the inclusion of universal values that



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promote peace and coexistence (Delors, 1996). Furthermore, the education system must shift from a traditional approach based on the accumulation of knowledge to one that fosters the development of skills, as proposed by various studies on curricular modernization (Castillo and Gamboa, 2012; Egido, 2022). In this context, mathematics education also faces significant difficulties, especially in the teaching of abstract concepts such as the limit of a function. This concept, fundamental to differential and integral calculus, presents cognitive and emotional barriers that hinder its learning (Blázquez and Ortega, 2000; Socas, 2007). In Ecuador, for example, PISA assessment results have shown low performance in mathematics, underscoring the need for a change in pedagogical methods and teaching curricula to improve educational outcomes (El Comercio, 2018; OECD, 2023).

This article stems from a thesis whose objective was to analyze the relevance of the prioritized mathematics curriculum, with an emphasis on communication, mathematical, digital, and socio-emotional skills, among second-year science students during the 2023-2024 school year. It also seeks to evaluate teachers' perceptions of the relevance and contextualization of this curriculum in their classes. To this end, the following research questions have been posed:

- What is teachers' perception of the implementation of the prioritized curriculum in relation to communication, mathematical, digital, and socio-emotional competencies with second-year high school students in the context of mathematics learning?
- How do teachers perceive the relevance and contextualization of the prioritized curriculum in their mathematics classes?
- What methodology should be used to evaluate the concept of the limit of a function in the mathematics textbook for second-year high school students based on the Ministry of Education's communication, mathematical, digital, and socio-emotional competencies?

This study is not only relevant for students and teachers but also has practical value, as it seeks to generate proposals that improve the learning of key concepts in mathematics, such as limits, which are fundamental to the exact sciences and other areas such as physics, engineering, and economics. The research also contributed to the continuing education of teachers, enabling them to implement teaching activities and improve their performance in the classroom.

The structure of this document is as follows: introduction, theoretical foundation, design of this research (approach, types, and level of research), data collection techniques and instruments, validity and reliability of the instruments, analysis and discussion of results. And finally, conclusions summarizing the findings obtained.

2. Theoretical foundation

2.1 Ecuadorian educational model

Ecuador's educational model is a "set of principles and approaches that guide the implementation of teaching and learning processes, based on a contextualized and flexible educational offering, to improve educational quality" (Ministry of Education, 2023a, p. 4). It is also considered "a framework that clarifies the meaning and paradigm of education; however, it allows institutions to generate innovative, relevant, and meaningful educational actions for their stakeholders" (Ministry of Education, 2023b, p. 5). The term "protagonists"



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refers to the students who interact inside and outside the educational institution with their teachers, peers, authorities, and families. These interactions "return to individuals the ability to discover, explore, inquire, and learn from one another through collaboration, cooperation, and the relationships established between stakeholders" (Ministry of Education, 2023b, p. 8). This model has a constructivist approach in which students are the permanent builders of their own knowledge through interaction with their family, social, and cultural environment. To achieve this, students must actively participate in their learning, developing critical and problem-solving skills by working in teams (Ministry of Education, 2023b, p. 10).

2.2 Educational quality

For the Ministry of Education of our country, educational quality allows for the co-responsible participation of the entire educational community, the autonomy of school management, and the relevance and flexibility in learning for the comprehensive training of competent citizens who achieve their life plans and contribute to the development of society, based on democratic, sustainable, equitable, and inclusive practices (2023b, p. 9). From this definition, it can be highlighted that the quality of education, in addition to focusing on students' academic achievements, also focuses on forming their values, emotions, attitudes, and skills to face the challenges of society. It is important to emphasize that the quality of education is an object in constant change and improvement; therefore, it requires adaptation as the needs and challenges of society evolve (Ministry of Education, 2023b, p. 9).

2.2.1 Relevance

The relevance of education implies that it must be meaningful to all people, regardless of their social or cultural context, abilities, and interests. This way, everyone can embrace the content of culture, both global and local, and develop themselves as subjects in society, developing their autonomy, self-governance, freedom, and identity (Blanco et al., 2008, p. 13). Along these same lines, for the Ecuadorian Ministry of Education, relevance in education constitutes one of the characteristics that the Organic Law on Intercultural Education attributes to the concept of educational quality. It is, therefore, a principle of education that seeks to ensure the quality of the educational process received by students, guaranteeing "an education that responds to the needs of their social, natural, and cultural environment at the local, national, and global levels" (Organic Law on Intercultural Education, 2015). "For the educational offer to be relevant, the curriculum and teaching methods must be flexible to adapt to the needs and characteristics of the students and the diverse social and cultural contexts" (Blanco et al., 2008, p. 13).

2.3 Ecuadorian curriculum

A curriculum is an educational project of each country with the aim of promoting the development and socialization of a new generation. The curriculum ensures the minimum conditions necessary to maintain continuity and coherence in the realization of pedagogical intentions, guaranteeing quality teaching and supporting the learning process (Ministry of Education, 2016, p. 4). "A curriculum is a document that guides and directs the learning process. Its content includes the knowledge, skills, and attitudes that the student is expected to learn at each stage of their educational path" (Ministry of Education, 2021, p. 5).

2.4 Prioritized curriculum with emphasis on competencies

The prioritized curriculum with an emphasis on communication, mathematical, digital, and socio-emotional skills is a document created with the aim of providing a quality education that adapts to the reality and needs of each educational institution and each student after



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the Covid-19 pandemic. Applying these skills helps provide a quality education and contributes to the comprehensive development of students and improves their ability to cope with situations that arise in their daily lives (Ministry of Education, 2021, p. 5).

2.4.1 Competencies of the prioritized curriculum

For the Ministry of Education (2021), communication skills (CC), mathematics (CM), digital skills (CD), and socio-emotional skills (SC) are students' ability to develop, integrate, and utilize different levels of interrelated knowledge, skills, procedures, aptitudes, and attitudes (pp. 7-9). Communication skills are the skills that promote the comprehension and production of texts, effective communication, and thus improve social interaction. Students must be able to speak relevantly and fluently. They must also understand a text when reading or listening to it and produce texts that can be written or oral so that the recipient can understand them. Reading is a source of information and study that allows for intellectual and human growth and allows for the development of "reflection, critical thinking, complex thinking, awareness, creativity, and the construction of new knowledge" (Ministry of Education, 2021, pp. 7-8).

Mathematical competencies are skills that promote critical, logical, and rational thinking when making decisions based on ethical and moral values. Students must be able to perform basic operations and use mathematical symbols with different numerical sets. They must also be able to solve everyday problems and express them in a reasoned, logical, argumentative, and communicative manner, integrating different types of knowledge. Furthermore, they will be honest, fair, ethical, and respectful members of a democratic, equitable, and inclusive society. Finally, mathematical competencies go hand in hand with the 21st-century competencies of "problem-solving, decision-making, and critical thinking" (Ministry of Education, 2021, p. 8).

Digital competencies are the knowledge and skills that foster the development of computational thinking, the responsible use of technology, as well as creating, sharing, communicating, collaborating, and providing solutions in digital environments. Students must be able to identify, define, and solve problems that arise in digital environments and that can lead them to educational, cultural, political, and economic environments through critical thinking. Furthermore, students cease to be technological consumers and become analysts and creators, people who manage technology appropriately, consciously, and responsibly. Digital competencies enable autonomous participation in the learning process (Ministry of Education, 2021, pp. 8-9).

Socio-emotional competencies are the knowledge, capacities, skills, and attitudes that enable the understanding and appropriate management of personal emotions versus the emotions of others. Students must be able to self-regulate their emotions, respect the emotions of their peers, collaborate and work as a team, make responsible decisions, and handle situations that challenge them in their learning process in a constructive and ethical manner. Furthermore, these competencies allow the development of "life skills proposed by the World Health Organization: self-knowledge, empathy, assertive communication, interpersonal relationships, decision-making, problem and conflict resolution, critical thinking, management of emotions and feelings, management of tension and stress" (Ministry of Education, 2021, p. 9).



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2.5 Learning theories associated with Mathematics

2.5.1 APOE

The Action-Process-Object-Schema (APOE) theory, for Arias (2019), is a cognitive model that is part of advanced mathematical thinking and through reflexive abstraction as a constructive mechanism allows the construction of mental objects. This theory describes how students understand mathematical concepts by applying the mental constructs of Actions, Processes and Objects, whose interaction with each other are organized into a Schema. These mental constructs are developed from the following mental mechanisms: internalization, coordination, inversion, generalization, encapsulation and/or decapsulation. The process that students follow to understand a mathematical concept, based on the APOE theory, begins with the manipulation of physical or mental objects constructed to form actions, which are internalized to form processes that are encapsulated and form objects. Objects can be de-encapsulated in the processes from which they were formed. Finally, actions, processes and objects can be organized into schemes that, if treated as objects and circumscribed in the organization of other more advanced schemes, it is concluded that they have been thematized into a mathematical object (Arias, 2019, pp. 83-84).

3. Research design

This research employs a mixed-methods approach, combining quantitative and qualitative techniques to analyze the relevance of the prioritized curriculum with an emphasis on competencies in the teaching of mathematics. From a quantitative perspective, a survey was conducted among teachers about their classes, and the results were statistically analyzed to draw general conclusions. According to Ulloa et al. (2017), "quantitative research offers us the possibility of generalizing the results more broadly; it gives us control over the phenomena and a perspective on their counting and magnitude" (p. 171). In parallel, a qualitative approach was incorporated, as it allows for greater interpretive depth when analyzing the contents and activities of the Ministry of Education's official textbook for the 2023-2024 school year using an analysis sheet. This approach provides "dispersion, interpretive richness, contextualization of the environment, details, and unique experiences" (Ulloa et al., 2017, p. 171).

The level of research is descriptive, as it details the characteristics of the curriculum and describes how students learn mathematical concepts from the perspective of communication, mathematical, digital, and socio-emotional competencies. As Hernández et al. (2014) state, this type of research seeks to "specify the properties, characteristics, and profiles of people, groups, communities, processes, objects, or any other phenomenon that is being analyzed" (p. 92). Furthermore, the study is based on documentary and field research. Information was collected from books, scientific articles, and testimonies from mathematics teachers. In the words of Arias (2012), "documentary research is a process based on the search, recovery, analysis, critique, and interpretation of secondary data [...] in documentary sources: print, audiovisual, or electronic" (p. 27), while field research "consists of collecting data directly from the subjects under investigation [...] without manipulating or controlling any variable" (p. 31).

3.1 Research techniques and instruments

For field research, the survey technique was used with its respective instrument, the questionnaire. For documentary research, the Document Analysis technique was applied



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through its instrument, Cards, as well as the content analysis technique using record tables as an instrument (Arias, 2012, p. 68).

3.1.1 Description of the questionnaire

The questionnaire of this research aimed to collect the perspective of mathematics teachers on the promotion of communication, mathematical, digital and socio-emotional skills in the development of their classes and was applied to 112 teachers through an online survey consisting of a questionnaire with eight items and a total of 29 subitems. The scale of possible responses is structured as follows: 5. Always (100%), 4. Almost always (75%), 3. Sometimes (50%), 2. Almost never (25%), 1. Never (0%).

3.1.2 Description of the record

The worksheet used in this research aimed to analyze specific content from two mathematics textbooks for second-year high school students in relation to the competencies of the prioritized curriculum. This worksheet applied the mathematics textbook analysis methodology (MALTM), proposed by Acaro (2020), which consists of three stages: 1) reference data from the textbook, 2) general outline of the textbook, 3) conceptual analysis. In total, the worksheet had 44 items and a scale with two possible answers: Yes or No. The value of "Yes" is three points and that of "No" is one point. The score is obtained by adding the score obtained (PO), multiplying it by one hundred (100) and dividing it by the sum of the ideal score (PI).

3.2 Validity of the instruments

The criterion used for instrument validation was expert validation. The questionnaire and the form were validated in terms of their structure, mathematical content, didactic aspects, and item wording. Table 1 presents the expert validators of the questionnaire, and Table 2 presents the expert validators of the form.

Expert	Area	Workplace
MSc. Cinthya Veloz	Mathematics	U.E.M. San Francisco de Quito.
MSc. Ruth Gonzáles	Spanish Language and Literature	U.E. Pedro José Arteta.
MSc. Edwin Lozano	Research and Psychology	Central University of Ecuador.

Cuadro 1. Expertos que validaron el cuestionario

Experto	Área	Lugar de Trabajo
PhD. Ana Lucía Arias	Mathematics	Central University of Ecuador.
MSc. Franklin Molina	Mathematics	Central University of Ecuador.
MSc. Lucia Goyes	Pedagogy	Central University of Ecuador.

Table 2. Experts who validated the form

3.3 Reliability of instruments

According to Hernández et al. (2014), "the reliability of a measuring instrument refers to the degree to which its repeated application to the same individual or object produces consistent and coherent results" (p. 200). This means that the results obtained must be the same in successive repetitions. To calculate the reliability of the questionnaire, a survey was administered to 21 master's students in Mathematics. Based on the results obtained, it was decided to calculate Cronbach's alpha coefficient, a numerical value that can vary between zero and one. The value obtained of 0.91 indicates that the instrument has high reliability.



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4. Results

This section is divided into two sections. The first analyzes and interprets the results obtained from the application of the questionnaire to 112 Mathematics teachers from 73 public, municipal, and private educational institutions, as well as the information collected from the application of the form to analyze Mathematics textbooks for second-year high school students during the 2023-2024 school year. The second section discusses the results, considering the theoretical constructs, background, and objectives of this research. In order to qualify the numerical results obtained from the application of the questionnaire and the form, a qualitative description was established as shown in Table 3.

Number of respondents	Percentage of respondents	Qualitative description
De 103 a 112	De 92 % a 100 %	Muy alto
De 90 a 102	De 80 % a 91 %	Alto
De 72 a 89	De 64 % a 79 %	Medio
De 50 a 71	De 44 % a 63 %	Bajo
De 0 a 49	De 0 % a 43 %	Muy bajo

Cuadro 3. Cualificación de los resultados numéricos para el cuestionario y la ficha

4.1 Analysis and interpretation of the questionnaire results

The analysis of each item included statistical column graphs and frequency tables to extract the most significant findings, highlighting the highest values of each sub-item and was qualitatively assessed as established in Table 3. In addition, for the interpretation of the information, the meaning of the results obtained was explained, relating them to the objectives and guiding questions of this research.

4.1.1 Relevance of the prioritized curriculum

To analyze the relevance of the prioritized curriculum, mathematics teachers were asked about the way they teach their classes. The question was whether Mathematics teachers consider their classes contextualized and relevant through the following actions: relating mathematical content to everyday situations and other subjects; adapting lessons to students' needs and interests; and connecting the content learned in class to their sociocultural environment.

Figure 1 presents the results regarding mathematics teachers' perspectives on the contextualized delivery of their lessons, considering several key elements to analyze the relevance of the prioritized curriculum in the area of Mathematics. Of the 112 teachers surveyed, 62 indicated that they always relate mathematical content to everyday situations and other subjects (subitem 1.1); 42 teachers responded that they do so almost always, and 8 that they do so sometimes. Regarding the adaptation of lessons to students' needs and interests (subitem 1.2), 55 teachers stated that they do this always; 50 almost always; and 7 sometimes. Finally, regarding the connection between the content learned and the students' sociocultural environment (subitem 1.3), 47 teachers indicated that they do this always; 56 almost always; 8 sometimes; and 1 teacher stated that they never do this.



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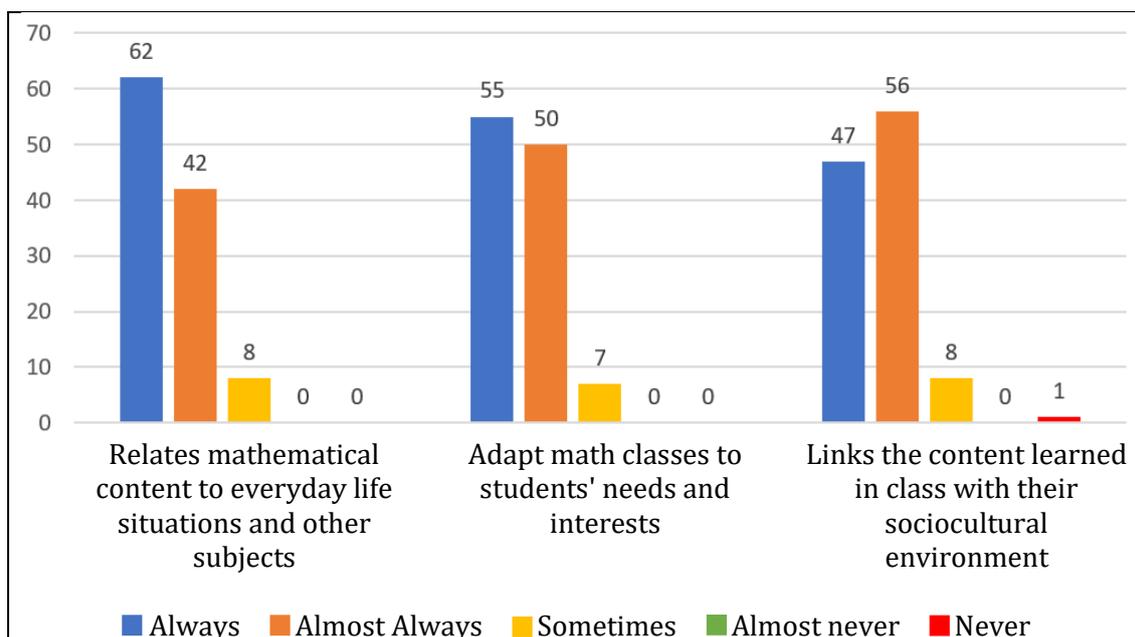


Figure 1. Perspective of the relevance of the prioritized curriculum. Adapted from: (Lima, 2024, p. 59).

These values show that, in this research according to the 112 teachers surveyed, the level of contextualization and relevance in the application of the prioritized curriculum in the teaching and learning process of mathematics is very high, since in all sub-items between 103 and 112 teachers surveyed, that is, between 92% and 100%. In addition indicate that they always or almost always conduct their mathematics classes connecting learning and educational actions with the realities, needs and aspirations of the student to guarantee an education that responds to the needs of their social, natural and cultural environment, contributing to the fulfillment of the right of students to receive a quality education.

4.1.2 Communication skills

To analyze the development of communication skills in Mathematics, teachers were asked whether they believe they foster these skills through the following actions: developing oral and written expression skills related to mathematics topics; improving reading comprehension and information production related to mathematics; communicating problem-solving processes using mathematical language in an orderly and coherent manner; and promoting reflection and creativity in academic activities.

Figure 2 shows teachers' perspectives on the application of communication skills in the classroom, highlighting specific actions that teachers are expected to promote. Of the 112 teachers surveyed, 45 indicate that they always develop oral and written expression skills related to mathematics topics (subitem 2.1); 57 do so almost always, 8 sometimes, and 2 almost never. Regarding improving reading comprehension and information production related to mathematical content (subitem 2.2), 43 teachers state that they always do so; 53 almost always, 14 sometimes, 1 almost never, and 1 never. Regarding the communication of problem-solving processes through orderly and coherent mathematical language (subitem 2.3), 76 teachers state that they always do so; 31 almost always, 4 sometimes, and 1 almost never. Finally, in relation to the promotion of reflection, critical and complex



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thinking, awareness, and creativity in academic activities (subitem 2.4), 64 teachers respond that they always do so, 42 almost always, and 6 sometimes.

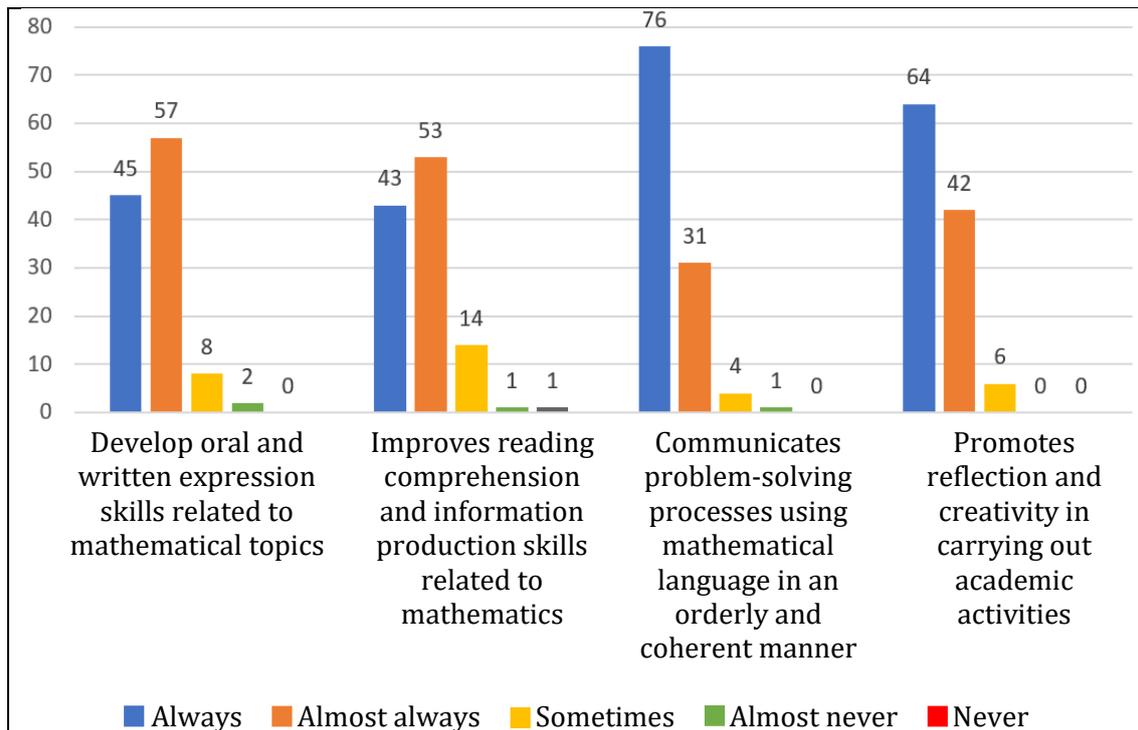


Figure 2. Application of communication skills. Adapted from: (Lima, 2024, p. 64).

These values show that, in this research according to the 112 teachers surveyed, the extent to which teachers promote communication skills in the teaching and learning process of mathematics is high, since in all sub-items between 90 and 102 teachers surveyed, that is, between 80% and 91%, indicate that they always or almost always conduct their classes encouraging oral and written expression, comprehension and production of texts and the resolution of mathematical problems, with the aim that students are able to speak with good enunciation, in an orderly and coherent manner, make correct use of the language and listen carefully, analyze a text when reading or listening to it and produce written or oral texts in a comprehensive way.

4.1.3 Mathematical skills

To analyze the development of mathematical competencies, teachers were asked how they foster them in the classroom. Teachers considered that these competencies were promoted through the following actions: explaining and applying mathematical concepts in solving exercises; proposing logical-mathematical reasoning problems of varying complexity related to everyday situations; and encouraging critical thinking and mathematical reasoning in decision-making, both inside and outside the classroom.

Figure 3 presents the results related to the application of mathematical competencies in classroom teaching. The data obtained show that, of the 112 teachers surveyed, 91 indicated that they always explain and apply mathematical concepts in solving exercises (sub-item 3.1); 19 do so almost always, and 2 do so sometimes. Regarding the formulation of logical-mathematical reasoning problems of varying complexity, linked to everyday life situations (sub-item 3.2), 71 teachers indicate that they do it always, 33 almost always, 7 sometimes and 1 almost never. Finally, regarding the promotion of critical thinking and mathematical



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reasoning in decision-making (sub-item 3.3), 81 teachers indicate that they do it always, 25 almost always and 6 sometimes.

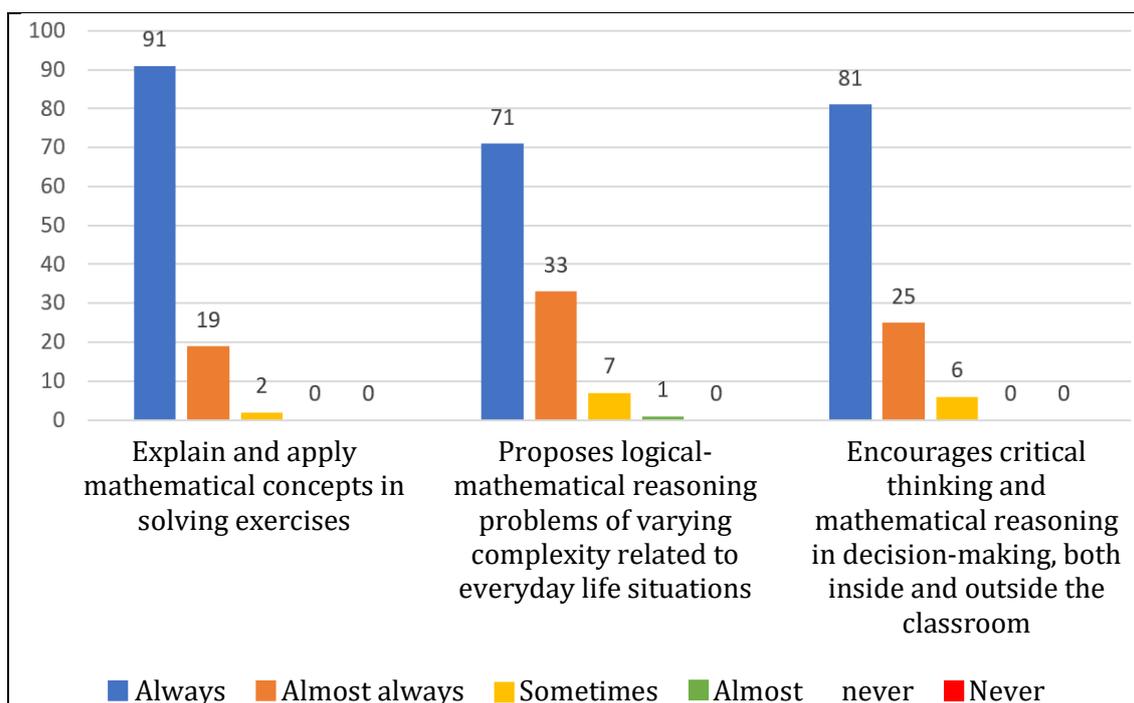


Figure 3. Application of mathematical skills. Adapted from: (Lima, 2024, p. 66).

These values show that, in this research according to the 112 teachers surveyed, the extent to which teachers promote mathematical skills in the teaching and learning process of mathematics is very high, since in all sub-items between 103 and 112 teachers surveyed, that is, between 92% and 100%, respond that they always or almost always conduct their classes encouraging the explanation and application of mathematical concepts, the posing of problems with varying complexity and encourage critical thinking and reasoning, so that students are able to correctly use mathematical operations, use their symbols with number sets, solve problems of everyday life and express them in a reasoned, logical, argumentative, communicative way, and integrating different knowledge.

4.1.4 Digital skills

To analyze the development of digital competencies in mathematics, teachers were asked how they integrate the use of technologies into their teaching practices through the following actions: creating digital mathematical content by identifying problems, defining them, and proposing solutions; using ICTs as tools to facilitate mathematics learning; explaining how to ethically and responsibly use information obtained in digital environments on mathematics-related topics; and selecting appropriate educational platforms to promote meaningful, interactive, and contextualized learning.

Figure 4 presents the results related to the application of digital competencies in Mathematics. The data show that, of the 112 teachers surveyed, 40 indicate that they always create digital mathematical content, identifying problems, defining them, and proposing solutions (subitem 4.1); 49 do so almost always, 18 do so sometimes, 4 almost never, and 1 never. Regarding the use of ICT for learning mathematics (subitem 4.2), 38 teachers state that they do so always, 47 almost always, 22 sometimes, and 5 almost never. Regarding the



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responsible use of information obtained in digital environments on mathematical topics (subitem 4.3), 45 teachers respond that they always explain it, 44 almost always, 20 sometimes, and 3 almost never. Finally, in relation to the selection of appropriate educational platforms to achieve meaningful learning (subitem 4.4), 44 teachers indicate that they always do so, 47 almost always, 15 sometimes, and 6 almost never.

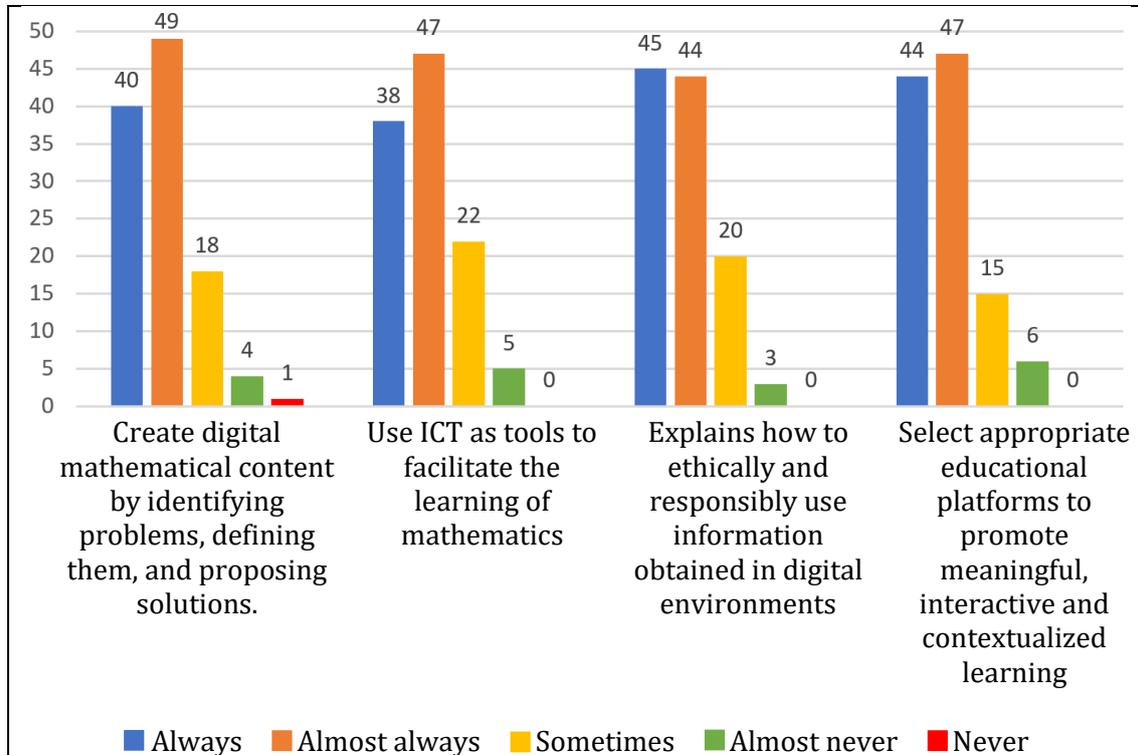


Figure 4. Application of digital skills. Adapted from: (Lima, 2024, p. 68)).

These values show that, according to the 112 teachers surveyed, the extent to which teachers promote digital skills in the teaching and learning process of mathematics is medium, given that in all sub-items between 72 and 89 teachers surveyed, that is, between 64% and 79%, always or almost always conduct their classes promoting the creation of digital mathematical content, the responsible use of ICTs and the selection of appropriate platforms for learning Mathematics so that students are able to identify, define and solve problems that arise in digital environments and that can lead them to educational, cultural, political and economic environments, through critical thinking, ceasing to be technological consumers and becoming analysts and creators, people who handle technology appropriately, consciously and responsibly.

4.1.6 Socio-emotional skills

To analyze the development of socioemotional competencies in Mathematics, teachers were asked how they integrate them into their teaching practices. In this question, consider that you foster these competencies through the following actions: you promote teamwork and collaboration among peers to solve mathematical problems; you guide students in controlling their emotions when faced with challenges related to mathematics in the classroom; you encourage the prevention of all types of violence and psychosocial risks inside and outside the classroom; and you promote self-awareness, empathy, communication, and tension and stress management.



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Figure 5 shows the results related to the application of socioemotional competencies in mathematics. Of the 112 teachers surveyed, 74 indicate that they always promote teamwork and collaboration among peers to solve Mathematical problems (subitem 5.1); 35 do so almost always, 2 do so sometimes, and 1 teacher never does this. Regarding guidance for controlling emotions when faced with challenges in the classroom related to mathematics (subitem 5.2), 63 teachers stated that they do it always, 42 almost always, and 7 sometimes. Regarding the prevention of all types of violence and psychosocial risks inside and outside the classroom (subitem 5.3), 82 teachers indicated that they always encourage it, 22 almost always, and 8 sometimes. Finally, regarding the promotion of self-knowledge, empathy, communication, and stress management (subitem 5.4), 77 teachers responded that they always do it, 31 almost always, 3 sometimes, and 1 never includes these actions in their classes.

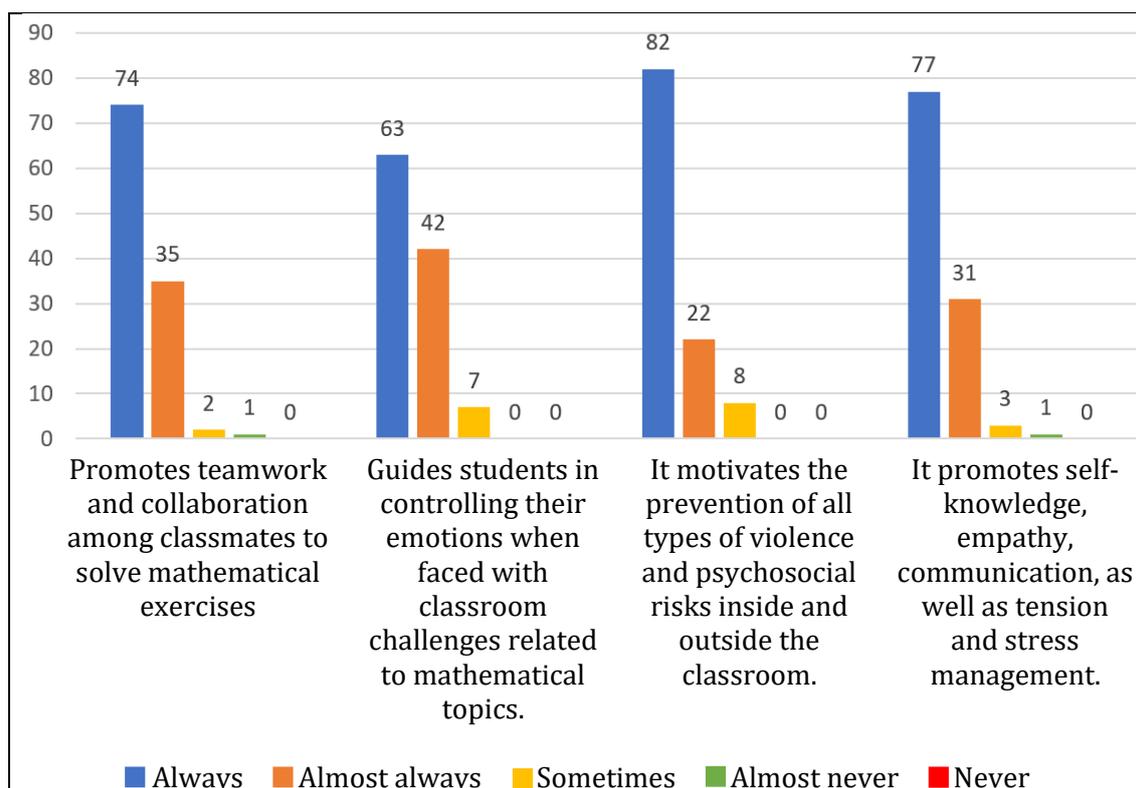


Figure 5. Application of socio-emotional competencies. Adapted from: (Lima, 2024, p. 71)).

These values show that, in this research, according to the 112 teachers surveyed, the extent to which teachers promote socio-emotional competencies in the teaching and learning process of mathematics is very high, because in all sub-items between 103 and 112 teachers surveyed, that is, between 92% and 100%, always and almost always conduct their classes encouraging teamwork and collaboration, self-knowledge, empathy, guiding the control of emotions and motivating the prevention of violence, with the aim of contributing to the socio-emotional development of their students in the context of learning mathematics..

4.2 Analysis and interpretation of the results of the form

The textbooks analyzed in this study were: Student Textbook for 2nd Year of High School Mathematics (Alfa), provided free of charge by the Ministry of Education, and the book, Culture and Mathematical Ingenuity (Beta), published by Santillana. Both textbooks were



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used during the 2023-2024 school year, and their content related to the limit of a function was analyzed, obtaining results in the three stages of the MALTM methodology.

4.2.1 First stage: reference data from the textbook

The following characteristics are observed in the Mathematics textbooks: it lists the author(s), the publisher, the year of publication, the place of publication, the availability of free textbooks, and the Ministry of Education's curriculum certification.

Table 4 shows that the Alfa textbook meets all six items in the first stage, giving it a score of 18. The Beta textbook, on the other hand, meets four items, but since it is neither free (item 5) nor certified by the Ministry of Education (item 6), it obtained a score of 14.

The results obtained in this research show that the Alfa textbook, by meeting all the evaluated items, is an option aligned with the official curriculum and equitably accessible to students, obtaining 18 points. In contrast, the Beta textbook, since it is neither free nor certified by the Ministry of Education, obtained 14 points, suggesting that, although it may be a complementary resource, it is not officially validated for use in the public education system. This highlights the importance of certification and accessibility in the selection of teaching materials.

Ítem	Alfa book		PI	PO	Beta book		PI	PO
	Yes	No			Yes	No		
	3	1			3	1		
1	x		3	3	x		3	3
2	x		3	3	x		3	3
3	x		3	3	x		3	3
4	x		3	3	x		3	3
5	x		3	3		x	3	1
6	x		3	3		x	3	1
	Subtotal		18	18	Subtotal		18	14

Table 4. Reference data for mathematics textbooks

4.2.2 Second stage: general outline of the textbook

The following characteristics are observed in the mathematics textbooks: they present the general objective, the author's objective(s), the general objectives of the national curriculum, a table of contents, a profile of the Ecuadorian high school graduate, the didactic organization of the units, icons to identify specific activities, knowledge assessment guidelines, the technological resources used, a bibliography, and the topic to be analyzed is included in the content. Table 5 shows that both textbooks analyzed achieve a PO of 22 out of 30. From items 7 to 16, the textbooks agree on the aspects they include and those they omit. However, there is a difference in item 17, which does not have an assigned score. However, it is determined that the Alpha textbook does not address the limit of a function, while the Beta textbook does.

The results obtained in this research indicate that both textbooks have a similar didactic structure and meet most of the criteria analyzed. However, a key difference is that the Alfa book, published by the Ministry of Education, does not address the limit of a function, while the Beta book, published by Santillana, does. Since both texts are aimed at second-year high school students, this difference is significant, as the limit of a function is a fundamental concept in the mathematics curriculum. This suggests that, although the Alfa book is the



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official material, it may not be sufficient to address all the required content, highlighting the importance of complementing teaching with other resources.

Ítem	Alfa book		PI	PO	Beta book		PI	PO
	Yes 3	No 1			Yes 3	No 1		
7		x	3	1		x	3	1
8		x	3	1		x	3	1
9		x	3	1		x	3	1
10	x		3	3	x		3	3
11		x	3	1		x	3	1
12	x		3	3	x		3	3
13	x		3	3	x		3	3
14	x		3	3	x		3	3
15	x		3	3	x		3	3
16	x		3	3	x		3	3
	Subtotal		30	22	Subtotal		30	22
17	Si	No			Si	No		
		x			x			

Table 5. General outline of mathematics textbooks

4.2.3 Third stage: conceptual analysis

The following activities are observed in Mathematics textbooks to promote the application of the prioritized curriculum competencies.

Communication skills (CC) include readings with examples and appropriate language; spaces for writing texts or summaries; and materials that stimulate reflection, critical and complex thinking, awareness, creativity, and the construction of new knowledge in students. Additionally, activities are included in which students communicate problem-solving processes through the effective use of language, both oral and written, with relevance and fluency.

Mathematical skills (MC) include activities to use and relate real numbers and their operations; employ formal mathematical language; work with different forms of representation (numerical, graphical, algebraic, and verbal); encourage logical and reasoned reasoning; relate mathematics to different contexts of everyday life; and promote awareness, responsibility, and critical analysis in the context of mathematical processes.

Digital skills (CD) include activities that enable the development of computational thinking. Activities to identify, define, and solve problems through the responsible use of mathematics-related software; activities in which students analyze and build mathematical knowledge through the use of ICTs (presentations, videos, web pages, simulators); and activities aimed at promoting digital responsibility.

In socio-emotional competencies (SC), activities are presented to promote self-knowledge, empathy, assertive communication, emotional management, collaboration, positive relationships, decision-making, as well as problem-solving and conflict management from a socio-emotional perspective.



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Table 6 shows that the Alpha book does not address the topic of the limit of a function, while the Beta book does, albeit partially. The latter obtains a score of 3 in items 19, 20, and 21, which focus on communication skills; in two of the six items related to mathematical skills; in items 33 and 35, which address digital skills; and in items 39, 41, 42, and 43, which refer to socio-emotional competencies, achieving a PO of 49 out of 81. In the other items, like the Alfa book, it does not meet the assessed aspects. Thus, the Alfa book achieves a PO of 9 out of 81.

Competencies	Ítem	Alfa book				Beta book			
		Yeas 3	No 1	PI	PO	Yes 3	No 1	PI	PO
CC	18		X	3	1		x	3	1
	19		X	3	1	x		3	3
	20		X	3	1	x		3	3
	21		X	3	1	x		3	3
	22		X	3	1		x	3	1
	23		X	3	1		x	3	1
	24		X	3	1		x	3	1
	25		X	3	1		x	3	1
	26		X	3	1		x	3	1
CM	27		X	3	1		x	3	1
	28		X	3	1		x	3	1
	29		X	3	1	x		3	3
	30		X	3	1	x		3	3
	31		X	3	1		x	3	1
	32		X	3	1		x	3	1
CD	33		X	3	1	x		3	3
	34		X	3	1		x	3	1
	35		X	3	1	x		3	3
	36		X	3	1		x	3	1
CS	37		X	3	1		x	3	1
	38		X	3	1		x	3	1
	39		X	3	1	x		3	3
	40		X	3	1		x	3	1
	41		X	3	1	x		3	3
	42		X	3	1	x		3	3
	43		X	3	1	x		3	3
	44		X	3			x	3	1
			Subtotal	81	27	Subtotal		81	49

Table 6. Curriculum competencies prioritized in mathematics textbooks

The conceptual analysis of communication, mathematical, digital, and socio-emotional competencies in the Alpha and Beta textbooks reveals that, although both textbooks have similar subscores, the Beta textbook outperforms the Alpha textbook in several aspects. Beta includes more activities that encourage reflection, critical thinking, the creation of reading-based texts, different forms of representation (numerical, graphical, algebraic, and verbal), logical and reasoning, the development of computational thinking, the analysis and design of mathematical content using ICT, as well as assertive communication, collaboration, positive relationships, and decision-making.



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However, both textbooks are significantly lacking in activities related to the curriculum competencies. This suggests that neither textbook fully meets the curriculum's objectives in terms of competency development, especially in the context of the boundary topic of a function.

4.2.4 Level of Compliance with Curriculum Competencies Prioritized by Mathematics Textbooks

In this research, the compliance level is considered a percentage obtained from the evaluation of specific content in a mathematics textbook using the MALTm methodology. To obtain this value, the score obtained (SO) is added, multiplied by one hundred (100), and divided by the sum of the ideal score (IS). Table 7 shows the results obtained from the application of the worksheet to mathematics textbooks for second-year high school students. In order to qualify the numerical results obtained from the application of the worksheet, for this research, the same qualitative description of the questionnaire (Table 3) is considered. It was determined that the Ministry of Education textbook (Alfa) obtained a compliance level of 52%, which is evaluated as low, while the Santillana Publishing House textbook (Beta) obtained a level of 66%, which is evaluated as medium.

Ítem 1 al 44	Alfa book		Beta book	
	PI	PO	PI	PO
Total	129	67	129	85
Percentage compliance level	100%	52%	100%	66%
Qualitative description	Low level		Medium level	

Table 7. Qualification of numerical results for the record

These values highlight the need to design teaching activities that enable the achievement of the competencies of the prioritized curriculum in the Ministry of Education's textbook for the second year of high school. Likewise, in the textbook used by private institutions (Beta), there is a need to improve and enhance activities in order to further promote the communication, mathematical, digital, and socio-emotional competencies of the prioritized curriculum.

4.3 Discussion of the results

The research evaluated the contextualization and relevance of the curriculum in second-year high school mathematics teaching, revealing that between 92% and 100% of the teachers surveyed relate the content to everyday life and other subjects, adapting their lessons to students' needs and interests. This finding confirms a strong ownership of the prioritized curriculum, in line with Barrios (2016), who emphasizes the importance of a structured and contextualized curriculum to promote meaningful learning. However, it is important to reflect on how this contextualization translates into concrete learning outcomes, given that adaptation to varied contexts can present challenges to the uniformity of educational quality.

Regarding the development of communication skills, teachers report fostering these skills in a range between 80% and 91%, promoting oral expression, reading comprehension, and the use of mathematical language. While teacher perceptions are positive, studies such as Toalombo (2021) and the INEVAL (National Institute of Statistics and Censuses)'s "Being a Student 2023" report show real deficiencies in students' verbal skills, which could indicate a discrepancy between teacher perceptions and student



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performance. This gap raises the need to investigate additional factors such as teacher training, applied pedagogical strategies, and the classroom environment that impact communication development in mathematics.

Analysis of the development of mathematical competencies shows that between 92% and 100% of teachers encourage the explanation of concepts, problem-solving, and critical thinking—essential practices for logical reasoning. However, the low achievement levels reported by INEVAL suggest that these efforts, although relevant, may not be sufficient to overcome learning challenges. This invites critical reflection on the effectiveness of the methodologies employed and the possible impact of external factors such as infrastructure, resources, and institutional support. Regarding digital skills, there is evidence of medium use of technological tools (64% to 79%), revealing a significant area for opportunity. Although it is worth noting that a considerable proportion of teachers use ICTs responsibly and recognize their importance, the average level of digital integration indicates the need to strengthen teacher training and support for more effective implementation of technologies that enhance mathematical learning.

Regarding the development of socio-emotional skills, this is perceived as a strengthened aspect, with 92% to 100% of teachers promoting teamwork, emotional control, and violence prevention, key aspects for comprehensive learning. This commitment coincides with Mina et al. (2023), who identify socio-emotional skills as the most accessible for teaching practice. However, it is important to explore how these skills impact academic performance and student motivation in the long term.

To conclude this discussion of results and with the aim of evaluating the fulfillment of communication, mathematical, digital, and socio-emotional competencies in Mathematics textbooks for second-year high school, specifically in the concept of the limit of a function. When comparing the results obtained with those of Acaro (2020), who analyzed textbooks for first and third years of high school, it is concluded that the official texts of the Ministry of Education, for the most part, present the dynamic conception of the limit. In contrast, the Santillana publishing house textbook for second-year high school shows both a dynamic and metric conception. In this analysis, the Maya publishing house textbook (2023) for second-year high school does not address the topic of the limit of a function, resulting in low compliance with the established indicators. On the other hand, the Santillana (2023) textbook for second-year high school shows an average level in the application of communication, mathematical, digital, and socio-emotional competencies. With these results it can be seen that the mathematics textbooks for second year of high school, with respect to the application of communication, mathematical, digital and socio-emotional skills of the prioritized curriculum, have on average a low level.

5. Conclusions

This research demonstrated that second-year science teachers perceive a contextualized and relevant application of the prioritized curriculum in teaching Mathematics. This contextualization favors the integration of content with everyday life and other subjects, promoting more meaningful and inclusive learning, regardless of the type of educational institution.



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One of the main contributions of the study is confirming that teachers promote the development of communication, mathematical, and socioemotional skills at high levels, which suggests a clear appropriation of the prioritized curriculum's approaches. However, the integration of digital skills still presents challenges, highlighting the need to strengthen teacher training in the pedagogical use of technologies. The analysis of textbooks, especially on the topic of the limit of a function, reveals that, although there has been partial progress, compliance with the prioritized curriculum criteria is still limited. This highlights the need to review and update teaching materials to ensure adequate coverage of the established content and skills. As a future line of research, comparative studies between teacher perceptions and student performance in mathematics are recommended to verify the real impact of the prioritized curriculum. It would also be valuable to analyze curriculum implementation at other educational levels and areas of knowledge, as well as to delve deeper into the design of innovative teaching strategies that effectively integrate digital skills.

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REVISTA

CÁTEDRA

The influence of academic stress on the performance of basic education students at the Central University of Ecuador

La influencia del estrés académico en el rendimiento de los estudiantes de educación básica de la Universidad Central del Ecuador

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(Received on: 10/04/2025; Accepted on: 25/05/2025; Final version received on: 30/06/2025)



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Suggested citation: Díaz-Parra, J., Curipallo-Peralta, N., Rojas-Avilés, H., & Parra-Muñoz, J. (2025). The influence of academic stress on the performance of basic education students at the Central University of Ecuador. *Revista Cátedra*, 8(2), 363-370.

Abstract

Academic stress significantly affects the performance of university students, manifesting itself in various ways: physical, emotional, and cognitive. Previous studies indicate that 77% of people worldwide suffer from moderate or severe stress (United Nations Development Program, 2022). In Ecuador, research such as that by Moscoso and Barsallo (2018) reveals that 43.2% of students experience moderate academic stress. This research sought to evaluate the level of stress in students of in-person basic education. To do so, a non-experimental-descriptive methodology and a deductive method with a quantitative approach were used. The SISCO SV-21 Inventory was applied to 586 students, selected through stratified probability sampling by semester. The results showed that a severe level of stress prevails among students, ranging from 61% to 100%. The main stressors identified were homework overload (M=3.68) and the type of work required (M=3.58). The most frequent consequences included concentration problems (M=4.10) and feelings of depression (M=3.77). Coping strategies that stood out were emotional control (M=3.86) and focusing on positive aspects (M=3.62). Statistical analysis ($\chi^2=150.530$, $p<.001$) confirmed the relationship between the semester completed and the level of stress. These findings suggest the need to implement institutional programs to manage academic stress, especially aimed at first-semester students and those in advanced semesters.

Keywords

Basic education, academic stress, stressors, Sisco SV-21, academic performance, mental health.

Resumen

El estrés académico afecta significativamente el rendimiento de los estudiantes universitarios, manifestándose de diversas formas: físicas, emocionales y cognitivas. Estudios previos indican que el 77 % de las personas a nivel global padecen estrés moderado o grave (Programa de las Naciones Unidas para el Desarrollo, 2022). En Ecuador, investigaciones como la de Moscoso y Barsallo (2018) revelan que el 43.2 % de los estudiantes experimentan estrés académico moderado. La presente investigación buscó evaluar el nivel de estrés en los estudiantes de Educación Básica Presencial. Para ello, se empleó una metodología no experimental-descriptiva y un método deductivo con enfoque cuantitativo. Se aplicó el Inventario SISCO SV-21 a 586 estudiantes, seleccionados mediante un muestreo probabilístico estratificado por semestres. Los resultados mostraron que en los estudiantes prevalece un nivel de estrés severo, ubicándose en un rango del 61 % al 100 %. Los principales factores estresores identificados fueron la sobrecarga de tareas (M=3.68) y el tipo de trabajo requerido (M=3.58). Las consecuencias más frecuentes incluyeron problemas de concentración (M=4.10) y sentimientos de depresión (M=3.77). Como estrategias de afrontamiento, se destacan el control emocional (M=3.86) y el enfoque en aspectos positivos (M=3.62). El análisis estadístico ($\chi^2=150.530$, $p < .001$) confirmó la relación entre el semestre cursado y el nivel de estrés. Estos hallazgos sugieren la necesidad de implementar programas institucionales para manejar el estrés académico, especialmente dirigidos a estudiantes del primer semestre y a aquellos en semestres avanzados.



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Palabras clave

Educación básica, estrés académico, factores estresores, Sisco SV-21, rendimiento académico, salud mental.

1. Introduction

Academic stress in university students is an increasingly recognized problem in the educational field due to its significant impact on students' physical, mental, and academic well-being. Academic stress arises from the pressures of university studies, such as the academic load, tight deadlines, and the need to balance studying with other personal or family responsibilities. This set of pressures can lead to various difficulties for students, affecting both their physical and mental health and manifesting in symptoms such as anxiety, exhaustion, frustration, and even serious illnesses that affect their health.

Stress significantly affects students' quality of life, negatively impacting their academic performance and personal development. A stressed mind is constantly overwhelmed by external concerns, which hinders concentration and memory, and causes sleep problems. Consequently, these problems lead to decreased motivation and energy levels, which hinder effective study and participation in academic activities.

According to the United Nations Development Program (UNDP) Human Development Report (2022), "stress, anxiety, and depression increased by 25% worldwide. The global survey revealed that 77% of people suffer from moderate or severe stress, 59% suffer from anxiety, and 35% from depression" (UNDP, 2022, p. 94). In Ecuador, academic stress is equally concerning. A study conducted at the University of Cuenca by Moscoso and Barzallo revealed that 43.2% of medical students experienced moderate academic stress and 33.3% faced high levels (Moscoso and Barzallo, 2018, p. 90). These data highlight the urgent need to implement effective strategies to prevent and reduce academic stress, in order to protect the mental health and optimize the performance of university students.

The objective of this paper is to evaluate the levels of academic stress experienced by students in the In-Person Basic Education program at the Central University of Ecuador by applying the Sisco SV-21 Inventory. The research questions are: What is the level of stress experienced by students? What factors generate it? How does it affect academic performance?

The article is structured in five sections, consisting of a literature review on academic stress, the methodology used, the results obtained, a discussion of the findings, and finally, the conclusions.

2. Literature Review

2.1 Stress

Stress is a natural response of the body to situations perceived as challenging or threatening. In fact, the World Health Organization (WHO) defines it as a state of mental worry caused by a complicated situation (WHO, 2023, para. 1). When this state becomes permanent, it can have significant negative effects on physical and mental health, making it difficult to concentrate and increasing anxiety levels in daily activities.

On the other hand, focused specifically on the educational field, academic stress is defined as "the discomfort that the student experiences due to physical or emotional factors that exert significant pressure, affecting their academic performance and their metacognitive



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ability to solve problems" (Zárate et al., 2018, p. 155). Given the multiple demands and pressures inherent in university life, stress has become a recurring problem among students.

2.2 Academic Stressors

According to Estrada et al. (2024), "academic stressors are factors linked to the educational environment that cause stress in students, which can have various adverse effects on their physical and mental health, as well as on their academic performance" (p. 1132). Therefore, academic stressors are considered to be the causes that negatively influence students. Ovalle mentions that stressors arise from a mixture of individual, social, and academic factors that interact with each other within the school environment. These factors can include insufficient time for submitting assignments, the workload, assessments, teacher demands, unclear assignments, and teacher attitudes, among others (Ovalle (2024, p. 44).

These factors, when combined, generate anxiety and stress for students at university. According to Olmedo and Cabezas (2021), the stressors that university students experience are "excessive homework, assessments, and group work, internal competition within their peer groups, and poor teaching practices by some teachers; these are some of the factors that affect students' emotional and academic stability" (p. 784).

2.3 Consequences of stress in university students

University students play different roles in their daily lives, whether in the academic, family, social, and even professional spheres. This burden of responsibilities generates stress, causing various problems such as lack of concentration, fatigue, poor nutrition, carelessness, sadness, poor academic performance, nervousness, feelings of anger, and aggression. On the other hand, Gusqui and Galárraga (2023) mention that "stress directly affects students' cognitive development because it decreases the level of learning, attention, concentration, and memory" (p. 4), which is the cause of poor academic performance.

Other consequences of academic stress include individual physical manifestations such as increased heart rate, perspiration, and muscle tension in the arms and legs; shortness of breath and teeth grinding, sleep disorders, chronic fatigue, headaches, and digestive problems. The most relevant behavioral reactions are deterioration in performance, a tendency to argue, isolation, discouragement, smoking, alcohol or other consumption, absenteeism, nervousness, increased or decreased appetite, and sleep (Silva et al., 2020, p. 77).

2.4 Strategies to cope with stress

Stress coping strategies are the procedures or methods students use to reduce stress and achieve emotional, social, and cognitive balance.

Likewise, coping strategies are essential for managing stressful situations, as they influence how a person responds to stress. These strategies include being assertive in expressing needs, planning to address problems, assessing oneself to maintain resilience, and seeking information to understand the problem (Linares & Mescua, 2022, p. 4). Together, these practices help reduce stress and improve responses to challenges.

The effective use of coping strategies reduces stress and anxiety levels, improves self-esteem and quality of life. It also improves academic performance and the ability to learn and apply knowledge and skills in practice (Sierra and Moreno, 2023, p. 80).



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Therefore, coping strategies are crucial for psychological well-being, mitigating stress and anxiety and boosting self-esteem. Beyond the personal, their impact extends to the educational sphere, directly improving academic performance and the ability to apply knowledge in practice. This underscores the need to integrate the development of these competencies as a fundamental pillar of students' comprehensive education.

2.5 Academic Performance

Academic performance reflects the level of understanding and application of knowledge acquired by university students in different areas of study, constituting a key indicator of their learning outcomes (Gutiérrez et al., 2021, p. 14). In this sense, it allows us to assess how students understand and apply the knowledge taught in the educational environment.

Zárate et al. (2018) mentions that "students enter university lacking study habits, which affects their academic performance. They lack adequate reading and note-taking techniques, and lack time management skills, and they also lack concentration" (p. 154). In this sense, teachers must use different methodologies to motivate students to constantly improve their learning. Students' academic performance progressively improves over time because they acquire different skills, attitudes, and knowledge at university. Students learn to allocate and organize their time, manage their resources, use effective study techniques, and be self-taught; these are key factors for students to achieve good performance.

3. Methodology

3.1 Type of Research

The research adopted a quantitative approach to obtain numerical data and calculate the stress level of students in the Basic Education program. This approach, as Belloso and Lizardo point out, allows for the quantification of data, behaviors, and opinions regarding the study variables (Belloso and Lizardo, 2023, p. 254).

The design was descriptive, non-experimental, and cross-sectional. Manterola et al. (2023) explain that cross-sectional research "is conducted at a specific time during the event of interest" (p. 146). In this study, data were collected at a single point in time, specifically during the 2024-2024 academic year. The descriptive and non-experimental nature of these studies is justified, according to Sousa et al., by the fact that these studies "allow the researcher to observe, describe, and substantiate various aspects of the phenomenon. There is no manipulation of variables. Descriptive designs describe what exists, determine the frequency with which this event occurs, and classify the information" (Sousa et al., 2007, p. 504).

Therefore, a complete and accurate description of academic stressors, the consequences of stress, and the coping strategies used by university students to mitigate their daily stress levels was provided, without manipulating the variables.

3.2 Research Method

The deductive method was used, which, according to Prieto (2018), "bases its foundations on certain theoretical foundations, until it configures particular facts or practices" (p. 11). This approach allowed conclusions to be drawn from existing theories and judgments, thus facilitating a deep understanding and interpretation of the data collected on the subject of study.



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3.3 Technique and Instrument

The research used a survey using the Sisco SV-21 Inventory questionnaire developed by Arturo Barraza in 2018, which measures the stress level of university students. This questionnaire has 23 items, including a filter question that determines whether or not the participant is eligible to answer the questionnaire. Another question identifies the intensity of students' academic stress. Finally, the third, fourth, and fifth questions contain different items, which identify the stressors, symptoms, or reactions participants experience when experiencing stress, and the strategies they use to cope with stress.

All questions are on a Likert scale: never, almost never, rarely, sometimes, almost always, and always. For analysis, these options were quantified by assigning a numerical value from 0 to 5, respectively. From this, SPSS software was used to calculate the standard deviation and the overall mean. Subsequently, this average was transformed into a percentage to determine the level of stress that the students present according to the measurement scale proposed by (Barraza, 2018), which classifies the level of stress as follows: mild stress (0-48%), moderate stress (49-60%) and severe stress (61-100%).

3.3.1 Reliability level

Reliability was verified using Cronbach's alpha ($\alpha = .78$) performed in the SPSS program as shown in Table 1, considered acceptable (George and Mallery, 2019). Content validity was established by expert judgment.

Reliability statistics	
Cronbach's alpha	N of elements
.780	23

Table 1. Reliability of the questionnaire

3.4 Population and Sample

The population consisted of students from the In-Person Basic Education Program at the Central University of Ecuador. Stratified probability sampling was used. According to Otzen and Manterola, this sampling consists of dividing a population into homogeneous subgroups, called strata, and then randomly selecting the individuals who will form the sample according to different inclusion and exclusion criteria (Otzen and Manterola, 2017, p. 228). In this research, stratified probability sampling was carried out by semesters, whose inclusion and exclusion criteria are established in Table 2.

Inclusion criteria	Exclusion Criteria
Students enrolled in the in-person Basic Education program during the 2024-2024 period	Students enrolled in the blended learning program and during other academic periods
Students who have provided informed consent	Students who do not have informed consent
Students who answered "Yes" to the first question	Students who answered No to the first question

Table 2. Inclusion and exclusion criteria of the sample

After applying the inclusion and exclusion criteria in the stratified probability sampling by semester, the following sample was obtained: first semester (n=67), second semester (n=70), third semester (n=90), fourth semester (n=59), fifth semester (n=65), sixth



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semester (n=65), seventh semester (n=50), eighth semester (n=52), and ninth semester (n=68), for a total of 586 students.

Because this is a research project involving human participants, the data provided was guaranteed to be anonymous and confidential. Furthermore, participants were informed that they were free to withdraw at any time without harming the researchers.

4. Results

4.1 Results of the questionnaire applied to the students

SPSS was used to process the data, and the following results were obtained for items 4, 5, and 6 of the questionnaire, which are used to determine students' stress levels. The items listed detail the stressors, symptoms, and coping strategies used by university students. Table 3 shows the stressors that are the reasons why students experience academic stress.

Stressors	N	Media	Standard Deviation
4.1 The overload of homework and schoolwork I have to do every day	586	3.68	0.50
4.2 The personality and character of my teachers	586	2.12	0.79
4.3 The way my teachers evaluate me (through essays, research papers, internet searches, etc.)	586	3.17	0.65
4.4 The level of demands my teachers place on me	586	2.28	0.78
4.5 The type of work my teachers ask me to do (topic review, worksheets, essays, concept maps, etc.)	586	3.58	0.89
4.6 Having limited time to complete the work my teachers assign me	586	3.10	0.65
4.7 The lack of clarity I have about what my teachers want	586	2.86	1.03

Table 3. Results of the questionnaire applied to students regarding academic stressors

According to Table 3, the most frequent stressors that university students present are the following: the most frequent being the overload of tasks and schoolwork that I have to do every day (M=3.68), followed by the type of work that the professors ask me to do (M=3.58), the way my professors evaluate me (M=3.17) and the limited time to do the work (M=3.10). Finally, the least frequent are the level of demand from my professors (M=2.28) and the personality and character of the professors who teach me (M=2.12).

Symptoms	N	Media	Standard Deviation
5.1 Chronic fatigue (permanent tiredness)	586	3.68	0.84
5.2 Feelings of depression and sadness (low mood)	586	3.77	0.79
5.3 Anxiety, anguish, or despair	586	2.69	0.75
5.4 Trouble concentrating	586	4.10	0.78
5.5 Feeling aggressive or increased irritability	586	3.41	1.08
5.6 Conflicts or a tendency to argue or argue	586	3.12	1.00



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5.7 Reluctance to do schoolwork	586	3.55	1.19
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Table 4. Result of the questionnaire applied to students regarding the symptoms presented by students of the Basic Education career

Table 4 shows the symptoms university students present when they are stressed. The most frequent are concentration problems (M=4.10), feelings of depression and sadness (low mood) (M=3.77), chronic fatigue (permanent tiredness) (M=3.68), and reluctance to complete schoolwork (M=3.55). Finally, the least frequent are: conflicts or tendency to argue or argue (M=3.12), and anxiety, anguish, or despair (M=2.69).

Strategies	N	Media	Standard Deviation
6.1 Focus on resolving the situation that worries me	586	3.38	0.64
6.2 Establish concrete solutions to resolve the situation that worries me	586	2.93	0.52
6.3 Analyze the positive and negative aspects of the solutions considered to resolve the situation that worries me	586	3.08	0.70
6.4 Maintain control over my emotions so that I am not affected by what stresses me	586	3.86	0.79
6.5 Recall similar situations that have occurred previously and think about how to resolve them	586	2.85	0.62
6.6 Develop a plan to address what stresses me and carry out its tasks	586	3.09	0.86
6.7 Focus on or try to obtain the positive aspects of the situation that worries me	586	3.62	1.40

Table 5. Result of the questionnaire applied to students regarding coping strategies

On the other hand, Table 5 shows the coping strategies used by university students when they are stressed, the most frequent being: Keeping control over my emotions so that I am not affected by what stresses me out (M=3.86), Focusing on or trying to obtain the positive aspects of the situation that worries me (M=3.62), and Concentrating on solving the situation that worries me (M=3.38). Finally, the least frequent are: Establishing concrete solutions to resolve the situation that worries me (M=2.93) and Remembering similar situations that have occurred previously and thinking about how to solve them (M=2.85).

4.2 Level of Stress presented by students

Figure 1 shows the stress level of students in the In-Person Basic Education program according to the semester they are enrolled in during the 2024-2024 period. It can be seen that the first, seventh, eighth, and ninth semesters have a severe stress level, ranging from 61% to 100%; the second, third, fourth, and fifth semesters have a moderate stress level, ranging from 49% to 60%. Finally, sixth-semester students have a mild stress level, ranging from 0% to 48%.



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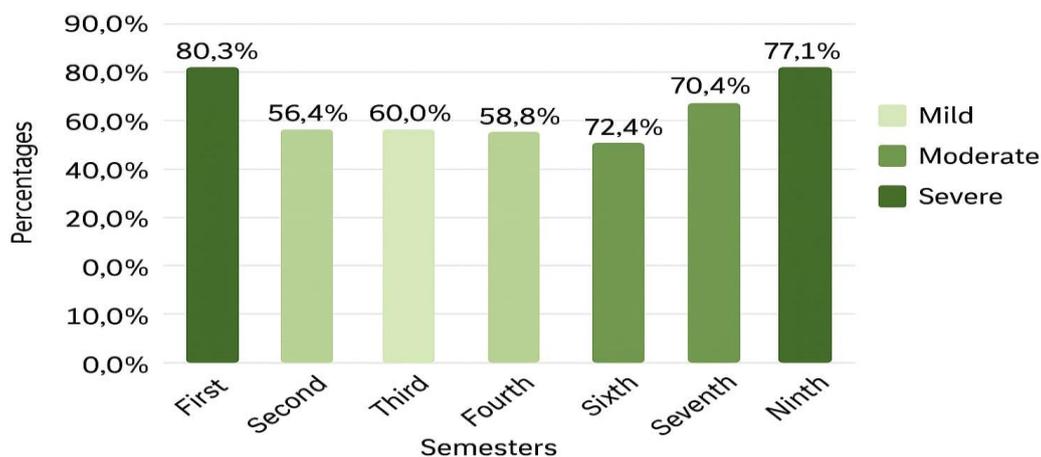


Figure 1. Stress level presented by students of the Basic Education Degree

4.3 Statistical Modeling

A Chi-square (χ^2) statistical analysis was performed with a 95% confidence level and a maximum error of 5% ($p < .05$) to evaluate the relationship between the semester the student is taking and the stress level. According to Hernández et al., the Chi-square analysis is a statistical test developed by Carl Pearson, which uses the analysis of two or more groups of categorical variables to determine whether or not there is a correlation and in turn the null hypothesis is discarded or the alternative hypothesis is accepted. If the result of the Chi-square coefficient is greater than 0.05, the null hypothesis is approved, therefore, there is no relationship between variables, while if the result of the Chi-square coefficient is less than 0.05, the alternative hypothesis is approved, therefore, there is a correlation between variables (Hernández et al., 2017, p. 294).

	Chi-square tests		
	Value	df	Asymptotic significance (bilateral)
Pearson's Chi-square	150.530 ^a	32	.000
Likelihood ratio	169.473	32	.000
Linear by linear association	98.556	1	.000
N of valid cases	586		

Table 6. Relationship between the semester the student is taking and the stress level

In Table 6, the Chi-square analysis yielded a significant value of 0.000, indicating statistical significance as it was less than the critical level of 0.05. This allows us to reject the null hypothesis and confirm that there is a significant relationship between the semester completed and the student's stress level, demonstrating that progress in the academic career directly influences reported stress levels.

The influence of the semester on stress levels can be explained by the structure of the curriculum and the demands inherent to each academic stage. At initial levels, students must adapt to a new university environment and adjust to the change in academic processes compared to high school. At intermediate levels, students have already acquired some



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familiarity with academic dynamics, so they tend to present mild or moderate stress levels. However, in the final semesters, students face a considerable workload, including courses, internships, community engagement, and graduation hours, which contributes to a high level of stress in the later semesters. This progression shows that both the beginning and end of the university journey are associated with greater emotional and academic demands.

5. Discussion of Results

The results show that the main stress-generating factors for students in the Basic Education program are related to homework overload ($M=3.68$), the type of work assigned by teachers ($M=3.58$), the way teachers evaluate them ($M=3.17$), and the limited time to complete assignments ($M=3.10$). These findings support the study by Infantas and Heredia (2023), which indicated that 40.6% of students feel stressed due to an overload of academic activities and assignments. Furthermore, 38.35% of students are stressed by the type of work their teachers assign, as it is long and unclear. Finally, 45.11% of students feel stressed due to the assessment methods used by teachers.

These results are consistent with the research by Tirado et al. (2023), which highlights that more than 40% of students always and almost always felt stressed by work overload, teacher evaluations, and limited time to complete activities. This allows us to corroborate the information with the results obtained.

Regarding the consequences of academic stress, the most frequently identified consequences were concentration problems ($M=4.10$), feelings of depression and sadness ($M=3.77$), persistent fatigue ($M=3.68$), and a lack of enthusiasm for completing university assignments ($M=3.55$). These results align with the findings of Velasco and Barraza, who observed that students had moderate to severe symptoms (80%), characterized mainly by anxiety (2.6) and restlessness (2.45). Among the physical symptoms (74.5%), chronic fatigue (2.45) and drowsiness (2.44) stand out. Finally, among behavioral symptoms (69.5%), there is a lack of enthusiasm for schoolwork (Velasco & Barraza, 2024, p. 41). This allows us to reaffirm the results obtained and emphasize that the prevalence of these symptoms highlights the urgent need for effective strategies for managing academic stress.

Due to the consequences experienced by students, it is necessary to identify the coping strategies used by university students, which are the following: maintaining control over my emotions ($M=3.86$), focusing on or trying to find the positive aspects of the worrying situation ($M=3.62$), and focusing on resolving the situation that worries me ($M=3.38$). In addition, Arpi et al. (2024) suggest implementing wellness and psychological support programs to improve students' mental health and academic performance. Likewise, it is mentioned that first-semester students and students in higher levels have a severe level of stress, that is, high, due to the different activities they have to present, as stated by Gusqui and Galárraga (2023) where the highest percentage of academic stress was in the most advanced educational level, with 90.2% and in the first level with 89.6% of students. Finally, Martínez et al. (2023) conclude in their research that "if the level of academic stress increases, academic performance will be reduced" (p. 3316). Similarly, Martínez (2018) obtained similar results in his study on the influence of stress on academic performance, which allows corroborating the results obtained within the research.

6. Conclusions

The absence of stress in students is essential for leading a healthy, productive, and balanced life, both personally and professionally. Academic stress has a negative impact on student



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performance, affecting not only their ability to concentrate and solve problems, but also their emotional well-being, causing depression, sadness, and depression. This makes it impossible to carry out daily activities effectively, as students with high stress levels are more likely to obtain lower grades. In this sense, the main factors that affect students' physical, emotional, and cognitive health are: work overload, the type of work teachers assign, limited time to complete assignments, and unclear instructions from teachers.

The results obtained show that students in the in-person Basic Education program at the Central University of Ecuador present different levels of stress depending on the semester they are enrolled in. In particular, students in the first, seventh, eighth, and ninth semesters are in the severe stress range; those in the second, third, fourth, and fifth semesters present moderate levels of stress; While sixth-semester students report a mild level of stress. Controlling stress is crucial because it allows for maintaining emotional stability, which facilitates a balance between responsibilities and free time. When this balance is achieved, it is easier to face daily challenges with a positive and resilient attitude. To achieve this state, it is necessary to apply coping strategies such as identifying concrete solutions to solve problems, controlling emotions, and developing an action plan to address worries. These actions not only reduce stress levels but also strengthen the ability to adapt to the demands of everyday life. Keeping in mind that, in any adverse situation, it is essential to capture the learning that arises from difficulty, since even mistakes represent an opportunity to grow. In this sense, we persevere in trying, since continued dedication is a fundamental pillar for achieving goals and making dreams come true.

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Declaration of authorship-CRediT

JACQUELINE DÍAZ-PARRA: State of the art, related concepts, methodology, validation, data analysis, writing, spelling check, and review of bibliographic references.

NADIA CURIPALLO-PERALTA: State of the art, related concepts, data analysis, organization and integration of collected data, conclusions, final draft and editing.

HÉCTOR ROJAS-AVILÉS: Related concepts, organization and integration of collected data, project management.

JENNY PARRA-MUÑOZ: Application of instruments, tabulation of results, drafting of conclusions.



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REVISTA

CÁTEDRA

The quality of the infrastructure of early childhood education centers in the city of Quito-Ecuador

La calidad de la infraestructura de los centros de educación inicial de la ciudad de Quito-Ecuador

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(Received on: 17/11/2024; Accepted on: 15/01/2025; Final version received on: 09/06/2025)

Suggested citation: Soto-Duque, L., Panchi-Culqui, E., & Subía-Arellano, A. (2025). The quality of the infrastructure of early childhood education centers in Quito-Ecuador. *Revista Cátedra*, 8(2), 92-110.

Abstract

The quality of infrastructure in early childhood education centers in the Metropolitan District of Quito, Ecuador (DMQ) has a significant impact on children's well-being and development. An adequate and safe physical environment is essential for learning and growth. Preschool-aged children are particularly sensitive to their environment. Therefore, the quality of infrastructure directly influences their ability to concentrate, participate in



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Revista Cátedra, 8(2), pp. 92-110, July - December 2025. e-ISSN: 2631-2875

<https://doi.org/10.29166/catedra.v8i2.7535>

educational activities, and socialize effectively. The objective of this study was to analyze the quality of the infrastructure of early childhood education centers that serve children aged 3 to 5 years. To carry out this analysis, a mixed methodology was used, based on a sociocritical paradigm, with a descriptive-explanatory scope and a non-experimental design. The research instruments used were an interview and a survey. The study sample consisted of four key informants for the interview and 94 volunteer participants for the survey. These participants were representatives of various early childhood education institutions. The conclusion was that the infrastructure of early childhood education centers in the DMQ does not meet the conditions required by existing regulations and, therefore, it is imperative to invest in its improvement to achieve quality education at this important stage of child development.

Keywords

Early childhood education, quality standards, infrastructure

Resumen

La calidad de la infraestructura en los centros de educación inicial del Distrito Metropolitano de Quito-Ecuador (DMQ) tiene un impacto significativo en el bienestar y el desarrollo de los niños. Un entorno físico adecuado y seguro es esencial para el aprendizaje y el crecimiento. Los niños en edad preescolar son especialmente sensibles a su entorno. Por ello, la calidad de la infraestructura influye directamente en su capacidad para concentrarse, participar en actividades educativas y socializar de manera efectiva. El objetivo de este estudio fue analizar la calidad de la infraestructura de los centros de educación inicial, que brindan servicio a niños de 3 a 5 años. Para llevar a cabo este análisis se empleó una metodología mixta que partió de un paradigma sociocrítico, con un alcance descriptivo – explicativo y un diseño no experimental. Los instrumentos de investigación utilizados fueron una entrevista y una encuesta. La muestra del estudio estuvo conformada por 4 informantes clave para la entrevista y 94 participantes voluntarios para la encuesta. Estos participantes eran representantes de diversas instituciones de Educación Inicial. Se determinó como conclusión que la infraestructura de los centros de educación inicial del DMQ no cumple con las condiciones requeridas por las normativas existentes y, por lo tanto, es imperativo invertir en su mejora para lograr una educación de calidad en esta importante etapa de desarrollo de los infantes.

Palabras clave

Educación inicial, estándares de calidad, infraestructura.

1. Introduction

In Ecuador, improving educational infrastructure has been a key issue in government policy over the years, reflecting the importance attached to the learning environment. In this context, recent governments have designed various projects aimed at strengthening this important element of the teaching-learning process.

During Rafael Correa's term in office (2007-2017), the New Educational Infrastructure program was implemented with the aim of providing public educational institutions with adequate furniture and equipment. According to the Ministry of Education (2023), this program sought to “increase access to education and improve the quality of existing infrastructure” (para. 3). In addition, priority was given to the construction and



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maintenance of classrooms throughout the country, establishing partnerships with decentralized autonomous governments to carry out educational infrastructure works. During the administration of Lenín Moreno (2017-2021), the New Educational Infrastructure Program was continued; however, in response to financial and administrative challenges, efforts were made to optimize resources through rehabilitation rather than complete replacement of infrastructure (Ministry of Education of Ecuador, 2021).

Finally, under the administration of Guillermo Lasso (2021-2023), emphasis was placed on quality and equity in education. This administration reaffirmed its commitment to these areas, continuing to invest in infrastructure to improve school conditions. In addition, it maintained the New Infrastructure Program for the universalization of quality and equitable education, with the aim of providing educational institutions with adequate infrastructure. In retrospect, recent governments have made significant efforts to improve educational infrastructure in Ecuador through various initiatives and programs. These efforts have materialized in the proposals implemented by the different administrations, although the practical effectiveness of these improvements has been limited (Ministry of Education of Ecuador, 2023).

The present research aims to analyze the quality of the infrastructure of early childhood education centers that serve children aged 3 to 5 years. According to the Ecuadorian Ministry of Education (2016), the physical infrastructure of each educational institution must be established based on the needs and requirements stipulated for each educational level, specifically determined by minimum occupancy, space equipment, and the ages and sizes of the students, in order to provide spaces that are adequate for the general and specific needs of each group.

The Ministry of Education (2023), in Article 13 of the General Regulations to the Organic Law on Intercultural Education, establishes the standards and indicators of educational quality. These must be observed both by the National Education Authority in its processes and by the National Institute for Educational Evaluation in its evaluations. They include learning achievements, professional performance, school management, well-being and coexistence, as well as the necessary infrastructure and equipment (Ministry of Education, 2023).

This research focuses on the question: What is the state of the quality of infrastructure in early childhood education centers serving children aged 3 to 5 in the DMQ? This quality encompasses physical and material aspects such as safety, hygiene, accessibility, and furniture, as well as specific criteria within the classroom. These elements are crucial in early childhood education centers, significantly influencing children's cognitive, emotional, and social development. According to Sando (2019), "the indoor physical environment influences children's well-being and physical activity." (p. 514). "The physical learning environment should be considered a causal factor distinct from cognitive load, interacting with both the characteristics of the learner and those of the type of learning task" (Choi, van Merriënboer, and Paas, 2014, p. 226).

Inadequate infrastructure negatively affects performance, highlighting the need to reflect on this issue in order to motivate action by governments, institutional authorities, and teachers. Espinoza and Flores (2020) suggest that "Deficiencies in educational infrastructure directly affect students' academic performance, limiting optimal conditions



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for learning and generating a negative impact on school results” (p. 78).

The article's general structure consists of: 2) a review of the literature, with an exhaustive search for theoretical references to support the study; 3) methods and materials, which are systematically described in terms of the development of the research; 4) results, which are established on the basis of quantitative and qualitative analysis; 5) discussion of the results, relating them to previous studies; and 6) conclusions that summarize the content of the study.

2. Literature review

The review of the scientific literature reveals various studies in Latin America and Ecuador. Theoretically, this refers to the analysis of school infrastructure, highlighting its importance in the learning process of children in their early years.

2.1 Educational infrastructure in Latin America

Various studies have revealed that educational infrastructure in Latin America, especially at the early childhood level, presents significant gaps that impact educational quality. Brown-Ríos (2022) points out the need to overcome these disparities, prompting research such as that conducted by UNESCO (2017) to assess quality in this context. Despite recent improvements, many institutions still lack basic services such as electricity and drinking water, primarily affecting the most vulnerable sectors.

Quesada (2019) highlights that the organization of educational spaces continues to restrict collaborative learning, and the lack of maintenance affects the functionality of facilities. Furthermore, Pacheco-Martínez (2021) indicates that deficiencies in educational infrastructure directly affect academic performance, emphasizing the need to comply with basic regulations in preschool education institutions.

2.2 Educational infrastructure in Ecuador in recent governments

In Ecuador, Bermúdez (2019) highlights that, although classrooms meet safety requirements, improved community interaction is necessary for comprehensive development. Cuenca-Reyes, et al. (2020) observe that, although many institutions comply with technical standards, others do not meet the requirements due to their outdated design. Locally, Quiña (2018) found that infrastructure in Quito is deficient, with old buildings that affect children's safety and development. These institutions face problems such as a lack of recreational areas and poor resource management to meet established quality standards. School infrastructure in the region still faces significant challenges. Responsible agencies and educational specialists must continue working on solutions that address the specific needs of current educational contexts.

Projects such as the New Educational Infrastructure (Ministry of Education, 2021b) have been implemented in Quito. These projects are intended to improve facilities and foster a suitable learning environment. However, evaluation of these advances remains limited.

Over the past few decades, the budget allocated to the education sector in Ecuador has experienced a sustained increase, but each administration has allocated resources differently, as indicated in their respective Reports to the Nation of the National Secretariat of Planning and Development. (Correa, 2017; Moreno, 2018; Lasso, 2023).

Under Rafael Correa's administration (2007-2017), significant investment was made in educational infrastructure, focusing on the construction and rehabilitation of educational



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institutions, improving learning conditions and access to public education. Subsequently, during Lenín Moreno's administration (2017-2021), although some of the previous projects were continued, the strategy focused on public spending efficiency. Furthermore, attention was paid to reviewing existing infrastructure, in addition to promoting teacher training and raising educational standards. Next, Guillermo Lasso (2021-2023) promoted the modernization of educational infrastructure. He integrated technology into classrooms and improved facilities throughout the country. His focus has been on promoting education as an engine of economic growth and social mobility. Finally, Daniel Noboa, who begins his term in 2023 in his current government, has placed education at the center of his development vision. He has pledged to increase investment in educational infrastructure and quality education. Although each administration has followed different strategies, the budget allocated to the education sector has shown a tendency to permanently increase.

2.3 Early Childhood Education Infrastructure.

Early childhood education infrastructure is essential for the comprehensive development of children in their early years. It not only marks the beginning of their formal education but also fosters their cognitive, emotional, and social growth. Childcare centers and preschool programs provide a safe and stimulating environment for early learning. Despite their importance, there are limitations in their accessibility and equity that highlight the need for policies that guarantee quality preschool education.

Friedrich Froebel (1826/2003) introduced the concept of "kindergartens" as a physical educational space connected to nature, using this metaphor to illustrate the role of the educator as a gardener who cares for the child's development. This approach highlights the importance of an environment that fosters exploration and learning in children (Rivas, 2015).

2.3.1 Distribution of physical space

From the children's perspective, the ideal classroom should be calm, welcoming, and motivating, promoting their emotional well-being and learning. Educational institutions must meet these criteria to foster effective learning. Appropriate design of the physical environment influences children's learning, safety, and emotional well-being (Castro-Pérez & Morales-Ramírez, 2015), encouraging exploration, creative play, social interaction, and the development of motor skills. In addition, key aspects such as safety, accessibility, lighting, and ventilation must be considered. Preschool centers must meet observable criteria in the Infrastructure Quality Standards. The Ministry of Education (2012) includes:

- Land Regulations: Planning must ensure a safe and suitable environment, taking into account location, accessibility, and proximity to services.
- Classroom Dimensions: Classrooms must be spacious, with a minimum of 1.20 x 1.80 square meters per child, to facilitate movement and activities.
- Adequate Lighting: Optimal natural and artificial light is crucial for children's comfort and concentration.
- Signage: Signage must be clear and understandable to guide children and promote positive behavior.
- Learning Environments: These should foster independence, cognitive development, and social interaction, allowing children to progress at their own pace.
- Outdoor Areas: These provide opportunities for active play, contact with nature, and physical development.



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- Community Activity Spaces: These promote socialization and the development of motor and social skills through games and sports.
- Safe children's play areas: Recreational spaces must be safe and age-appropriate for children, promoting comprehensive development in a supervised environment.

2.3.2 Administrative management for obtaining resources

The management of an educational center involves the planning, coordination, and monitoring of activities aimed at obtaining public and private funding. These resources are used to cover operating expenses, infrastructure, educational materials, and personnel. This may include the search for grants, donations, government funding, and fundraising strategies, as well as the efficient management of available resources. The management staff is responsible for administrative management in schools, emphasizing the need to improve their performance through mechanisms that optimize their work. In private preschools, Esquivel and Huamaní (2016) conclude that there is a significant relationship between administrative planning and service quality. In the administration of an early childhood education institution, it is crucial to properly manage the following aspects:

- Furniture: The Ministry of Education (2023) establishes that institutions must have adequate classroom furniture, designed for each educational level. This includes ergonomic and safe furniture that facilitates educational and recreational activities, ensuring the comfort and safety of children.
- Updated inventory: Maintaining an up-to-date inventory is essential for the functionality and safety of the center. APPSGATE (2023) indicates that efficient inventory management saves time, reduces costs, and improves the functionality of the educational environment.
- Periodic maintenance: Periodic maintenance of furniture and equipment is essential to ensure a safe and functional learning environment.
- Equipment and teaching resources: These elements are essential in early childhood education institutions. They provide tools for learning and promote children's comprehensive development (Ministry of Education of Ecuador, 2021).
- Food area: According to Campos et al. (2003), cafeterias in educational centers are essential for children's health and nutrition. They must comply with space and safety regulations.
- Administrative area: The Ecuadorian Ministry of Education (2017) emphasizes that principals must focus on improving leadership and management to ensure quality learning.
- Teachers' lounge: Enríquez-López and Peña-Benítez (2020) indicate that furniture must adapt to the ergonomic needs of teachers. The goal will be to improve their comfort and work efficiency.

This comprehensive approach to resource and space management ensures an environment. Children develop appropriately alongside the effective teaching staff.

2.3.3 Hygiene and cleaning

Promoting healthy habits and the appropriate use of fun educational resources motivate children to acquire and strengthen their knowledge. This is demonstrated by building new skills and reinforcing existing ones (Vizhñay-Cajamarca, 2019). To meet health requirements in educational institutions, the following elements must be considered:



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- Sanitary facilities: They must have at least one toilet for every 25 students, one urinal for every 25 students, and one sink, all in optimal condition. Staff bathrooms must be gender-segregated.
- Basic services: It is essential that educational institutions have basic services such as water, electricity, sewage, garbage collection, telephone, and internet.
- Cleaning and disinfection: Maintaining an adequate level of cleanliness is crucial for children's health. McMichael (2019) emphasizes that infrastructure and resources for hand hygiene are key to promoting hygiene habits and reducing associated diseases.
- Waste management: Promoting environmental education through pedagogical strategies such as ESVI (Life Spaces), which include bio-garden and recycling projects. These activities, such as organic waste management and the reuse of materials, stimulate naturalistic intelligence in students as they interact with nature (Tiquillahuanca, 2019).

2.3.4 Safety

The right to safety in early childhood education centers is compromised by the lack of adequate mechanisms and the institutional incapacity to guarantee it. The absence of prevention programs in security and civil protection reveals a gap between education and prevention, leaving teachers and students without the necessary tools to face emergencies. It is crucial to demand that authorities implement a comprehensive security model that covers all educational levels and the specific needs of each community. Furthermore, it is necessary to improve teachers' preparation for emergencies, encouraging their training and participation in the creation of a sustainable safety culture (Reyes-Torres, 2023).

Key safety principles include:

- Accessibility. Educational institutions must comply with regulations that ensure the use of the environment for all people, regardless of their physical or sensory condition (Rojas and Santos, 2005).
- Doors with anti-panic locks. These locks are designed to facilitate quick and easy exit in the event of an emergency. The mechanism is activated by a bar that is pushed to open the door (Porlan-Soto, 2022).
- Effective security systems. Efficient management is essential in the construction of educational facilities. The various risks involved are considered to develop effective contingency plans (Pineda and Sotelo, 2013).
- Risk management plan. The Ecuadorian Ministry of Education has prioritized school safety through Public Policy 2018-2030. It seeks to reduce the risks of natural disasters and protect the continuity of education. The 2023-2024 risk management plan includes strategies to protect the life and safety of the educational community. It is important to ensure educational continuity in emergencies and develop a community resilient to disasters (Ministry of Education, 2023).

3. Methods and materials

This research adopts a sociocritical paradigm for evaluating the quality of infrastructure in early childhood education centers (public, private, and fiscomisional) in the DMQ, with the aim of identifying structural inequalities that affect the education of children aged 3 to 5. A mixed methodological approach is used, combining quantitative and qualitative methods. The study is descriptive and explanatory in scope, seeking to identify and



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characterize the physical and functional conditions of the infrastructure. The research design is non-experimental in its quantitative phase. For the qualitative phase, grounded theory is used. Finally, the study is field-based.

Structured surveys were used as techniques to collect quantitative data on the perception of these variables by teachers and administrators. They were also used to measure specific aspects such as safety, accessibility, and the condition of the facilities.

This analysis allows for the identification of patterns and trends, providing a solid empirical basis for understanding the inequalities and deficiencies that exist in educational centers. At the same time, in-depth interviews are conducted to collect qualitative data that delve into the experiences and perspectives of the participants. This qualitative component is essential in the socio-critical paradigm and allows us to capture the voices and experiences of those directly affected by poor infrastructure. Through these methodologies, it is possible to identify the physical problems of the centers, as well as their impact on children's learning and well-being. Exposing the dynamics of exclusion that perpetuate these conditions. The combination of these methods ensures a more holistic and nuanced understanding of the situation.

The population consists of teachers and administrators from various public, private, and public-mission early childhood education institutions in the city of Quito. The sample for the interview will consist of four participants who will serve as key informants for the study. For the survey, the sample consists of a total of 94 early childhood education teachers from various institutions in the city of Quito. Participants will be chosen intentionally, using a non-probabilistic sampling technique, and their characteristics are shown in Table 1.

		Frequency	Percentage
Respondent's position	Authority	6	6.4
	Teaching	83	88.3
	Assistant		
	1-5	5	5.3
Years of experience	6 to 10	31	33.0
	11 to 15	24	25.5
	Over 16 years	19	20.2
	old		
	Technologist	20	21.3
Academic qualifications	Bachelor's	5	5.3
	Degree		
	Master's	59	62.8
	Degree		
	Tax	30	31.9
Type of institution where they work or have worked	Tax	46	48.9
	Commission		
	Municipal	2	2.1
	Private	15	16.0
	Early	31	33.0
	Childhood		



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Level at which they work or have worked	Education (0 to 3 years)		
	Early Childhood Education (3 to 5 years)	25	26.6
	Authority	69	73.4
Have worked in institutions in the Quito District	Si	61	64.9
	No	33	35.1
	Total	94	100.0

Table 1. Sociodemographic characteristics of the participants

Within the qualitative approach, the interview technique is used, and the semi-structured interview is used as the data collection instrument. The interview was validated by three professionals with expertise in Early Childhood Education.

For the quantitative approach, a survey is used. The instrument is a questionnaire containing questions corresponding to the variable: infrastructure quality. Cronbach's alpha statistic was applied to the questionnaire, yielding an internal consistency coefficient of 0.91, as shown in Table 2.

	Cronbach's alpha	No of elements
Quality of infrastructure	0.917	11

Table 2. Reliability statistics

Qualitative data analysis is carried out using semantic networks that show the connections between concepts and their semantic relationships. Coding operations are used to analyze and categorize initial data and identify patterns, themes, and emerging concepts. For quantitative data analysis, SPSS statistical software is used, generating a contingency table for the respective frequency analysis.

4. Results

Table 3 presents the main results, thanks to the discourse analysis from which the following categories of analysis emerged: 1. Distribution of space, 2. Safety and inclusion, and 3. Influence on educational excellence. Within the category "Distribution of space" in the subcategory: current condition of the space, concern was found regarding the adequacy and quality of educational infrastructure. This was mainly in early childhood education classrooms. The lack of certain essential spaces, such as corner rooms and specific green areas for education at this level, was noted. In the subcategory: ideal condition of the space, the importance of having well-distributed and adequate spaces to promote learning and the comprehensive development of children was highlighted. The importance of well-designed and accessible play areas was emphasized. In addition, the need for multipurpose spaces that can be adapted for both daily learning and special events involving families is highlighted.

Within the category "Safety and inclusion" in the subcategory: safety measures in place,



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there is concern about the comprehensive safety of children in the educational institution. It expresses the need for adequate infrastructure to minimize accidents, emergency preparedness, and the importance of ensuring safe environments in both physical and psychological terms. In the subcategory: necessary adaptations for inclusion, the need to adapt educational facilities to ensure the effective inclusion of children with disabilities is emphasized. In addition, the importance of adjusting infrastructure to meet specific standards for children and not just for adults is highlighted.

Within the category “Influence on educational excellence” in the subcategory: relationship with teaching quality, the criteria are similar. The common criterion among participants is that the lack of adequate infrastructure negatively affects the quality of education at the early childhood level. Poor infrastructure can lead to children feeling uncomfortable, unmotivated, and insecure, which directly impacts their learning and academic performance.

Category	Subcategory	Common Meaning
Space Distribution	Current condition of the space	There is widespread concern about the quality and adequacy of infrastructure in early childhood education classrooms. The lack of specific spaces such as playrooms and green areas is highlighted, especially in new or marginalized institutions.
	Ideal condition of the space	Participants agree that a well-planned and adequate distribution of spaces is crucial to promoting learning and comprehensive development. They emphasize the importance of thematic and recreational areas that facilitate teaching and family interaction.
Safety and Inclusion	Present safety measures	The comprehensive safety of children is a shared concern, with an emphasis on constant supervision. The need for physical measures such as security cameras and the importance of having adequately equipped areas to prevent accidents is highlighted.
	Necessary adaptations for inclusion	Participants agree on the need for physical adaptations to ensure the effective inclusion of children with disabilities. This includes adequate ramps, handrails, and inclusive play spaces that meet specific standards for children.
Influence on Educational Excellence	Relationship with the quality of teaching	There is consensus that the lack of adequate infrastructure negatively impacts the quality of education at the early childhood level. This affects learning, emotional and social development, and generates demotivation in both children and teachers.

Table 3. Qualitative Analysis



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Regarding the descriptive quantitative analysis, the following measures of central tendency are obtained, outlined in Table 4. The sample size ($N = 94$) is equal in both periods. The means (39.56 and 39.28) are very similar, indicating that the average quality of the infrastructure has not changed significantly between the two periods. The average value is close to 39 in both cases. The median (41.00 and 40.00), which represents the midpoint of the data, is slightly higher in the first period (2008-2016) at 41, while in the second period it is 40. This shows that the distribution of the data is similar, but with a slight shift toward lower values in the second period. The mode (43 and 44) also varies slightly, with 43 in the first period and 44 in the second. This suggests that the most recurrent values are similar in both periods.

Regarding the standard deviation (8.781 and 8.837), the dispersion of the data is practically equal in both periods, indicating that the variability in infrastructure quality is consistent. The skewness is negative in both periods (-0.296 and -0.256), which means that the distributions are slightly skewed to the left.

	Total infrastructure quality 2008-2016	Total infrastructure quality 2017-2021
N	94	94
Mean	39.56	39.28
Median	41.00	40.00
Mode	43	44
Standard Deviation	8.781	8.837
Skewness	-.296	-.256
Minimum	14	14
Maximum	55	55

Table 4. Comparative analysis between the measures of central tendency of the two periods

The minimum (14 in both cases) and maximum (55 in both cases) values for infrastructure quality are identical in both periods. This indicates that the observed quality ranges have not changed. For infrastructure quality from 2008 to 2016, the Kolmogorov-Smirnov test yields a value less than 0.05. This suggests that the null hypothesis is rejected, indicating that the data for this period do not follow a normal distribution. For infrastructure quality from 2017 to 2021, the Kolmogorov-Smirnov test yields a significance value greater than 0.05. The null hypothesis is rejected, suggesting that the data follow a normal distribution. See Table 5.

			Kolmogorov-Smirnov^a		
			Estadístico	gl	Sig.
Total	infrastructure	quality	.118	94	.002
2008_-					
Total	infrastructure	quality	.084	94	.102
2017-2021					

Table 5. Normality Test

In the case of the location of care units (item 1), the percentage of agreement and total agreement remains stable. Slightly lower in the most recent period, suggesting that the



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centers comply with regulations, but some areas for improvement remain. For functional and recreational spaces (item 2) and the layout of lockers (item 3), the results remain constant between both periods. This indicates a moderate level of satisfaction.

Item 4, which evaluates toilets and sinks, shows a slight improvement in the recent period, although there are still high levels of disagreement. Other items, such as space per student and classrooms (items 5 and 6), reflect small variations, remaining within similar margins in both periods. Finally, material resources (item 8) and trained staff (item 9) receive more positive evaluations in 2017-2021. However, concerns remain about the availability of financial resources (item 10) and infrastructure improvements (item 11).

When comparing the 2008-2016 and 2017-2021 periods, gradual improvements can be seen in some aspects, while others show stagnation or slight declines. With regard to the individual analysis of the frequency of response options: Strongly disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly agree (SA), the results for each question are shown in Table 6.

Ítems	Períodos	Frecuencia en %					Total
		T D	D	I	D A	TA	
1. The location of the MIES and MINEDUC care units complied with the regulatory and planning standards, according to parameters established by the National Secretariat for Risk Management.	2008 - 2016	2.1	10.6	20.2	46.8	20.2	100
	2017-2021	2.1	13.8	20.2	40.4	23.4	100
2. The Early Childhood Education Centers have functional educational spaces connected to the recreational spaces.	2008 - 2016	3.2	8.5	18.1	47.9	22.3	100
	2017-2021	3.2	9.6	18.1	46.8	22.3	100
3. The Early Childhood Education Centers have lockers for students, interior shelves for teaching materials, and interior shelves for students and teachers.	2008 - 2016	2.1	13.8	8.5	51.1	24.5	100
	2017-2021	2.1	11.7	11.7	48.9	25.5	100
4. The Early Childhood Education Centers have one toilet and one urinal for every 25 students, and one sink and one toilet for children with special educational needs.	2008 - 2016	6.4	21.3	22.3	35.1	14.9	100
	2017-2021	7.4	21.3	19.1	37.2	14.9	100
5. The Early Childhood Education Centers have outdoor areas with	2008 - 2016	6.4	18.1	23.4	36.2	16	100



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1.50 square meters of space per student.	2017-2021	7.4	18.1	22.3	36.2	16	100
6. The Early Childhood Education Centers have classrooms of 1.20 square meters per child in a total area of 72 square meters.	2008 - 2016	5.3	21.3	24.5	34	14.9	100
	2017-2021	5.3	21.3	23.4	35.1	14.9	100
7. The institution's learning environments are ideal for the teaching-learning process.	2008 - 2016	1.1	11.7	19.1	47.9	20.2	100
	2017-2021	2.1	9.6	17	50	21.3	100
8. The amount of material resources (games, teaching materials, infrastructure, etc.) available in the MINEDUC services was adequate for the children's comprehensive development.	2008 - 2016	3.2	14.9	16	42.6	23.4	100
	2017-2021	2.1	12.8	16	46.8	22.3	100
9. The Early Childhood Education Center had sufficient trained staff (teachers, assistants, psychologists, etc.) to adequately meet the children's needs.	2008 - 2016	3.2	6.4	24.5	36.2	29.8	100
	2017-2021	3.2	6.4	25.5	40.4	24.5	100
10. The MIES and MINEDUC care units had financial resources allocated to the Early Childhood Education Center to cover operating and maintenance expenses.	2008 - 2016	9.6	8.5	26.6	35.1	20.2	100
	2017-2021	10.6	8.5	25.5	38.3	17	100
11. The infrastructure, equipment, and furniture were improved.	2008 - 2016	4.3	19.1	18.1	38.3	20.2	100
	2017-2021	8.5	21.3	18.1	38.3	13.8	100

Table 6. Descriptive analysis of the items in the educational infrastructure quality survey

5. Discussion of results

The trend reflected in Table 6 suggests that there has been a slight improvement in the perception of compliance with standards in early childhood education centers. However, significant concerns remain among respondents, as reflected in the decrease in the percentage of those who agree in general. In line with this criterion, Earthman (2004) mentions that “over the last three decades, numerous studies have shown that there is a relationship between student performance and the condition of school buildings” (p. 18).

The fact that the number of undecided people remains stable could indicate a lack of clarity in the communication of the results of the policies implemented. This result coincides with the statement by Crampton (2009), who mentions that “the number of undecided people



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remaining stable could indicate a lack of clarity in the communication of the results of the policies implemented” (p. 318). On the other hand, the perception of the availability of functional educational spaces shows stability with a slight increase in disagreement. In this regard, Berner (1993) states that “in those schools where a large number of parents participated through their membership in the parent-teacher association (PTA), the buildings were in better condition than those where parental involvement was lower” (p. 27).

The results of this research confirm its importance by showing both slight improvements in the perception of compliance with standards and persistent concerns about infrastructure in early childhood education. The analysis revealed three main categories: space distribution, safety and inclusion, and influence on educational excellence. The lack of adequate spaces such as playrooms and green areas stands out, as does the need for multipurpose spaces. The urgency of improving safety and adapting facilities for children with disabilities was also identified.

6. Conclusions

The data suggest that the condition of classroom equipment and furniture does not fully meet users' expectations. Although perceptions of the adequacy of these elements remain stable, the slight increase in total disagreement indicates growing dissatisfaction. This finding is concerning, considering that equipment and furniture are essential for an appropriate environment for children aged 3 to 5. In line with this, the qualitative analysis reveals that the infrastructure in early childhood education classrooms has significant deficiencies, especially in the availability of specific spaces such as corner rooms and green areas, which is more evident in new institutions or those located in marginalized areas. This finding allows for concrete actions to be taken, such as providing ergonomic furniture adapted to the age of the children, as well as implementing specific spaces for play and learning, such as corner rooms and green areas. In addition, the results provide valuable input for education authorities to prioritize investments aimed at ensuring adequate, safe, and stimulating physical environments that optimize the comprehensive development of children aged 3 to 5.

Perceptions of the adequacy of outdoor spaces in educational centers also reflect challenges; although the assessment of sufficiency remains unchanged, the increase in disagreement and the stability in the number of undecided respondents indicate that these spaces are progressively failing to meet users' expectations. This situation could stem from a lack of investment or maintenance in these areas, which is in line with a widespread concern about the quality of the educational environment identified qualitatively. This concern underscores how deficiencies in the environment directly affect children's learning and overall development. In this regard, the need for a well-planned distribution of spaces is highlighted, not only to facilitate the teaching-learning process, but also to promote interaction and participation of families in the educational environment.

On the other hand, the view on administrative management and the obtaining of financial resources shows mixed results. Some respondents acknowledge an improvement in the availability of resources. The percentage of those who totally agree decreases and disagreement increases, evidencing concern about the sufficiency and effectiveness of resource allocation. The interview reveals concern about the implementation of constant supervision measures. There is also an urgent need to make physical adaptations to ensure the effective inclusion of children with disabilities. This includes ensuring that facilities



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have adequate ramps, handrails, and inclusive play areas, complying with specific standards geared toward the needs of children.

The results reflect that the infrastructure in the DMQ's Early Education Centers faces considerable challenges that negatively impact educational quality. Dissatisfaction with infrastructure, equipment, and resource management highlights the need to improve these aspects to ensure that children receive a quality education. It is observed that inadequate infrastructure negatively impacts the quality of education at the early childhood level. This affects learning, emotional and social development, and generates demotivation in both children and teachers. Although efforts have been made to improve the infrastructure in the Early Childhood Education Centers of the Metropolitan District of Quito (DMQ), significant challenges remain. Although there has been a slight improvement in the perception of compliance with standards and the availability of educational spaces, overall dissatisfaction is evident. Limitations in equipment, furniture, and outdoor spaces underscore that users' expectations have not been fully met. This suggests that the quality of infrastructure, despite some progress, remains a critical area that requires ongoing attention and substantial improvements.

The main contribution of this research is to highlight, based on clear data, the deficiencies in the infrastructure of Quito's Early Childhood Education Centers that affect the development of children aged 3 to 5, proposing concrete improvements such as adequate classroom equipment, the creation of recreational and green spaces, the planning of outdoor areas that encourage family participation, adaptations for the inclusion of children with disabilities, and better resource management. Finally, the analysis of infrastructure must be addressed in the future from the perspective of its environmental and sustainability implications. Research into the context in which children learn in their early years should be of public interest and a priority for governments.

Acknowledgments

It is important to highlight the collaboration of key informants from different educational institutions and participants who kindly collaborated in the application of the survey..

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LUISA SOTO-DUQUE: conceptualization, methodology, validation, formal analysis, research, writing: original draft, writing: review and editing, and visualization.

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REVISTA

CÁTEDRA

The influence of the ecuadorian education system on the development of critical thinking in Unified General Baccalaureate

La influencia del sistema educativo ecuatoriano en el desarrollo del pensamiento crítico del Bachillerato General Unificado

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(Received on: 08/06/2018; Accepted on: 29/06/2025; Final versión received on: 10/07/2025)

Suggested citation Chamba-Zarango, A.P. & Aguilar-Gordón, F.D.R. (2025). The influence of the Ecuadorian educational system on the development of critical thinking in Unified General Baccalaureate students. *Revista Cátedra*, 8 (2), 111-136.

Abstract

Students' limited ability to analyze texts or synthesize information demonstrates a significant weakness in their ability to critically assess reality. This raises questions such as: What is the current state of Ecuadorian education? How does the educational system influence the development of complex skills and critical thinking? The objective of this work is to investigate the impact of the Ecuadorian educational system on the teaching-learning process, in order to propose activities that promote the development of critical thinking at the high school level. The research was based on analytical-synthetic and hermeneutic methods. The analytical method allowed for relating the foundations of the educational legal framework to classroom teaching processes, while the hermeneutic method facilitated the



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Revista Cátedra, 8(2), pp. 111-136, July-December 2025. e-ISSN: 2631-2875

<https://doi.org/10.29166/catedra.v8i2.8399>

interpretation of pedagogical work through the interview technique, a technique that proved key to exploring teachers' perceptions and practices and identifying challenges and opportunities in the development of critical thinking. The results highlight the urgency of strengthening students' metacognitive skills, implementing teaching strategies that provide lasting tools for identifying truth criteria in discourse, and developing skills for formulating meaningful questions. It is concluded that Ecuadorian education faces difficulties stemming from reforms influenced by government interests, inadequate curriculum management, and insufficient teacher preparation. Overcoming these barriers requires a renewed approach that prioritizes critical education, fosters intellectual autonomy, and revitalizes the commitment of the educational system.

Keywords

Skills, teachers, strategy, metacognition, critical thinking, educational system.

Resumen

La limitada capacidad de los estudiantes para analizar textos o sintetizar información evidencia una debilidad significativa en su habilidad para evaluar críticamente la realidad. Esto plantea interrogantes como: ¿cuál es la situación actual de la educación ecuatoriana? ¿cómo influye el sistema educativo en el desarrollo de habilidades complejas y en el desarrollo del pensamiento crítico? El objetivo de este trabajo es: investigar la incidencia del sistema educativo ecuatoriano en el proceso de enseñanza-aprendizaje, con el fin de proponer actividades que promuevan el desarrollo del pensamiento crítico en el nivel de bachillerato. La investigación se apoyó en los métodos analítico-sintético y hermenéutico. El método analítico permitió relacionar los fundamentos del marco legal educativo con los procesos de enseñanza en el aula, mientras que el método hermenéutico facilitó la interpretación del quehacer pedagógico mediante la técnica de la entrevista, técnica que resultó clave para explorar las percepciones y prácticas docentes, y para identificar desafíos y oportunidades en la formación del pensamiento crítico. Los resultados destacan la urgencia de fortalecer las habilidades metacognitivas de los estudiantes, la implementación de estrategias de enseñanza que proporcionen herramientas duraderas que permitan la identificación de criterios de verdad en los discursos y el desarrollo de habilidades para la formulación de preguntas significativas. Se concluye que la educación ecuatoriana enfrenta dificultades derivadas de reformas influenciadas por intereses gubernamentales, inadecuada gestión curricular e insuficiente preparación docente. Superar estas barreras requiere un enfoque renovado que priorice la formación crítica, fomente la autonomía intelectual y revitalice el compromiso del sistema educativo.

Palabras clave

Destrezas, docentes, estrategia, metacognición, pensamiento crítico, sistema educativo.

1. Introduction

Education is facing a serious crisis. On the one hand, the massive amount of information available online prevents educators from establishing criteria of truth or falsehood regarding the content they are learning. On the other hand, legal regulations regarding education focus more on their rights than their duties. Thus, the teaching-learning process fails to meet the skills proposed in the curriculum. It is common to find self-controlled learners who fail to question the criteria expressed in both offline and online media. Their



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thinking increasingly takes on a simplistic structure, leaving no room for doubt, wonder, or questioning.

The objective of this work is to investigate the impact of the educational system on education in order to propose strategies for developing critical thinking in students enrolled in the unified general baccalaureate program. This research aims to demonstrate that the development of critical thinking is possible as long as educators have adequate resources in the classroom. Therefore, it is argued that there is a relationship between current educational regulations and the actions of professionals in the classroom.

The central problem lies in the absence of critical thinking in education. This manifests itself in recurring difficulties among students, such as the inability to analyze texts, synthesize information, identify main ideas, and a marked lack of interest in reading, among other aspects. International organizations, such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO), highlight education as a key means to foster the development of these skills, urging states to implement timely educational policies adapted to the specific realities of each nation.

In this context, fundamental questions arise: What is the current situation of the educational system? How does this reality affect the development of critical thinking in students? Are educators sufficiently prepared to foster critical thinking? What strategies are effective in promoting critical thinking in the educational process? These questions guide reflection and highlight the need for a renewed approach to education, capable of responding to the cognitive and social demands of the 21st century.

The topic addressed is important because it seeks to demonstrate the context in which teachers operate, the difficulties encountered in implementing skills and abilities, and how to foster the acquisition of logical reasoning. The research is relevant because it analyzes the potential advantages of perfecting this cognitive skill, which may lead to future research on specific strategies to assist educators and students in integrating content.

The methodology of this research is qualitative, supported by the interpretive hermeneutic paradigm. The methods that aided this work are analytical-synthetic and hermeneutic. The analytical method allows for the articulation of the assumptions of the educational legal framework with the teaching-learning processes. The hermeneutic method guides the interpretation of educational work and strengthens critical thinking. Additionally, a case study is used as a specific research method. The interview technique used was a four-question script as a research instrument. The interview was conducted during the 2023-2024 school year with twelve teachers from four institutions in the city of Quito. The research process was also supported by a bibliographic review.

The paper is organized as follows: The first section analyzes the current state of Ecuadorian education. The second section reflects on the influence of educational reform on the development of critical thinking and the difficulties teachers face in generating meaningful learning. The third section presents the methodology, explains the technique, research instrument, and information from the interviewees. Finally, the fourth section presents the results obtained from the application of the research technique and the information obtained from the bibliographic review. It also highlights the advantages of developing critical thinking and presents some strategies to enhance this type of thinking in learners.



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2. The reality of the current Ecuadorian educational system

It is widely known that education has existed since the beginning of humanity. However, the analysis of its purpose and importance in society began with the postulates of the French Revolution, a period in which several universities and schools led by representatives of the Church were closed. From this moment on, pedagogy was reorganized in terms of its purposes, content, learning strategies, teaching methods, sequencing, resources, and evaluation, providing universal guidelines for its process. The educational system is understood as a series of components that determine the teaching-learning process; its regulation depends on the State, an institution that seeks cohesion between different sociopolitical, socioeconomic, and sociocultural spheres for the development of a nation. In the case of Ecuador, several irregularities arise when implementing what is institutionalized in legal regulations within the classroom; a fact that, far from reducing social inequality, markedly differentiates the privileged population from the less fortunate. For this reason, the following section explains the current reality of Ecuadorian education.

To understand the educational task, it is necessary to understand its structure. The educational system contains organizations made up of human beings, whose functioning varies according to the social progress of a nation, country, or state. In the words of Chiavenato (2007), it "provides a more complete and contingent way of studying the complexity of organizations and the management of their resources" (p. 3). It does not isolate external or internal environmental factors, functions, or social levels; everything is integrated into a whole. The system determines human behaviors, values, and forms of reflection. It is closely related to the mode of production, generating complex behavior in the economic sphere, as different organizations attempt to produce what responds to the needs of a given society.

Currently, this type of organization refers to a global society, which involves the behavior of organizations and the motivation of the individual. This reality is defined by Wallerstein (2006) as a world-system: "where we are faced with a space-time zone that crosses multiple political and cultural units, which represents an integrated zone of activity and institutions that obey certain systemic rules" (p. 15), crossing demographic barriers and changing the understanding of space-time. The current global village demands cooperative work between institutions; therefore, if one of them does not participate in this requirement, it is absorbed by other well-founded organizations, capable of influencing learning, motivation, the individual's perception of the world, and even the dynamism of education.

The educational plan is understood in different ways depending on the nation in which it is developed. It depends on power plays defined by developmental theory and the economic market. In the words of Martí-Castro (2003), the educational system "is the organization of education determined and organized by the State" (p. 393). Each country has a different educational organization according to the demands of individuals, it is crossed by religious, political, economic, cultural factors, pedagogical models, technology, among other factors; therefore, educational policies have the obligation to guide their actions in the direction of the current political - economic model, it cannot act independently. According to Freire (1997), this situation is usually visible in countries with low economic resources, this disconnection translates into high rates of unemployment, school dropouts, increasing poverty, violence, corruption, governments incapable of investing adequately in education or others, witnessing a weak State.

From another perspective, Zayas and Rodríguez (2010) define the "educational system as the official conglomerate or grouping of schools and the administrative body that



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transcends and organizes them" (p. 5). This system offers all kinds of resources, tools, possibilities, and strategies for access to education. It is comprised of students, teachers, administrators, infrastructure, school management, and educational policies. These components, according to Martí-Castro (2003), give rise to various types of educational systems: open, closed, horizontal, vertical, and professionalized. An open educational system occurs when the educational subject can access any type of institution without any obstacles or when the admission of high school graduates to higher education is guaranteed; on the other hand, when access is limited or presents difficulties in the process, it is called a closed educational system.

According to Martí-Castro (2003), the educational system "is horizontal when it allows students to change disciplines without losing the level of education previously achieved" (p. 393). On the other hand, education is delivered vertically when prior knowledge or previously acquired knowledge is not considered. Professionalized education is defined when the learner develops skills specific to the social context, for example, the use of new technologies or artificial intelligence itself. When education does not respond to social demands, it is defined as deprofessionalized education. The implementation of a specific type of educational plan depends on the state's leaders in relation to their interests. Therefore, UNESCO (2022) evaluates governments' implementation of all these elements, components, and educational standards.

Based on the results published in the 2022 UNESCO Global Education Monitoring Report, it is asserted that education is capable of improving the quality of life of human beings. Therefore, it is necessary to pay attention to the standards that ensure adequate progress in the teaching-learning process. The report exposed different educational realities worldwide, as well as the serious consequences left by the pandemic. To do so, it based its approach on the Sustainable Development Goals (SDG4), which were approved by world leaders at the United Nations summit held in September 2015. The SDGs emerged as part of the 2030 Agenda for Sustainable Development and entered into force on January 1, 2016, with the aim of raising awareness of a shared responsibility among nations and generating social progress. Based on this assessment, UNESCO (2022) concluded that there are around ten countries with the best education in the world, including: Canada, Finland, Hong Kong, the People's Republic of China, the Netherlands, Singapore, Germany, Japan, Russia, and South Korea.

UNESCO (2022) emphasizes that the Sustainable Development Goals were based on the following characterizations: First, early childhood education, considering the entry rate to initial levels. Second, primary and secondary education, comparing the proportion of children who entered primary and completed secondary school. In addition, we assessed whether students achieved a minimum level of proficiency in both reading and mathematics. Third, equity, which verifies the gender disparity index in secondary school completion. Fourth, the proportion of qualified teachers for the respective level; the presence of teachers in areas unrelated to their professional training is common; all of these objectives are also addressed through public spending on education.

In the case of Ecuador, there are some improvements in coverage, as mentioned by (Olsen and Prado, 2022), "in Ecuador, at the beginning of the 2020 school year, enrollment in public schools increased by 6.5%, or 120,000 students" (p. 107); however, due to COVID-19, participation in education decreased due to insufficient digital resources or internet coverage. On the other hand, according to the Ministry of Education (2023), there are high



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rates of secondary school completion, although there are low rates of entry to higher education institutions.

Ecuadorian education is regulated by the Supreme Statute of the Republic of Ecuador (2008), which includes Bilingual Intercultural Education and Higher Education, both of which aim to guide educational work. Current education is the result of a multitude of social phenomena that respond to the political, economic, and sociocultural needs of the dominant hegemonic sector, as has been the case since the 1990s, when educational investment was scarce, as was the reflection on its pedagogical processes. It was during the administration of former President Rafael Correa (2007-2017) that education was regulated and organized by the Organic Law on Intercultural Education (2011), currently amended in 2023, and the Higher Education Law (LOES).

The Magna Carta of Ecuador (2008) states that education is a universal right for every individual, in which families, authorities, and all of society must participate responsibly. The State is responsible for ensuring its adequate process through the development of relevant educational policies and timely social investment, among others. The State must promote appropriate training to ensure the good life through equity, justice, and social inclusion. The educational process is closely linked to the economic structure; greater investment in education leads to greater professionalization of the population.

Regarding this, UNESCO (2022) states the following: "The pandemic demonstrated that jobs in highly affected and crucial sectors for the economy depend on vocational training, which can meet urgent demand and increase resilience to crises" (p. 268). In the case of Ecuador, the pandemic particularly affected the productive sector, an aspect that brought a series of consequences such as high school dropout rates due to poor connectivity, the massive layoff of workers from different institutions, the lack of resources to cover basic needs, and other similar phenomena that gradually affected different social sectors, mainly the country's middle and lower classes.

Education is centered on the learner, who possesses diverse dimensions. The national education system seeks to integrate a broad intercultural vision, drawing on the country's cultural, geographic, and linguistic diversity. In Ecuador, Intercultural Bilingual Education and Ethnoeducation are primarily targeted at all Indigenous peoples and communities, as well as the Afro-descendant population. This is in compliance with the guidelines established in the Ten-Year Education Plan (2006-2015) regarding the universalization and coverage of education, reaching several rural communities and other communities that were neglected in past decades. Thus, the Constitution of the Republic of Ecuador (2008) defines in Article 343 that: "The purpose of the national education system shall be the development of individual and collective capacities and potential of the population, enabling learning and the generation and utilization of knowledge, techniques, skills, arts, and culture" (p. 106).

In Ecuador's Magna Carta (2008), the educational plan covers modalities, levels of education, resources, plans, types of education, educational support, programs, policies, and actors. Thus, it offers both formal and non-formal education: the former responds to curricular guidelines and the fulfillment of skills; on the other hand, non-formal education concerns the instruction of human beings throughout life; it does not follow a gradual process. This includes formal and non-formal education. There are three modalities: in-person, blended, and distance learning. According to a UNESCO analysis (2022), these modalities have allowed for easy access to education. Ecuador has increased its enrollment rate in both early childhood and higher education; open-access programs have been



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implemented for those with unfinished studies. At the same time, non-state higher education institutions were suggested to award 10% scholarships to the student population.

The Educational Curriculum (2016) establishes three levels of education: Early childhood education, which covers children between the ages of three and five. Basic education, which consists of ten years of compulsory education, is made up of four sublevels: 1) preparatory, 2) elementary, 3) middle, and 4) upper elementary. Finally, high school, which comprises three years of compulsory education, offers the Bachelor of Science and the Technical Baccalaureate.

The Bachelor of Science is based on the study of a common core of scientific and humanistic subjects, with the goal of achieving the exit profile expressed in the Compulsory Education Curriculum (2012), which focuses on justice, solidarity, and innovation. Consequently, the Unified General Baccalaureate has been applied since the 2011-2012 school year to the present. On the other hand, the technical baccalaureate focuses its studies on technical disciplines that allow for undertaking economic activities. Regarding the type of support, Article 345 of the Constitution of the Republic of Ecuador (2008) states that: "Education as a public service shall be provided through public, fiscomisional, and private institutions. Educational establishments shall provide free social services and psychological support, within the framework of a system of inclusion and equity."

Education is the country's priority; each leader must ensure continuity in the educational process. The State is responsible for allocating economic resources for its investment, creating relevant educational policies, establishing educational plans capable of meeting educational standards, and programs that lead individuals to act in the reality in which they find themselves. The educational field cannot be disconnected from the political, economic, and cultural context; it must be able to respond to the demands of society. The educational process is centered on the Ecuadorian Constitution (2008) and is regulated by other bodies, including the Intercultural Bilingual Education and Higher Education. Their guidelines are based on the Ten-Year Plan (2006-2015) with the goal of ensuring justice, social equity, inclusion, and social progress. However, the guidelines proposed by macro-level bodies are not compatible with the processes carried out in the classroom (micro-level), which generates a disparity between conceptual, attitudinal, and procedural content. Therefore, it is considered appropriate to analyze the reality of educational work and its impact on the development of intellectual thought.

3. Impact of educational reform on the development of critical thinking

Education is the result of a global space in which national and international factors intervene, creating their own educational policies according to the social reality in which they operate. On the other hand, the vast majority of countries that make up the less developed economic blocs adapt internationally accepted quality standards to education, unrelated to the regional, cultural, linguistic, political, and economic context. No state remains indifferent to the educational program; this explains the rethinking of Ecuadorian education in the 1990s, a time when the country was experiencing a series of political, social, and economic difficulties. Educational reforms aim to achieve the formation of an ideal type for society, but by not considering a country's idiosyncrasies, the educational level falls short of the desired levels of progress, a fact reflected in the election of its leaders. For this



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reason, this section analyzes the impact of educational reform on the development of critical thinking.

The creation of any type of policy must be clear, to the point of leaving no room for interpretation. In 1983, the Education Law was enacted; its content presented a simple and poorly developed construction, its results were reflected in the Curriculum Reform of 1996, where there was no articulation between the mandatory minimum content and skills; moreover, evaluation criteria and indicators were not presented. According to Chamba and Aguilar (2022), education "responded to a utilitarian system, conceiving the subject as a means to achieve certain ends. This is how the political-economic-social system entered into crisis and with it the moral norms that guide the educational policies of the Ecuadorian system" (p. 190). The investments made in health or education were insufficient; the neoliberal economic model in force until then focused its gaze on the economic enrichment of its assets, external debt, corruption, unemployment, mobilizations and other events that fractured the country's economy.

The educational plan, until before 2007, presented certain gaps in its very content, not to mention its process within the classrooms. Staff were also not paid promptly, and education was privatized, with a high rate of garage institutions. The educational model applied in the teaching process was traditional, its methods centered on memorization and repetition of content. Similarly, the teacher's actions were based on behaviorism, with punishment or reinforcement being a primary element in evaluation. Once high school was completed, the panorama was similar in universities. There was no authentic reflection on pedagogical processes. This fact demonstrates the reason for the lack of defined student movements, a passive education, and a scarce cultural capital that prevented adolescents and young university students from questioning their reality. If they took to the streets, they did so motivated by a political party or perhaps because the political-economic situation had become unlivable.

From that moment on, the education law was reformed and enacted in 2011. The LOEI (Organic Law on Intercultural Education) is structured with more solid epistemological foundations, aimed at achieving Buen Vivir through the practice of justice, equity, and social inclusion, as manifested in the exit profile of the National Education Curriculum (2016). The institution in charge of monitoring compliance with the LOEI, the application of the Curriculum, and the achievement of learning objectives is the Ministry of Education. As UNESCO (2022) states in its report, "if a center is found to have committed an infraction, sanctions are applied, such as a written warning, a temporary suspension, or a permanent suspension if children's rights are violated." (p. 149).

The 2016 Curriculum is based on socio-constructivist principles and considers the prior knowledge necessary to construct meaningful learning applicable to everyday life to be essential. It revisits the contributions of critical pedagogy and places the individual at the center of all learning. While it is true that attempts are made to implement socio-constructivist principles in the classroom, it is also true that the teaching staff is scarce, an aspect that impedes the production of meaningful learning among students. The pedagogical importance of assessment is once again focused on as a means of verifying content acquisition. The contributions of critical pedagogy to Ecuadorian education are almost nonexistent, both in the teaching-learning process and in curricular planning, largely due to a lack of awareness of its theoretical assumptions. Furthermore, educators do not receive ongoing training; their knowledge has been limited to that acquired at university.



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Likewise, in certain institutions, such as those supported by private institutions, the necessary time for timely teacher training is lacking.

This reality prevents educators from being creative when presenting a class, leading an expository class without employing innovative teaching and learning techniques relevant to the development of complex skills in students. This is in constant contradiction with the provisions of the Curriculum (2016), which focuses its methodology "on student activity and participation that fosters rational and critical thinking, individual and cooperative work in the classroom, which involves reading and research, as well as diverse possibilities for expression" (p. 14).

The educational reality of teachers prevents them from developing these types of skills or fostering interest in certain activities such as reading, writing, or research. Their workload is divided into pedagogical and administrative hours, without taking into account the time required for planning, class preparation, resource searches, assessment, and review of assignments, among other activities. Ecuador is one of the countries that has not strengthened its interest in reading. However, at the ministerial level, the inclusion of a reading plan in the educational program has been proposed, with the aim of improving reading comprehension levels.

Reading is an indispensable skill that enhances human learning and involves processes of understanding and interpreting the world as a whole. In accordance with Giroux (1986), reading should offer "opportunities for individual development, social mobility, and political and economic power for the dispossessed and disadvantaged" (p. 2). To the point that all educational agents must question the current reality, learning methods, teaching strategies, institutional management processes, and the national system, and recognize the type of political and economic ideology that is intended to reproduce it. All of this is done with the aim of innovating the educational reality and effectively implementing the foundations of critical pedagogy, which requires action as agents of individual or social transformation.

The educational goal of achieving social inclusion is increasingly distant. This was evident with the COVID-19 pandemic. Social inequality affected thousands of children and young people in the educational field. Private institutions had greater advantages over public or fiscomisional institutions. From 2019 to 2025, educational quality has declined significantly. The knowledge acquired by students is insufficient. The impact of technology on the educational environment has not been considered. The problems faced by families and teachers with the use of digital resources, tools, and devices have also been problematic.

Added to this is the isolated work of each area of knowledge suggested in the curriculum, giving rise to a hierarchy of subjects. From the perspective of Aparici-Marino et al. (2018), "school institutions have always been based on a scale of knowledge in which the arts remain at the bottom of academic relevance, while mathematics and languages reside at the top" (p. 38). This interplay of knowledge has generated a kind of hierarchy in the subjects taught, especially at the high school level. In the national curriculum of the education system, there is a set of subjects linked to the humanities that have been taken into account to fill the school curriculum.

These subjects are given little importance, have a minimal workload, and contain unattractive content that represents no interest to young people, so they are openly undervalued and receive little attention from the various stakeholders. Added to this is the lack of enthusiasm among the teaching staff, the irrational eclecticism of pedagogical



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models, and the oversaturation of teachers in the constant preparation of reports, which often forces them to neglect other important teaching functions. Teachers neglect their role in strengthening students' skills and superficially focus their attention on addressing curriculum content. As a result of this behavior, education professionals, for the most part, show a lack of critical thinking in everything they read, learn, observe, and hear.

This educational reality is even more critical in indigenous communities and populations of African descent. In this regard, the goal is to improve the quality of education at all levels and modalities, with an intercultural, bilingual, and inclusive approach. According to the UNESCO assessment (2022), "Ecuador approved a National Strategic Plan for Afro-Ecuadorian Ethno-Education for 2020-2025 that establishes the so-called Guardians of Knowledge Educational Units, as well as teacher training and curricular interventions" (p. 317). The National Strategic Plan for Ethno-Education aims, among other things, to make visible in the National Education System and rescue the history of the Afro-Ecuadorian people, their contributions, knowledge, and expertise. Before the pandemic, teachers in these types of institutions were Spanish speakers, unfamiliar with the culture and identity of these peoples and nationalities.

The analysis of educational outcomes after the pandemic led to a reform of the LOEI published on February 22, 2023, in which importance is given to evaluation, being qualitative for early childhood education and quantitative for subsequent levels. Although the LOEI Regulation (2023) establishes in art. 20 that: "[the evaluation] values integral development... and not only academic performance" (p. 318), so far, the grade is important to promote it to the following year, verify the fulfillment of objectives, measure the skills and indicators met. In the same way, the 2021 Prioritized Curriculum was also implemented, this is focused on the acquisition of skills with knowledge of life and for life. Through this curriculum, we aim to strengthen skills that were underdeveloped during the confinement caused by the pandemic, which is why communication skills were proposed, which help in social interaction, the acquisition of comprehensive reading and the production of texts. These include: mathematical skills, digital skills and socio-emotional skills.

The development of current education presents a series of problems, challenges, and challenges since those in power forget the purpose of education, to the point of turning it into a means to achieve certain ends in line with the current economic model. This reality generates school dropouts, a lack of inclusive education, and easy-going behavior, among other things. Even more so with the pandemic that began in 2019, the educational process experienced difficulties with virtual learning. These effects are visible in post-pandemic education, where young people are observed with little critical thinking, a lack of questioning of what they see on social media or what they learn in educational institutions, and have become mechanical subjects.

Added to this is the performance of teachers in the classroom. In the face of so many reforms, they have become mechanical entities, losing their ability to execute processes that lead students to develop complex thinking processes. Teachers have forgotten their role as intellectuals who transform society. According to Giroux (2001), "teachers often occupy themselves with learning how to teach, with which books to do it, or with mastering the best way to transmit a given body of knowledge" (p. 62). What matters is the content, which will be contrasted with the summative assessment.

Educators need to awaken from this lethargy; they must act as political agents in the teaching-learning process, guide and orient the treatment of content, and awaken doubt



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through the use of strategies that develop different competencies in the learner. At the same time, one of the tasks of pedagogical action is to question the role of the school and its agents, despite the fact that in the context under investigation, there are administrators who do not accept suggestions for change and tend to disengage professionals who do not conform to institutional ideology and guidelines. The educator of recent times in Ecuador must overcome the instrumentalist tendency, focused on mere productivity and mercantilist tendency and instead must contribute to:

... change the cognitive matrix to transform current Ecuadorian society;... revolutionize thinking regarding the specific needs of Ecuadorians by modifying teaching and learning processes that generate analytical, critical and proactive subjects who walk towards their individual and social project... (Aguilar-Gordón and Rosero-Guillén, 2019, p. 31).

This is how mutual recognition is projected for the construction of situated education that responds to the country's specific requirements and needs, where interculturality, geographic, cultural, and linguistic diversity are fully emphasized. The main rule in creating a document is to maintain uniformity and internal coherence. In many respects, spelling and orthotypography allow freedom when writing certain things, so sometimes there is a debate about whether, for example, something should be written in capital letters or italics. But where there is no debate is that, once a writing style has been chosen, it should always be written the same way.

4. Methodology

The approach of this research is qualitative, characterized by a detailed description of the phenomena studied. According to Hernández-Sampieri et al. (2010), "the qualitative approach is selected when the purpose is to examine how individuals perceive and experience the phenomena that surround them, delving into their points of view, interpretations, and meanings" (p. 358), that is, the beliefs, experiences, attitudes, and behaviors of the interviewees.

The work is based on bibliographical research, drawing on books, theses, journal articles, legal documents such as the Magna Carta, LOEI, curricula, and other documents related to the topic. It is an explanatory research because the text details the problems of current Ecuadorian education, identifies the difficulties educators face when implementing strategies for the development of critical thinking, and describes some strategies for strengthening this cognitive skill. Explanatory research, according to Martínez (2010), "seeks, first and foremost, descriptions and relationships between characteristics of the phenomena it studies. Based on the relationships found, it is possible to formulate empirically based generalizations" (p. 5).

The methods that guided the construction of this paper are the analytical-synthetic method and the hermeneutic method. The analytical-synthetic method allows for the articulation of the assumptions of the legal framework, such as the 2008 Constitution of the Republic of Ecuador, the LOEI (Economic Law of Ecuador), its reform, and the curricular assumptions implemented in the classroom. The hermeneutic method facilitates the interpretation of educational processes and their impact on the development of critical thinking.

As this is a qualitative research project, a semi-structured interview with a four-question script was considered appropriate as the research instrument. To achieve this objective, criterion-based sampling was used, which "...involves selecting cases that meet a



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predetermined criterion of importance" (Patton, 2001, p. 238). For this purpose, professional profile, knowledge of the Ecuadorian educational reality, and years of experience in the field under investigation were taken into account. Ten professionals with undergraduate and graduate degrees at the master's level and two with postgraduate degrees (bachelor's or bachelor's degrees) were selected. It was also necessary to determine the number of questions and the time that would be used to collect, process, analyze, and systematize the information. Three educators were selected from each of the identified institutions.

The interviews were conducted with twelve teachers from four institutions in the city of Quito during the 2023-2024 school year. Considering the country's reality, the four institutions were selected based on their operating nature. One was municipal, one private, one co-financed (self-managed with support from state funds), and one fiscal or public. All participants teach high school or have a relationship with this educational level. Below is a table explaining the informant profiles.

Interviewee (E)	qualification	Workplace	Function
E1	Master's in Education and Development Projects with a Gender Perspective.	Municipal Educational Unit	Vice-Principal of the North Technical Industrial Private School Academic Coordinator of the EBSI project and the Fernández Madrid Municipal Educational Unit
E2	Master's in Educational Leadership Innovation	Municipal Educational Unit	Teaching Academic Coordinator
E3	Master's Degree in Management and Leadership	Municipal Educational Unit	Teaching in Basic General Education
E4	Electronics and Telecommunications Engineer	Private Educational Unit	Teaching
E5	Master's Degree in Management and Leadership	Private Educational Unit	Teaching
E6	Bachelor's Degree in Pedagogy	Public Educational Unit	Teaching and Curriculum Area Head
E7	Bachelor's Degree in Philosophy and Master's Degree in Education	Public Educational Unit	Teaching and Head of Integrative Projects
E8	Bachelor's Degree in Pedagogy	Public Educational Unit	Teaching
E9	Bachelor's Degree in Philosophy and Master's Degree in Educational Projects	Co-financed Educational Unit	Teaching and Inspection of Unified General Baccalaureate
E10	Bachelor's Degree in Philosophy and Pedagogy	Co-financed Educational Unit	Teaching and Head of the Student Counseling Department (DECE)
E11	Bachelor's Degree in Education with a track in Philosophy and Master's Degree in Philosophy.	Municipal Educational Unit	Vice-Rectorate and Teaching



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E12	Bachelor's Degree in Psychopedagogy and Master's Degree in Education.	in Private and Educational Unit	Inspector, teaching, and head of integrative projects.
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Table 1. Interviewee data

The interview was conducted following all the formal aspects necessary for its application, all phases were duly planned to proceed appropriately before, during and after the interview.

5. Analysis and discussion

The interview seeks to understand perceptions about the current state of Ecuadorian education and its impact on the development of critical thinking at the unified general high school level. To this end, each question is presented in the following space with its respective analysis.

In the first question, "What is your opinion about the implications of the latest reform of the LOEI for the educational process?" Seven of the interviewees (58%) maintain that there are positive aspects, as this type of institution has been given a certain degree of autonomy, especially in deciding on the curriculum and the teaching of transversal skills (E1). The reform is positive in that it proposes improving educational quality through teacher training and the implementation of new methodologies that promote more inclusive teaching (E5); the reform has positive aspects such as the flexibility of the curriculum, which allows for the adaptation of content to the needs of students and the reality of the national context (E7); The reform has a successful approach because it promotes comprehensive education, although the educational infrastructure and the provision of teaching materials still need to be strengthened (E8). Additionally, one of the positive aspects is the improvement in teacher performance evaluations, which guarantees the preparation of educators and their commitment to teaching in accordance with the needs of today's society (E9). Furthermore, the strengthening of technical and technological education within the reform is positive because it allows young people to prepare for the workforce, providing alternatives for those who do not follow the traditional academic path (E11). The trend toward valuing the inclusion of people with disabilities and the diversification of teaching is also positive, but requires specialized training (E12).

From another perspective, three participants (25%) assert that the latest reform to the LOEI affects the educational process. With the reduction in teaching hours, it is very difficult to achieve skills acquisition in the unified general baccalaureate (E2, E3). The reform has not had a significant impact on the educational process. Although changes are proposed, some of them have not been accompanied by adequate resources or effective teacher training (E4).

One of the informants (8%), when referring to the question, referred to the entire process of reforms experienced in Ecuadorian education in recent times and stated that the educational reform implemented in 2011-2012 eliminated specializations and harmed high school graduates, turning them into generalists without a solid foundation to adequately continue their higher education or confront society (E6).



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One of the interviewees (8%) is "skeptical about the benefits of the reform because they think that the issue of administrative overload that we teachers face is still not being effectively addressed, which distracts from teaching itself" (E10).

It is observed that the diversity of responses depends on the experiences each one has in their professional work and the conditions of the respective institutions to which they are attached. They also point out that the LOEI only benefits students, harming the work of educators due to the assigned administrative burden. This situation demonstrates a gap between the two institutions, where private institutions are more likely to prepare their students due to the added benefit added to their academic curriculum; while public education suffers the consequences of a reform that is not in line with its reality. In agreement with Chamba and Aguilar (2022), the country is experiencing a kind of "...commodification of education (...), making clear the inability of the State to make improvements... and thereby overcome the conception that every school or public institution presents a low [educational] quality" (p. 199).

In the second question, does the current educational curriculum respond to the cultural, economic, and political needs of the educational community or society in general? Three of the interviewees (25%) mention that the reformed curriculum of 2016 responds to the reality of the country; the problem is not the curriculum design, but the way it is applied (E1, E4, and E6); for their part, one of the informants (8%) explains that educators focus more on content, neglecting the development of skills, performance criteria, abilities, attitudes, etc. (E3). From another position, two interviewees (17%) indicate that the curriculum does not respond to the country's context; it is a conglomerate of theoretical assumptions adopted from different countries, which is why there are gaps and disagreements regarding the teaching load, the teaching of subjects unrelated to the professional profile for which they were trained (E2, E5), in addition to the reduction in teaching loads in English, social sciences, language and literature; as well as the elimination of computer science as a subject. These facts prevent the educational subject from acquiring digital, communication, or social skills.

In the words of Aparici et al. (2018), "these reproductive models that shape current education must urgently be overcome by logics that enhance horizontal and non-hierarchical communication inside and outside the classroom in order to develop critical thinking" (p. 9).

Three interviewees (25%) agree that the Ecuadorian educational curriculum has some elements that respond to the cultural and social needs of the community, such as inclusion, cultural diversity, human rights, and values (E9), but it lacks a critical-analytical approach, needs to be updated (E7), and needs to establish a greater connection to respond to the social changes, technological challenges, and economic, labor, and political realities facing our society (E12).

Three informants (25%) maintain that "although the curriculum promotes certain cultural values and has an inclusive approach, it is not sufficient to meet the country's economic demands" (E8). There should be greater integration of content related to the local economy (E10), entrepreneurship, and public policies so that students are better prepared to face the future (E11).

In the third question, what is the importance of developing critical thinking in high school students? Four informants (33%) emphasize that the advantages of fostering this type of thinking are multiple, including: it helps them confront their reality, recognize the impact of



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education on their lives, and identify themselves as individuals with rights and obligations (E2). In the context of people with unfinished education, this type of thinking will help them understand that acquiring a degree does not grant them an ontological existence (E4), therefore, they voluntarily go back to their studies, a practice through which Freire (1997) explains that the student would discover himself critically as a maker in this cultural world, that his actions modify the world, being able to propose solutions from his experience and the simplicity of his life" (p. 106). Another advantage of developing critical thinking focuses on the acquisition of a historical awareness (E1); the subject is able to improve creation and recreation skills, starting from simple situations to complex ones. (E3)

On the other hand, two participants (17%) stated that this type of thinking is simply a social ideal and impossible to achieve due to the lack of training provided by educators, authorities, and even the Ministry of Education itself (E6, E10).

The four informants (E5, E7, E9, and E12), equivalent to 33%, stated that developing critical thinking is essential for young people to be able to analyze and question the information they receive, make informed decisions, and be responsible citizens. It is a skill that will help them face the challenges of the future and be agents of change in society; it allows them to better understand the world around them, to make informed choices and decisions, and to actively participate in social and political affairs. Indeed, by developing this thinking skill, young people will cease to be mere recipients of information and become active and proactive individuals. It is very important to foster critical thinking in high school students, as it gives them the tools to question, reflect, and make decisions based on analysis, not just on emotion or popular belief. This type of thinking is key to students' personal and social development.

In the words of one informant, "Critical thinking is essential for addressing complex problems, enabling them to question established structures and systems. It helps develop more aware young people with the ability to change their environment" (E9).

Despite this, two interviewees (17%) affirm that although this type of thinking is important because it helps young people question what they are taught and make their own decisions, excessive questioning can lead to an attitude of constant distrust of authorities, which could generate unnecessary conflicts in some cases (E8). Therefore, they recommend the need to find a balance. Likewise, (E11) expresses their doubts when they maintain that, "from an educational perspective, critical thinking is a skill that allows us to process and evaluate information efficiently, but it is not always easy to develop" (E11).

Regardless of the above, it can be asserted that critical thinking is a powerful tool that enables academic improvement, the development of human autonomy, the strengthening of ethical and moral values, and contributes to professional and work performance in society.

In the fourth question, do teachers have the necessary tools to work on developing critical thinking skills in their students? Four informants (33%) stated that there are technological tools, digital platforms, and interactive teaching methods that encourage critical thinking (E1, E3).

Similarly, informant (E5) stated that educators have tools such as pedagogical guides, digital resources, and active teaching strategies that promote the development of critical thinking. According to (E7), these tools allow for the application of methodologies such as problem-based learning and debate, which encourage analysis, discussion, and questioning. From



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another perspective, six interviewees (50%) expressed their concern about the lack of tools to fulfill the announced purpose, they agree that teachers do not have enough tools to develop critical thinking in learners, "...pedagogical tools are often limited and not updated, there is not enough training for teachers in innovative methodologies that stimulate these types of skills" (E9),

likewise, they affirm that although there is an intention to promote critical thinking, "the tools are very general and do not adapt to the different realities and needs of young people" (E11); often "we lack specific resources and training materials that allow us to teach these skills more effectively" (E2, E6). One of the training programs is not always focused on these competencies, the problem lies in the fact that "although the importance of critical thinking is recognized, there are not enough tools or the necessary support to develop them, the activities we can carry out are limited by the lack of materials and the requirement to comply with a rigid curriculum" (E4, E10).

Two interviewees (17%) condition their response to the context, stating that some institutions have sufficient tools, such as digital resources and active methodologies, that allow for the development of critical thinking. However, it often happens that these tools are not fully utilized or are not sufficient for the entire teaching team (E8, E12). This is even influenced by the type of educational institution in which we find ourselves. The existence or lack of resources determines the quality of education, access and availability of tools, resources, technology, teacher training, among others.

As observed, the majority of interviewees (67%) state that they do not have the necessary tools to fulfill their purpose. Additionally, the professor does not read, does not research, does not seek more information, repeats what they were taught long ago during their university studies, does not modify their teaching methodology, is not familiar with new technological tools, and is unaware of new teaching-learning strategies and techniques such as the use of thinking routines, writing essays, graphic organizers, and posters. This situation impedes the development of metacognitive skills, leaving a clear disconnect between what is learned and what is experienced.

6. Results

Based on the information obtained from the interviews and the analysis of documents on the topic, it is found that critical thinking must originate with the teacher, who, through their mediation, generates significant contributions from the classroom to society. Teachers must incorporate this intellectual skill; to this end, they must incorporate reading, reflection, and research into their routine; they must participate in research activities, educate themselves, and constantly train themselves to the point of becoming an ethical and political educator. Pretending to be educationally neutral is a crime today. Freire (1997) mentions that: "One of the beauties of educational practice is precisely the recognition and assumption of its political nature, which leads us to truly respect students by not trying to impose our points of view on them, surreptitiously or rudely" (p. 42). The advantages of fostering critical thinking at the high school level are briefly outlined below. The following advantages arise from this:

a. The ability to propose transformative actions beyond the educational community, identify social problems, reflect on their cause and effect, and question the dynamics of sociopolitical and sociocultural settings. Only in this way will the educational subject abandon the convergent thinking imposed for centuries and embrace divergent thinking with new alternatives for knowledge. While it is true, Giroux (1986) points out that: "Schools will not



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change society, but we can create pockets of resistance within them that provide pedagogical modules for new forms of learning and social relations, forms that can be used in other spheres" (p. 39), such as universities; spaces in which the new high school graduate is expected to participate in groups and social movements in search of justice and social inclusion.

b. Interpretation of language when transmitting content in the media, on social networks, in political discourse, in literary genres, in musical genres, among others. Both educator and student must ask themselves certain questions: Who is sending the message? What do they want to communicate through the message? Who is behind the discourse? According to Vygotsky (1995), "words play a prominent role both in the development of thought and in the historical development of consciousness as a whole. A word is a microcosm of human consciousness" (p. 113), which hides realities or distorts the intentionality of the message to be communicated. Language is one of the main means of manipulating consciences used by the dominant sectors over the oppressed. Thus, it is possible to visualize differences in the educational level between a middle-class institution versus an upper-class institution. The educational institutions of a middle-class social class are educated with the purpose of intellectual consumption, reproducing behaviors and ideologies, to the point of becoming the future working class of the country. While private institutions to which members of the upper class belong are educated to produce content, laws, lead, command over a working class, generally, these types of subjects are supported by policies that in one way or another end up affecting the employee, allowing the greatest economic benefit of business organizations, plunging millions of Ecuadorians into poverty.

c. Acquisition of complex levels of thinking, such as analysis. Analysis is a cognitive activity responsible for breaking down each of the elements of a given reality. According to Cangalaya (2020), "analysis allows us to explain a phenomenon into each of its parts and characteristics, in such a way that the cause-effect relationships between them can be clearly established" (p. 146). Analysis allows us to understand the intentionality of teaching, a text, a speech, or the surrounding information. This requires another cognitive operation, synthesis, which integrates relevant information and discards all trivial and unnecessary content.

d. Constructing contextualized conclusions, which guide the possible implementation of solutions. The skill of analysis aims to raise questions about the knowledge acquired during the teaching-learning process. Analysis must be strengthened and implemented from the earliest educational levels to find its consolidation in higher education through disciplines and strategies that allow for the construction, proposal, and distribution of knowledge. However, from the position of Aparici et al. (2018), "those disciplines least valued by the legal and judicial framework are precisely those that contribute most to this construction of perspective and to this transformation of society. They are subjects related to the arts and philosophy" (p. 111), which in the Ecuadorian case have reduced course loads or have been eliminated from the institutional academic curriculum.

e. An ethical-moral formation of the subject, which implies the cognitive level of evaluation. Evaluation is the human capacity to determine positive or negative actions toward oneself and in one's relationships with others. According to Cangalaya (2018), "evaluation allows one to make the right decisions in the situations that the subject must face throughout one's life" (p. 147), addressing the possible effects or consequences of a certain behavior. Evaluation not only occurs intrapersonally; it must be applied interpersonally, in the educational environment. The evaluation process has become a task of selection and



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elimination. It is important for the educational agent to go beyond hetero-evaluation and apply peer or self-evaluation; in this way, evaluation will no longer be viewed as a rigid method. The correct application of evaluation expands in the educational subject the capacity to accept responsibility for their actions, the appropriate use of their freedom, and the ability to correct errors—in other words, to broaden the horizon of human consciousness.

f. Strengthening conscience: There are several meanings of conscience; however, the common definition holds that conscience is the act by which the subject perceives themselves, others as their peers, and the world. Like the skill of evaluation, it is related to the subject's moral actions. The development of critical thinking grants individuals the ability to identify social problems, recognize social injustice, or infer when a right has become a privilege. As human beings change the environment in which they operate, Freire (2004) says, "it was no longer possible to exist except by being open to the radical and profound tension between good and evil, between dignity and indignity, between decency and modesty, between the beauty and ugliness of the world" (p. 25). In other words, acquiring awareness means deciding, choosing, judging, fighting, and engaging in politics. It is common to observe teachers who have put aside their struggle, only aspiring to a promotion or reclassification due to economic incentives, thus dissipating their social conscience.

These are just some of the many advantages for society of developing critical thinking in the classroom. This type of metacognitive skill must be present in students, and even more so in education professionals; otherwise, the teaching-learning process will not enhance human metacognitive abilities; it will only respond robotically to social demands, will be at the mercy of the most powerful sector, and will not provoke social transformation. However, the achievement of critical thinking requires certain methods from the teacher to foster students' interest. The following section reflects on teaching methodologies and their relationship with the development of critical thinking.

7. Strategies for the development of critical thinking in unified general high school students.

The results obtained from the interview demonstrate educators' limited knowledge of strategies that help enhance critical thinking. Therefore, before proceeding with the corresponding exposition, it is important to understand their concept.

The term strategy (*strategia*) comes from two Greek roots, *stratos* (army) and *agein* (guide), which means the art of conducting military operations. Initially, the concept arose from a warlike concept due to the military campaigns commonly carried out during the Ancient Age. Secondly, strategy is understood as a plan devised to achieve a specific goal. In the educational field, with the aim of achieving the purpose of education, we speak of pedagogical strategies. According to Tennuto et al. (2003), "...they are a set of activities that are designed with a predetermined objective, in accordance with the teaching purposes established" (p. 781) in the educational plan. The timely application of teaching strategies in high school can ensure the development of critical thinking. It is important to clarify that if these types of techniques are introduced from the early stages of school, there is a potential for fostering critical thinking in the classroom.

To develop logical reasoning, it is suggested to be guided by the five cognitive levels proposed by Marzano (2001): retrieval, comprehension, analysis, application, and



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metacognition. Below, to contribute to the development of critical thinking in unified high school, some teaching strategies are presented according to their cognitive level.

The first cognitive level, or retrieval, refers to the prior knowledge possessed by the learner. To this end, several activities are proposed: brainstorming. Brainstorming originated in the business world in the 1950s. This involves presenting a topic or question in the classroom so that, within a period of 10 to 15 minutes, learners, drawing on their prior knowledge, individually or in groups, can propose several ideas in a clear and concrete manner and then share the ideas they have developed. According to Delgado (2022), "Brainstorming is based on four fundamental principles: freedom of thought, avoiding pre-emptive critical scrutiny, the more ideas the better, and multiplying the ideas" (p. 58). This type of activity aims to identify real problems and formulate possible solutions through a series of alternatives presented in the brainstorming session. It must be ensured that the learner does not resort to the use of digital devices.

Another strategy is the thinking routine, also known as the S-QS-A strategy (I know-I want to know-I learned). It is used to activate prior knowledge related to a text, topic, or problem. It also generates doubts about knowledge by posing questions or proposing new content. In addition, it allows the student to acquire the ability to contrast between what he or she knows and what he or she has learned. The strategy is used before studying a text, topic, or problem. It is done as follows: using the blackboard, the teacher designs a table with three entries. In the first, the teacher writes the question: "What do I know?"; in the second, "What do I want to know?"; and in the third, "What did I learn?" When sharing the information, it is necessary to record all ideas, both correct and incorrect, and through explanation, the corresponding ideas are discarded. Applying the thinking routine at the beginning of a new topic generates curiosity and interest in learning and understanding. In this sense, Delgado et al., (2020) state that: "this technique not only allows a diagnostic assessment but also a formative one to verify the significant learning achieved" (p. 89). The objective of this technique is to detect prior knowledge of a topic to expand knowledge through questions that allow relating the skills and content learned with their context.

At the second cognitive level, known as comprehension, the learner is able to adapt their prior knowledge with the knowledge constructed in the classroom. To achieve this objective, it is proposed to use graphic organizers (mind maps, conceptual maps, synoptic tables, mind maps). The use of graphic organizers serves to identify central ideas of the text, topic or problem, organize the content, prioritize information, compare theories. The strategy can be used after having studied a topic or read a text. The teacher is required to use various types of graphic organizers when presenting their classes so that the student can relate to the construction of these. According to Delgado (2022), "among the benefits that this strategy provides us we have that: it encourages creativity, increases our analytical capacity, allows us to enrich our communication, allows us to prioritize and organize information" (p. 59). Graphic organizers should initially be created by hand. Once the student has developed the skill of constructing them, they can be created using various digital applications. The objective of this tactic focuses on synthesizing information to elicit relevant ideas rather than trivial or secondary ones.

At this cognitive level, oral presentation is required, which develops communication skills such as observation, listening, speaking, and argumentation. Through presentations, the individual and/or group level of understanding is verified. According to Tennuto et al. (2003), oral presentations "will help organize and categorize both information and important concepts within a meaningful intellectual framework" (p. 787). It is



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recommended that students be asked to present real-life examples consistent with the topic during their presentations. The objective of this approach is to allow students to clearly explain their understanding of a given piece of content while also being able to relate it to specific cases from their own experience.

At the third cognitive level or analysis, the use of the academic essay and the application of the Q thinking routine (QV – QnV – QI) are proposed. The essay allows the learner to recognize new problems related to a given topic and deepen their knowledge. The subject not only learns the content, but rather apprehends reality. The academic essay has been one of the underused strategies in the classroom; according to Castañeda and Reyes (2020), it constitutes: "a meeting bridge between critical thinking and argumentative theory, as it brings to the fore skills and dispositions to generate deep reflection on the particular point of view regarding a specific aspect of a certain matter" (p. 170). The teacher should guide the construction of the academic essay, which contains three elements: introduction, development, and conclusions. In the development, it is suggested to add the following components: argumentative paragraphs, counterargument paragraphs, and refutation paragraphs. In this way, the student's skills of analysis and synthesis will be enhanced.

Paraphrasing Delgado et al., (2020), the Q thinking routine (QV – QnV – QI), is an uncommon technique within the teaching-learning process, it serves to generate autonomous knowledge, it consists of answering the three questions: What do I see? What don't I see? What do I infer? These must be written at the end of a certain topic and once the learner has developed this skill, they will be able to question the content provided by the teacher, their methodology, the functioning of the institution and the very ideology of hegemonic sectors, forcing them to investigate outstanding aspects about what they cannot see. There is no in-depth research on this technique, however, from Garcito's perspective (2021) with this strategy: "critical sense can be developed much more and problems can be analyzed from other perspectives, paying attention to their causes and most likely consequences" (p. 55). The Q thinking routine is occasionally used in the social sciences to promote reading comprehension. It is recommended that this be used in the different subjects.

The fourth cognitive level, called application, involves collaborative and cooperative work. At this level, the existence of a subject with perceptive skills is assumed, where learning is transformed into meaningful learning. For this cognitive level, the application of debate or project-based learning is recommended. Debate helps persuade through argumentation and involves the development of communication, digital, and socioemotional skills. Implementing this strategy in the classroom, according to Giroux (2001), "involves developing a unique language attentive to the problems experienced in daily life, particularly to the extent that they are related to experiences connected to classroom practice" (p. 66). It requires prior knowledge, an understanding of the subject matter, analysis, as well as the selection of relevant information from the background, and a grasp of the content.

Project-based learning is one of the most common activities in educational institutions, contemplated by the Ministry of Education for implementation at all educational levels, according to Tennuto et al. (2003) this "involves not only the teaching of procedures, skills, and problem-solving strategies, but also the development of value-based activities that are positive for learning, using problem-solving as a strategy" (p. 830). To date, this strategy has not been implemented correctly in Ecuador. First, two PBL projects are required per partial exam; second, teachers propose the topics to be worked on, neglecting the learner's active initiative; third, project-based learning consists of creating an applicable proposal,



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while in schools, the presentation of a specific product is proposed, with only challenge-based learning.

The fifth cognitive level, also called metacognition, consists of the development of autonomous learning, the interrelation of information, and the ability to argue, write, question, and persuade on a topic or problem. According to Jaramillo and Simbaña (2014), metacognition "refers to the ability to maneuver, regulate, or control cognitive resources or strategies in order to ensure the success of a task or problem solution" (p. 302). At this cognitive level, the learner can answer himself/herself as suggested in the following questions: Did I achieve it? How did I achieve it? When did I achieve it? To do this, the strategy of questioning and research can be carried out. The posing of questions is null or almost absent in the classroom, it is generally carried out by those teachers with a foundation in the philosophy of education, it consists of asking philosophical questions to the text, the topic, or the problem posed, this strategy requires the pertinent intervention of the teacher. Formulating questions is not an easy task; the student is used to asking questions with immediate answers. The approach to this type of questions reveals your capacity for comprehensive, analytical, and synthetic reading of the text and the context.

Once the questions have been posed, they must be shared in class for discussion. In this space, the teacher no longer transmits any type of knowledge; their role is to act as a guide in the discussion. Based on Tuirán (2019), "the purpose is to instigate students' curiosity and imagination, guide their argumentative skills, make them aware of their difficulties and how to overcome them" (p. 18). The strategy of asking questions gives rise to the investigative desire of others, to the inquiry into knowledge, etc. Currently, research is a complex process that has had difficulties being applied in the classroom. It should be emphasized that, research as a subject appears in the third year of high school; if the teacher limits himself only to reaching that level, there will continue to be a lack of interest on the part of students in committing to social transformation. Research must be present in all curricular subjects and must be exercised by teachers.

Critical thinking is not an easy cognitive skill to develop; it requires teacher training and the appropriate application of properly planned strategies. All cognitive levels must be considered to strengthen critical thinking. In this section, according to the cognitive level, those that can help foster the development of critical thinking in high school have been briefly presented. However, there are still several strategies, such as short films, learning narratives, dramatization, gamification, and the inverted classroom, which are intended to be worked on by other researchers or theorists related to learning, teaching, or philosophy.

8. Conclusions

The education system influences the development of critical thinking among students in the unified general high school system. It regulates both the role of the teacher and the learner. The current state of Ecuadorian education still presents a series of difficulties due to reforms brought about by the interests of the ruling government. The latest educational reform, the LOEI (Organic Law of Education), sets forth guidelines regarding merit-based and competitive examinations, assessment-related topics, course load, and the epistemological foundations of the curriculum.

Education is mediated by the Curriculum for Compulsory Education Levels, which is based on the achievement of skills with performance indicators. However, the administrative and pedagogical burden assigned to teachers has limited them solely to teaching content that is verified in assessment processes, a situation that sheds light on the gap between what is



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expressed in the educational plan and what is implemented in the classroom. In a scenario like the one described above, education has recently declined in quality, affecting generations who have had to undergo the so-called "curriculum update" and the implementation of educational reforms unrelated to the context of Ecuadorian basic and secondary education.

The 1996 curriculum reform in Ecuador marked a key change in the education system. Beginning that year, 10 years of compulsory education were established and the curriculum was structured around areas of knowledge. This was the so-called "Consensual Curriculum Reform," which established the general objectives for basic education and the new curriculum. From 2009 to 2012, the reform known as "Updating and Strengthening Basic General Education and the Unified General Baccalaureate, which prioritized know-how and skills," was implemented. In 2016, the so-called "Curricular Adjustment" was introduced for basic general education and the unified general baccalaureate. In 2018, the "Reform of the basic general education curriculum" emerged, which focused on the development of competencies in students; In 2021, the "Consensual Curriculum Reform for Basic Education" was established.

The so-called "Curriculum Update and Strengthening Process" for Basic General Education came into effect in 2009, and in the 2011-2012 school year, the so-called Unified General Baccalaureate (BGU) was established.

Regarding Basic General Education, in documents from the Ministry of Education (2016), it was characterized as "...being a skills-based mesocurriculum, structured in curricular blocks conceived as learning units, (...) which presents the characteristics of an annual program for each of the areas of knowledge, with all the necessary elements for teaching action" (p. 6). The intention was good in the sense that it relied on the principles of critical pedagogy, revaluing the role of the student as the protagonist of their learning, and because it sought to comply with Article 343 of the 2008 Constitution and Article 2 of the Organic Law on Intercultural Education, a regulation that, as a whole, raises the need to prepare individuals to face and solve everyday problems.

Regarding the update and implementation of the Unified General Baccalaureate, the same document from the Ministry of Education (2016) indicates that one of the purposes was to provide:

.... a general education appropriate to their age.... came to replace the set of plans and programs for specializations that were used until then for this educational level, articulating this training offer with the current curriculum of Basic General Education and responding to the same structure (p. 6).

However, despite the intentions described for both cases, the results were not as expected. Thus, in 2016, based on teachers' experience and information regarding the implementation of the proposed curriculum and previous curriculum designs, the so-called "curricular adjustment" was implemented for Basic General Education and the Unified General Baccalaureate. A "more open and flexible proposal was presented, with the aim of providing better tools for addressing the diversity of students in different educational contexts (...) in accordance with Article 10 of the Regulations of the Organic Law on Intercultural Education" (Ministry of Education, 2016, p. 7).



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The reforms since 2016 have followed the same trend without achieving a major impact on the main local educational stakeholders. They continue to use classroom practices and curricular models from other countries unrelated to Ecuadorian reality as references. The consequences of these reforms, which have clearly impacted training, are still being felt. In the intellectual, procedural, and attitudinal aspects of students, there is a clear gap between secondary and higher education. There are problems with comprehension, little interest in research, "don't-care" attitudes, poor analytical, critical, and reflective capacity for problem-solving, etc.

There is a lack of coordination between the mandatory minimum content and the skills that must be developed throughout the educational process until the completion of high school, resulting in a low-quality education where learners struggle to analyze, argue, reflect, question, and classify information. Educational reforms must be oriented toward the teaching-learning process, must be consistent with the reality of the classroom, must contribute to reducing student passivity, reducing the number of teachers who act mechanically, responding to the models under which they were trained, and reducing the administrative and management burden currently placed on education professionals.

The presence of tired teachers prevents them from developing certain cognitive skills in their learners, which are essential for reflecting on the Social injustice and inequity. The Ecuadorian educational space requires sound, timely, and pertinent policies centered on both the teacher and the student. Teachers, as intellectual transformers, have the obligation to awaken critical thinking in their learners. Critical thinking inherently encompasses complex cognitive operations such as analysis, reflection, argumentation, questioning, and cooperative work. The development of these skills brings with it a series of advantages for society in the classroom, including the development of awareness, reflection on ethical and moral behavior, recognition of the Other, Good Living, social inclusion, and so on. To participate in these types of advantages requires a well-prepared teacher, since an education professional who does not read or research will have difficulty fostering the development of critical, reflective, and creative thinking in others. In general, in the Ecuadorian educational context, as recommended by Aguilar-Gordón and Rosero-Guillén, it is essential to (2019):

...Assess and apply the principles stipulated in the Constitution of the Republic of Ecuador and in all the regulations established in the derived laws: Organic Law of Higher Education, Law of Intercultural Education and make a reality all the provisions that promote the construction of a comprehensive and holistic education (p. 35).

An education that promotes critical, reflective, and proactive thinking that allows for the appreciation of each individual by examining themselves, understanding others, and constructively undertaking social transformation.

Finally, education professionals must not only ensure the development of thinking but also implement relevant methodologies to generate critical thinking. Teachers need to create means to acquire this type of thinking, and it is advisable that these be applied from lower levels. However, there are certain strategies that can be applied with high school students, according to the cognitive level formulated by Marzano (2001). Five cognitive levels were considered, with certain proposals to be developed in the classroom: 1) retrieval, including brainstorming or thinking routines; 2) comprehension, with graphic organizers or oral presentations; 3) analysis, through the development of an academic essay or an exercise



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applying the three Qs; 4) application, through debate skills or project-based learning. 5) metacognition, a more complex level, requires formulating questions with a philosophical character and research.

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Declaration of authorship-CRediT

ALEXANDRA PATRICIA CHAMBA-ZARANGO: Data collection, conceptualization, data analysis, methodology, and drafting of the original draft.

FLORALBA DEL ROCÍO AGUILAR-GORDÓN: Definition of the central theme and structure of the research, supervision of the research process, formal and conceptual review of the original draft, rewriting, in-depth research, editing, and final adjustments.



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REVISTA

CÁTEDRA

Development of historical thinking in the first year of high school: analysis of the activities in the History textbook

Desarrollo del pensamiento histórico en el primero de bachillerato: análisis de las actividades del libro de texto de Historia

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(Received on: 21/02/2025; Accepted on: 25/04/2025; Final Version received on: 20/07/2025)

Suggested citation: Nasimba-Mera, E. & Fraga-Luque, O. (2025). Development of historical thinking in the first year of high school: analysis of the activities of the History textbook. *Revista Cátedra*, 8(2), 137-152.

Abstract

The limited development of historical thinking among students represents a central problem in the teaching of history, as it restricts their ability to critically interpret the past and move beyond the mere accumulation of information. Given this situation, the present study aims to analyze the extent to which the activities in the first-year high school history textbook contribute to the development of historical thinking among students. To this end, the 121 activities in the textbook were examined according to the type of historical concept, cognitive demand, and type of activity. A mixed approach and content analysis technique were used, employing a code book and analysis sheet as instruments. The information was



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processed using frequency tables, contingency tables, and a word cloud, with the SPSS and MAXQDA programs. The results highlight that activities related to first-order concepts and with low and intermediate cognitive demands predominate, which highlights the need to diversify the activities in textbooks, incorporating approaches that encourage critical analysis, interpretation, and the reflective use of historical knowledge.

Keywords

Didactics, history, textbooks, first year of high school, historical thought.

Resumen

El escaso desarrollo del pensamiento histórico en el estudiantado representa una problemática central en la enseñanza de la Historia, dado que restringe su capacidad para interpretar críticamente el pasado y superar la mera acumulación de información. Ante esta situación, el presente estudio tiene por objetivo analizar en qué medida contribuyen las actividades del libro de texto de Historia del primer año de Bachillerato al desarrollo del pensamiento histórico en el estudiantado. Para ello, se examinaron las 121 actividades de dicho manual de acuerdo con el tipo de concepto histórico, exigencia cognitiva y tipo de actividad. Se empleó un enfoque mixto y la técnica de análisis de contenido, utilizando como instrumentos un libro de códigos y una ficha de análisis. El tratamiento de la información, que incluyó el uso de tablas de frecuencias, tablas de contingencia y una nube de palabras, se realizó con los programas SPSS y MAXQDA. De los resultados se destaca que predominan actividades relacionadas con conceptos de primer orden y con una exigencia cognitiva baja e intermedia, lo que pone de manifiesto la necesidad de diversificar las actividades en los libros de texto, incorporando enfoques que fomenten el análisis crítico, la interpretación y el uso reflexivo del conocimiento histórico.

Palabras clave

Didáctica, historia, libros de texto, primero de bachillerato, pensamiento histórico.

1. Introduction

Over the last decade, the development of historical thinking has become established as a primary goal of history teaching and learning. This approach allows us to move from models focused on the mere transmission of content to pedagogical models focused on reflection, criticism, and construction (Ibagón and Minte, 2022, p. 121). In this way, students are given an active and leading role in the discipline of history, in line with the demands of the 21st century.

Leading researchers in history teaching, such as Domínguez and Santisteban, agree that the teaching and learning of history should not be limited to the transmission and repetition of facts, dates, and figures, but should focus on the development of historical thinking (Domínguez, 2015, p. 8; and Santisteban, 2010, p. 35). This allows students to acquire the skills and abilities essential for actively and independently constructing knowledge, considering that history is not a finished fact but a construction that is constantly being revised and interpreted.

Therefore, with the aim of contributing to the development of historical thinking in high school students, this study analyzes one of the most widely used teaching materials in the teaching and learning of history: the textbook. According to Saíz and Colomer, this resource,



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“like other resources used in the subject of history, should aim to promote adequate historical education” (p. 3); that is, to encourage the development of historical thinking.

“Textbooks have traditionally been one of the central resources in education systems, especially in Ecuador” (Sánchez, 2021, p. 41). Their relevance lies not only in the historical narrative they contain, but also in the activities that guide the teaching and learning process. Hence, their analysis provides insight into how the teaching and learning of history is structured in the classroom.

Previous studies in Spain have revealed that the activities in secondary school textbooks present challenges for the development of historical thinking. Research carried out by Ferreras et al., Gómez et al., and Simón shows a predominance of activities focused on memorizing factual content, to the detriment of those that foster historical thinking (Ferreras et al., 2020, p. 171; Gómez et al., 2020, p. 1; and Simón, 2023, p. 1). This situation highlights the need to balance the use of first- and second-order concepts to strengthen this competence in high school.

In this context, the present study seeks to answer the following research question: to what extent do the activities proposed in the history textbook for the first year of high school in Ecuador contribute to the development of historical thinking? This question is justified by the need to critically analyze the textbook, one of the most widely used teaching materials in the teaching and learning of history. This resource plays a key role in pedagogical mediation and in the formation of specific cognitive skills, such as the aforementioned capacity for historical thinking.

In terms of the organization of the article, the second section presents the theoretical foundations of historical thinking. The third describes the methodology used for the analysis of the activities, while the fourth presents the main findings. Finally, the fifth section discusses the results and conclusions. The purpose is to contribute to the reflection on the teaching and learning of history and to highlight the need to design teaching strategies that effectively promote the development of historical thinking in the classroom.

2. Theoretical reference

Historical thinking has been extensively studied by various authors. Among them, Wineburg (2001) defines it as a “set of skills specific to historical work that enable students to construct knowledge autonomously” (n.p.). This type of thinking encompasses various cognitive skills that enable students to interpret, understand, and reflect on the past.

This type of thinking “is not intuitive and natural knowledge, but requires a gradual learning process” (Saíz and López, 2015, p. 89). Therefore, certain elements must be considered during the teaching and learning process of history in order to develop it. First, Domínguez (2015) points out that “it is necessary to work with first-order or substantive concepts and second-order or methodological concepts” (p. 46); the latter are the ones that should predominate in the formation of historical thinking.

First-order concepts are those related to specific dates, figures, and events, with a more conceptual nature. For example, knowing the date of the Battle of Pichincha or who the main figures of the Liberal Revolution were. These are classified as:

- Chronological: Knowledge of the dates on which a particular event occurred or their order.



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- Factual: Knowledge of specific concepts, theories, or facts from the past (Gómez and Miralles, 2015, p. 59)

On the other hand, second-order or methodological concepts are those that are more strategic and focus on understanding history. Within the second-order concepts, Seixas and Morton (2013) present six key concepts:

Historical relevance: Ability to establish the relevance of specific events or individuals based on one's own criteria. Historical sources: Critical analysis of primary and secondary sources for subsequent interpretation. Change and continuity: Identification of continuities and changes over time. Causes and consequences: Evaluating the multiple causes and consequences of historical events. Historical perspective: Understanding the perspectives of people in the past based on historical context. Ethical dimension: Generating ethical judgments and assessments of past actions based on context (p. 4).

First-order and second-order concepts complement each other and are interdependent. However, in order to learn to think historically, it is crucial to place greater emphasis on second-order concepts, as these enable us to understand and make sense of first-order concepts. Thus, it is essential to teach not only 'knowing' (content), but also 'doing' (applying), using second-order concepts, which require a higher level of cognitive complexity (Moreno et al., 2023, p. 91).

According to Martínez et al., historical thinking requires more complex skills than simple memorization and repetition of content (Martínez et al., 2022, p. 1), which implies a higher level of cognitive processing. Marzano and Kendall's taxonomy (2007) structures the cognitive system into four levels: "retrieval, comprehension, analysis, and application" (p. 13). In this sense, to foster historical thinking, it is necessary to transcend the level of retrieval and propose activities that promote comprehension, analysis, and application of historical knowledge.

For the development of historical thinking, it is essential to propose activities that give students an active role, in line with a constructivist pedagogical model. The focus should be on strategies based on research, inquiry, and problem solving, as these favor the development of complex cognitive skills and, consequently, the construction of historical thinking (VanSledright, 2011, n/p). In contrast, mechanical activities and short-answer questions distance themselves from this approach by limiting analysis and critical reflection on historical events.

3. Methodology

3.1 Data collection technique and instruments

This study uses a mixed-methods approach and uses content analysis as its primary technique, which allows for the interpretation of documentary sources through the application of both quantitative and qualitative procedures (Guix, 2008, p. 27). To collect and analyze the activities proposed in the first-year high school history textbook, two Excel-based instruments were designed: a codebook and an analysis sheet.

For the analysis process, activities were specifically selected from the first-year high school textbook, issued by the Ministry of Education in 2020 and published digitally and free of



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charge on the "Recursos Educativos 2" website. A total of 121 activities were analyzed, distributed across the six units comprising the textbook. Data collection was carried out using an analysis sheet (Table 1), in which the 121 activities were recorded, along with the unit to which they belong, the name of the unit, the thematic content, and the page on which they are located. In addition, three additional columns were included to classify each activity according to the type of historical concept, the level of cognitive demand and the type of activity.

Unit of analysis	Unit of analysis			Categorías				
	Activities	Nº Unit	Unit Name	Thematic content	Página	Type of historical concept	Cognitive demand	Type of activity
	Activity 1							
	Activity 2							
	Activity...							

Table 1. Analysis Sheet

In addition to the analysis sheet, a codebook was designed based on criteria previously defined in studies on historical thought. This instrument allowed us to define each category and subcategory for the classification of the 121 activities according to the type of historical concept, cognitive demand, and type of activity. To define the type of historical concept (Table 2), the studies by Gómez and Miralles (2015) and Seixas and Morton (2013) were considered. The cognitive demand (Table 3) was defined based on the taxonomy of Marzano and Kendall (2007), while the classification of the type of activities (Table 4) was based on the work of Gómez et al. (2019).

	Types of Historical Concepts	Example
Conceptos de primer orden	<i>Chronological Knowledge</i> Knowledge of the dates on which a particular event occurred or their order.	What event occurred in the year 1492?
	<i>Factual Knowledge</i> Knowledge of concepts, theories, or events from the past.	What are the differences between history and historiography?
	<i>Historical relevance</i> Establishes the importance of certain events or figures.	Explain the importance of Moses to Israel.
Conceptos de segundo orden	<i>Historical Sources</i> Examine historical sources (primary or secondary) for further interpretation.	Examine the Greek sculpture below and detail what information it provides.
	<i>Change and Continuity</i> Recognizes those aspects that change over time and those that remain constant.	How does ancient Roman law differ from the current Ecuadorian legal system?
	<i>Causes and Consequences</i>	Outline the causes and consequences of the Jewish diasporas.



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<i>Analyzes the multiple causes and repercussions of a historical phenomenon or event.</i>	
<i>Historical perspective</i>	Imagine you are a citizen of Athens and you are writing a letter to your sister who lives in another city. In your letter, explain your situation as a citizen in Athens.
Determines the perspective of people in the past according to the historical context. Understands the attitudes and actions of the past.	
<i>Ethical dimension</i>	Do you agree with the establishment of castes in Ancient India? Justify your answer.
Generates ethical judgments and evaluations of past actions based on context. Evaluates crimes, injustices, benefits.	

Table 2. Types of Historical Concepts. Adapted from: Gómez and Miralles (2015) and Seixas and Morton (2013)

Cognitive Demand	Examples
<i>Remediation</i> To complete the activity, students must recognize or recall the knowledge in the same way it is presented in the text. Verbs such as select, identify, determine, name, describe, locate, list are often used; or questions such as: What? Who? Where? When?	What physical changes did hominids undergo?
<i>Comprehension</i> To complete the activity, students are required to integrate or symbolize the acquired knowledge. Actions such as describe how or why, describe the effects of, describe the relationship between, explain how, make connections between, represent, draw are often used. At this level, work tends to be done on developing graphic organizers or interpreting tables, images, or maps.	Draw a comparison chart between the Paleolithic and Neolithic periods.
<i>Analysis</i> To complete the activity, students are required to identify similarities or differences, classify knowledge into categories, analyze errors, make generalizations, or develop specifications, which implies generating new knowledge that they did not previously possess. Verbs such as differentiate, identify problems, identify drawbacks, judge, and evaluate are often used. concludes, infers, deduces, defends, predicts.	Discuss the differences between the original, romantic, and current meanings of the term culture.
<i>Aplication</i> To complete the activity, students are required to identify similarities or differences, classify knowledge into categories, analyze errors, make generalizations, or develop specifications, which implies generating new knowledge that they did not previously possess. Verbs such as differentiate, identify problems, identify drawbacks, judge, and evaluate are often used. concludes, infers, deduces, defends, predicts.	Research and write a micro-essay on the origin of Israel.

Table 3. Levels of cognitive demand. Adapted from: (Marzano and Kendall, 2007)



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Type of activity	Example
<p><i>Short Question</i> Students are asked to answer short questions based on the textbook.</p>	What does the term culture mean?
<p><i>Objective Test</i> Students are asked to: fill in the blanks, order events, choose the correct option, match columns, or complete statements.</p>	Relate each event to the historical period.
<p><i>Text Commentary</i> Students are asked to analyze texts presented in the textbook. This includes identifying main ideas, opinions, syntheses, and interpretations.</p>	What message does Gombrich's text want to convey?
<p><i>With Images and Figures</i> The activity involves the use of images and/or figures found in the textbook</p>	Observe the drawing of Mesopotamian civilization and answer: What advantages can be gained by being located near a river?
<p><i>With Maps</i> The activity involves the use of maps provided in the textbook.</p>	Look at the map and answer: Which territories were conquered by Alexander the Great?
<p><i>Graphic Organizers</i> Students must create diagrams, mind maps, concept maps, or comparison charts.</p>	Draw a comparative table of historiographical currents.
<p><i>Creation</i> Students must produce something new, fostering creativity and innovation. This includes creating poems, journals, and songs.</p>	Imagine you are a citizen of Ancient Athens. Write a letter to a family member telling them the most interesting aspects of the polis.
<p><i>Information Search</i> This involves students gathering information from different media (beyond the textbook)</p>	Research the events that occurred after the fall of the Berlin Wall. Were there further military interventions by the United States?
<p><i>Collaborative</i> It involves not only intellectual exercises but also teamwork. It includes debates, roundtable discussions, and role-playing.</p>	Hold a debate based on the following question: What is culture? Who can be considered a cultured person?

Table 4. Type of activities. Adapted from: (Gómez et al., 2019)

3.2 Data analysis

For data analysis, SPSS and MAXQDA were used, combining quantitative and qualitative techniques. First, a descriptive statistical analysis was performed in SPSS for each category: historical concepts, levels of cognitive demand, and types of activities. Frequency and percentage tables were generated, as well as contingency tables between categories.

Subsequently, the textual content of the 121 textbook activities was imported into MAXQDA to identify patterns and trends in their formulation. A word cloud was generated to visualize the most frequently used terms and analyze their relationship to the development of historical thought.



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4 Results

Regarding the type of historical concept, a predominance of first-order concepts was found over second-order concepts, as shown in Table 5. The majority of activities (58.7%) focused on factual knowledge, that is, specific information about historical concepts, theories, figures, or events. This is evident in questions such as: What Germanic kingdoms existed at the end of the 5th century? Where was the term culture first used? These questions can be quickly and explicitly answered in the textbook.

In contrast, second-order concepts, fundamental to the development of historical thought, are found in a lower percentage, with a total of 38.9%. Within this category, causes and consequences are the most common, at 11.6%; while ethical dimension, change and continuity, and historical sources register percentages lower than 6%. Which shows a scarce presence of activities in which students generate ethical judgments, recognize the aspects that are transformed and maintained over time, and make use of historical sources for their respective interpretation.

Type of historical concepts		Frequency	Percentage
First-order concepts	Factual Knowledge	71	58.7
	Chronological Knowledge	3	2.5
Second-order concepts	Historical Relevance	10	8.3
	Historical Sources	6	5.0
	Change and Continuity	5	4.1
	Causes and Consequences	14	11.6
	Historical Perspective	7	5.8
	Ethical Dimension	5	4.1
Total		121	100.0

Table 5. Frequencies and percentages of the type of historical concept

Regarding cognitive demands, the most common cognitive demand was comprehension (45.5%), followed by retrieval (27.3%), and analysis (25.6%), as detailed in Table 6. This shows that most activities focus on the first three levels of Marzano and Kendall's (2007) taxonomy, prioritizing recognition, recall, integration, symbolization, classification, association, generalization, and specification of historical knowledge.

However, a limited presence of activities was also observed at the application level, which is key to fostering skills such as problem-solving, researching diverse sources, decision-making, and experimentation. Of the 121 activities analyzed, only two fall within this level, highlighting the need to incorporate teaching approaches that promote more active and meaningful learning.

Cognitive Demand	Frequency	Percentage
Recovery	33	27.3
Comprehension	55	45.5
Analysis	31	25.6
Application	2	1.7
Total	121	100.0

Table 6. Frequencies and percentages of the level of cognitive demand



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Regarding the type of activities, short questions are the most frequent, accounting for 62%. Examples of these questions include: What is work? What was the economic basis of the Mesopotamian empires? Activities with graphic organizers are a considerable distance behind (13.2%). The remaining activities, related to images and figures, text commentary, collaborative activities, maps, and objective tests, account for less than 10%. This highlights the need to propose a greater diversity of activities that allow students to take an active role in constructing historical knowledge.

It is important to note that, of the 121 activities analyzed, only one creative activity and two information-searching activities were found, reflecting the limited presence of activities that encourage students to produce something new and research diverse sources that involve going beyond the textbook. Table 7 details the data obtained.

Type of activity	Frequency	Percentage
Short Question	75	62.0
Objective Test	3	2.5
Text Commentary	7	5.8
With Images and Figures	9	7.4
With Maps	4	3.3
Graphic Organizers	16	13.2
Creation	1	0.8
Information Search	2	1.7
Collaborative	4	3.3
Total	121	100.0

Table 7. Frequencies and percentages of the type of activity

The analysis of the relationship between the type of historical concept and cognitive demand, based on the Chi-square test (Table 8) shows a highly significant association. First-order concepts (chronological and factual) are related to the first two levels of cognitive demand: recovery and comprehension, while second-order concepts have a greater relationship with the level of comprehension and analysis (Table 9). Evidence that working with second-order concepts, fundamental for the development of historical thinking, also implies greater cognitive demands, as pointed out by Martínez and Gómez (2018).

	Value	Gl	Asymptotic significance (bilateral)
Pearson's Chi-square	56.268a	21	<.001
Likelihood ratio	61.052	21	<.001
N of valid cases	121		

Table 8. Chi Square test between type of historical concept and cognitive demand



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Type of historical concept		Cognitive demand				Total	
		Recovery	Comprehension	Analysis	Application		
Type of historical concept	Factual Knowledge	30	28	11	2	71	
	Chronological Knowledge	2	1	0	0	3	
	Historical Relevance	0	7	3	0	10	
	Historical Sources	0	3	3	0	6	
	Change and Continuity	0	1	4	0	5	
	Causes and Consequences	1	12	1	0	14	
	Ethical Dimension	0	0	5	0	5	
	Historical Perspective	0	3	4	0	7	
	Total		33	55	31	2	121

Table 9. Contingency table between historical concept and cognitive requirement

The analysis of the relationship between concept type and activity type, based on the Chi-square test (Table 10), also reveals a highly significant association between both categories. The majority of short-question activities are linked to first-order knowledge, while the remaining activity types are distributed to a lesser extent among the different types of historical concepts, as seen in Table 11.

It is noteworthy that text commentary activities and image and figure activities are related to historical sources (second-order concepts). These types of activities could be used as a starting point to encourage the use of primary and secondary sources for the construction of historical knowledge. These findings in themselves reveal the need to diversify activities to foster historical thinking, rather than relying solely on short questions.

	Value	Gf	Asymptotic significance (bilateral)
Pearson's Chi-square	98.199 ^a	56	<.001
Likelihood ratio	66.166	56	.166
N of valid cases	121		

Table 10. Chi Square test between type of historical concept and type of activity



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Type of historical concept	Type of activity	Type of activity									Total
		Short question	Objective Test	Text comment	With images and figures	With maps	Graphic organizers	Creation	Search for information	Collaborative	
Factual knowledge		47	1	2	3	4	9	0	2	3	71
Chronological knowledge		1	1	0	0	0	1	0	0	0	3
Historical relevance		6	0	0	1	0	3	0	0	0	10
Historical sources		0	0	2	4	0	0	0	0	0	6
Change and continuity		4	0	0	0	0	1	0	0	0	5
Causes and consequences		11	1	0	0	0	1	0	0	1	14
Historical perspective		3	0	2	1	0	0	1	0	0	7
Ethical dimension		3	0	1	0	0	1	0	0	0	5
Total		75	3	7	9	4	16	1	2	4	121

Table 11. Contingency table between historical concept and cognitive requirement

Finally, after generating the word cloud in MaxQda, it was evident that the most frequent terms are closely related to specific historical facts, such as the names of empires, figures, and events, reflecting a focus on factual knowledge, as shown in Figure 1.

The most frequent word is "what?", followed by words such as "answers," "comparative," "elaborates," "relationship," "believe," "observes," and "explains." This reveals a predominance of factual knowledge, but also highlights the presence of activities that encourage an active role for students in learning, through observation, reflection, comparison, and explanation. There are activities that promote the development of historical thinking, although to a lesser extent.



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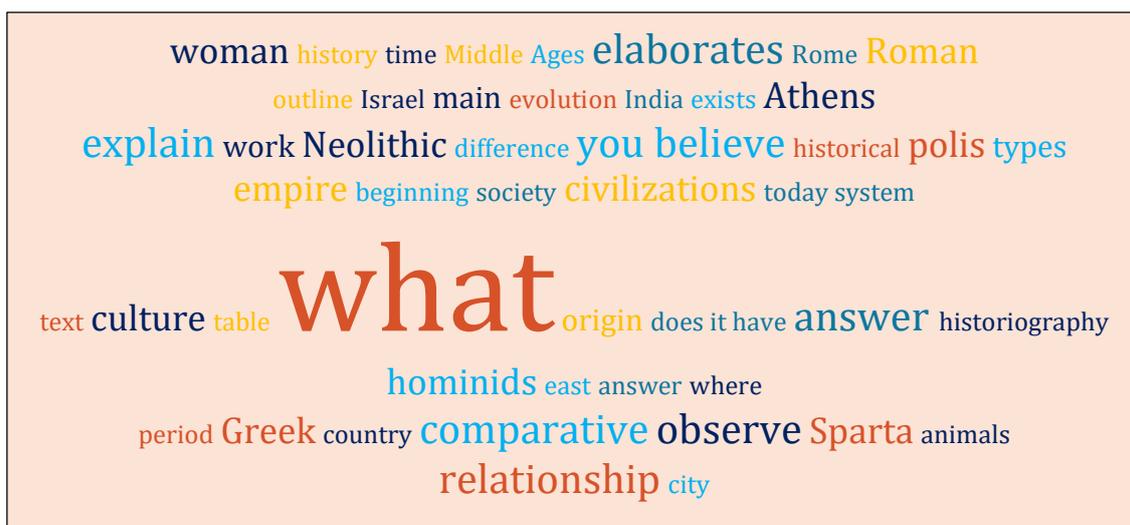


Figure 1. Word cloud of textbook activities

It is also important to note that the most frequently used words in the activities are: "culture," "Roman," "Greek," "empire," "Sparta," "Athens," "civilizations," "women," "Neolithic," and "hominids," which reveal an emphasis on topics related to ancient civilizations, especially Greece and Rome. This approach suggests the need for a more appropriate balance in the selection of activities for each of the topics covered in the textbook.

5 Discussion and conclusions

The results obtained show a clear prevalence of first-order concepts over second-order concepts in the activities analyzed. This finding is consistent with previous studies conducted in other contexts, such as Spain, where a similar trend has been identified in history textbooks (Simón, 2023, p. 1). The activities present a predominantly factual and conceptual focus, rather than a critical understanding and interpretation of history. This coincidence with international research reinforces the need to rethink the design of activities, incorporating second-order concepts more frequently.

Of the six second-order concepts, the concept of ethical dimension, along with the concepts of change and continuity and historical perspective, are among the least present in the activities analyzed. As evidenced in the Spanish textbooks, "the concepts of historical relevance and historical consciousness or the ethical dimension of history have a lesser presence" (Martínez and Gómez, 2018, p. 160). For this reason, it is imperative to rethink the balanced inclusion of first- and second-order concepts in History textbook activities to foster the development of historical thinking.

The cognitive demands of the activities proposed in the History textbook focus primarily on the first three levels of Marzano and Kendall's (2007) taxonomy. Consequently, it is important to design educational activities that mobilize complex cognitive capacities and thinking skills specific to the historical discipline (Gómez, 2014, p. 14), thus allowing us to



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transcend the mere repetition and memorization of content. Students must be able to research, make decisions, solve problems, and argue to actively construct their knowledge.

There are few activities that invite students to produce something new, research diverse sources, or work collaboratively, which reinforces the need to incorporate these types of proposals more frequently in textbooks. In line with these findings, it is important to note that, according to Carretero and Gartner, fostering the development of historical thinking requires creating spaces for dialogue, debate, and discussion, in which students can question assumptions, evaluate sources, and recognize the complexity of historical events (Carretero and Gartner, 2024, p. 84).

There is a significant association between the type of historical concept and cognitive demand. Second-order concepts allow students to develop and integrate complex skills (Martínez and Gómez, 2018, p. 149). Therefore, by working with the six second-order concepts—historical relevance, historical sources, change and continuity, causes and consequences, historical perspective, and ethical dimension—it is also possible to foster complex cognitive skills in which students take on a leading role.

Thus, it is concluded that the activities proposed in the first-year high school history textbook in Ecuador offer limited contributions to the development of historical thinking. This highlights the need to review and enrich the didactic design of these materials, incorporating proposals that promote more active, reflective, and contextualized learning, in line with current approaches to the teaching and learning of history.

To foster the development of historical thinking in high school students, it is necessary to design activities that address first- and second-order concepts in a balanced manner, with special emphasis on the latter. These activities should pose diverse cognitive demands, transcending the remedial level to promote comprehension, analysis, and application. Likewise, it is crucial to propose a variety of activity types that give students an active role in the teaching and learning of history at this level of education.

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REVISTA

CÁTEDRA

Problem-Based Learning and its incidence in the teaching-learning process of Chemistry

Aprendizaje basado en problemas y su incidencia en el proceso de enseñanza-aprendizaje de la Química

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(Received on: 25/02/2025; Accepted on: 28/03/2025; Final version received on: 25/06/2025)

Suggested citation: Castillo-Gaona, V., & Quezada-Lozano, G. (2025). Problem-Based Learning and its incidence in the teaching-learning process of Chemistry. *Revista Cátedra*, 8 (2), 153-175.

Abstract

This research is based on the ongoing search for methodologies that streamline learning, with a specific focus on problem-based learning (PBL) as a key pedagogical challenge to ensure meaningful knowledge acquisition and competency development in students. The methodological strategy was integrated into microcurricular planning, organizing disciplinary knowledge so that students could identify problems relevant to their educational context. Through collaborative group discussion, they formulated conjectures, conducted independent research, and strengthened their capacity to synthesize and disseminate findings for decision-making. The main objective of this study is to analyze the



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impact of Problem-Based Learning on the Chemistry learning process. To this end, the academic performance of students who implemented PBL was compared with those who followed a traditional methodology. A quantitative approach with a quasi-experimental design was adopted, with a sample of 62 participants: 31 in the experimental group and 31 in the control group. These students were in their first year at the Ciudad de Cuenca High School during the 2023-2024 school year and were administered pre- and post-tests, as well as a satisfaction survey. The results of the control group revealed that the majority of students had good average grades, while a smaller number achieved very good average grades. In contrast, the performance of the experimental group was very good, with 100% of the 31 students achieving this grade. It is concluded that the implementation of Problem-Based Learning favors the development of disciplinary competencies with a collaborative approach, conflict resolution, and decision-making in students.

Keywords

ABPr, teaching, Chemistry, educational intervention, academic performance.

Resumen

La presente investigación se fundamenta en la búsqueda constante de metodologías que dinamicen el aprendizaje, con un enfoque específico en el aprendizaje basado en problemas (ABPr) como un desafío pedagógico clave para asegurar la adquisición significativa de conocimientos y el desarrollo de competencias en los estudiantes. La estrategia metodológica se integró en la planificación microcurricular, organizando los saberes disciplinares de manera que los estudiantes identificaran una problemática relevante para su contexto educativo. A través de la discusión grupal colaborativa, formularon conjeturas, desarrollaron investigación independiente y fortalecieron su capacidad de síntesis y difusión de hallazgos para la toma de decisiones. El objetivo principal de este estudio es analizar la incidencia del Aprendizaje Basado en Problemas en el proceso de aprendizaje de la Química. Para ello, se comparó el rendimiento académico de los estudiantes que implementaron el ABPr con aquellos que siguieron una metodología tradicional. Se adoptó un enfoque cuantitativo con un diseño cuasiexperimental, con una muestra de 62 participantes: 31 en el grupo experimental y 31 en el grupo control. Estos estudiantes cursaban el primer año en el Colegio de Bachillerato Ciudad de Cuenca durante el año lectivo 2023-2024, y se aplicaron pre y pospruebas, así como una encuesta de satisfacción. Los resultados del grupo control revelaron que la mayoría de los estudiantes se ubicó en la categoría de promedio bueno, mientras que un número menor alcanzó calificaciones de promedio muy bueno. En contraste, el desempeño del grupo experimental fue muy bueno, con el 100% de los 31 estudiantes alcanzando esta calificación. Se concluye que la implementación del Aprendizaje Basado en Problemas favorece el desarrollo de competencias disciplinares con enfoque colaborativo, resolución de conflictos y toma de decisiones en los estudiantes.

Palabras clave

ABPr, enseñanza, Química, intervención educativa, rendimiento académico.

1. Introduction

Education is a fundamental component for the comprehensive development of both individuals and society as a whole. In this context, the constant search for effective pedagogical methodologies emerges as a relevant challenge to ensure the meaningful acquisition of knowledge and skills by students. This research aims to explore the impact of



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Problem-Based Learning (PBL) on the academic performance of high school students in Chemistry. In this way, crucial questions about its impact on both academic performance and competency development are addressed.

The justification for this research on PBL is based on a theoretical review of updated scientific articles that explain the methodology for its implementation, the evaluation process, the advantages of educational intervention in the teaching and learning process of experimental sciences, among other aspects of interest to the study. The implication of the methodology modifies the way students acquire knowledge and how teachers share it. In the field of chemistry teaching, PBL has been shown to have a significant impact. A review by Bueno (2018) indicates that

the methodology has become an attractive alternative for implementing changes in educational models in higher education, particularly because its learning environment is conducive to the development of higher-order thinking skills, such as critical thinking (p. 91).

Education in the Ecuadorian educational system is undergoing transformations at all levels, with a particular focus on the Baccalaureate (high school) program. These changes seek to improve the quality of instruction students receive and achieve academic excellence. Chemistry, in particular, has applications in multiple fields of industry and scientific research, in addition to being present in many aspects of daily life. Based on a reading of the 2016 National Curriculum for Chemistry, in my personal opinion, I can say that, regarding the teaching of this subject, this level is fundamental for students to develop the foundations of their scientific and cognitive knowledge and skills. This prepares them to face new challenges, increases their self-confidence, and allows them to appreciate their own abilities. It is necessary to consider the importance of this area of experimental sciences, given that it is an element that students at the Educational Unit located in Cuenca, Ecuador, do not always want to take on. This is due to the breadth of the area of knowledge, the lack of strategies and methodologies that streamline learning, the limited ongoing training process for teachers, and the limited understanding of the purpose of their study, which involves technological, digital, and contextualization tools.

Chemistry is perceived as difficult and boring, which implies or translates into a limitation for teachers and students who fail to understand this area of knowledge. Authors such as Flores et al. (2020) state that "students who fall into rote memorization have difficulty acquiring the skills to understand chemical language, much less transfer it to their long-term memory" (p. 20). Given this, there is an urgent need to implement innovative teaching strategies that transcend and encourage participation in the teaching-learning process.

Researchers such as Varela et al., (2021) provide the guidelines in their studies to recognize the validity and relevance of including methodologies that focus on learning and that use real-world problems as a context for students to learn chemical skills in problem solving and achieve academic success. For their part, Parra et al. (2022) state that, "it is one of the most important strategies to develop students' skills in the training process, the application of which will form the basis for the necessary qualitative changes in personality" (p. 101). Likewise, Freire et al. (2021) demonstrate that, "meaningful learning helps to develop, pose, consult, solve exercises and problems, as a complement to PBL applied to the learning of



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homogeneous and heterogeneous fractions and relate them to the real context of students” (p. 498). Guamán and Espinoza (2022) indicate that, “the individual comes to learn through the experience acquired in relation to the world” (p. 126).

Based on the above, teaching and learning Chemistry is a tedious and complicated process, and achieving learning outcomes is an even more difficult process. In this sense, it is of great importance to include PBLr as a methodology that energizes students' learning and, therefore, improves their performance, satisfaction, and develops skills inherent to their disciplinary study. PBLr is a pedagogical methodology that has been developing strongly in recent years. It is characterized by the fact that "integration in medical education breaks down boundaries between different departments and leads to greater connectivity between different disciplines due to the dissolution of barriers" (Dasgupta, 2020, p. 63).

In the field of Chemistry teaching, PBLr has demonstrated a significant impact. A review by Hmelo-Silver (2004) notes that, “one of the main advantages is increasing student motivation. Since learning questions arise from the problem (in response to students' need to know), intrinsic motivation should be enhanced” (p. 259). Furthermore, more recent studies have shown that this methodology generates “the use of problems as the beginning of the learning process, collaborative work in small groups, student-centeredness, the role of tutors is guiding, and there is ample time for self-study” (Wijnia et al., 2019, p. 274).

Today's education requires students to be more active and independent in seeking information about the knowledge being taught. Here, the teacher is merely a facilitator, and the student is the focus of all learning. Learning in educational institutions has become more dynamic, particularly incorporating the PBLr methodology, which has gained increasing popularity in the educational field in recent times. This is demonstrated by the study conducted by Velázquez et al. (2021), which states that, "it encourages students to become more involved in learning, generating their own strategies to deal with real-life situations. Students remember information more easily because it is more meaningful to them" (p. 152).

Instead, it is seen as an essential part of developing self-management skills, which are essential for facing the challenges of everyday life. This perspective, as a student-centered educational approach, implies that those who embark on this method must acquire the ability to control and assume responsibility for their own learning.

PBL is a teaching strategy that promotes inquiry-based learning. It mobilizes and enhances the development of scientific and critical thinking, teamwork, and autonomy, among other aspects. Its design and implementation require consideration of the training of both teachers and students (Hernández and Moreno, 2021, p. 3).

In other words, it provides life skills so that students are able to overcome the obstacles that exist in their environment. Within this context, it is not only about acquiring academic knowledge, but also about fostering the development of fundamental competencies to face real challenges in daily life. This approach places significant emphasis on students' ability to solve practical problems, make informed decisions, and manage their own learning autonomously. Therefore, PBLr not only contributes to academic training but also prepares



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students to be more competent and self-sufficient citizens, capable of facing the challenges they face in their personal and professional environments.

This research focuses on the important findings it presents and contributes to subsequent research in secondary and university education, as it provides valuable information on the impact of PBLr on chemistry teaching. The results support pedagogical decision-making and allow for adjustments in educational practices to maximize meaningful student learning. Furthermore, the study has broader implications for society, as effective, contextualized, and quality education in the natural sciences contributes to the development of critical, competent, and active citizens in the scientific field, as microcurricular planning represents a tool that organizes and facilitates the cognitive process.

The article is structured as follows: Section 1. Introduction summarizes the aspects contained in the article; Section 2. Literature Review explains the theoretical elements and the articulation of the PBLr phases in microcurricular planning; Section 3. Methods and Instruments focuses on the methodological processes and instruments used; Section 4. Discussion and Results refers to the most relevant findings of the research; Section 5. Conclusions highlights the relevance of the article to educational intervention.

2. Theoretical reference

2.1 Problem-Based Learning

Today's education requires students to be more active and independent in their search for information about the disciplinary knowledge taught. Specifically, the teaching-learning process in educational institutions has been strengthened with the use of methodologies that streamline the way knowledge is acquired. In this sense, Problem-Based Learning (PBL) fosters elements of cognitive development involving both the teacher and the student. For their part, the teacher becomes a facilitator, and the student is the fundamental axis of this process.

The study conducted by Velázquez et al. (2021) states that Problem-Based Learning (PBL) is one of the educational methodologies that has been well accepted in higher education institutions. It is an active learning process that works by solving problems related to the interaction between students and their professional environment. This perspective as a student-centered educational approach implies that those who embark on this method must acquire the ability to control and assume responsibility for their own learning. This aspect is underscored in the research by (Hernández and Moreno, 2021, p. 3). This methodology is defined as "the development of scientific thinking based on situated and contextual problems and disciplinary integration that promotes the development of critical and proactive citizens."

Within this context, it is not only about acquiring academic knowledge but also about fostering the development of fundamental skills to face real challenges in daily life. This approach places significant emphasis on students' ability to solve practical problems, make informed decisions, and manage their own learning autonomously. Therefore, PBL not only contributes to academic training but also prepares students to be more competent and self-sufficient citizens, capable of facing the challenges they face in their personal and professional environments. Under this order of ideas, it can be said that PBLr consists of presenting students with authentic and meaningful problem situations that can facilitate their research and inquiries. Similarly, in higher education, this methodology aims to train



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professionals with diverse social skills, capable of contributing to group work and taking on challenges that provide solutions to the problems we face as a society (Coronel et al., 2023, p. 35).

2.2 Theoretical aspects that support Problem-Based Learning (PBL) in Chemistry learning

PBL is based on a variety of theories, such as constructivism, cognitive theory, and situated learning. These theories have particular implications for chemistry learning. Constructivism is a learning theory that advocates the idea that individuals are not passive recipients of information, but rather active participants in the construction of their own knowledge. According to this perspective, learning is a process in which people interpret and give meaning to information based on their experiences and prior knowledge. When acquiring knowledge or information, students use different knowledge methodologies throughout their experience. By participating in conflict resolution in their environment and actively intervening in the real world, they improve their ability to solve different tasks and activities (Ronquillo et al., 2023, p. 259).

An essential feature of constructivism is the importance of social interaction in the learning process. It recognizes that people learn through communication, collaboration, and interaction with others. Dialogues and debates with peers and mentors play a fundamental role in the construction of meaning and the acquisition of new knowledge. Furthermore, constructivism also emphasizes the idea that learning is an active and personal process, in which each individual constructs their own unique understanding of information (Mosquera, 2024).

Another central concept in constructivism is problem-based learning, which promotes integrated learning methods and highlights the need to align study time in medical education with global needs (Dasgupta, 2020, p. 62).

Thus, constructivism is a learning theory that emphasizes the importance of actively constructing knowledge through interaction with the environment and social collaboration. This pedagogical approach has become a pillar of modern education, promoting critical thinking, problem-solving, and the development of deep understanding in students.

Cognitive Learning Theory (CLT), which focuses on how students process information and how higher-order thinking skills develop (Morinigo & Fenner, 2021, p. 1), addresses how individuals construct knowledge, taking into account cognitive development. Information processing theory is also used to understand how problems are solved using analogies and metaphors. Essentially, this theory views learning as a cognitive process, meaning it involves mental activities such as perception, memory, thinking, and problem-solving. Furthermore, one of the key aspects of the theory is the idea that people are not passive recipients of information, but rather actively participate in the construction of their knowledge. Likewise, students develop a cognitive process so that they are inquisitive and demonstrate skills in research and problem-solving; so that they think critically and creatively; and are reflective in order to act with integrity, honesty, and ethics (Veliz and Rangel, 2022, p. 1454).

Furthermore, CAT places a strong emphasis on problem-solving as a means of learning. Individuals learn by addressing challenges and applying cognitive strategies to find solutions. It also promotes meaningful learning, where acquired knowledge connects with prior knowledge and can be applied in real-life contexts. Metacognition, or the ability to be



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aware of and control thought processes, is another essential aspect of this theory. “Students learn to self-regulate their learning, identify effective strategies, and evaluate their own knowledge, leading to more autonomous and effective learning” (Cuenca et al., 2021, p. 12). In short, CAT underscores the importance of the mind and cognition in the educational process, which has significantly influenced pedagogy and the creation of teaching strategies that focus on the development of critical thinking, problem-solving, and deep understanding of information.

Situated learning is most effective when it takes place in a context that is relevant and meaningful to the student. Problem-solving from a STEM perspective as a central strategy for achieving these contextualized learning approaches is promising for promoting thinking skills and inquiry in chemistry education (Primera, 2022). This educational approach is based on the idea that learning is most effective when it takes place in contexts and situations that are relevant and meaningful to students. Rather than focusing solely on the acquisition of abstract knowledge, it focuses on the practical application of that knowledge in real-life situations. A distinctive feature is that it takes place in the environment or context in which students are expected to apply their skills and knowledge.

This approach is also related to the theory of constructivism, as it improves academic performance and the development of interpersonal and social skills. It is based on student action, which responds to the need for self-learning proposed by constructivism (Castillo, 2021, p. 2479). Finally, constructivism emphasizes the active construction of knowledge by students, drawing on previous and new experiences, emphasizing the importance of social interaction and *Vygotsky's zone of proximal development*. Cognitive Learning Theory focuses on information processing and the development of cognitive skills, emphasizing metacognition as a key element. Finally, Situated Learning emphasizes the relevance and meaning of learning in practical contexts, promoting intrinsic motivation and active interaction with the environment. Each theory offers unique perspectives on how students acquire knowledge and skills, complementing each other.

2.3 Articulation of the phases of Problem-Based Learning in microcurricular planning

Articulating the phases of PBLr in microcurricular planning is an essential process for effectively implementing this pedagogical strategy. These include problem identification, hypothesis formulation, independent research, knowledge synthesis, and evaluation, and each should have a designated space within the teaching process.

It is important for educators to design learning experiences that allow students to move through these stages systematically and coherently. The activities and resources assigned should support the development of the problem-solving and critical thinking skills required at each stage, such as: evaluating information sources, questioning the validity and relevance of data, and seeking connections to their problem. Likewise, assessment should be integrated into all phases to monitor student progress and provide timely feedback. In general, “for the use of PBL in education, it must be configured by the teacher in their curriculum planning resource, the microcurriculum” (Manobanda et al., 2022, p. 174).

The articulation of the PBL phases in microcurricular planning is essential for designing an effective and coherent educational process. “Greater participation in curriculum discussions and planning is needed.” (Dasgupta, 2020, p. 65). A proposal is presented below:



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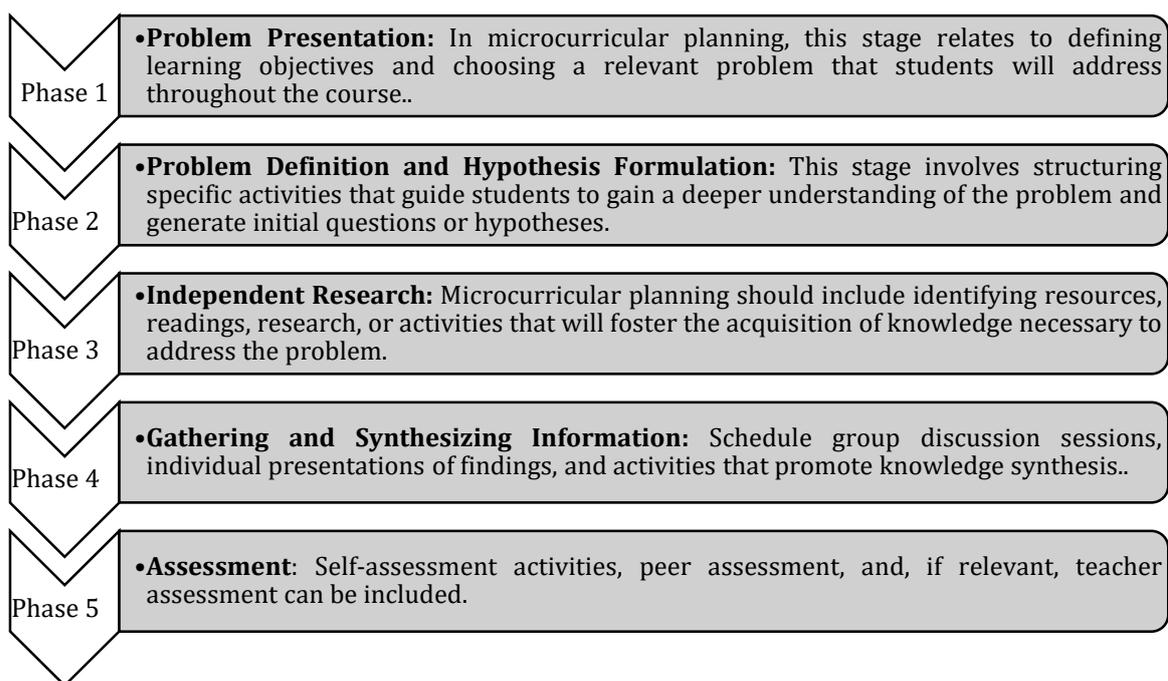


Figure 1. PBL phases in microcurricular planning. Source: Prepared by the authors.

Microcurricular planning should be detailed and sequential, ensuring that each phase of PBL is clearly articulated in the teaching moments of a lesson. It is important to consider how activities from one phase will be connected to the next, and how students' autonomy and critical thinking will be fostered. Furthermore, formative assessment should be incorporated throughout the process, which will help teachers measure students' progress and make adjustments as needed. Effectively articulating the PBL phases in microcurricular planning ensures a coherent and meaningful learning experience for students.

3. Methods and instruments

The research approach of this article is quantitative. Ortega-Sánchez points out that this approach allows for the representation of first-year high school students' satisfaction with the application of Problem-Based Learning (Ortega-Sánchez, 2023). Furthermore, a descriptive and inferential statistical analysis was applied to the collected data to determine whether rPBL improves the teaching-learning process in Chemistry.

"The design is quasi-experimental and transactional; the scope of the research was descriptive-explanatory with a hypothetical-deductive method" (Hernández et al., 2018, p. 150). This type of design is used in research involving two groups: one experimental and one control, with the aim of determining whether "the pedagogical intervention with the experimental group is effective when compared to the control group" (Galindo-Domínguez, 2020, p. 24), as shown in Table 1. The analysis focused on a single period. The question to be answered was: How does Problem-Based Learning (PBL) as a methodology impact and improve the teaching-learning process of Chemistry in first-year high school students?

To define the context of the research, a population comprised of the first years of the Cuenca High School was established during the 2023-2024 academic year. The research focuses on the use of rPBL as a methodological strategy for learning chemistry through the



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implementation of its phases in microcurricular planning. This research aims to modify the traditional practice of teachers in the classroom and, in this way, place greater emphasis on the role of the student in their learning process, with their involvement in each phase of the methodology. Furthermore, the institution was accessible for the application of the instruments and the collaboration of the institutional authorities was ensured to carry out the study.

“The selection of participants was carried out through non-probabilistic, purposive sampling; the expert establishes the criteria” (González, 2021, p. 2). Therefore, the entire population was selected, as each of the students and teachers are essential for obtaining data. Therefore, they are the subjects from whom all the necessary non-probabilistic, census-type data with criteria will be obtained. The sample consisted of a total of 62 students who made up the A and B parallel groups of the educational institution: 31 from the experimental group (EG) and 31 from the control group (CG). The research design is presented below.

Groups	Methodology	Sample: First-year high school students	Intervention in the learning of Chemistry	Post-test
Control Group (CG)	Traditional	31 students	5 traditional lessons	
Experimental Group (EG)	Problem-Based Learning	31 students	5 lessons with PBLr in didactic sequences	X

Table 1. Quasi-experimental design

Table 1 shows some relevant elements of the quasi-experimental design. Five micro-curricular plans were developed in response to Performance-Based Skill (PCS) CN.Q.5.1.6. Relate the electronic structure of atoms to their position in the periodic table to deduce the chemical properties of the elements. In each class, the learning objective was modified, and the PBLr phases were incorporated into the teaching moments. Learning experiences were proposed that focused on the development of the methodology's phases and achievement indicators. The plans were approved by the academic vice-rector of the educational institution.

For data collection, and based on the premise that the PBL intervention impacts the teaching-learning process of chemistry, standardized tests (post-tests) were used to collect data on academic performance by assessing the understanding of disciplinary knowledge focused on: the classification of the periodic table, the location of the chemical elements according to the current periodic table, the identification of representative chemical elements, knowledge of the physical and chemical properties of metals, and the physical and chemical properties of non-metals. This process was carried out at the end of each pedagogical intervention and involved structured lessons on disciplinary knowledge with value scales that were able to assess the impact of the methodology on learning.

Likewise, at the end of the didactic mediation, a survey was administered on the perception of PBL in the teaching-learning of chemistry. This survey was structured with questions focused on eliciting students' opinions regarding: collaborative pedagogical activities; presentation and definition of the problem; hypothesis formulation; independent research; Data collection and synthesis; Methodology evaluation. Response options were organized



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into frequency scales. It is important to mention that the instrument was adapted from a similar study by the author (Santiago, 2016). The contribution regarding the questions in the evaluation instrument allowed us to identify the study's relevance to competency development, enabling students to achieve an objective perspective, critical thinking, and self-directed learning throughout their lives, not just during school. These competencies are reinforced by applying the methodology to the teaching sequence.

4. Discussion and results

4.1 Analysis of academic performance using PBLr

The analysis of the grades of the 62 students is presented in the following table, since it is relevant to evaluate the effectiveness of the intervention with the Problem-Based Learning methodology; in the first instance, the performance of the control group.

Control Group Activity Ratings					
		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Average Good	19	61,3	61,3	61,3
	Average Very Good	12	38,7	38,7	100,0
	Total	31	100,0	100,0	

Table 2. Ratings of the Control Group's activities

Table 2 presents the ratings for the control group's activities, which are distributed across two performance categories: average-good and average-very-good. The table shows the distribution of ratings in terms of frequency, percentage, valid percentage, and cumulative percentage.

4.1.1 Distribution of grades

El grupo control estuvo compuesto por 31 estudiantes, todos con calificaciones válidas. La distribución de las calificaciones es la siguiente: Promedio bueno: 19 estudiantes (61,3%) recibieron esta calificación. Esto indica que una mayoría significativa del grupo control se ubicó en este nivel de rendimiento. Promedio muy bueno: 12 estudiantes (38,7%) obtuvieron esta calificación, lo que representa el resto del grupo. El porcentaje acumulado refleja que, al sumar ambas categorías, se llega al 100%, lo que confirma que todas las calificaciones del grupo se distribuyen entre estos dos niveles.

4.1.2 Interpretation of the results

The distribution of scores in the control group shows that the majority of students fell into the good average category, while a smaller number achieved very good average scores. This suggests that, overall, the control group's performance was solid, but with a greater concentration in the intermediate performance range.

Experimental Group Activity Ratings					
		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Average Very Good	31	100,0	100,0	100,0

Table 3. Ratings of the Experimental Group's activities

In this analysis, the experimental group's activity grades are presented. The data show an even distribution within a single performance category: very good, with all students in this group receiving this grade. The table summarizes the frequency, percentage, valid



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percentage, and cumulative percentage. The experimental group consists of 31 students, all with valid grades.

4.1.3 Distribution of grades

Very good average: 31 students (100%) achieved this grade. This means that every student in the experimental group demonstrated high and uniform academic performance. The cumulative percentage is 100%, indicating that there are no other grade categories within this group.

4.1.4 Interpretation of Results

The results of the experimental group are notable for their homogeneity in performance, as all students obtained a very good average grade. This finding indicates that the students in this group showed a consistently high level of performance in their activities. The uniformity in grades may indicate the effectiveness of problem-based learning applied to this group. However, the lack of variability in grades may also limit the ability to assess individual differences in performance, and it may be relevant to further investigate the reasons behind this homogeneous result. Compared to the control group, where grades showed greater diversity, the experimental group stands out for its uniformly high level of performance, which implies the success of the implemented strategies.

4.2 Analysis of competencies using PBLr

Learning assessment is an important indicator for determining the effectiveness of problem-based learning versus traditional teaching, as PBLr allows for more meaningful learning because it involves active student participation.

To implement the PBLr methodology, a sample of 31 first-year high school chemistry students was considered. These students were organized into groups of four and five students. Five learning activities were presented to each group, each focusing on analysis, interpretation, and scientific research. As part of this process, a detailed synthesis of the information was presented in the form of infographics, graphic organizers, summaries, and other materials.

The results of the competencies assessed through learning experiences are presented as follows: Activity **one** focuses on evaluating collaborative teamwork. With traditional teaching, the average performance is 7.61 points, while with PBLr it is 8.74 points, demonstrating that the methodology improves student performance. In Activity **two**, the development of problem-solving skills is more evident since the methodology is more familiar to the students; therefore, the result is evident in the grades for PBLr: 9.00 and the traditional methodology: 8.00 points. For Activity **three**, PBLr continues to be effective, with an arithmetic mean of 9.11 versus 7.94. It is important to highlight that, in both groups, motivation is essential to achieving favorable results. In activity **four**, the average score for traditional teaching is 7.98 and for PBLr, 9.05. Active participation is assessed here. This activity strengthens learning interactions because each student has the right and opportunity to influence and collaborate in the actions to be carried out. In activity five, the PBLr average was 9.11 compared to traditional teaching, which scored 7.89. Constant feedback in the research process and in the development of activities is essential.

These results support the successful application of Problem-Based Learning because it fosters the development of competencies over time and is also characterized by strengthening students' ability to search, use, and critically evaluate information, an essential factor for solving complex problems. These results suggest that this aspect is being



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satisfactorily addressed in the current educational environment, according to España and Viguera (2021). In today's society, it is essential to consider the educational use of methodologies that seek to develop problem-solving skills using information resulting from individual and group research.

To explore the impact of problem-based learning on the development of cognitive skills and the retention of knowledge acquired in chemistry, the normality test table is analyzed. First, the null (H_0) and alternative (H_a) hypotheses are defined:

1. Null hypothesis (H_0): The activity ratings in both groups follow a normal distribution.
2. Alternative hypothesis (H_a): The activity ratings in at least one of the groups do not follow a normal distribution. The results of the normality tests are then evaluated.:

Control group:

- Kolmogorov-Smirnov: Statistic = 0.107, p-value = 0.200
- Shapiro-Wilk: Statistic = 0.933, p-value = 0.055

Experimental group:

- Kolmogorov-Smirnov: Statistic = 0.112, p-value = 0.200
- Shapiro-Wilk: Statistic = 0.951, p-value = 0.172

Since the p-values are greater than the commonly used significance level (such as 0.05), there is not enough evidence to reject the null hypothesis in either group. Therefore:

- • Control Group: H_0 cannot be rejected. The activity ratings in the control group follow a normal distribution.
- • Experimental Group: H_0 cannot be rejected. The activity ratings in the experimental group also follow a normal distribution.

After confirming the normal distribution of grades in both groups of 31 students, as evidenced by the Shapiro-Wilk normality test, the means of each group were compared using the independent samples t-test. This comparison allowed us to assess whether there were significant differences in academic performance between the experimental group (using rPBL) and the control group (using traditional methodology).

The results obtained from the t-test highlight the significant difference in grades between the two groups. This test was essential to validate the study hypothesis, as it revealed that the pedagogical intervention using rPBL had a statistically significant impact on student performance. The detailed test values and their interpretation are presented below.



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		Independent samples t-test								
		Levene's test for equality of variances		t-test for equality of means					95% de	
		<i>F</i>	<i>Sig.</i>	<i>T</i>	<i>gl</i>	<i>Sig.</i>	Diferencia de medias	Stand error difference	Inf.	Sup.
GC and GE Ratings	Equal variances are assumed	.023	.88	-14.95	60	,00	-5.59	.37	-6.33	-4.84
	Equal variances are not assumed			-14.95	59.97	,00	-5.59	.37	-6.33	-4.84

Table 4. Independent samples t-test

Table 4 provides the results of an **independent samples t-test** comparing scores between two groups: the **Control Group (CG)** and the **Experimental Group (EG)**. The results are analyzed below.:

1. Levene's Test for Equality of Variances:
 - The F-value is 0.023, and the p-value is 0.88
 - Since the p-value is greater than 0.05, there is insufficient evidence to reject the null hypothesis of equality of variances.
2. t-Test for Equality of Means:
 - Equal variances are assumed:
 - The t-value is -14.95 with 60 degrees of freedom (df).
 - The p-value is 0.000 (significant at the 0.05 level).
 - The difference in means between groups is -5.59.
 - The 95% confidence interval for the difference in means is between -6.33 and -4.84

Conclusion:

- Since the p-value is significant (less than 0.05) in both cases, the null hypothesis of equal means is rejected.
- The difference in means suggests that the scores in the Experimental Group are significantly higher than those in the Control Group.
- The confidence interval does not include zero, which supports this conclusion.

As can be seen, the methodology has a student-centered didactic approach, serving as an appropriate medium for real-world learning. In relation to the application of PBLr, teachers



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play multiple roles in the teaching process, such as facilitators, supervisory guides, and referees, rather than providers who emphasized the explanation of topics and the transfer of knowledge. In PBLr, it is important to:

Maintaining student motivation while guiding them toward inquiry into core areas of the profession. The problems presented must be real, complex, and challenging; it is a teaching strategy that helps students develop adaptable knowledge and skills, such as problem-solving, communication, self-directed learning, and teamwork (Coronel et al., 2021, p. 38).

“It is a student-centered pedagogical method in which students learn by solving open-ended problems as part of a team” (Freund et al., 2022, p. 3). (Lee and Jo, 2023) notes that, “students propose solutions based on individual and cooperative learning, and focus on realistic and authentic problems” (p. 4). Finally, “teachers must design problems that are not aimed at predictive answers, but rather can trigger an in-depth inquiry into multifaceted topics” (Okolie et al., 2021, p. 96)).

4.3 Perception of PBLr in the Teaching and Learning of Chemistry

To assess students' perceptions of the use of PBL in the teaching and learning of chemistry, a survey was conducted at the end of the course. In this way, the participants' expression of their general opinion on the methodology can be counted on.

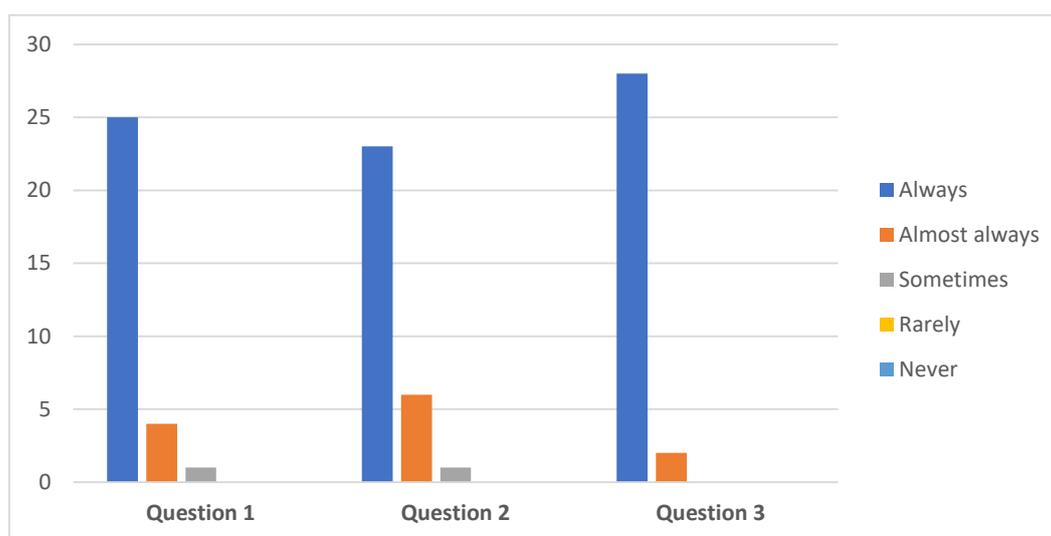


Figure 2. Pedagogical activities with a collaborative approach

In general terms, from the survey applied to 31 students, 25 indicate that the pedagogical activities used by the teacher allowed them to actively participate in the teaching-learning process of chemistry; significantly evidencing that the application of the PBLr methodology is subject to the current needs of knowledge development and construction. The teacher encourages collaborative work, as mentioned by 23 students, and 28 indicate that the education professional provides the necessary guidance for the development of work in the formed teams. This work environment, Benoit points out, is a strategy that promotes the active role of the student and favors their cognitive and metacognitive development, allows them to respond to activities that take into account their individual abilities, creates



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purposeful work environments for the development of individual and group competencies (Benoit, 2021). "Improvement of analytical reasoning, problem solving and collaborative learning" (Liu and Pasztor, 2022, p. 3).

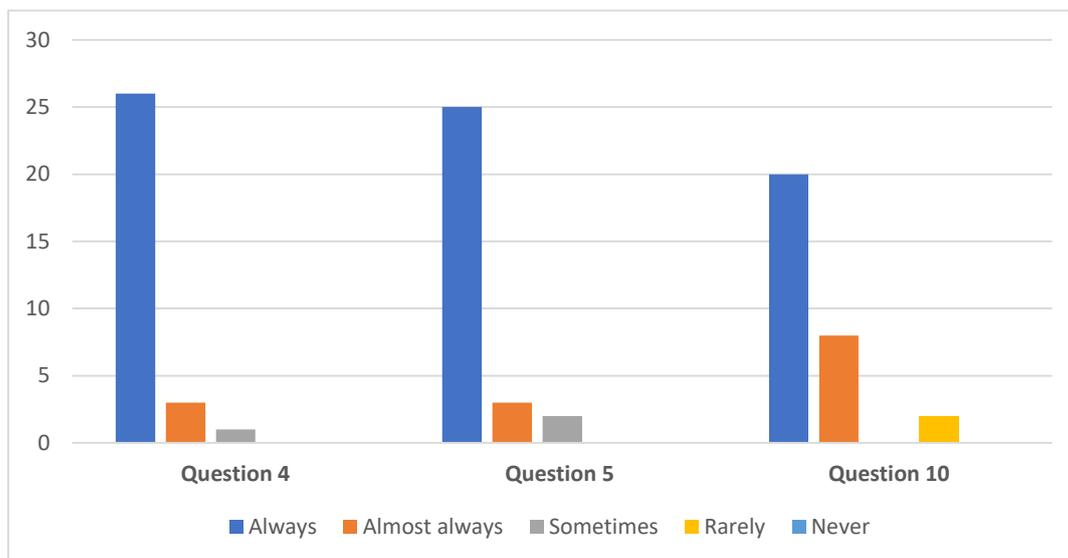


Figure 3. Presentation and definition of the problem

The results of the fourth question indicate that approximately 25 students demonstrate a high level of responsibility in carrying out the activities assigned to their work groups. Overall, the results suggest a solid foundation for group learning activities. The fifth question shows that 25 teachers effectively integrate theory with practical activities, thus providing students with a more comprehensive and contextualized learning experience.

Meanwhile, 20 students believe that objectives and time management are clear, as these can be crucial factors for understanding, analyzing, and synthesizing knowledge in the Chemistry subject. These results support the idea that planning and goal setting are key components of the teaching methodology, which is consistent with the principles of Problem-Based Learning (PBL). Therefore, this process should be included in microcurricular planning; it becomes an educational practice that has always required innovation in all areas of life, as it provides a new opportunity for active participation and learning. improves critical thinking and problem solving (España and Viguera, 2021; Márquez et al., 2023).



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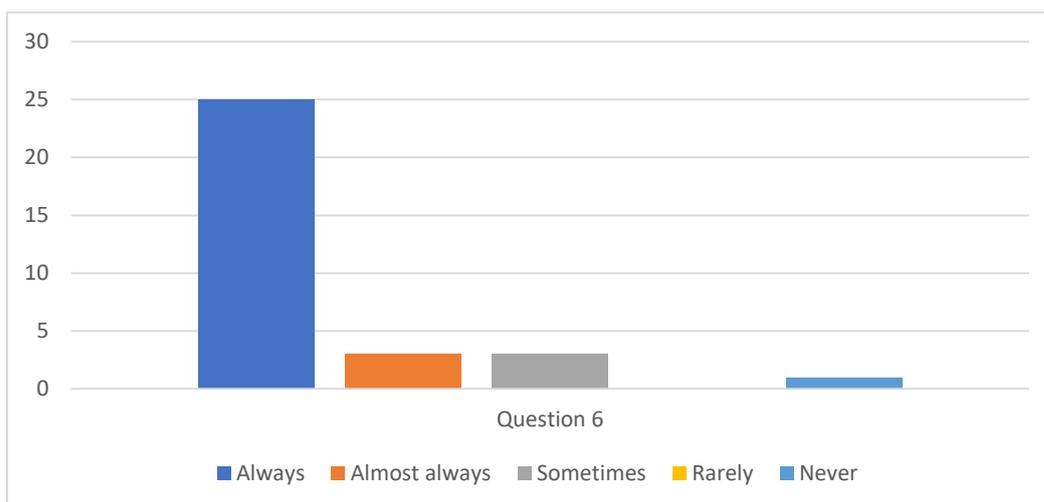


Figure 4. Hypothesis formulation

These results support the idea that students regularly experience challenges and problem-solving situations in their learning, which is consistent with the philosophy of PBLr. The ability to actively and autonomously confront and solve problems is essential for the development of research skills, which can positively contribute to activities of this type in chemistry. (Mosquera, 2021; Barbieri et al., 2020; Puello, 2023) The preliminary inquiry reveals that students had weaknesses when conducting argumentative analysis. It develops research potential, the integration of theory and practice, and viable problem-solving skills for structured problems for which the existing and desired states are identified. Finally, it fosters conscious thinking and learning processes; it promotes critical thinking.

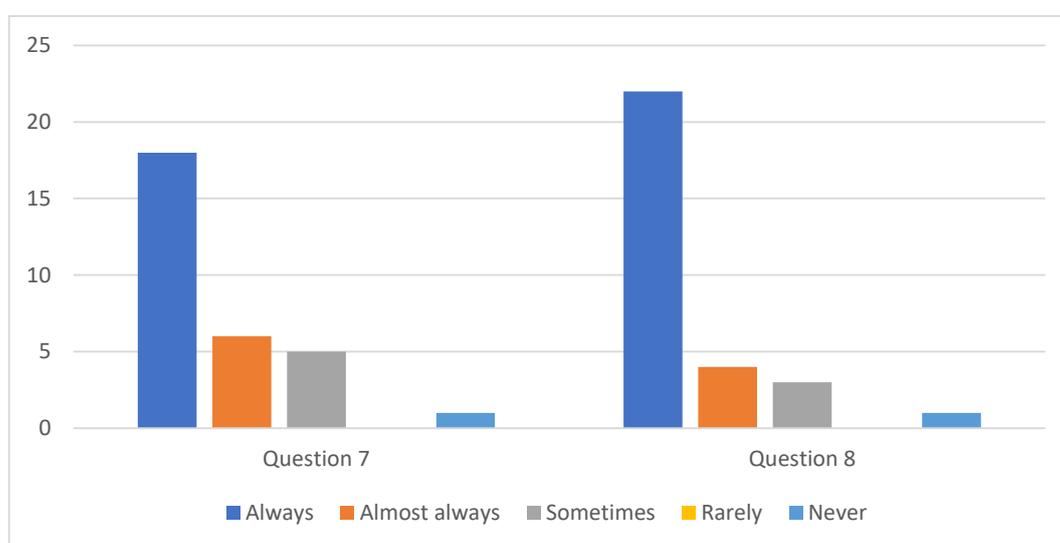


Figure 5. Independent research

In questions seven and eight of the survey, it is determined that the results support the successful application of Problem-Based Learning (PBLr), since students determine and value the contextualization of problems in real life and this in turn significantly increases the motivation and relevance of learning. The connection with everyday situations enhances students' ability to apply their knowledge in practical contexts, thus strengthening their research skills. (Meriño et al., 2024) point out that there is "the



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development of research competence in students; it is the expression of the appropriation of the knowledge of the subjects that make up the disciplines of the study plan" (p. 197). Therefore, the results support the idea that students are engaged in the reflection and practical manipulation of concepts.

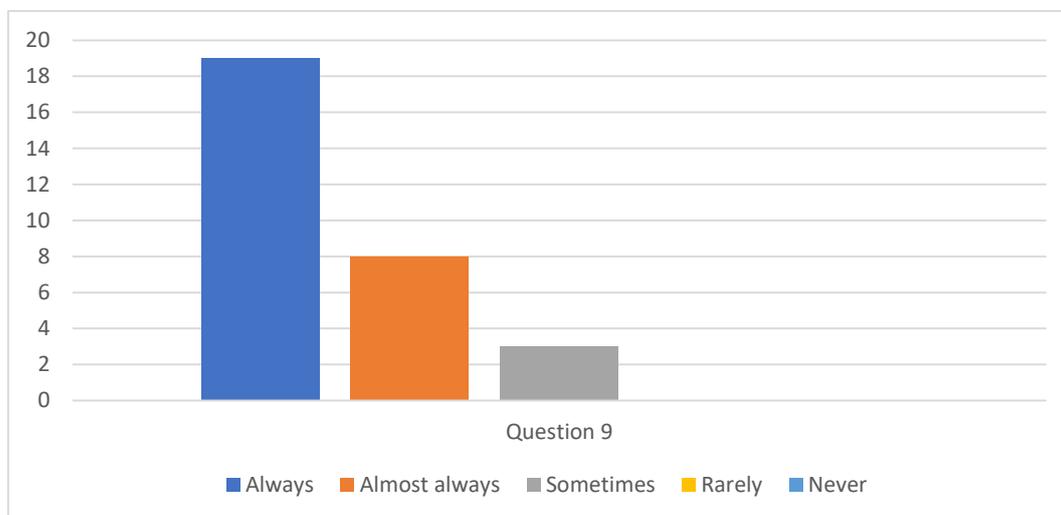


Figure 6. Gathering and synthesizing information

Students' reflection is framed in that, the application of PBLr in addressing real-world problems, learning becomes a participatory and interactive experience, where students are encouraged to ask questions and seek answers, promoting the analysis, evaluation and synthesis of information, through cognitive processes that include perception, attention, language, memory, learning, motivation, thinking and problem solving. (Pazos-Yerovi and Aguilar-Gordón, 2024). In addition, giving meaning to learning from different contexts, developing a critical and participatory sense of students, establishing relationships between teaching and technical-professional aspects (Carneiro, 2023).



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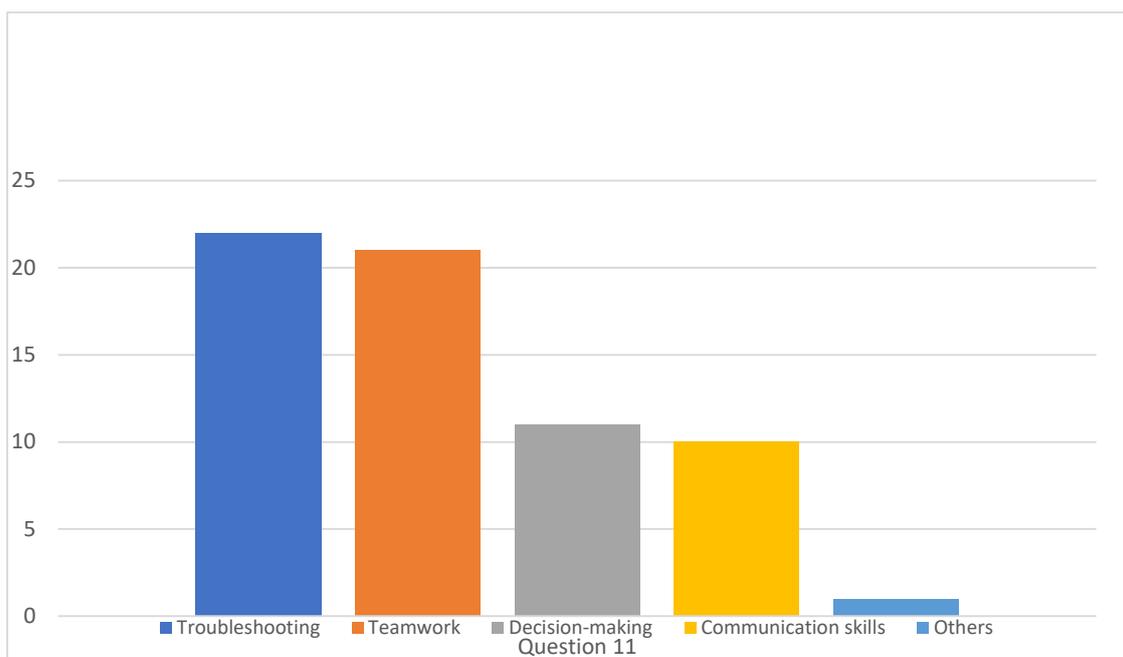


Figure 7. Evaluation

The information in Figure 7 is compiled from the responses of 22 students who mention that the skill they develop most is problem-solving, 21 of them consider it to be teamwork, 11 that this learning methodology allows them to prepare for decision-making; and 10 students emphasize communication skills. In this regard, Cornejo-Sanabria and Carpio-Quesada (2023) point out that, “pedagogical mediation where students can fit into the educational environment and be inclusive in the teaching-learning process” (p. 79) consequently, the role of the teacher represents a fundamental element to innovate in the teaching-learning process. “Recognition and respect for disabilities is the skill in which students reach the highest levels of performance after using PBL” (Fernández-Jiménez et al., 2014, p. 339).

5. Conclusions

The data indicate that the application of PBLr impacted the learning process of students in the control group compared to those who followed the traditional methodology; the academic performance of students in the experimental group was higher. This implies that the methodology favors the development of cognitive skills and, consequently, increases academic performance. In the teaching and learning of chemistry, the development of disciplinary skills goes hand in hand with the development of competencies specific to the methodology. This process is evidenced in the research, as it enhances teamwork in the classroom, promotes engagement, provides solutions to problems in the context presented, promotes constant feedback, and fosters a high level of student motivation.

It is necessary to propose new forms of microcurricular planning in educational institutions, one that articulates the phases of Problem-Based Learning in chemistry teaching, since it has proven to be an effective methodological tactic that modifies the learning process. By focusing on microplanning and problem-solving, students not only actively participate in their own learning process but also acquire fundamental skills such as independent research and the ability to synthesize. Group discussion fosters a collaborative environment that enhances the teaching process. Findings from the comparative analysis of academic



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performance show a notable improvement after the intervention with active methodologies, as opposed to conventional strategies. Therefore, PBLr emerges as a valuable option for promoting meaningful learning in the field of chemistry..

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Declaration of Authorship-CRediT

VÍCTOR CASTILLO-GAONA: State of the art, related concepts, methodology, validation, data analysis, writing - first draft.

GRETHY QUEZADA-LOZANO: State of the art, related concepts, data analysis, organization and integration of collected data, project management, conclusions, final writing and editing.



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REVISTA

CÁTEDRA

Active learning through projects in mathematics: a strategy for effective implementation of curriculum design

Aprendizaje activo a través de proyectos en matemáticas: una estrategia para la implementación efectiva del diseño curricular

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(Received on: 13/03/2025; Accepted on: 26/04/2025; Final version received on: 26/06/2025)

Suggested citation: Arias-Albuja, M., Coronel-Sánchez, M., & Logacho-Morocho, L. (2025). Active learning through projects in mathematics: A strategy for the effective implementation of curriculum design. *Revista Cátedra*, 8(2), 176-189.



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Abstract

This article analyzes the use of Project-Based Learning (PBL) as an active teaching strategy to strengthen mathematics teaching at the upper elementary and high school levels. This research arose from the need to align pedagogical practices with current curriculum design, promoting meaningful learning that transcends memorization and fosters the development of competencies. The objective of this work is to evaluate the effect of PBL on mathematics teaching within the Ecuadorian curriculum context, identify relevant teaching activities for its implementation, and design a methodological guide to support teachers in its application.

The study adopted a mixed approach, with an interpretive perspective, combining qualitative and quantitative techniques. Data collection was conducted through surveys administered to 160 students and 30 teachers from different public and private educational institutions in Quito, Ecuador. The findings reveal that PBL is highly valued for its ability to generate contextualized and relevant learning, although it faces obstacles such as a lack of resources, limited time, and insufficient teacher training. PBL contributes to a better understanding of mathematical content by integrating it with real-life problems, in addition to enhancing skills such as critical thinking, collaboration, and problem-solving. Students prefer active methodologies that connect learning to their environment, which underscores the importance of reinforcing this approach through actions that mitigate its limitations.

Keywords

Project-based learning, meaningful learning, curriculum, mathematics instruction, active methodologies.

Resumen

El presente artículo analiza el uso del Aprendizaje Basado en Proyectos (ABP) como estrategia didáctica activa para fortalecer la Enseñanza de la Matemática en los niveles de básica superior y bachillerato. La investigación surge de la necesidad de alinear las prácticas pedagógicas con el diseño curricular vigente, promoviendo un aprendizaje significativo que trascienda la memorización y fomente el desarrollo de competencias. El objetivo de este trabajo pretende evaluar el efecto del ABP en la enseñanza Matemática dentro del contexto curricular ecuatoriano, identificar actividades didácticas pertinentes para su implementación y diseñar una guía metodológica que apoye a los docentes en su aplicación. El estudio adoptó un enfoque mixto, con una perspectiva interpretativa, combinando técnicas cualitativas y cuantitativas. La recolección de datos se realizó a través de encuestas aplicadas a 160 estudiantes y 30 docentes de distintas instituciones educativas fiscales y particulares en Quito-Ecuador. Los hallazgos revelan que el ABP es bien valorado por su capacidad para generar aprendizajes contextualizados y relevantes, aunque enfrenta obstáculos como la escasez de recursos, el tiempo limitado y la insuficiente formación docente. El ABP contribuye a una mejor comprensión de los contenidos matemáticos al integrarlos con problemas reales, además de potenciar habilidades como el pensamiento crítico, la colaboración y la resolución de problemas. Los estudiantes prefieren metodologías activas que conectan el aprendizaje con su entorno, lo cual subraya la importancia de reforzar este enfoque a través de acciones que mitiguen sus limitaciones.

Palabras clave

Aprendizaje basado en proyectos, aprendizaje significativo, currículo, instrucción Matemática, metodologías activas.



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1. Introduction

In the current educational context, there is a growing need to apply methodologies that promote meaningful learning, the development of competencies, and the connection between theoretical knowledge and its practical application. The demands of the 21st century require pedagogical approaches oriented toward the development of competencies applicable to real-life contexts, preparing students to address authentic challenges through practical skills (Ramírez-Díaz, 2020, p. 7). In this sense, PBL has established itself as an active methodology with great potential, especially in areas traditionally considered abstract, such as mathematics. This research addresses a central problem that affects the quality of the teaching-learning process in higher basic education and high school: the difficulties teachers face in effectively implementing PBL in the classroom. Quimis-Cajamarca et al. (2024) identified that "68% of mathematics teachers report significant difficulties when implementing active methodologies" (p. 112). The nature of the problem lies in the fact that, while PBL offers multiple benefits such as fostering critical thinking, collaboration, accountability, and contextualizing learning, its practical application in the classroom presents numerous obstacles.

The challenges identified in this study include a lack of time within curriculum planning, a scarcity of adequate teaching resources, and limited teacher training in active methodologies. These obstacles create a gap between contemporary pedagogical proposals and their actual implementation in the classroom. As Martínez (2021) points out, "many teachers perceive PBL as a methodology that is difficult to adapt to the teaching of mathematics, due to its conceptual and abstract approach" (p. 67). Furthermore, teachers often perceive PBL as a methodology that is difficult to adapt to the teaching of mathematics, due to its conceptual, abstract, and systematic approach. The importance of addressing this problem lies in the transformative potential of PBL to improve not only students' academic performance but also their motivation and engagement in the educational process.

The main objective of this research is to identify strategies that support teachers in overcoming the aforementioned barriers, thus facilitating the effective application of PBL in the teaching of mathematics. The questions guiding this study include: What factors hinder the implementation of PBL in mathematics at the upper elementary and high school levels? What perceptions do teachers and students have about the use of active methodologies? What strategies can contribute to a more effective implementation of PBL in this discipline? The research is geographically focused on educational institutions in the city of Quito and primarily addresses mathematics subjects at the upper elementary and high school levels, without extending to other educational levels or disciplines. The purpose of this article is to offer a comprehensive look at the problems of implementing PBL in mathematics, providing empirical evidence and developing a practical and contextualized methodological proposal that contributes to improving the quality of the educational process.

Regarding the structure of the article, section 2 presents the basic definitions related to the research, section 3 details the process by which the study was carried out, section 4 presents the results of the pretest and posttest through a descriptive statistical analysis, section 5 addresses the discussion based on the analysis of the dimensions of the study, and finally, section 6 formulates the conclusions based on the results obtained.



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2. Theoretical Foundation

Active methodologies are based on the premise that learning is more effective when students actively participate in their own learning process, becoming protagonists in the construction of their knowledge. Ruiz (2013) argues that thinking is a tool designed to resolve problematic situations that arise in the course of activities (p. 106). These methodologies, among which PBL stands out, seek to break with the unidirectional teaching model by promoting the integration of theory and practice through the resolution of real and significant problems, which fosters more meaningful and contextualized learning (Cosquillo-Chida et al., 2025, p. 273).

PBL is based on pedagogical constructivism, a movement that views students as active agents in their learning process. López (2020) argues that this approach facilitates the acquisition of key competencies through the research, design, execution, and evaluation of projects that respond to specific needs (Cosquillo-Chida et al., 2025, p. 273). In the field of mathematics education, various studies have shown that this methodology favors the development of competencies such as logical thinking, analytical skills, and teamwork by engaging students in real-life situations that require the integrated and collaborative application of knowledge. For example, García and Martínez (2019) report that the implementation of PBL in mathematics classes significantly improved students' problem-solving and logical reasoning (García and Martínez, 2019, p. 78).

The Ministry of Education of Ecuador (2016) establishes that the national curriculum is based on a competency-based approach that prioritizes practical and contextualized skills, thus promoting comprehensive education adapted to the real needs of students (Ministry of Education of Ecuador, 2016, p. 23). According to this organization, "education should prioritize the application of knowledge in real-life settings, fostering student autonomy" (Ministry of Education of Ecuador, 2016, p. 32).

The implementation of PBL includes selecting the topic and posing the guiding question, forming teams, defining the final product, planning, researching, analyzing and synthesizing information, developing the product, presenting it, providing a collective response to the initial question, and finally, evaluating and self-assessing (Granda-Roblez & Solórzano-Martínez, 2022, pp. 16-17). This structure allows teachers to guide and support the learning process, ensuring relevance and the achievement of educational objectives. However, proper implementation of PBL requires addressing obstacles such as limited teacher training, a lack of teaching materials, and opposition to methodological innovation. Therefore, it is essential to design strategies and guides that facilitate its incorporation into the classroom, adapting them to specific educational contexts.

2.1 Active methodologies

The challenges of the modern world require students to develop critical, creative, and collaborative skills to face the challenges of the 21st century. In this context, traditional education based on memorization of content has shown limitations, especially in subjects such as Mathematics, where conceptual understanding is fundamental. "Active methodologies comprise those pedagogical approaches that transform the teaching process into experiences that promote direct student involvement in their learning" (Labrador-Piquer and Andreu-Andrés, 2008, p. 35). These methodological proposals represent an effective solution, enabling students to construct knowledge by addressing real-life problem situations and establishing bridges between theoretical foundations and their practical applications.



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However, the implementation of these approaches in the school setting presents significant challenges, particularly regarding instructional design and learning assessment processes. To face these challenges, the Ministry of Education of Ecuador (2021, p. 34) recommends implementing the following active methodologies: project-based learning, problem-based learning, question-based learning, collaborative learning, gamification, and flipped classroom.

2.1.1 Project-based learning

Constructivism is a pedagogical model that views students as active subjects, capable of making decisions and judgments. This approach implies an interactive dynamic between teachers and students, where a constant exchange of knowledge takes place, enabling the joint construction of knowledge. According to Martí et al. (2010), Project-Based Learning "centers on the student and promotes intrinsic motivation" (p. 13) and has among its objectives "to promote greater responsibility for one's own learning" (p. 14), thus placing students as protagonists of their learning process and fostering their autonomy. This participation not only favors the application of knowledge in real-life contexts but also significantly improves the retention and assimilation of information.

According to López (2020), PBL is "an innovative teaching methodology that enables students to acquire knowledge and develop skills by developing projects aimed at solving real and meaningful problems" (p. 78). This pedagogical approach places students as active participants in their learning, connecting academic content with real-world situations while developing comprehensive skills. As a constructivist methodology, PBL facilitates deep and transferable learning, preparing students to solve complex challenges beyond the school context.

2.1.2 Phases of Project-Based Learning

Granda-Roblez and Solórzano-Martínez (2020) describe project-based learning has several phases:

topic selection and guiding question, where a relevant topic is chosen and a question is formulated to guide the investigation. Team formation, where students are organized into groups to encourage collaborative work. Definition of the final product, where a final product such as a presentation, brochure, or model is created, which requires evaluation. Planning, where students must create a work plan to carry out the project activities. Research, where students must seek and share information for their project, with the teacher acting as a guide. Analysis and synthesis, where students give their perspective and share ideas to answer the question posed. Product development, where students must use all the learning acquired to create a product that answers the question posed at the beginning. Presentation and evaluation: the product must be presented through an exhibition and evaluated using a rubric. (pp. 16-17).

These phases allow for the planning, development, and execution of innovative projects for the construction of knowledge through the effective participation of students.

2.2 Project-based learning competencies

The implementation of PBL in the area of Mathematics not only strengthens the understanding and practical application of theoretical concepts but also promotes the



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development of various essential competencies for students' comprehensive learning. In this sense, competence is manifested in individuals' ability to mobilize knowledge, skills, attitudes, and values in diverse and complex contexts, allowing them to solve problems effectively and adapt to new situations (Ministry of Education of Ecuador, 2023, p. 6). This approach allows students not only to solve mathematical problems effectively but also to adapt to new situations and challenges, fostering meaningful and transferable learning to real-life scenarios. In this context, Gómez and Santos (2012) identify three fundamental skills that are developed through PBL in mathematics: critical thinking and research, collaboration, and communication. As the authors point out, "these combined skills allow students to approach mathematical challenges with greater autonomy and creativity." (p. 81).

2.3 Relationship of PBL with the current curriculum design in Mathematics

The current Mathematics curriculum in Ecuador is divided into three curricular blocks: Algebra and Functions, Geometry and Measurement, and Statistics and Probability (Ministry of Education of Ecuador, 2016, p. 23). This design seeks to develop competencies that integrate knowledge, skills, attitudes, and values, enabling students to solve problems effectively and adapt to new situations. Mariñez-Báez (2024) emphasizes that the competency-based approach to teaching mathematics "involves the combination of knowledge and the development of skills put into action in a contextualized situation" (p. 144), thus promoting practical application and fostering comprehensive student development.

PBL is closely aligned with the current curriculum design for teaching mathematics in Ecuador. This methodological approach promotes active and participatory learning, where students investigate, reflect, and make decisions to solve problems presented by the teacher. This dynamic is consistent with the Ecuadorian curriculum, which emphasizes the development of practical skills and competencies in real-life contexts. According to Tustón-Villacrés (2020), this relationship is supported by stating that "active methodologies such as PBL emerge as a response to the lack of interest generated by traditional approaches, significantly increasing student motivation and a deeper understanding of mathematical content." (p. 112).

2.4 Application of PBL in the classroom

PBL is an active, student-centered methodology that promotes the development of competencies through the resolution of real-life problems. As established by the Ministry of Public Education, in the classroom, it allows students to research, design, implement, and evaluate meaningful projects, fostering autonomy and critical thinking. PBL engages students in complex and authentic tasks that integrate knowledge from different areas. Furthermore, it highlights that this methodology promotes teamwork and effective communication, essential skills for comprehensive education. Project-based learning increases student motivation and engagement by allowing students to take an active role as protagonists of their own learning process (Ministry of Public Education, 2022). In the current educational context, its application in the classroom represents an effective strategy for linking theory and practice, respecting diverse learning rhythms. It also strengthens the connection between school content and the student's social reality. Therefore, PBL is a powerful tool for transforming traditional teaching into a more meaningful and participatory experience.



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3. Methodology

The study adopted a mixed-method approach, combining structured questionnaires with 160 students and structured and semi-structured interviews with 30 teachers to gain a deeper understanding of perceptions. This approach was chosen for its ability to "integrate the strengths of both methods and provide a more complete understanding of the phenomenon studied" (Creswell & Creswell, 2018, p. 215). This approach was chosen for its ability to capture both measurable outcomes and participants' subjective perceptions, providing a more holistic understanding of the effects of the implemented strategies. Its implementation was structured in three fundamental stages that allowed, on the one hand, to apply the methodological strategy in real-life classroom contexts, and on the other, to qualitatively analyze its impact from the perspective of educational stakeholders. First stage: the initial phase of the project focused on identifying the main weaknesses in the application of PBL in the Mathematics classroom and in understanding the existing pedagogical practices, the proposal was developed in the context of regular Mathematics classes in public and private educational institutions in the city of Quito, this stage included the following activities:

- **Questionnaire application:** A questionnaire was designed and applied to collect data on students' perceptions of the use of PBL in the Mathematics classroom, including their levels of motivation, confidence, and attitude toward the subject. Probabilistic sampling was used, as the population exceeded 200 individuals. To ensure the confidentiality rights of participating students, the header of the data collection instrument specified the context regarding the objective of the survey, including authorization from the educational institution, a commitment to reliability, informed consent, and ethical implications of biosecurity.
- **Interviews with teachers:** Structured and semi-structured interviews were conducted with all teachers to explore their perceptions, experiences, and reflections on the use of PBL in mathematics. This allowed us to identify the teaching methodologies used, common classroom challenges, and teacher training needs. In this case, no sampling technique was applied since the population was less than 200 individuals. These interviews revealed a strong focus on traditional methods, with an emphasis on memorization and mechanical problem-solving, as well as a low level of incorporation of technological tools.

The methodological approach adopted placed students as the protagonists of their own learning, guided by a teacher who assumed the role of facilitator. The initial activities included the administration of a multiple-choice pretest to assess the level of prior knowledge on the selected topics. Subsequently, the students worked in collaborative groups developing projects that required the use of mathematical tools for decision-making, data analysis, and reasoning solutions.

Second stage: The second stage of the research aimed to deepen the understanding of the effects of PBL from a qualitative perspective. To this end, a representative group of teachers and classes were selected, in which a structured observation sheet was applied. The intervention was based on the Fundación Chile (2021) model, which establishes that an effective approach to Project-Based Learning requires three essential elements: detailed planning, the availability of adequate resources, and formative assessment that accompanies the entire process. This instrument allowed for the systematic recording of evidence of PBL use at different stages of pedagogical practice: planning, implementation, and evaluation.



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Based on the findings, innovative pedagogical strategies were designed and implemented to address the identified critical areas. This phase was characterized by a focus on teacher training, the reorganization of classroom practices, and the introduction of active methodologies.

- **Teacher training workshops:** Intensive workshops were held to train teachers. These workshops included training in active methodologies, such as problem-based learning (PBL), promoting a more dynamic and participatory approach in the classroom.
- **Reorganization of classroom practices:** Traditional lectures were transformed into interactive learning environments, where students actively participated by using strategies such as problem-based learning (PBL) and solving problems related to real-life situations. The use of practical and experimental activities was promoted to connect mathematical concepts with concrete applications, fostering deeper and more meaningful understanding.
- **Cooperative learning strategies:** Students worked in heterogeneous groups, which facilitated the exchange of ideas, the development of social skills, and collaborative problem-solving. Group dynamics were designed to encourage equitable participation, ensuring that each team member contributed to the achievement of common goals.

Third Stage: This stage of the project focused on measuring the impact of the implemented strategies and collecting feedback from participants to identify opportunities for improvement.

Finally, a post-test was administered to measure students' academic progress. The results showed a significant improvement compared to the initial diagnostic assessment. Triangulation between quantitative data (post-test results and statistical analysis using Pearson's correlation coefficient) and qualitative data (testimonials, observations, and interviews) confirmed the existence of a very high positive correlation ($r = 0.906$) between the use of PBL and improvements in the teaching-learning processes of mathematics. The results showed significant improvements, corroborating what López (2023) stated: "Systematic PBL increases the understanding of abstract mathematical concepts by 40%" (p. 148). The activities carried out in this phase included:

- **Post-tests:** Post-tests were designed and administered to assess progress in students' skills. These tests were aligned with the project objectives and allowed for comparison of results with baseline data. The results showed significant improvement in student performance, with notable increases in their ability to solve problems and apply mathematical concepts practically.
- **Interviews and focus groups:** Interviews were conducted with students and teachers to explore their perceptions of the project experience, identifying strengths and areas for improvement in the strategies implemented. The focus groups provided a space for open discussions, where participants shared their opinions and suggestions on the project's impact on their teaching and learning processes.
- **Comparative data analysis:** Post-test results were compared with baseline data to assess the degree of improvement achieved. Qualitative data collected from the interviews and surveys were also analyzed to identify relevant patterns and trends.



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This research does not include hypotheses, so the proposal concluded with the preparation of a final report that integrated the results obtained and offered recommendations aimed at the continuous improvement of teaching practices. These include the need to systematically incorporate PBL into curriculum planning, strengthen teacher training in active methodologies, and foster an institutional culture that values pedagogical innovation in the area of Mathematics.

4. Results

The results of the study confirm the existence of a significant relationship between the application of Project-Based Learning (PBL) and the improvement of teaching-learning processes in Mathematics, according to the data obtained through statistical analysis..

INDICATOR	PRETEST		POSTEST	
Always	6	20 %	18	60%
Almost always	14	46.67 %	11	36.67%
Sometimes	8	26.67 %	1	3.33%
Almost never	2	6.66 %	0	0%
Never	0	0 %	0	0%

Table 1. Results of activity 1, use of active methodologies

INDICATOR	PRETEST		POSTEST	
Always	13	43.33 %	19	63.33%
Almost always	11	36.67 %	8	26.67%
Sometimes	5	16.67 %	3	10%
Almost never	1	3.33 %	0	0%
Never	0	0 %	0	0%

Table 2. Results of activity 2, PBL optimizes time for key content

INDICATOR	PRETEST		POSTEST	
Always	15	50 %	20	66.67%
Almost always	11	36.67 %	10	33.33%
Sometimes	3	10 %	0	0%
Almost never	1	3.33 %	0	0%
Never	0	0 %	0	0%

Table 3. Results of activity 3, PBL facilitates the connection with everyday life

The data obtained from the pretest and posttest reveal a significant impact of implementing Project-Based Learning (PBL) in three key areas: the adoption of active methodologies, the optimization of time for priority content, and the connection between learning and everyday life.

Regarding the use of active methodologies, notable progress was observed. While in the pretest, only 20% of teachers reported always using them, this percentage tripled in the posttest, reaching 60%. Furthermore, responses indicating sporadic ("sometimes") or almost nonexistent ("almost never") use decreased dramatically, demonstrating a more consistent and widespread adoption of these strategies. This change reflects that PBL not only promotes innovative pedagogical practices but also manages to permanently integrate



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them into the classroom dynamic. Regarding the optimization of time for key content, the results show that 63.33% of teachers perceive that PBL allows them to address essential topics more efficiently, compared to 43.33% who considered this to be the case before its implementation. The disappearance of responses such as "almost never" (which fell from 3.33% to 0%) suggests that PBL is recognized as an effective method for managing time without sacrificing depth of learning.

Finally, in the dimension of connection with everyday life, 66.67% of teachers state that PBL always facilitates this connection, a considerable increase from the initial 50%. The elimination of negative responses ("sometimes" and "almost never") reinforces the idea that this methodology is especially effective in contextualizing knowledge and making it relevant to students. The results confirm that PBL is an effective method for transforming educational practices, fostering more active, efficient, and meaningful learning. To consolidate these gains, it is recommended:

1. Strengthen teacher training in PBL project design and evaluation.
2. Promote spaces for reflection where teachers can share experiences and adjust their practices.
3. Include students in project evaluation, gathering their feedback to continuously improve the methodology.

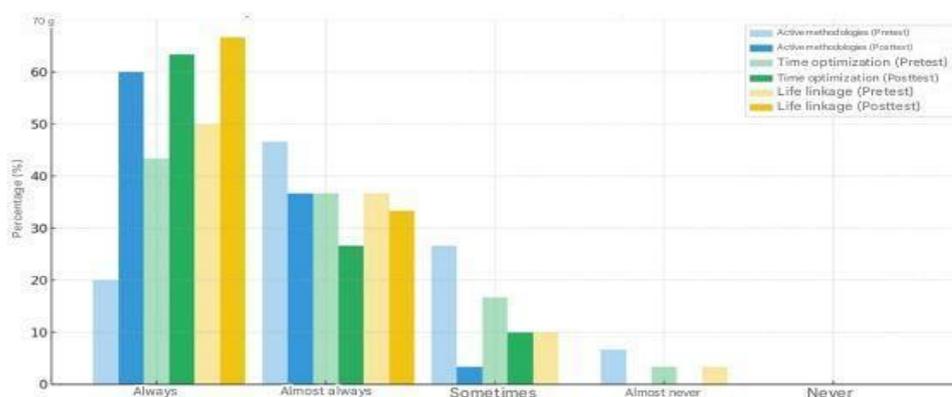


Figure 1. Variation in the increase in the percentage of correct answers between the pretest and posttest

In summary, the discussion of these results confirms that Project-Based Learning is a methodology that enhances the teaching of mathematics, allowing for greater conceptual understanding and better connections to everyday life, in addition to fostering student autonomy and critical thinking. However, its implementation still faces significant challenges that must be addressed through institutional educational policies and a sustained commitment to teacher training and support.

5. Discussion

The results presented in this study support, with clear quantitative evidence, the positive impact of implementing Project-Based Learning (PBL) on the teaching-learning process of mathematics. Although fellow teachers may have applied other methodologies more effectively, the application of pre- and post-tests allowed us to observe substantial changes in three relevant pedagogical dimensions: the use of active methodologies in the classroom,



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the optimization of time for the treatment of key content, and the connection of learning with everyday life.

From a scientific perspective, the findings align with social constructivism and the postulates of Vygotsky (1978), who explained that "every function in a child's cultural development appears first at the social level and then at the individual level; first between people and then within the child" (p. 57). By placing the student at the center of the educational process, through the resolution of contextualized and meaningful problems, not only is the acquisition of knowledge facilitated, but also the development of higher cognitive skills such as critical thinking, autonomy, and the ability to transfer what they have learned to real-life situations.

In the dimension of the use of active methodologies, the increase from 20% to 60% in the "Always" category reflects a transition from traditional practices focused on transmission to active, participatory, and reflective models. This change is essential to fostering meaningful learning, as it allows students to construct knowledge through exploration, collaboration, and the practical application of abstract concepts. It should be noted that students were constantly encouraged to carry out this research, which could have caused some bias in the posttest results.

On the other hand, the positive perception regarding the optimization of time to address priority content (from 43.33% to 63.33%) reinforces the idea that PBL does not entail a loss of efficiency in curricular coverage. As Bell's (2010) study demonstrates, "project-based learning, when well-structured, can cover up to 28% more curricular content than traditional methods in the same amount of time" (p. 147). On the contrary, it organizes knowledge in an integrated and contextualized manner, which facilitates deeper and more lasting understanding, reducing the need for rote repetition or fragmented teaching.

The third dimension, related to connecting learning to everyday life, also showed significant improvements (from 50% to 66.67%). This result is didactically relevant, as it demonstrates how PBL goes beyond the traditional view of knowledge, helping students recognize the applicability of mathematical knowledge in their environment. Contextualizing mathematical content through PBL increases students' perception of usefulness. This connection enhances motivation, interest, and a sense of belonging, factors closely linked to academic performance and school retention.

From a research perspective, these results must be considered within the specific context of the sample analyzed; however, they offer a solid basis for future research that delves into the long-term effects of PBL, its impact on other educational levels, as well as on initial and continuing teacher training.

6. Conclusions

The results obtained from surveys conducted with teachers and students at various educational institutions in the city of Quito show that, despite the recognition of its benefits, the implementation of PBL in mathematics teaching remains limited. Among the main factors restricting its systematic application are lack of time, a shortage of adequate teaching resources, and insufficient teacher training in the use of this methodology.

Despite these barriers, PBL is positively valued by the educational community, as it facilitates a more dynamic, contextualized teaching-learning process aligned with the national curriculum proposed by the Ministry of Education of Ecuador. It constitutes an



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active methodology with high potential for promoting meaningful learning and the development of mathematical skills in upper elementary and high school students. Its integration strengthens a deeper understanding of mathematical concepts and their application in real-life contexts, while promoting the development of transversal skills such as critical thinking, problem-solving, and collaboration.

The design of pedagogical activities based on disciplinary projects, supported by criteria of pedagogical relevance, adaptability, and the promotion of critical thinking, is essential to enriching the educational process in the area of Mathematics. These activities, in addition to promoting meaningful learning, integrate educational values such as equity and inclusion, contributing to the comprehensive development of students and strengthening the current curriculum. The implementation of PBL has proven to be a valid pedagogical methodology, empirically and theoretically supported, that improves the quality of the teaching-learning process in Mathematics. The consolidation of its benefits will depend on educational policies that promote its systematic incorporation, adequate teacher training, and the establishment of a school culture that values evidence-based methodological innovation.

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Declaration of authorship-CRediT

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MILTON CORONEL-SÁNCHEZ: State of the art, related concepts, data analysis, organization and integration of collected data, final writing and editing.

LUIS LOGACHO-MOROCHO: State of the art, related concepts, data analysis, organization and integration of collected data, conclusions, final writing and editing.



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Annexes

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